Appendix A: **Fact Sheets**

All forest burning, whether wildfire or prescribed, changes the form, distribution, and amount of elements or nutrients in the forest ecosystem. Nutrients are continually cycled within and among the various organic components of the soil. Most nutrients in a forest cycle through living plants. In the Pacific Northwest forest, three nutrients are changed in burning. Nitrogen, and to a lesser degree sulfur and phosphous, are the elements normally lost. Depending upon the severity and intensity of the fire, the amounts lost directly from the soil differ. Because nitrogen loss is the greatest, many of the following facts deal with nitrogen.

Loss of nutrients from the forest ecosystem may occur as a result of leaching into the soil, removal of litter or surface soil from site by erosion, and gaseous losses of elements.

Additions of nutrients occur from deposition in precipitation and dust, weathering of rock and fixation of atmospheric gases. The weathering of soils and rocks accounts for a substantial portion of most of the nutrients accumulated in forest ecosystems except for nitrogen, because only a small amount of nitrogen occurs in rocks. Nitrogen is added to Pacific Northwest forests as inorganic compounds in precipitation or dust from the atmosphere.

Effect of temperature

Moist, thick duff normally will protect the soil from heating by fire. If the litter layer is dry and partially burned and if it is thin, the underlying soil can be heated substantially. The degree of soil heating during a fire depends on:

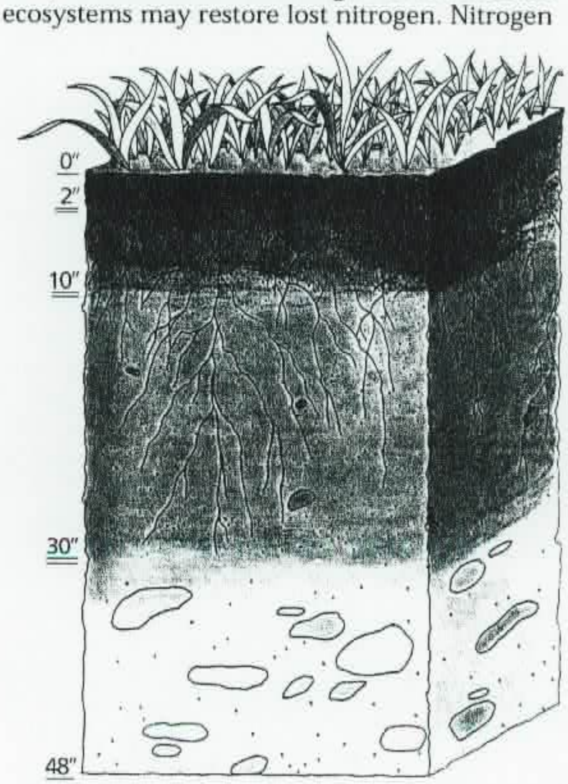
- type of fuel (grass, brush, trees)
- intensity of fire
- nature of litter layer (thickness, packing, moisture content)
- soil properties (water, texture, organic matter)

Severe or stand-replacing fires

- May burn the duff and the top layer of soil so that only ash remains on the surface and the mineral soil is "cooked" and discolored by a chemical change. Soil surface would need to reach 1000°F and one inch underground would need to reach 400°F to change in this way. In the 1988 Yellowstone fires, only one percent of the soil burned that severely.
- Can cause nitrogen, phosphorus, potassium and calcium to vaporize (738°F needed). Ash and charcoal do add minerals to the soil.
- Causes an increase in soil pH, phosphorus, potassium, calcium and magnesium immediately after burning.
- Can kill soil micro-organisms to 3" (they soon recover); lack of micro-organisms may account for increased plant growth because of no competition for nutrients.

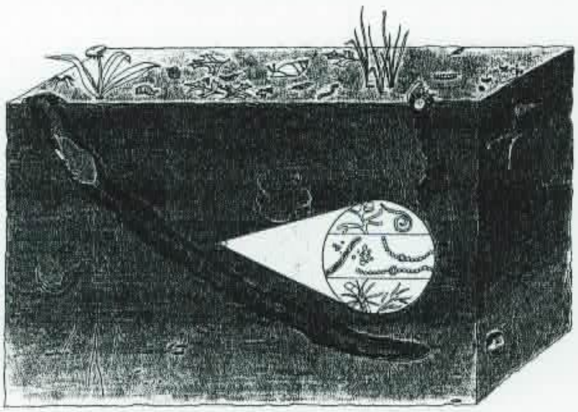
Chemical properties

Plants containing nitrogen-fixing nodules on their roots, such as lupine or ceanothus, grow prolifically after a fire. Therefore, nitrogen fixation, is more active following fires and in some ecosystems may restore lost nitrogen. Nitrogen



becomes available when it is cycled through soil organisms, oxidized by fire, precipitated, or added in the form of nitrogen fertilizer.

Nitrogen losses in excess of 1,000 pounds per acre are likely to occur from old-growth forests of the Cascade Mountains and Coast Range during wildfire or prescribed burning in the fall when the entire forest floor is dry and readily consumed.



Soil organisms/microflora

Soil is a complex, heterogenous community of organisms that influences tree growth in many ways. The soil ecosystem of organisms and the non-living environment in which they reside make up the soil ecosystem. The dynamics of this ecosystem aren't easily observed, thus hindering our understanding of forest ecosystems as a whole.

Many living things ranging in size from microscopic bacteria and fungi to large mammals, remain below ground all or part of their life cycle. Looking only at the non-mammals that remain predominately below ground, they range in size from <u>microbiota</u> (algae, protozoa, fungi, bacteria, and cyanobacteria) to <u>macrobiota</u> (insects, earthworms, and plant roots). These organisms cycle plant nutrients through the soil and also serve as reservoirs for nutrients. Soil organisms respond directly to variations in their environment and they also modify their environment chemically and physically, making them a major factor in soil formation.

Soil invertebrates decrease drastically immediately after a fire, but these effects seem to be transitory with numbers increasing each year after a fire.

Bacteria proliferate in a burned area, perhaps because their growth and reproduction were favored by decreased soil acidity, optimal temperature, moisture, and nutrient-rich ash.

Root rot fungus *(Rhizina undulata)* has been found to become more severe after a fire. Soil micro-organisms killed during an intense fire contribute to an increase in plant growth due to lack of competition for nutrients. Nitrogen-fixing bacteria are especially sensitive to fire and die at only 167°F in moist soils. In moderate fires these bacteria multiply rapidly but are lost in severe fires. Plants with nitrogen-fixing bacteria in root nodules (lupine, alder, ceanothus) readily inhabit areas affected by severe fire.

Many tree species form mutually beneficial root symbioses (mutualism) with a wide variety of fungi. This union of plant and fungal tissue is termed mycorrhiza ("fungus-root"). Mycorrhizal fungi draw energy from trees and provide benefits in return — enhanced water and nutrient uptake, extended root life, and protection against root diseases. The fungi are essential for the growth and establishment of many tree species. Many soil organisms compete for the same resou[illegible] plants do and can affect tree gr[illegible] has also been found tha[illegible]nisms, such as the ea[illegible]eding on the mycor-[illegible] convert the nitro-[illegible] a usable form [illegible]ter passing through the worm's gut.

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Prescribed burning is only one of several management practices that affects the hydrology of forested watersheds. Where effects of fire have been studied and evaluated, the results are usually mixed with other management practices.

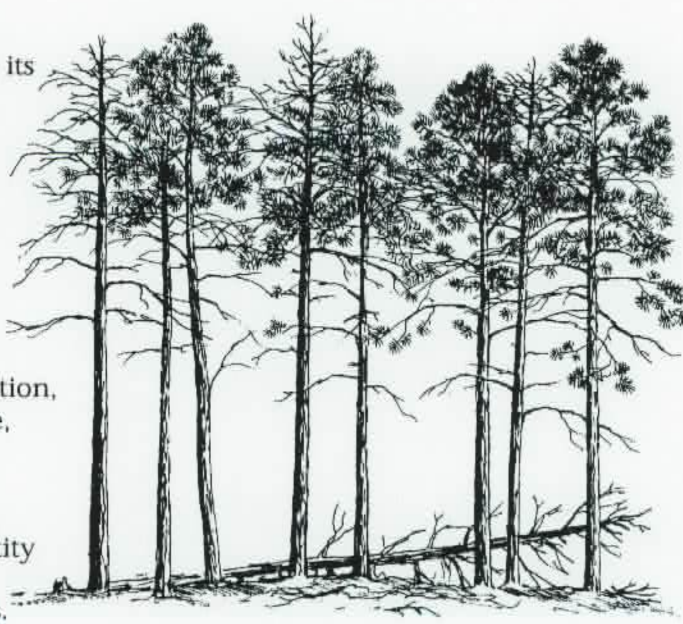
Case histories supply much of what is known about the framework of fire and its role in water quality and quality of forested watersheds. Fire effects on water remain unpredictable because those effects are related to a wide range of topographic conditions, site differences in soil characteristics and moisture content, variation in fuel moisture and fuel loads, density of vegetation, various microclimates associated with a given slope, aspect and topographic position, and variation in weather patterns before, during and after a fire.

Scientists tend to classify hydrological responses to fire in terms of water quantity and timing, physical water quality, and chemical water composition and nutrients.

Water Quality

Turbidity and sediment are perhaps the most significant water quality responses associated with fire. Turbidity is an optical property of a water and measures the amount of suspended particles in the water such as silt, clay, plankton, microscopic organisms and organic matter. Sediment is the soil that gets in the water of the stream and then settles in the stream bed. Sediment can degrade water quality and affect a wide range of aquatic organisms. What happens to a watershed after a fire often depends upon what was happening in the watershed before the fire. However, results generally indicate that where terrain is steep and a hot burn occurs, substantial increases in sediment can occur.

Daily temperature fluctuations of forest streams are largely regulated by the amount of solar radiation received. Removing the forest canopy can cause an increase in water temperature which directly affects living organisms.



Plant communities accumulate and cycle nutrients and provide a biological continuum which links soil, water and the atmosphere. This orderly cycling of nutrients is disrupted by fire, either in form, quantity or distribution. For example, a reduction in plant cover and surface organic matter increases the susceptibility of nutrients to erosional losses. Nutrient uptake by plants is reduced, which futher increases the potential for nutrient loss by leaching. Nutrient concentrations and export can be influenced by fire but the effects are often relatively small. Nitrogen has been the most widely studied nutrient and changes in concentration range from zero to a several-fold increase. Although changes in selected nutrient levels have been measured that exceed drinking standards for short periods of time following fire, water quality of such streams often quickly returns to pre-fire levels. Concentrations of a particular nutrient are usually reduced as the stream mixes with tributary and groundwater flow.

Fire has great potential to alter the water quality of streams draining forested watersheds. Whether such changes happen depends upon a large number of site-specific factors.

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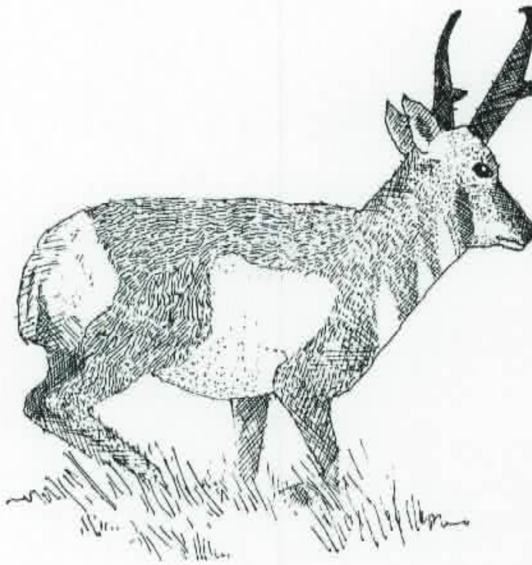
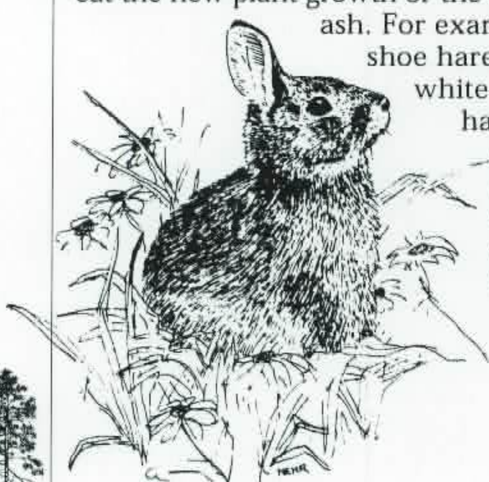


The effect of fire on animals depends on the type of fire and type of vegetation. Fire in areas of heavy fuel loading tends to be more intense and kills more animals, especially invertebrates and micrc-organisms. Generally, vertebrates are rarely killed in fires and where death does occur, it usually has a negligible effect on the species population.

Fire releases minerals into the soil which stimulates plant growth. Animals, in turn, benefit from additional minerals when they eat the new plant growth or the charcoal and ash. For example, snow-shoe hares and white-tailed deer have been observed eating the charred bark or ash after a fire.



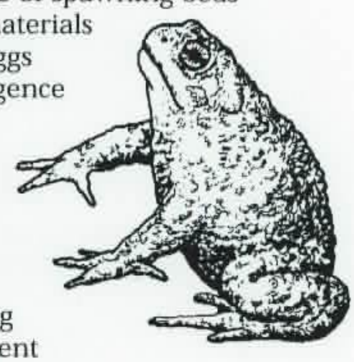
Unlike those who eat foods found only in mature forests, animals with flexible habits and diets thrive. Birds and animals which require old-growth conditions decrease.

Fire provides habitat for a wide variety of animals by creating a burn pattern (mosaic) that provides diversity in vegetation for wild-life use. The surviving elk, pronghorn ante-lope, deer, and similar animals will find new pathways for moving to and from water, calving areas, and summer/winter ranges.

Effects of fire on stream habitats:

Removal of streamside vegetation often increases erosion (sedimentation) which reduces available habitat and raises stream temperatures.

• Increased sedimentation has several affects on fish habitat:
  - reduces the size of spawning beds
  - deposits fine materials that smother eggs
  - prevents emergence of fry
  - increased tur bidity causes fish to have trouble seeing their food
  - reducing resting places as sediment fills up pools



• Increased stream flow may crush or dislodge eggs.

• Higher stream temperatures will decrease oxygen content, increase incidence of fish disease and increase oxygen demand on fish.

• Increased nutrient loading causes increased algae production which results in a more diverse population of insect larvae. This is beneficial if toxic levels aren't reached.

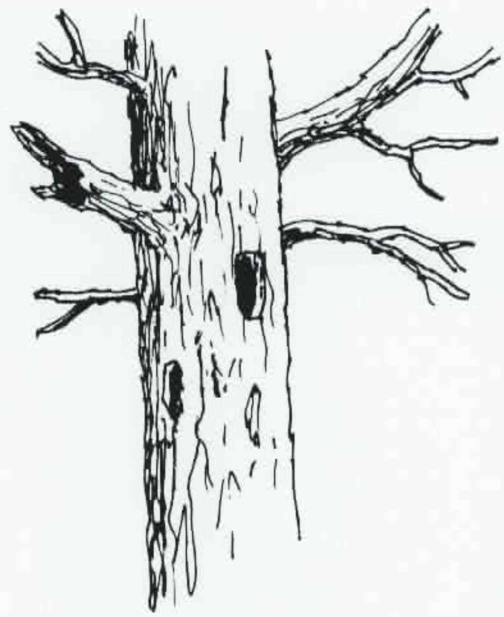
Impact of fire on invertebrates:

• Invertebrates tend to decrease because the animals or their eggs are killed by flames or heat.

• Fire destroys the sap that keeps bark insects away. These insects soon move into a burned forest followed by woodpeckers and other birds, especially those who nest in cavities.

• Flying insects are attracted to heat and smoke and to killed or damaged trees. Populations of certain species may increase during and after a fire.

• Fire provides immediate food for some insect pests while destroying food that many rely on in the "long run."



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4 Fact Sheets: **Fire Effects on Plant/Flora Adaptation**

Plants will survive if they have the ability to avoid or resist fire. Such adaptations might include:

• Rapid reproduction after a fire (increase flower production = increased seed) i.e., prairie grasses, lodgepole pine. In fact, fire increases the germination rate of seeds by (1) opening site to sunlight; (2) in some cases removing seed coats that inhibit germination (ceanothus seeds require heat of 113°F for 8 minutes, but can survive temperature of up to 300°F) or (3) destroying the compounds in soil that have previously inhibited germination.

• Thick bark in trees. Giant sequoia has bark two feet thick.

• High moisture content. Deciduous trees are more resistant than evergreen because of higher moisture content in foliage.

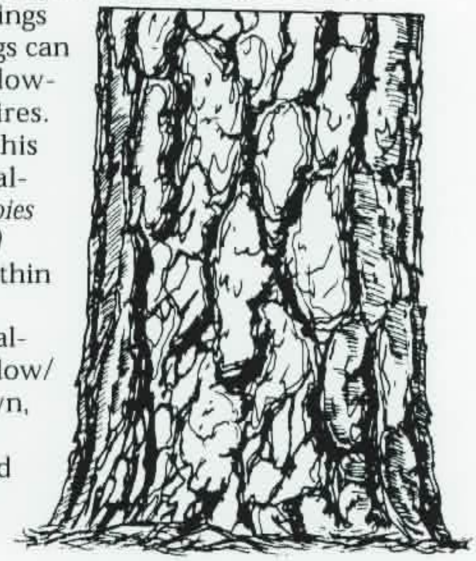
• Lack of resins. Species with foliage that contains oils, resins and other flammable liquid will burn quickly and intensely.

• Some species are dependent on fire to burn competing species.

Examples:

• The giant sequoia (redwood) - *(Sequoia sempervirens)* has thick duff, deep roots, high branches and thick trunks which are protection against fire.

• The ponderosa pine *(Pinus ponderosa)* has thick bark, deep roots, a high and open crown, fire resistant needles and a habit of growing far apart from one another plus their seedlings and saplings can withstand low-intensity fires. Compare this to the subalpine fir *(Abies lasiocaarpa)* which has thin bark, resin blisters, shallow roots, low/dense crown, flammable needles and grow close together.



Possible benefits of fire:

• Sanitizes and eradicates disease with lethal fire temperatures.
Examples: Trees infected with dwarf mistletoe; destruction of litter and duff layer usually prevents or reduces sporulation of root rot fungi and other fungi.

• Destroys insect vectors of disease.
Example: Destroys eggs or insect transmitting blueberry stunt virus.

Possible harmful effects of fire:

- Stimulates germination of Rhizinia, a fungus which attacks conifer seedlings.
- Intense heat causes fire scars on trees. Scars leave a tree vulnerable to disease and insects.
- Smoke injury may wound leaves and provide routes for invasion of harmful microorganisms.
- Burns up trees, reducing the value of that tree, for habitat and products.

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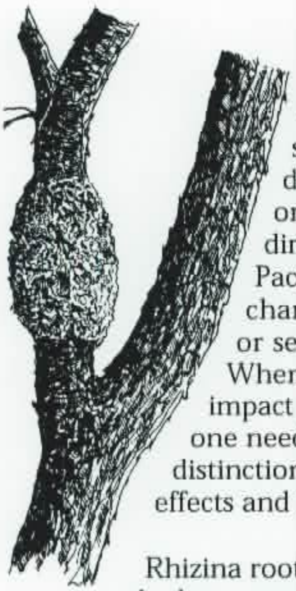
Fire Effects on Diseases of Conifers



It is widely understood that prescribed fire/burning affects the incidence and severity of forest tree diseases. However, only a few studies have directly linked fire in the Pacific Northwest to changes in the incidence or severity of diseases. When reading about the impact of fire on diseases, one needs to recognize the distinction between direct effects and indirect effects.

Rhizina root rot seems to be the only documented example of the direct effect of fire on a forest disease in the Pacific Northwest. Spores of the fungus lie dormant in the soil until stimulated to germinate by the fire's high temperatures. The fungus colonizes woody debris and may later infect the roots of conifer seedlings, mostly Douglas-fir. The seedlings are affected in groups and may die in periods of moisture stress.

Three other major root diseases found in the Pacific Northwest show indirect effects of fire in which the action is mainly on the host, such as an injury or encouraging a shift in the plant species. Laminated root rot, armillaria root disease, and annosus butt rot and root disease have in common a saprophytic phase during which they occupy stumps and roots. Tree roots from newly replanted trees may come in contact with the buried stumps or roots and become infected.

One other important indirect effect of prescribed burning may be that it injures some trees, leaving them open to root diseases. Injured live trees are easier stressed, thus more vulnerable to attack by root pathogens.

There also are stem diseases and foliage diseases that may be affected by prescribed burning but not enough information is available to consider here.

Dwarf mistletoe causes growth loss and death in coniferous trees. Mistletoes are endemic, parasitic seed plants that can cause spike tops, witches' brooms, and resin-filled cankers. A live host is required for mistletoe growth and survival. In the past, wildfires have probably sanitized forests by destroying mistletoe-infected stands. However, the net effect of these periodic fires has probably been to encourage dwarf mistletoe growth by maintaining forests in susceptible seral types.

Additional research is needed but based upon available data, important considerations for prescribed burning on forest diseases are:

• Using fire to destroy residual trees that can carry dwarf mistletoe into a regenerated stand.

• Using fire to destroy undesirable residual seedlings, or accomplish a species conversion in tree stands to control dwarf mistletoe or root disease.

• When conducting a prescribed burn, avoiding injuires to trees that provide infection pathways for a variety of pathogens to enter the tree.

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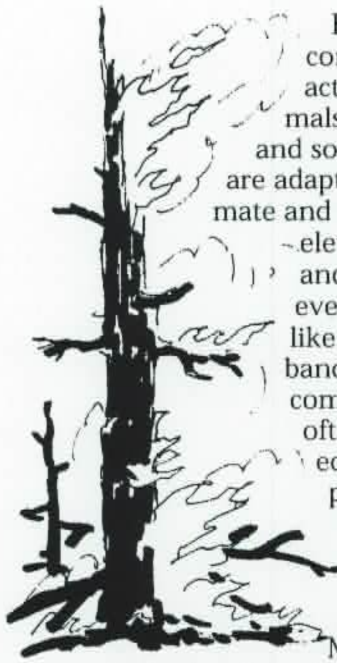


Ecosystems are composed of interacting plants, animals, fungi, bacteria and soils. Ecosystems are adapted to local climate and land forms, elevation, sunlight and, sometimes, even fire itself. Fire, like other disturbances within a complex system, often changes the ecosystem in complex ways. Changes can be mild or severe, short-lived or long-lasting. Most species of plants, animals, fungi, bacteria and soils within an ecosystem are directly or indirectly affected in some way by fire.

Fire Effects

The effects of fire within an ecosystem depend on what the fire burned, where it burned and how hot or intense it was. A fire's intensity is related to the amount and distribution of burnable vegetation, humidity, temperature, wind patterns due to slope, weather, winds (including fire-generated), and fuel moisture content. Fires may burn through the overstory or canopy, the understory, the duff layer, or all three. Intense fires can burn all three layers and even "cook" the mineral soil below. Forest fires usually do not completely burn a forest. Within a fire's perimeter, areas may burn severely, moderately, lightly, or not at all. This scattered and patchy pattern of burning intensity produces what is called a "mosaic" burn.

Patterns and intensities of a burn have different consequences for different species of plants and animals. Species of plants and animals that reside in ecosystems with frequent fire have evolved ways to avoid serious injury and/or ways to rapidly reproduce after a fire. These are said to be fire "-tolerant" or "-adapted" species.

Plants

The growing part of grasses, called the meristematic tissue, is low to the ground and often is not damaged by fire. If the fire is not too hot, grasses continue to grow just like a lawn after mowing. Many forbs, or flowering plants, have underground bulbs which allow growth the following spring. Even if the above ground parts of shrubs are damaged by fire, some shrubs regenerate when their roots put up new stems.

Many young tree species are easily killed by fire, but become quite fire-resistant when they have grown tall and produce thick insulating bark. Some plants, including trees, have seeds adapted to fire. A new population sprouts from seed when germination conditions are favorable.

Animals

Many animals rely on the shape and height of shrubs and trees, called the vegetative structure, and are displaced when fire removes that vegetative structure from an area. Deer and elk which rely on certain vegetative stucture for hiding and thermal cover, often avoid severely burned areas until

some browse returns. Gophers and ground squirrels often avoid even intense fires by hiding in their burrows, but their survival is determined by how much of their food supply remains.

Birds usually escape fire, but their young may not if a fire occurs during nesting season. Canopy-nesting and canopy-feeding birds are often displaced by canopy fires. Other species, like woodpeckers, may move into a canopy burned area to take advantage of insect populations. Whether a particular species continues to use a burned area depends on whether the necessary feeding, nesting and rearing habitats remain.

Fire has an effect on insects, both beneficial and pests. Since fire changes the environment in which they live, the effect can be a direct or indirect kill. Fire control policies of the last 75 years have greatly increased insect pests. Insects moving into burned forests increases the number of insect eating birds such as the woodpecker.

Since many insects spend part of their life cycle on the forest floor, light ground fires provide a direct control method. In the Pacific Northwest, several insect pests spend the winter months on the forest floor. Fire can be used as a control method because ecosystems where these pests occur are adapted to fire by trees with thick, heat-protecting bark. But this type of control can only be used periodically since fire consumes fuel and it takes between four and five years for that ground fuel to build up again.

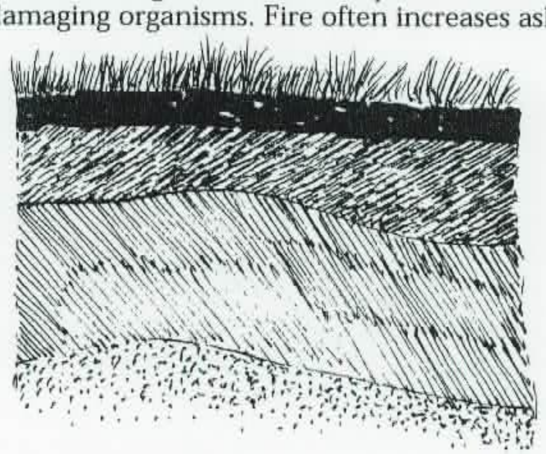
Soil

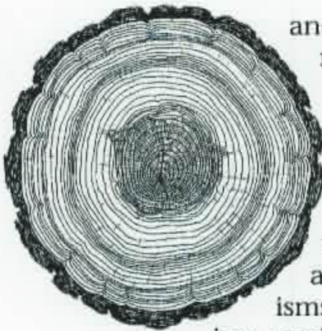
We know less about soil biota than any other aspect of the soil, so our knowledge of fire and soil biota is still rudimentary. Soil organisms, insects, fungi, bacteria, nematodes, arthropods and worms may remain in a burned area if the fire intensity did not consume the duff layer. However, these organisms are affected by changes in soil acidity (pH), mineral content, humidity, temperature and food-chain alterations.

Fire frequently removes many species of plants and animals until suitable habitat regrows in the burned area. It may take many years, even decades before plants and animals are able to immigrate from populations in adjoining areas.

In a mosaic burn, forest edges or ecotones may be increased while interior forest habitat is decreased. An increase in edges usually results in increased numbers of species because ecotones are used by ecotone species as well as by species from both adjacent habitat types. The mosaic burn may also fragment large habitat areas into isolated habitat "islands" that are too small to maintain an interior species or are not connected by migration corridors.

There are many more effects of fire. Sometimes fire weakens tree resistance to organisms like fungi and insects. Other times fire stimulates organisms that compete with tree damaging organisms. Fire often increases ash





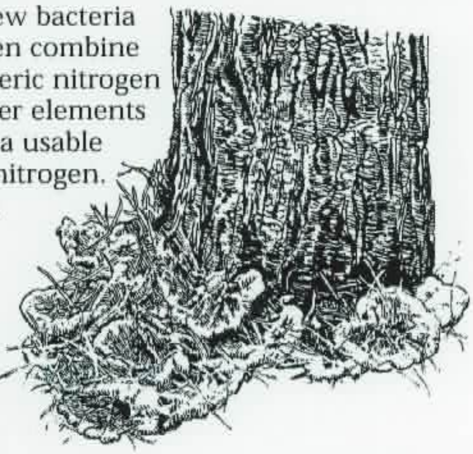
and soil erosion into mountain streams. The resultant increase in turbidity, sedimentation, and changes in pH and mineral content of the stream affects aquatic organisms, including spawning, rearing and feeding habitats of fresh water fish. Fire may increase the rate at which trees fall into a stream.

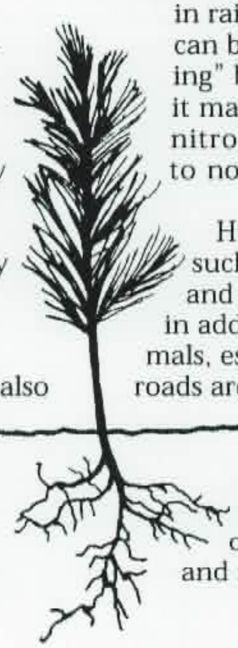
When fire alters vegetative structure, there are effects on humidity, temperature and sunshine (microclimate). Vegetation moderates an area's microclimate by raising humidity, reducing temperature extremes and intercepting sunlight. When fire removes vegetative structure, soil temperatures increase, humidity drops and temperatures are unusually high in summer and cold in winter. When vegetation and duff are gone, rainfall and snowmelt that used to be stored and released slowly during the year, now quickly penetrate into aquifers or run into streams leaving the site drier. These conditions make it difficult for vegetation to reestablish.

Although we talk about average rainfall, temperatures and weather, there are no average years! The ultimate effects of fire are heavily influenced by the weather that follows the fire. Heavy rains increase soil erosion. Cool and wet years usually increase the rate of vegetative regrowth. Drier years usually slow ecosystem recovery.

When plants, animals and duff are burned, food chain and nutrient cycles also are affected. In the process of photosynthesis, plants use carbon dioxide, water and nitrogen to produce carbohydrates, fats, proteins, and oxyen. Plants also use minerals from the soil such as phosphorus, potassium, sulfur, calcium, iron and magnesium. When plants burn, oxygen in the air combines with the carbohydrates, fats and proteins to produce carbon dioxide, water and nitrogen which is released into the atmosphere. The minerals return to the soil unless the fire is too hot and some minerals are vaporized into the atmosphere.

The availability of nitrogen is a major limiting factor in most ecosystems. Although nitrogen molecules make up 78% of the air, neither plants nor animals can use this form. Only a few bacteria and lichen combine atmospheric nitrogen with other elements to make a usable form of nitrogen. Nitrogen "fixing" bacteria live in nodules on the roots of legumes like peas, beans, clover and alder. Some nitrogen is "fixed" by lightning. The nitrogen dissolves in raindrops and falls to the ground. Fire can be hot enough to kill nitrogen "fixing" bacteria and lichen. If this happens, it may take years, even decades for nitrogen "fixing" organisms to return to normal.



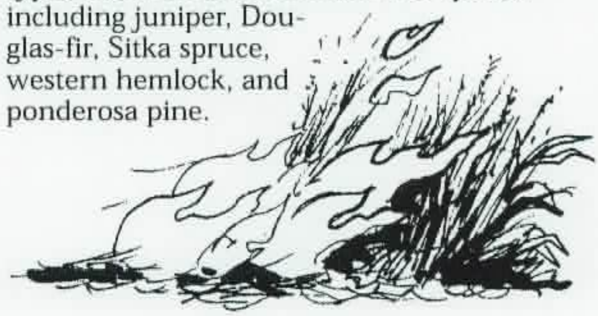


Human activities in response to fire, such as salvage logging, road building and rehabilitation efforts, often result in additional impact on plants and animals, especially if soil is disturbed and roads are left open.

Efforts to speed ecosystem recovery can be effective. In moderate to severely burned areas, replanting of native trees, shrubs and grasses and riparian rehabilitation are often beneficial. Riparian rehabilitation usually includes placing logs and other woody debris into stream channels to slow erosion, and planting riparian shrubs and trees to speed vegetative recovery. Effects of any fire are complex, somewhat unpredictable and are usually determined by post-fire assessment. Restoration is usually limited by available funding and efforts are often restricted to aerial seeding of exotic grasses to slow soil erosion and to planting seedlings of commercially valuable trees. One can debate the negative and positive effects of using non-native or exotic grasses in this effort. Sometimes salvage logging, which removes many of the larger burned trees, is permitted. This reduces the amount of decaying wood and animal habitat on site, and reduces nutrient recycling. Ecosystem recovery may be slowed.

After a fire, species and populations of plants and animals change over time. One group of associated plants is replaced or succeeded by another plant association or community which in turn is replaced by yet another. Each succeeding plant community provides habitat for certain animal species adapted to that habitat. The change from one group of plants and animals to another is called ecological "succession." In a typical succession, shrubs gradually replace grasses and forbs. Eventually trees replace shrubs as the dominant vegetation. Different species of birds, mammals and insects are present during each successional stage.

With these factors in mind, the following fact sheets discuss fire effects on several forest types based on the dominant tree species including juniper, Douglas-fir, Sitka spruce, western hemlock, and ponderosa pine.



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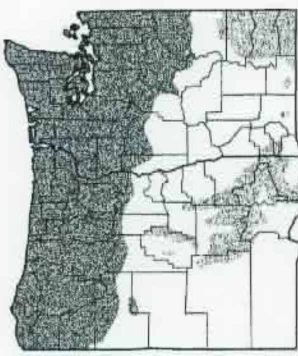
Forest Description

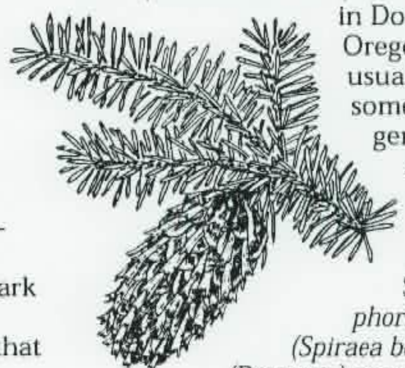
Douglas-fir *(Pseudotsuga menziesii)*, also called red fir, has been a major component of western North American forests since the mid-Pleistocene. Douglas-fir grows in a variety of climates and grows best on well-aerated, deep soils with a pH from 5 to 6.

The natural occurrence of Douglas-fir in extensive stands is mainly a result of fire. Adaptations which enable Douglas-fir to survive its less fire-resistant associates are: 1) rapid growth and longevity, 2) thick corky bark on its lower boles and main roots, and 3) a capacity to form adventitious roots or roots that grow from other tissues near the tree base.[3]



Associated Species

At its upper and lower limits, the Douglas-fir zone normally abuts the grand fir *(Abies grandis)* and ponderosa pine *(Pinus ponderosa)* zones. Climax Douglas-fir forests are generally absent in Oregon except for parts of the Wallowa Mountains. However, the eastern slopes of the Cascades and northeastern Oregon mountains contain large forested areas similar to Douglas-fir ecosystems. Douglas-fir, ponderosa pine, lodgepole pine *(Pinus contorta)* and western larch *(Larex occidentalis)* are major tree species in Douglas-fir forests. In Oregon, grand fir is usually in the mix. In some areas, shrubs are generally absent from an understory dominated by pinegrass *(Calamagrostis rubescens)*. Snowberry *(Symphoricarpos albus)*, spirea *(Spiraea betulifolia)* and roses *(Rosa spp.)* comprise a shrub understory in other areas.



Fire Effects on the Forest

Any of the four trees mentioned above may dominate in the Douglas-fir zone because pine and larch are better adapted to fires which were common prior to 1900.[4] Fire frequency may be in the 70 to 100 year range. Fire kills a portion of canopy trees and surviving trees often occur in patches. Many small trees die because of thin bark and low crowns. Trees establish in newly available growing space and the species is largely determined by the available seed source.[6] Frequent, low intensity fires keep sites open so they are less likely to burn intensely even under severe fire weather conditions. Fires are likely to be more intense over time if a forest has been protected from fire.[1]

Succession

Because Douglas-fir forests tend to burn in a patchy (mosaic) pattern, and larger trees tend to resist all but crown fires or severe crown scorching, the post-fire succession of this forest type is also patchy and highly varied. In a stand replacement fire, succession goes from grass-forb to shrub to trees to closed canopy. Where the overstory has survived fire, more shade tolerant species have the competitive advantage. Ponderosa pine is relatively shade intolerant. Seedlings of more shade tolerant species like Douglas-fir and grand fir will often form the understory and eventually replace Ponderosa pine. Many forest stands have lost overstory pine due to control of fire and selective harvest of large pine thus allowing more shade tolerant species to dominate. In addition, since lodgepole pine cones are fire adapted, some stands are almost or completely occupied by even-aged stands of lodgepole pine, their cones having supplied the major conifer seed source after a fire.

As succession proceeds, plant species change. The abundance and distribution of the plants on site also changes. It should not be hard then to understand that animal species, including some invertebrates, change not only in abundance but in diversity.

Wildlife

Wildlife habitats are determined by the interspersion and structure of plant communities and by the mix of species within a community. All of these are important but most wildlife species respond more to the structure of the vegetation than to the plant species in a community. For example, mature stands of a deciduous hardwood forest community provide habitat for a different group of wildlife species than does the temperate coniferous forest community, yet the grass-forb stage of each ecosystem may host the same wildlife species.[2]

Habitat conditions determine vertebrate wildlife abundance, both in the number of species and the number of individuals. The abundance of most wildlife species is directly dependent upon the condition of available habitat, whether used for breeding feeding or resting. For example, elk prefer a patchy habitat with areas of forest for thermal and hiding cover adjacent to openings for feeding. A mosaic burn in a large Douglas-fir forest can result in more of this patchy habitat. Similarly, the edge (or ecotone) habitat is also increased resulting in a greater variety of species while populations requiring interior forests will be reduced.[5]

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Forest Description

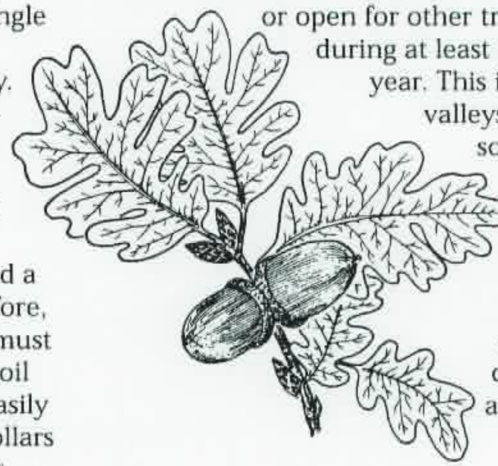
Oregon white oak *(Quercus garryana)* is found in pure, closed canopy stands mixed with conifers or deciduous trees, scattered as single trees or groves, and generally contains various species of shrubs in the understory. It grows to large sizes, and is found extensively as scrub forest.[3] Pacific madrone *(Arbitus menziesii)* and hazelnut *(Corylus cornuta)* are tall shrub/tree components of the understory in some areas.

Oregon white oak has a deep taproot and a well-developed lateral root system. Therefore, it is wind-firm even in wet areas. Acorns must be kept moist under leaves or in shallow soil until germination. This tree also sprouts easily from dormant buds on cut stumps, root collars (root suckering) and along exposed trunks. Sprouts provide the most certain way to obtain natural regeneration because acorns are often damaged or eaten by a host of insects, mammals and birds.

Quercus garryana Dougl.

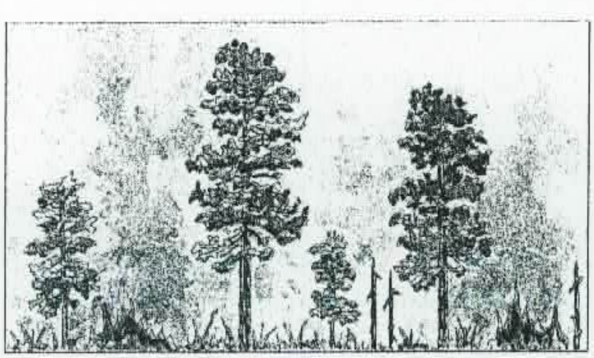
Associated Species

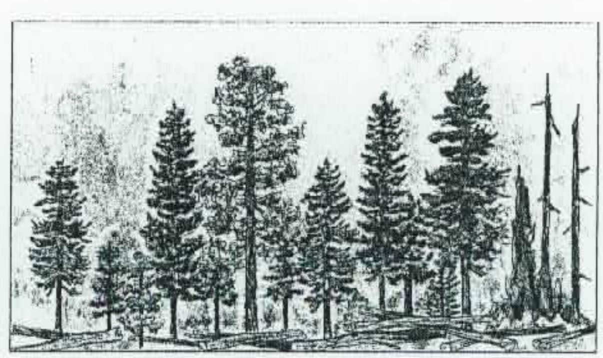
White oak grows on a wide variety of sites. On good sites it is often crowded out by species that grow faster and taller. Hence, Oregon white oak is most common on sites that are too arid or open for other tree species, during at least part of the year. This includes inland valleys and foothills, southern slopes, rocky ridges and a narrow transition zone east of the Cascades between conifer forests and steppe.[3]



Fire Effects on the Forest

Most oak woodlands were established by frequent low intensity fires that removed understory shrub and tree components, often including seedling or sapling stages of Douglas-fir and oak. These fires resulted in overstories of large, fire-resistant oaks. In a sense many white oak woodlands could be called a fire-climax ecosystem. If frequent fires are removed, the understory Douglas-fir survives and gradually displaces the oak.[6] White oak is not very shade tolerant and will not grow under a closed canopy of Douglas-fir.[3]





Succession

In savannas, fire exclusion leads to an increasing density of shrubs and oaks, transforming the savanna into woodland. In woodlands, fire exclusion leads to an increase in shrubs and other tree species at the expense of oaks. Post-settlement impacts to oak woodlands such as clearing for farmland and urban development, grazing of livestock and fire exclusion limits our understanding of fire succession and stand development. Much is hypothesis rather than fact.[1]

If a severe fire burned the overstory, understory, ground and duff layers, succession would probably start by immigration of community species from adjoining areas. Some regeneration from surviving acorns and root shoots could be expected. Thus, white oak would probably grow on the site. The grass-forb community would be displaced by an increasing shrub community and that would gradually be displaced by oaks as they grew to overstory size.

Wildlife

Wildlife habitats are determined by the interspersion and structure of plant communities and by the mix of species within a community. All of these are important to certain species of wildlife, but most wildlife species respond more to the structure of vegetation than to the plant species in a community. For example, mature stands of a deciduous hardwood forest community provide habitat for a different group of wildlife species than does the temperate coniferous forest community, yet the grass-forb stage of each ecosystem may host the same wildlife species.[2]

For example, the acorn woodpecker *(Melanerpes formicivorus)*, an oak woodland species common in the Umpqua and Rogue inland valleys, would be excluded by severe fire that destroyed the overstory, just as pileated woodpeckers *(Dryocopus pileatus)* are excluded from severely burned coniferous forests. Another example is the western jumping mouse *(Zappus princeps)* which occupies the grass-forb and shrub seral stages of several forest ecosystems, including white oak and mixed conifer.

In summary, the Oregon white oak woodland must have frequent fire disturbance to continue to exist in most areas.

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[6] Walstad, John D., et. al., ed.s, 1990, NATURAL AND PRESCRIBED FIRE IN PACIFIC NORTHWEST FORESTS, Oregon State University Press, Corvallis.

Forest Description

Western juniper *(Juniperus occidentalis)* is the driest forest ecosystem in the Pacific Northwest. In many forest stands, it is a single species overstory. In ecotones, ponderosa pine *(Pinus ponderosa)* and curlleaf mountain-mahogany *(Cercocarpus ledifolius)* are the most common tree associates.[3,4]

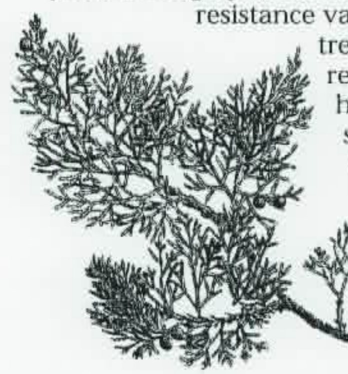
Juniperus occidentalis Hook.

Associated Species

Big sagebrush *(Artemesia tridentata)* is the most common shrub species associated with western juniper. Other shrubs common to western juniper communities are gray rabbitbrush *(Chrysothamnus nauseosus)*, green rabbitbrush *(C. viscidiflorus)*, bitterbrush *(Purshia tridentata)*, wax currant *(Ribes cereum)* and horsebrush *(Tetradymia spp.)*. Common grass associates are bluebunch wheatgrass *(Agropyron spicatum)*, cheatgrass *(Bromus tectorum)*, Idaho fescue *(Festuca idahoensis)*, prairie Junegrass *(Koeleria cristata)*, Sandberg bluegrass *(Poa sandbergii)*, bottlebrush squirreltail *(Sitanion hystrix)* and Thurber needlegrass *(Stipa thurberiana)*.

Fire Effects on the Forest

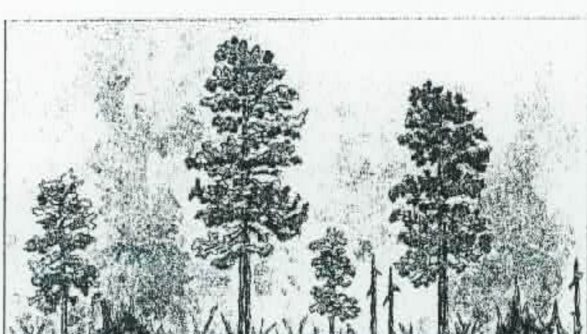
Western juniper is a short stature tree with a strong root system. Seedlings, saplings and poles are highly vulnerable to fire although fire resistance varies with age. Mature trees have some fire resistance because they have little fuel near the stem, relatively thick bark and foliage fairly high above ground.[3]



Western junipers rarely form a closed canopy such as found on the middle elevations of Steens Mountains in southeastern Oregon. Usually, they are dispersed and crown fires are not frequent except when winds assist spread through more closely spaced trees. Fire is usually spread by shrubs and is more likely to be extensive if grasses are the dominant fuel.[1]

Succession

Little is known about successional relationships in western juniper ecosystems. Burning kills juniper and temporarily produces a grass-forb or shrub dominated community which is gradually reinvaded by trees.[4] Fires in western juniper woodlands leave little evidence to reconstruct historical fire patterns. Associated bunchgrasses regrow if meristematic tissue is not killed, and many shrub species sprout from charred stubs except for sagebrush. Because



juniper competes for scarce soil moisture, removal by fire allows rapid regrowth of fast growing grass and shrub species. Western juniper woodlands can burn spring through fall, but spring burns are often less intense due to higher moisture content of grasses and shrubs.[1]

Western juniper woodlands have become more extensive and dense since the late 1800's. Expansion is attributed to the control of fire and domestic livestock grazing. Controlling fire allows slow growing juniper to spread and livestock grazing reduces grasses needed to carry fire between trees. Conversely, livestock grazing has contributed to the spread of sagebrush by reducing competition with grasses for moisture, and to the spread of cheatgrass which is considerably more flammable than native grasses. Both sagebrush and cheatgrass can carry fire through juniper woodlands.

As succession proceeds, plant species change. The abundance of plants and how those plants are distributed on-site also changes. It should not be hard then, to understand that animal species, including soil invertebrtes change, not only in abundance but in diversity.

Wildlife

Wildlife habitats are determined by the interspersion and structure of plant communities and by the mix of species within a community. All of these are important to certain species of wildlife, but most wildlife species respond more to the structure of vegetation than to the plant species in a community. For example, mature stands of a ponderosa pine forest provide habitat for a different group of wildlife species than does the mature western juniper woodland community, yet the grass-forb stage of each ecosystem may host the same wildlife species like blacktail jackrabbits *(Lepus californicus)*.[5]

Habitat conditions determine vertebrate wildlife abundance both in the number of species and the number of individuals. Wildllife species numbers also vary depending on how the habitat is used — whether the animals are breeding, feeding or resting in a habitat. The limiting factor for many bird species is the availability of nesting or perching sites. When fire kills western juniper, it takes several decades before associated birds such as great horned owls (*Bubo virginianus)* and several hawk species return.

Juniper fruits are consumed by a number of wildlife species including robins *(Turdus migratorius)* and coyotes *(Canis latrans)* when more nutritious foods are limited.

Lastly, water is the limiting factor for both plants and animals in arid ecosystems and western junipers transpire considerable moisture. The expansion of juniper along rare high desert (upper Sonoran) streams contributes to instream flow reductions which has consequences for aquatic organisms and riparian dependent species.

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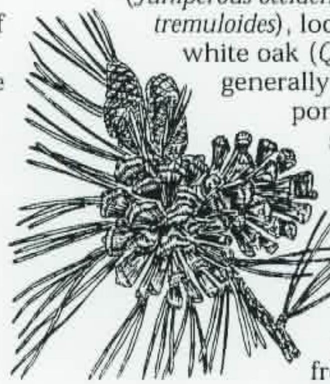
Forest Description

Ponderosa pine *(Pinus ponderosa)*, also called western yellow pine, is widely distributed in eastern Oregon and Washington. It occupies a narrow band on the high pumice plateau east of the Cascades, including large areas of the Blue Mountains in northeastern Oregon and extreme southeastern Washington, and extensive tracts in the Okanogan Highlands of northeast Washington. Upper limits of Ponderosa pine forests may grade into forests of Douglas-fir *(Pseudotsuga menziesii)*, grand fir *(Abies grandis)* or white fir *(Abies concolor)* depending on locale. Throughout much of Oregon, they abut sagebrush *(Artemesia tridentata)* steppe or open western juniper-sagebrush woodland at lower limits, often forming a mosaic pattern with these drier ecosystems. The well-drained pumice region of central Oregon retards growth of Ponderosa pine for the first 50 to 80 years until the roots reach moist, buried soil beneath the pumice layer. Frequent understory shrub associations include bitterbrush *(Purshia tridentata)*, bitterbrush and fescue *(Festuca spp.)*, bitterbrush and green manzanita *(Arctostaphylos patula)*, bitter brush and ceanothus *(Ceanothus velutinus)*, and green manzanita. Eastern Oregon understory associates include snowberry *(Symphoricarpos albus)*, mallow ninebark *(Physocarpus malvaceus)* and bunchgrasses.

Pinus ponderosa Laws

Associated Species

Ponderosa pine is associated with a rich variety of tree species. Four species — western juniper (*Juniperous occidentalis*), aspen (*Populus tremuloides*), lodgepole pine and Oregon white oak (*Quercus garryana*) — are generally associates in climax ponderosa stands. Moister sites may contain Douglas-fir, grand-fir, western larch and/or western white pine (*Pinus monticola*).[3,4]



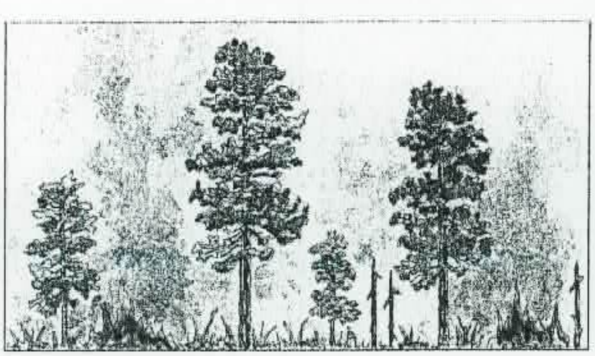
Ponderosa pine forests evolved within a frequent low-intensity fire regime of four to twenty-five years. Fuels, in the form of needles and twigs, can accumulate in a mature forest to support annual low-intensity fire.[1,6]

Fire Effects on the Forest

Ponderosa pine has thick insulating bark, deep roots and tap root, moderately high and open branches, relatively open canopy, and low foliage flammability. Only western larch (*Larix occidentalis*) is more fire resistant. The length and spacing of the needles also seems to lessen fire damage as the longer needles often burn only part way leaving stems and part of their surrounding needles intact. Larger pine will often survive up to 50 percent crown scorch.

Succession

Because ponderosa pine is a fairly fire resistant species, past fires have had a profound effect on



its distribution. Frequent fires have kept ponderosa pine dominant in the higher elevation ecotones adjacent to Douglas-fir and grand fir forests. Since ponderosa pine tends to burn in a mosaic pattern and larger trees tend to resist all but crown fires or severe crown scorching, post-fire succession is also patchy and highly varied. In a stand replacement fire, succession follows the usual pattern of grass-forb to shrub to trees to open canopy. If succeeding fires are absent from the stand, when the pines get larger, rapid build-up of needle litter inhibits forb and shrub growth thus reducing the understory.[4]

Post-fire ponderosa pines typically develop in a mosaic of small, even-aged, but different-aged patches. In mature stands, existing overstory trees limit survival of regenerating understory pines through competition for light and moisture. The surviving understory, only a few feet tall, is usually destroyed by the next low-intensity fire. When a mature stand finally succumbs to insects and disease, succeeding fires burn the debris and create openings for a new age class. Fuel accumulates in openings more slowly than under mature stands, so the next fire or two burns lightly or skips the opening altogether. Lack of fuel in openings allows pines to grow large enough to survive fires that eventually pass through.[6]

Post-fire salvage logging may retard recovery of the understory. In unburned ponderosa stands, selective tractor logging reduced herb and shrub coverage by 33 percent, denuding some areas and burying others in slash. The understory required approximately 14 years to recover. Deforestation by fire generally results in dominance by understory species present before the disruption with invaders playing a minor role.

Rodents play an important role in post-fire succession. At least 15 percent of ponderosa pine seedlings in Central Oregon develop from unrecovered rodent seed caches. Rodents are also significant in establishing bitterbrush. As succession proceeds, plant species change. The abundance of plants and how those plants are distributed on-site also changes. It should not be hard then, to understand that animal species, including soil invertebrates, change not only in abundance but in diversity.

Wildlife

Wildlife habitats are determined by the interspersion and structure of plant communities and by the mix of species within a community. All of these are important to certain species of wildlife, but most wildlife species respond more to the structure of vegetation than to the plant species in a community. For example, mature stands of a Douglas-fir forest community provide habitat for a different group of wildlife species than does the mature Ponderosa pine community, yet the grass-forb stage of each ecosystem may host the same wildlife species.[2]

Habitat conditions determine the number of vertebrate wildlife species as well as the number of individuals. Wildlife species numbers also vary depending upon how habitat is used — are the animals breeding, feeding or resting in a habitat? Elk prefer a patchy habitat with areas for thermal and hiding cover adjacent to openings for feeding. A mosaic burn in a large ponderosa pine forest can result in the patchy habitat preferred by elk. Similarly, ecotone habitat is increased resulting in a greater variety of bird species while bird populations requiring interior forests are reduced. Deer, being browsers rather than grazers, make more use of the seral shrub stage.[5]

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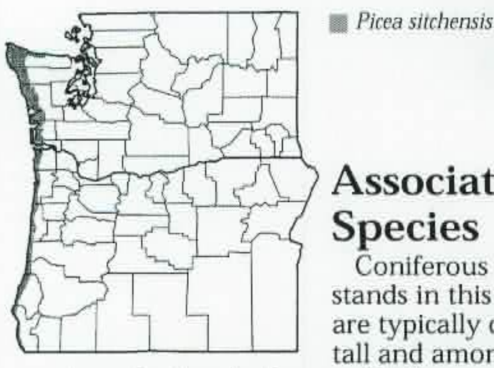
11 Fact Sheets: **Fire Effects on Sitka Spruce Forests**

Forest Description

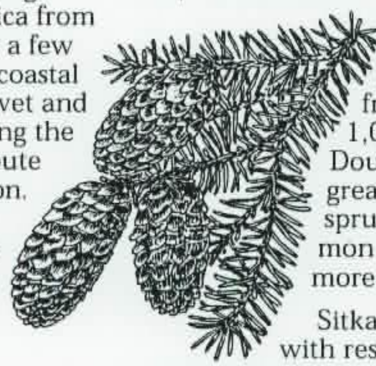
The Sitka spruce *(Picea sitchensis)* zone is a narrow coastal forest ecosystem extending along the western coast of North America from Alaska to northern California. It is only a few miles wide except where it extends up coastal river valleys. The climate is uniformly wet and mild. Frequent fog and low clouds during the relatively drier summer months contribute to the 200 to 300 cm of annual precipation.



Associated Species

Coniferous forest stands in this zone are typically dense, tall and among the most productive in the world. Tree species are Sitka spruce, western hemlock (*Tsuga heterophylla)*, western red cedar *(Thuja plicata)*, Douglas-fir *(Pseudotsuga menziesii)*, grand fir *(Abies grandis)* and Pacific silver fir *(Abies amabilis)*. Lodgepole pine *(Pinus contorta)* is common along the ocean.[4] Root grafts occur in Sitka spruce, on the same tree or with adjacent trees, and live stumps occur that are fed through the root grafts from adjacent trees.[3] Mature forests have lush understories with dense growth of shrubs, forbs, ferns and small plants such as lichens, mosses, algae and fungi covering vegetation and ground surfaces.[4]

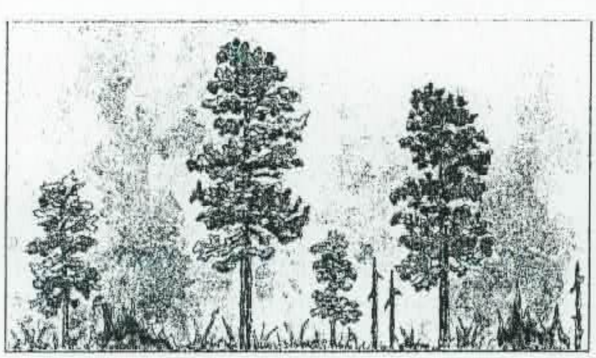
Fire Effects on the Forest



Sitka spruce forests rarely burn due to the wet, humid coastal climate. Fire regimes could be called "episodic" rather than cyclical. Estimates of fire intervals have varied from 200 years to well over 1,000 years in different areas. Douglas- fir, which has a greater fire tolerance than Sitka spruce, would be more common if this ecosystem burned more frequently.

Sitka spruce has very thin bark with resin pockets and highly combustible foliage. It has shallow roots due to shallow soils and/or high water tables. Fire usually kills this species by root char and occasional crowning. Fire in a mature Sitka spruce forest is usually a stand replacement event because of the dense understory and fire sensitive nature of the species.[1]

Two quite different patterns of post-fire tree colonization have been documented: little regeneration and immediate regeneration. Little regeneration is due to shrub dominance which occurs when a crown fire burns the seed source or where sprouting shrubs are abundant in the understory. Dense shrub communities of salmonberry *(Rubus spectabilis)*, salal *(Caultheria shallon)*, red huckleberry *(Vaccinium parviflorum)*, red alder *(Alnus rubra)* or vine maple *(Acer circinatum)* may result. Each of these shrubs is capable of rapid regrowth after fire because they sprout from roots or rhizomes. The resulting thick shrub cover may form a relatively permanent shrub field preventing re-establishment of tree species.



Succession

The more common post-fire successional pattern, immediate regeneration, happens when there is a seed source present and less shrub competition. Interestingly, where windthrow provides openings for new Sitka spruce to grow, between 88 percent and 97 percent of seedlings germinate on and grow from logs.[1] Seed germinates on almost any seedbed, but survival may be low. "Nurse" logs can provide a moist but well drained growth medium.[3]

Early stages of secondary succession following logging and burning of Sitka spruce stands is similar to succession described for western hemlock stands. There is a stronger tendency, however, toward development of dense shrub communities.[4]

As succession proceeds, plant species change. The abundance of plants and their distribution on-site also changes. It should not be hard then to understand that animal species, including soil invertebrates, change not only in abundance but in diversity.

Wildlife

Habitat conditions determine vertebrate wildlife abundance, both in the number of species and the number of individuals. Wildlife species numbers also vary depending upon how a habitat is used — are the animals breeding, feeding or resting in a habitat? For example, the pileated woodpecker (*Dryocopus pileatus)* and clouded salamanders *(Aneides ferreus)* use late successional forests, mature and old-growth dominated, but are absent from early successional forests that are grass-forb and shrub dominated.[2]

When Sitka spruce succession results in a relatively permanent shrub-dominated seral stage, the number of animal species adapted to humid, deciduous shrub ecosystems will be abundant. For example, yellow warblers *(Dendroica petechia)* would be relatively abundant while the coniferous forest dwelling Townsend's warbler *(Dendroica townesendi)* would be relatively rare.

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Forest Description

Western hemlock (Tsuga heterophylla) is either a major or a minor component in at least 20 forest types.[3] These forests are quite varied in character but western hemlock is the common late successional dominant species.[1] Western hemlock thrives in a mild, humid climate where frequent fog and precipitation occur during the growing season. The best stands are in humid and superhumid coastal regions. In subhumid regions with relatively dry growing seasons, western hemlock grows primarily on northerly aspects, in moist stream bottoms, or on seepage sites. Inland, it grows along the western and upper eastern slopes of the Oregon Cascade Mountains where there is more precipitation because moisture is released as clouds rise to cross the Cascades.[3]

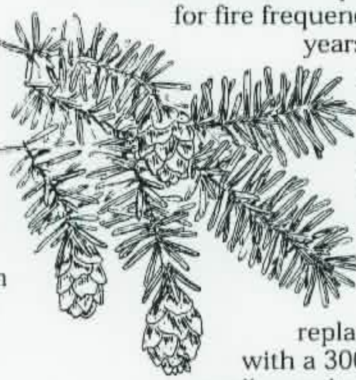
Tsuga heterophylla (Raf.) Sarg.

Associated Species

Western hemlock, a shallow-rooted species, does not develop a taproot. The roots, especially the fine roots, are most abundant near the surface and are easily damaged by harvesting equipment and fire. Because of its thin bark and shallow roots, western hemlock is highly susceptible to fire; even light ground fires are damaging. Its shallow roots make pole-size and larger stands of western hemlock susceptible to severe wind-throw.[3] Near openings created by fire, there is an increased possibility of wind-throw.

Fire Effects on the Forest

In the humid and superhumid coastal regions fire is best described as "episodic" with estimates for fire frequency varying from 3,500 years to 750 years to 250 years. The interior, drier forests of the Cascades average stand replacement fires in a somewhat "cyclical" period of 95 to 150 years.[1]



A severe stand-replacement fire on sites with a 300 to 600 year cycle usually results in a mixed dominance of Douglas-fir and western hemlock or Pacific silver fir. In stand replacement fires on sites characterized by moderately moist (mesic) to wet conditions, western hemlock and Douglas-fir colonize together. However, hemlock grows more slowly in open conditions and may appear to be younger than the Douglas-fir.[1]

If fire is absent for 700 to 1000 years on wet sites, Douglas-fir drops out and western hemlock becomes the primary seed source for post-fire regeneration.[1] Early stages of secondary succession following burning have been the subject of a number of studies. Unfortunately much research has been limited to the first five to eight years after complete tree removal. Therefore, detailed successional patterns for the entire period of forest re-establishment have not been worked out.[4] One example of successional sequence in the Cascade Mountains follows:

Succession

During the first growing season after burning, sparse plant cover is made up of residual species from the original stand plus small amounts of invading herbaceous species such as woodland groundsel *(Senecio sylvaticus)*, fireweed (*Epilobium angustifolium)* and autumn willowweed *(Epilobium paniculatum)*. A moss-liverwort stage also may occur during the first year.

During the second year, invading annual herbaceous species dominate and produce large numbers of small, windborn seeds. A high percentage of second year cover is made up of woodland groundsel. In subsequent years, woodland groundsel fades out because its high nutrient requirements are generally satisfied only on recently burned sites. Perennial invading herbaceous species, such as fireweed, common thistle *(Cirsium vulgare)* and bracken fern (*Pteridium aquilinum)* build until the fourth or fifth year when their rate of increase slackens.

This successional stage, sometimes called the weed stage, gradually gives way to shrub domination. Shrubs, including residual species such as vine maple (*Acer circinatum)*, trailing blackberry *(Rubus ursinus)*, Oregon grape *(Berberis nervosa)*, Pacific rhododendron *(Rhododendron macrophyllum)* and salal *(Gaultheria shallon)*, as well as invaders such as ceanothus *(Ceanothus velutinus)* and willows (*Salix spp.)* dominate the site until they are overtopped by tree saplings, generally Douglas-fir.[4] However in the late successional stage, Douglas-fir will eventually yield to western hemlock. Douglas-fir dominance in many western hemlock forests is due to fire since older Douglas-fir are more resistant to fire than western hemlock.

Another example of succession occurs in the Coast Range. Here residual herbaceous species that survive fire are a more important component of successional vegetation, especially swordfern *(Polystichum munitum)*. Typical shrubs involved in succession are salmonberry *(Rubus spectabilis)*, thimbleberry *(Rubus parviflorus)* and salal.[4]

As the forest continues to develop, the canopy closes and natural thinning accelerates. Lack of light in the understory significantly reduces shrub and herb cover. The simplified forest structure is reflected in lower plant and animal diversity. Small logs fall to the forest floor and overstory trees begin to exhibit significant diameter variations.[6]

As succession proceeds, plant species change. The abundance of plants and how those plants are distrubuted on-site also changes. It should not be hard then, to understand that animal species, including some invertebrates change, not only in abundance but in diversity.

Wildlife

Habitat conditions determine vertebrate wildlife abundance, both in the number of species and the number of individuals. Wildlife species numbers also vary depending upon how a habitat is used — are the animals breeding, feeding or resting in a habitat? For example, the pileated woodpecker (*Dryocopus pileatus)* and clouded salamander *(Aneides ferreus)* use late successional forests that are mature and old-growth dominated but are absent from early successional forests that are grass-forb and shrub dominated.[2]

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Glossary

Abiotic: non-living.

Adaptation: the process of a plant, or animal species making adjustments to their environment. Any structure or response that helps an organism survive.

Aspect: the direction a slope is facing.

Basal: basal area - a measure of the amount of wood on a site.

Biotic: living.

Broadcast Burning: fire intentionally set for a specific purpose [see prescribed burning].

Canopy: the layer formed by the leaves and branches of trees or shrubs.

Carnivore: an animal that primarily eats meat.

Cover: the percentage of vegetation type covering the ground.

Crown fire: fire that spreads through the top [or crowns] of the trees.

Combustion: the oxidation, or burning, of any material. Combustion breaks down organic materials into raw minerals and energy [which is released in the form of heat].

Deciduous: a plant that seasonally loses all of its leaves.

Decomposers: organisms that help break down and decay dead organisms and the wastes of living organisms.

Desertification: the transformation of rangeland into desert.

Duff: organic layer of the soil consisting of dead and decaying leaves, branches, wood, and other plant parts.

Ecosystem: the interacting system of a biological community and its non-living environment; all are linked together by energy and nutrient flow.

Ecotone: an edge between dissimilar habitats.

Elevation: the height above something.

Endemic: plants that are peculiar or restricted to a particular place.

Erosion: the wearing away of the land surface by wind or water.

Fire: the state or process of combustion, or oxidation, in which ignited material combines with oxygen and gives off light, heat and flame. A source of ignition, oxygen, and fuel are required for a fire to burn.

Fire-dependent System: when the long term maintenance of an ecosystem depends on fire.

Fire Management: the art and science of using fire as a tool to increase beneficial products and services from natural environment.

Fire-opened Cones: Fire enables cone to open and seeds to be released, seeds quickly sprout in the nutrient rich soil. [See serotinous cone.]

Fire Prevention: methods used to prevent fire including, public education on how to minimize wildfire risk.

Fire Protection Agency: there are two types of fire protection agencies. The city or rural fire department is funded by taxes paid by property owners to protect structures [such as houses, barns, garages, sheds etc.] The wildland agencies [ie, Oregon Department of Forestry, Washington Department of Natural Resources, U.S. Forest Service and Bureau of Land Management)] are trained to control forest and wildland fires, not structural fires.

Fire Resistant Material: building materials that are non-combustible and aid in reducing fire risk to homes. Most important with roofing material.

Fire Suppression: the art and science of putting out fires. Suppression strategies include: confine, contain, and control.

Fire Triangle: an instructional aid in which the sides of a triangle are used to represent the three factors (heat, oxygen, and fuel) necessary

Glossary

for combustion and flame production. When anyone of these factors is removed, flame production ceases.

Flammable Fuels: natural materials that aid in fuel build up including: firewood, dry vegetation, dry grass, bush and land clearing debris.

Food Chain: the transfer of energy from the plant source through a series of animals and on to decomposers.

Food Web: all the intertwined food chains within an ecosystem.

Forbs: low growing, annual or perennial, herbaceous plants other than grasses, sedges or rushes.

Fuel: any combustible [burnable] material which will support a forest fire: dead and down wood material in a forest or any substance or composite mixture susceptible to ignition and combustion.

Fuel Break: a 30 foot defensible space around a home. Use less flammable ground vegetation for landscaping.

Fuel Ladder: fuels that enable fire to climb from ground level to tree tops.

Fuel Management: the planned manipulation and/or reduction of living or dead forest fuels for forest management and other land-use objectives.

Fuel Moisture: the amount of moisture in down, woody material.

Fuel Species: the species type of the down wood.

Germination: the process in which a seed coat splits and a young plant begins to grow.

Ground fire: a fire that not only consumes all the organic material [duff] on the forest floor, but also burns into the underlying soil.

Habitat: the place where an organism lives that provides it with its necessary resources of food, water, shelter and living space.

Heavy Fuel: a forest area that has a lot of dead trees and downed, dead material on the ground.

Herbaceous [herb]: any flowering plant or fern that has a soft, rather than woody, stem.

Herbivore: an animal that eats only plants.

Leach [leaching]: the removal of soluble substances from soil by percolating water.

Light Burn: a degree of burn which leaves the soil covered with partially charred organic material; large fuels are not deeply charred.

Limiting Factors: factors such as climate, food, water and shelter which limit the kinds and numbers of plants and animals living within an ecosystem.

Microbiotic: microscopic organisms.

Microorganism: an organism microscopic in size, observable only through a microscope.

Moderate Burn: a degree of burn in which all organic material is burned away from the surface of the soil layer, which is not discolored by heat. Any remaining fuel is deeply charred. Organic matter remains in the soil immediately below the surface.

Mosaic Burn [vegetation mosaic burn]: an irregular burning process that results in islands of unburned vegetation in which two or more types of plant communities are interspersed creating a patchwork pattern.

Mosaic Pattern: areas of different age trees, created by fire.

Mycorrhiza: a symbiotic relationship between a tree root and a fungus. The resulting structures which mutually benefit each organism are called mycorrhizae.

Niche: the role an organism plays in its habitat.

Nutrient: a naturally occurring element or compound [mineral] needed by living organisms. Some important nutrients are nitrogen, phosphorus, potassium and calcium.

Nutrients: any material a cell needs to live and grow. Nutrients may be absorbed by a plant, created during photosynthesis, or taken in by an organism as part of its food.

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Nutrient Rich Soil: after a light fire, soil is nutrient rich and makes an excellent seed sprouting bed.

Omnivore: an animal that eats both meat and plants.

Overstory: the portion of trees in a stand forming the upper crown cover or canopy.

Pathogen: an organism, essentially microbiotic, or a virus, directly capable of causing disease.

Parasite: an organism that lives by deriving benefit from another organism, parasites usually do harm to their host but do not kill it. Parasitic: to be a parasite on.

Population Control: balances the number of producers and consumers in an ecosystem.

Prescribed Fire [or burn]: the controlled application of fire to wildland fuels in either their natural or modified state, under such conditions of weather and fuel moisture, as allow the fire to be confined to a predetermined area. The intention is to employ fire scientifically so as to realize maximum net benefits with minimum damage and obtain planned objectives of silviculture, wildlife management, grazing, hazard reduction, etc.

Primary Consumer: an organism that eats plants [herbivores].

Producer: an organism that uses energy from the sun to make its own food [plants].

Rainy Climate: water soaked soil and vegetation burn less often and more slowly.

Removal of Heavy Fuels: dead trees and underbrush are removed.

Resin: also known as sap or pitch of the tree, helps protects the tree from insects.

Rhizome: a root-like stem growing under or along the ground that sends out roots from its lower surface and leaves or shoots from its upper surface.

Root Sprouts: roots that are protected under the soil from fire and that sprout new trees.

Saprophytic: a plant organism that is incapable of synthesizing its nutrient requirements from purely inorganic sources, and feeds on and commonly assists in decay of dead organic material.

Secondary Consumers: animals that eat other animals [carnivores].

Sediment: small particles of clay, silt and rock that are washed from the land, carried along and settle to the bottom of a body of water.

Sere [seral]: the series of communities that follow one another in a natural succession, as in the change from a bare field to a mature forest. A seral stage refers to one such communities.

Serotinous Cone: cones of certain conifer species [ex. Lodgepole pine, Knobcone pine] that remain closed after maturity, awaiting events such as fire before opening and shedding their seeds.

Severe Burn: a degree of burn in which all organic material is burned from the soil surface, which is discolored by heat, usually to red. Organic material below the surface is consumed or charred.

Slope: the inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Snag: a standing dead tree.

Spot Fire: a fire set outside the perimeter of the main fire by flying sparks or embers.

Stand Replacement Fire: usually wildfires, often involving intense crown fires, in which an entire stand of tree type and age is altered.

Structural Fire: fires to structures such as houses, barns, sheds, garages, etc..

Succession: the process that occurs when one community gradually replaces another.

Surface Fire: a fire that burns fuels on the ground as well as small shrubs and trees.

Surface Fuel: the loose surface litter on the forest floor, normally consisting of fallen leaves, needles, twigs, cones and small branches that have not yet decayed. Also grasses, shrubs, tree seedlings, down logs, stumps, and forbs interspersed with the litter.

Thick Bark: protects the growing layer of the tree.

Topography: the physical features of a region or place.

Understory: the portion of trees in a stand below the upper crown cover.

Urban Interface: any region where large areas of natural vegetation border or surround man-made structures; towns, subdivisions, and individual homes.

Vector: an organism that transmits disease germs.

Wildfire: any wildland fire that is not a prescribed fire.

Wildland Fire: a fire occurring on remote and generally uninhabited land.

Woody: plant material that has bark.