Photo Guide for Assessing Wildfire Severity

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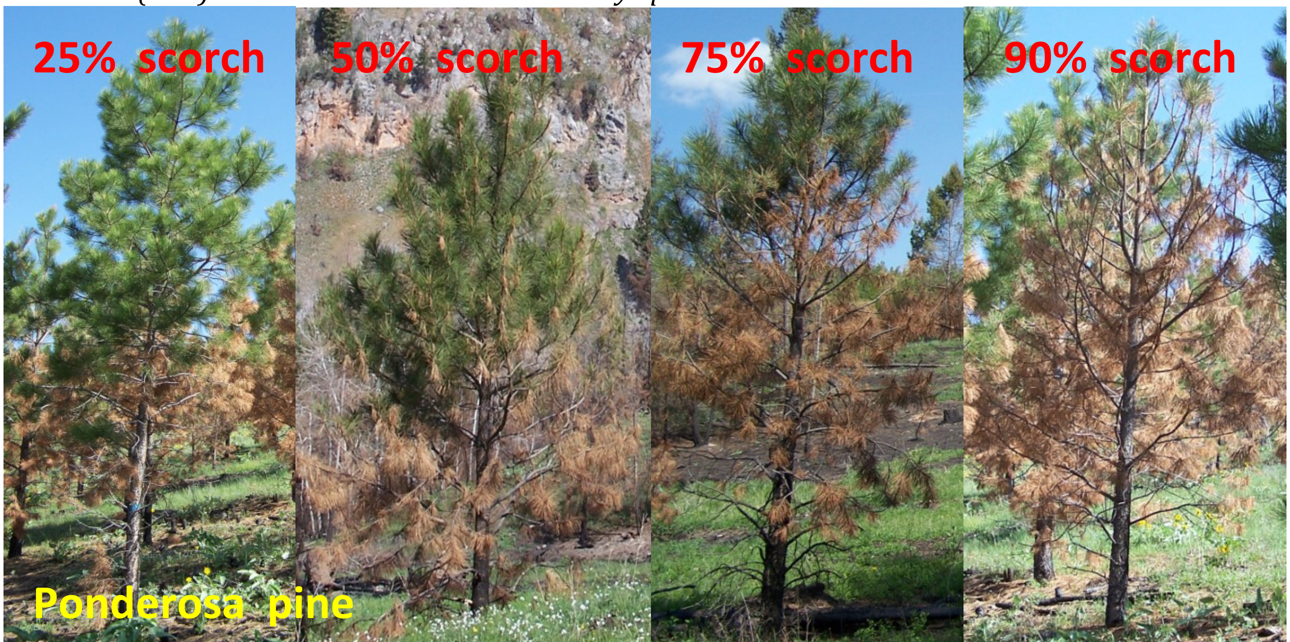
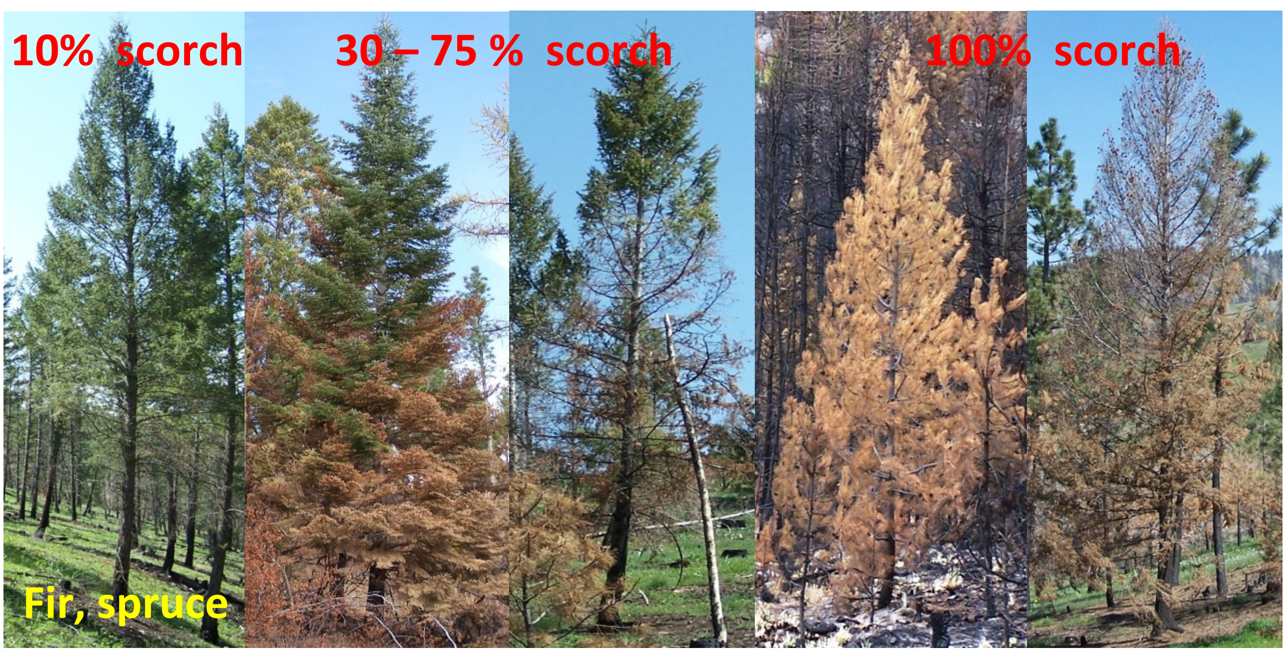


90% survival if stem cambium has not been damaged → 20% chance of survival

Ponderosa pine and **western larch** are the most fire resilient species and can survive considerable crown damage. Scorch is when surface fires produce enough heat to kill needles but not ignite them. If the branches and buds have also been killed the tree will retain the needles into the winter. If the branch tissue has survived with buds that will start producing new buds and needles for the next spring resulting in branches dropping injured or scorched needles in fall/early winter after a wildfire.



75% survival 75% of trees will not survive → 100% all tree species have been killed

Douglas-fir, **spruce**, **subalpine fir**, **grand fir** and **lodgepole pine** have thinner bark, more heat sensitive needles and shallower root systems than either ponderosa pine and western larch. In most cases even minor crown scorch will indicate eventual tree death as this is associated with enough heat loading to cause extensive root, stem and branch cambium damage. Fire impacted trees of these species can be expected to die from their injuries for as long as 5 or more years after a wildfire event.

Older trees have thicker bark and can be more resilient to surface fires depending on species. The left picture above shows a ponderosa pine that will survive and a Douglas fir next to it that will not. Alternatively ancient trees (2nd picture from left) or those with poor crowns tend to have less physiological reserve and are prone to dying several years after a wildfire. Increasing post fire water availability can help trees recover from fire effects. Regardless of age or watering, 100% crown scorch (3rd picture) or crown consumption (4th picture) results in tree death.

The thin cambium layer under the bark of the tree is the growing tissue of the tree and is very sensitive to heat. Prolonged fire next to stem can provide enough of a heat load to "bake" this tissue which will result in tree death <u>if</u> the damaged cambium extends around the circumference of the tree. In all species healthy cambium tissue is a creamy or slightly off-white color and is moist or pitchy (C). Heat damage may first be seen as a darker brown colored inner bark (B) or discolored cambium and sapwood (A). Discoloration begins immediately after heat damage occurs and becomes more pronounced with time. Thin barked tree species such as spruce (2nd picture) and fir (3rd picture) are very sensitive to cambium damage and will show such thermal damage as distinctly darkened cambium and outer sapwood . Ponderosa pine and western larch may suffer 50% of their circumference damaged and survive whereas other tree species may die with only 25% of their circumference damaged. Thermal stem damage usually occurs near the base of the tree when branches, needle or duff surface layers are thick. This kind of fire can occur as part of a raging crown fire or as what appears as a mild surface fire with some crown scorch. Sample only small areas of inner bark on a few trees to get an idea of overall forest damage as sampling can harm trees.

Tree scorch and mortality is a measure of wildfire severity to trees, however, soil surface assessment is an important measure of wildfire severity to under-story vegetation which is equally important.


Surface fuel and grass mosaic

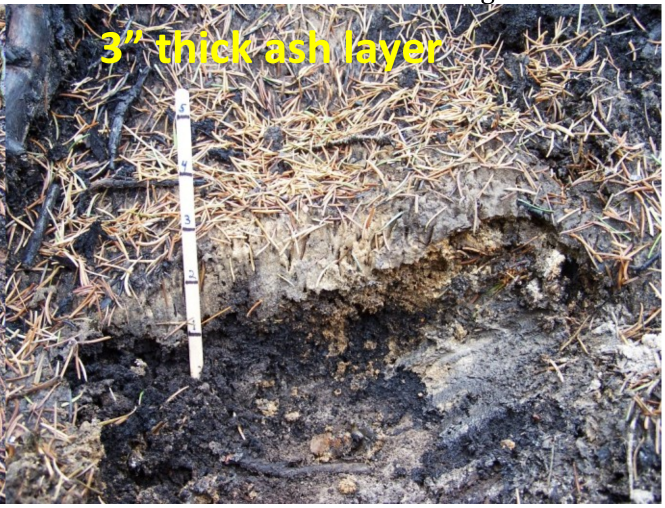

Resprouting grasses in foreground

The condition of the forest understory as well as fuel accumulations are important factors that affect post-fire vegetation regrowth. In most forest situations tree density affects understory vegetation by both shading plants and smothering them with soil surface needle accumulations. Picture 1 above shows a typical scenario where there is a healthy under-story vegetation component in tree canopy gaps and virtually no vegetation immediately underneath denser clumps of trees. This has a compounding effect as the thick needle-duff layer tends to prevent grass and forb growth and supports a long duration smoldering fire that imparts a high heat load to the soil surface. This can kill off all shallower rooted plants thus preventing them from resprouting. Alternatively, forest gaps with little tree overstory do not accumulate thick needle mats and thus a wildfire that burns through such openings tends to be of short duration, allowing most plants to maintain live root systems and quick resprouting potential. Picture 2 above shows prolific grass resprouting four weeks after a wildfire and an ensuing rain in a more open area. Resprouting areas will hinder erosion and recover quickly with no restoration actions required, whereas darker areas under the former dense trees may persist without any natural regeneration for months or sometimes years.

Ash color and depth are good preliminary means of estimating understory fire severity. Typically darker areas are the result of significant charcoal formation, incomplete combustion and lesser soil heat loading. White ash is an indicator of complete combustion and greater soil heating. A white ash spot in the middle of the opening on the right picture indicates that significant soil heating occurred compared to the darker areas from combustion of a former large dry log. Brush piles or tree deadfalls can cause the same (left picture forground). White ash areas will recover to native vegetation much more slowly because of changes in soil properties (water repellency) making them also more prone to noxious weed invasion.

A closer examination of soil surfaces also provides valuable clues to fire severity effects on soil.

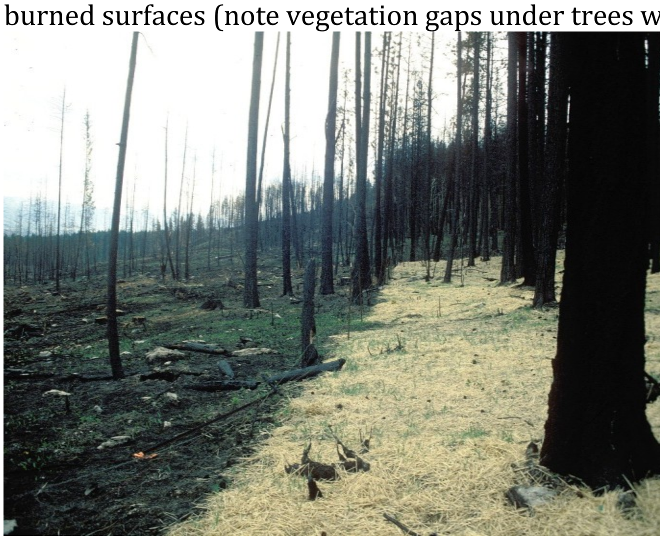
Wildfire conditions where the deeper forest floor organic layers did not burn result in only the upper layer of litter and duff burning off. This leaves behind charred but recognizable organic debris such as conifer needles and twigs. This also indicates that many plant roots survived allowing for rapid plant resprouting as moisture becomes available. The intact organic layer also is effective at absorbing surface water which minimizes soil surface erosion potential. Such soil surface fire effects are often considered good for soil.

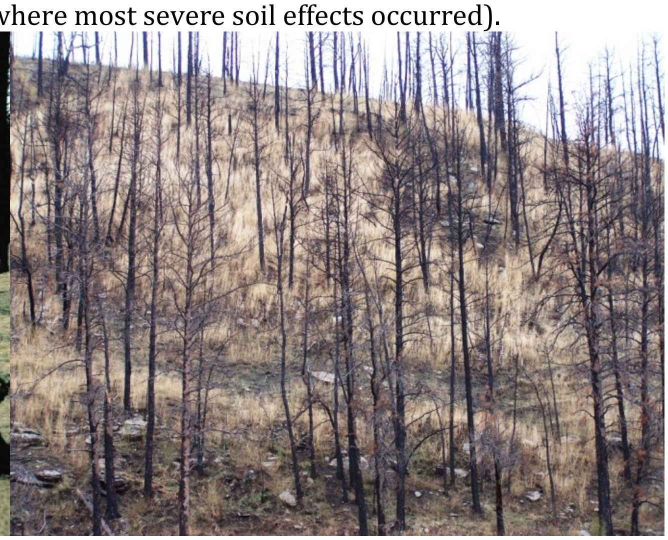


A fire where the majority of the surface organic layer was consumed due to exceedingly dry conditions or accumulations of surface fuels results in little recognizable surface debris with only fine ash being left behind. Such severely burned surfaces are characterized by thin to thick accumulations of fine ash. Such ash layers absorb water fairly well, however, may not allow water percolation through them into the mineral soil below. Such severe soil surface impacts can indicate poor plant resprouting and inhibit new plant colonization from seeds. Depending on the soil texture and site conditions, thick ash layers can persist for years (shown below) where 8 years after wildfire native vegetation remains sparse. Weed invasion on such sites can become an issue if they were present before the fire or found nearby.

Areas that have had severe wildfire impacts to both the overstory trees and understory grasses and forbs are highly prone to surface erosion because of a combination of ash properties and the lack of surface water flow obstructions. These areas are also more prone to noxious weed invasion because of the potentially poor native plant recovery. Many mitigation techniques exist and often a combination of practices are needed. Contour felling (left picture below) of dead trees and subsequent berming onto the soil surface is a proven technique to slow surface water flow and catch soil erosion (right picture below).

Straw mulch is also effective (left picture below) however it is expensive and care should be taken not to mulch too thickly as this may inhibit natural plant resprouting and introduce weed seeds. Preferred grass seeding (right picture below) is an effective tool to speed up recovery though this has little impact on potential erosion as grass seed may take one year to germinate and most erosion occurs in the first fall, winter and spring. In addition, without some soil surface scarification broadcast seed may not germinate well on severely burned surfaces (note vegetation gaps under trees where most severe soil effects occurred).





Any management action that improves water infiltration through ash layers and into the deeper mineral soil will assist in minimizing surface erosion and increasing plant recovery. The easiest technique is to increase organic debris on the soil surface . This will occur naturally across scorched forests as scorched needles, twigs, branches and stems fall onto the soil surface the first fall. Severely burned forests will naturally deposit organic debris at a slower rate as few needles remain and twigs and branches will take 2-10 years to drop and tree stems 3-15 years (depending on species). Fire killed forests should be avoided during wind storms!

An alternative restoration technique is salvage logging of fire killed trees, however wood markets for this material must be available. The wood of fire killed trees is still intact and can be milled if harvesting occurs in a timely manner following wildfires. Fast growing or younger ponderosa pine typically degrades quickly – within 3 months to a year of a wildfire. Lodgepole pine will persist for various markets for several years though stems that develop spiral cracks in them have minimal value to sawmills, though may be bought by the log home industry or post and pole businesses. Douglas-fir wood can remain viable for 3-5 years depending on stem size and site conditions. For ecological purposes salvage logging may have the best impact if done as soon as possible after a wildfire because the trees retain their best wood quality, and the act of salvage logging will create an extensive woody debris load on top of burned soils which is an effective barrier to soil surface water flow and erosion. Surface woody debris may also create safe sites for tree and plant seeds to germinate, hastening natural revegetation. Ash surfaces can easily heat up from the sun and surpass lethal vegetation temperatures during the summer months – with soil surface temperatures exceeding 160°F. The consistent shade produced by horizontal woody debris (horizontal or persistent shade) provides cooler sites than the ephemeral shade of the vertical stems (vertical or moving shade) of fire killed trees. In areas with thick ash accumulations the mixing with mineral soil from logging equipment can also help with ash created water infiltration problems and alleviate some of the hostile microenvironment to germinating seeds.

Results of severe wildfire effects on a lodgepole pine forest (left picture) on a private ranch ownership and the same site one year later (right picture) following salvage logging. Areas with poor grass recovery were also seeded with a preferred grass mixture to hasten recovery. The same area (below) two years after the wildfire with salvage logging and reseeding. In most wildfire situations natural understory vegetation recovery will occur without any assistance, though the time required will vary depending on the local site conditions and species present.

Natural tree recovery will depend on original tree species and severity of the burn. Severely burned areas with a lodgepole pine or larch components will recover naturally as these species have wildfire resistant cones (lodgepole pine) or can seed in across great distances (larch). Ponderosa pine and Douglas-fir sites with severe wildfire effects will typically not naturally recover as the seeds from these species cannot survive severe wildfires. Replanting the first spring after a wildfire is essential if a restoration to forest is desired. Alternatively such sites will convert to range or shrublands.