Wildfire Severity Photo-guide for Assessing Damage and Aiding Recovery of Trees and Forests across the Northern Rockies

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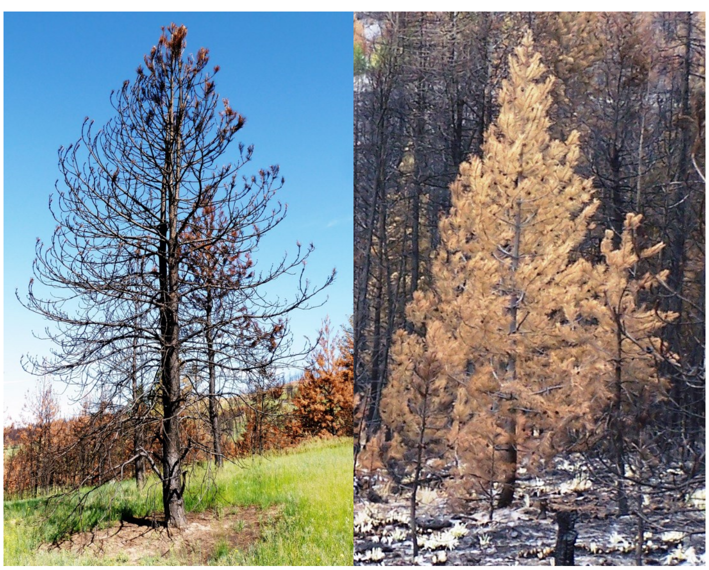
Introduction

This guide was developed using extensive post-fire evaluations of trees and surface vegetation over several decades. Wildfires can cause different levels of damage to trees and understory vegetation depending on fire intensity, duration, time of year, forest type, species impacted and fuel types. For some vegetation types, such as many grasslands, recovery can be fairly quick. Others, such as dense forest with heavy surface fuel loading vegetation, recovery can take a decade and the site may be significantly altered for a century or longer. Thus knowing the type of vegetation that existed on a site prior to the fire is the first critical element of determining what kind of recovery may take place. The second step will be to examine the severity of the fire on both overstory vegetation (trees) and understory vegetation (grasses, forbs, shrubs). The term "severity" is used to describe how much of the original vegetation was killed, and what impacts the fire had on the soils. A **low severity** fire can be defined as burning through dead fine fuels and causing minimal damage to existing vegetation, such as burning tops off grasses, forbs and shrubs. In many western native plant communities, a low severity fire may increase site productivity by enhancing nutrient cycling and soil productivity, though some fire sensitive plants and tree species are also easily killed by such a fire. A **high severity** fire results in the death of most of the overstory trees and understory vegetation, even those that have adaptations such as deep roots or thick bark that allow them to survive some fire. A high severity fire often results in changes to a soils ability to absorb water and can lead to potential mass erosion. The final step is to assess the extent of the fire impacts across the landscape. Across the mountainous west, every landscape is part of a primary watershed that collects and funnels water into primary streams. Fire impacted landscapes generally have a lesser ability to absorb water the first year after a fire, and high intensity rainfall events. Rapid spring snowmelt can also lead to soil erosion, debris flows, plugged culverts and downstream flooding. Stabilizing soils and increasing soil water absorption after a fire are an important part of helping an impacted landscape recover.



Picture 1. Foliage consumption of an entire coniferous tree (left) usually indicates tree death. Depending on the tree species, scorching (right) may leave cambium and buds alive that will resprout in the spring.

Starting the assessment

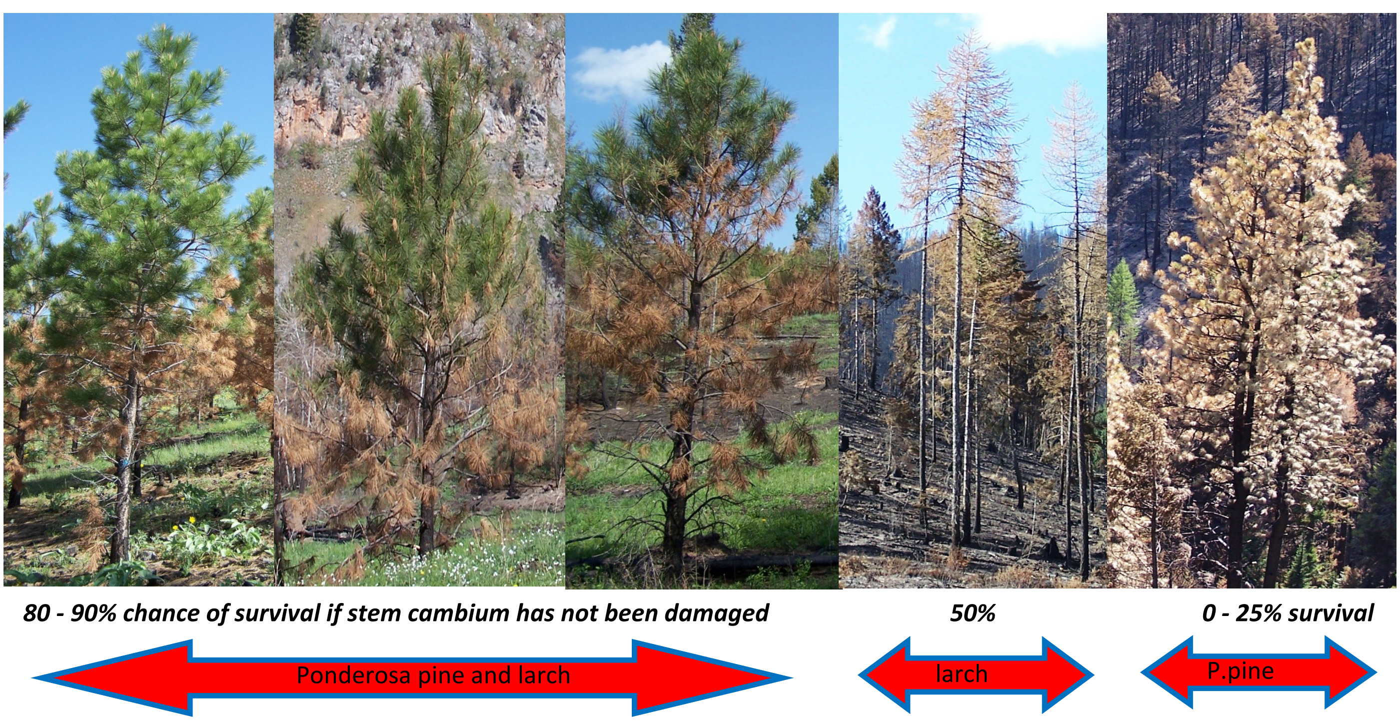
The most visible impact of a wildfire is the effect it has on the dominant vegetation—which will be the tallest and most expansive plant species that existed before the fire. For any forested ecosystem, the first assessment will be of the trees that grew there. Although different tree species have different abilities to survive a wildfire (discussed in further detail within this publication), in general, when a conifer crown burns or "torches" leaving only a blackened stem and branch skeleton behind (Picture 1), the tree is dead and will not recover. Alternatively, if a tree is "scorched" by the heat of a wildfire which turns leaves or needles brown or red, but does not consume them into black skeletons, some species may survive. Assessing scorched trees can be tricky, with some species very sensitive to heat and killed if only a small portion of the crown is scorched, and others surviving almost 100% scorch. Aside from species differences, survival will also depend on the tree condition before the fire, how long heat remained near the tree (a short bake versus a long bake), and what the after-fire weather was like.

For clarification, the term "fire intensity" is often misused to describe fire severity. Fire intensity describes how much energy was released by the fire over a specific time duration. A "high intensity" fire typically has enormous flames that can reach 30 to 300 feet into the sky. In some forest situations and most range fire settings, this kind of fire will release a lot of energy, but only persist on any location for 10 minutes or less. Although a high intensity fire will typically kill most trees, and thus be categorized as "severe" on trees, the impact on forest understory vegetation will depend on prior surface fuel loading and understory vegetation. Thus a "severe" fire on trees does not automatically mean it will have had severe impacts on surface vegetation such as grasses. Alternatively, a surface fire burning in heavy surface fuel loading may be a "low intensity" fire because flames rarely exceed 4 ft heights, but it may smolder on the soil surface for days and sometimes weeks, imparting a lot of heat over a long period of time into the soil surface. Such a fire may also result in high fire severity even though it does not burn the crowns of trees. The steps described in this guide were developed to assess the recovery needs of your burned forest.

Assessing tree crowns

The four main evaluation criteria for trees following a forest wildfire are: 1) Tree species, 2) Crown needles and buds, 3) Stem inner bark and cambium layers, and 4) Root crown and surface roots. Fire impacts tree crowns through radiant heat and direct combustion. Living tissue starts to die when it is heated to 150°F for a minute or more because cell walls and proteins start to break apart at this temperature. This kind of damage occurs from radiant heat—similar to what you experience standing next to a wood stove or campfire as well as convective heat—hot gasses moving through tree crowns. High intensity fires can radiate lethal heat as far as 100 yards from the flames. High winds can push super heated gases 1/2 mile or more. Alternatively, live needles or leaves do not combust until they reach a minimum temperature of 500°F and this will only occur when most of the water in the leaves has evaporated. Direct flame contact or high radiant

Fire resistant tree species – ponderosa pine and western larch



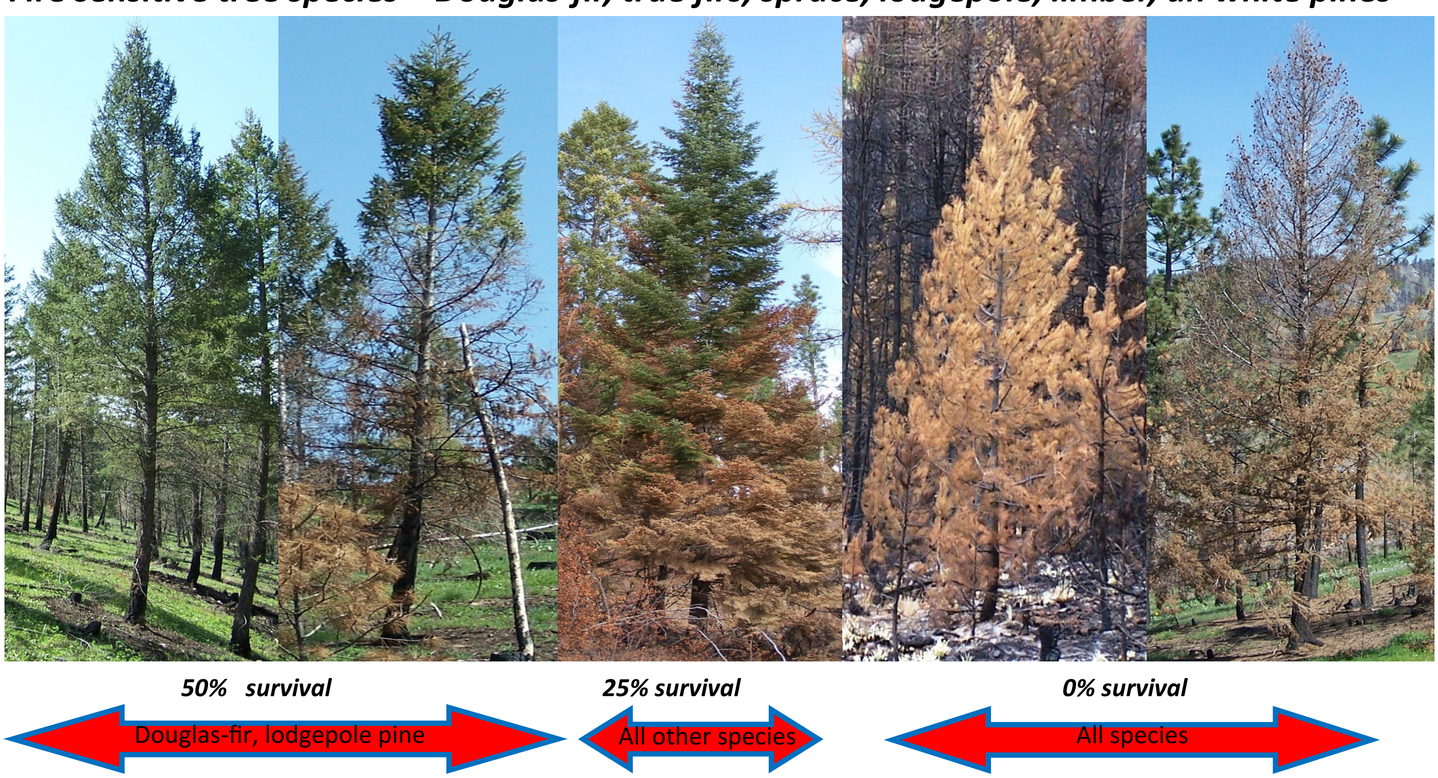
Picture 2 Different levels of crown scorch on <u>ponderosa pine</u> and <u>western larch</u> and their probability of survival.

heat loading can cause leaves to combust. Depending on plant tissue water content and plant heat shock proteins that develop as leaves mature and adjust to warmer summer weather, heat damage to plant tissue can take different times to develop. A plant that has a high cellular water content is less susceptible to heat damage than a drought stressed plant, and a plant that has adjusted to higher summer temperatures is also less susceptible to initial heat damage. Young plant tissue, such as newly emerged leaves in the spring are very sensitive to heat, though they have a high water content. Trees in a thinned forest, that have more space and access to water, just like lawn trees that are well watered, tend to experience less heat damage from a fire. Overall, well hydrated mature leaves are the most resistant to heat damage and combustion.

Different tree species have different leaf or needle configurations to balance light absorption with water-use conservation and temperature regulation. Ponderosa pine is adapted to grow on hot and dry sites and thus has long, narrow and widely spaced needles that allow air to move through them to keep them cool, as well as large thick buds with a high moisture content. These adaptations protect them from short periods of extreme radiant heat and make their needles and buds one of the most fire resistant of any species to radiant or convective heat from a wildfire. Western larch might be even more fire resistant than ponderosa pine, though uses a very different needle strategy. Since larch species are deciduous and drop their needles every fall, they can suffer 100% needle loss but survive a fire if their buds remain intact. Since tree buds are close to the branches and have a relatively large volume to surface area ratio, they can maintain a higher moisture content than needles and survive greater heat. Picture 2 shows an estimate of these fire adapted species crown survivability to different levels of heat and needle scorch, with mature larch able to survive more needle scorch than ponderosa pine.

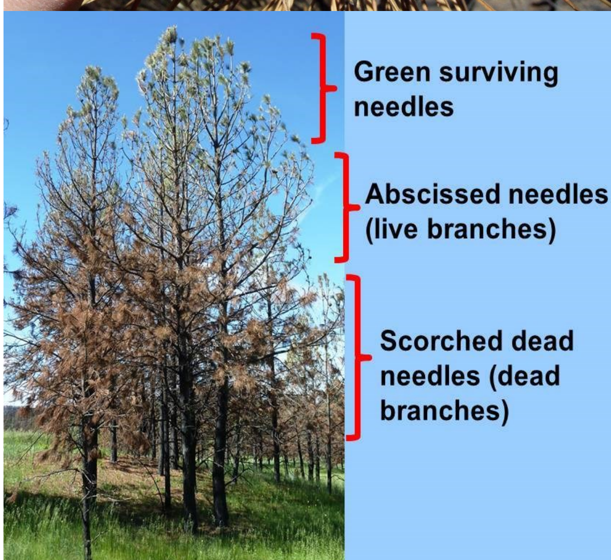
Douglas-fir, grand fir, subalpine fir, spruce and cedar alternatively have flatter and denser needle configurations that allows them to absorb sunlight better in the shaded understory where they tend to start growing. In order to take advantage of spotty sunlight they produce numerous small buds for advantageous branch growth. Smaller buds heat up more quickly and suffer quicker damage than the large widely spaced

Fire sensitive tree species – Douglas-fir, true firs, spruce, lodgepole, limber, an white pines



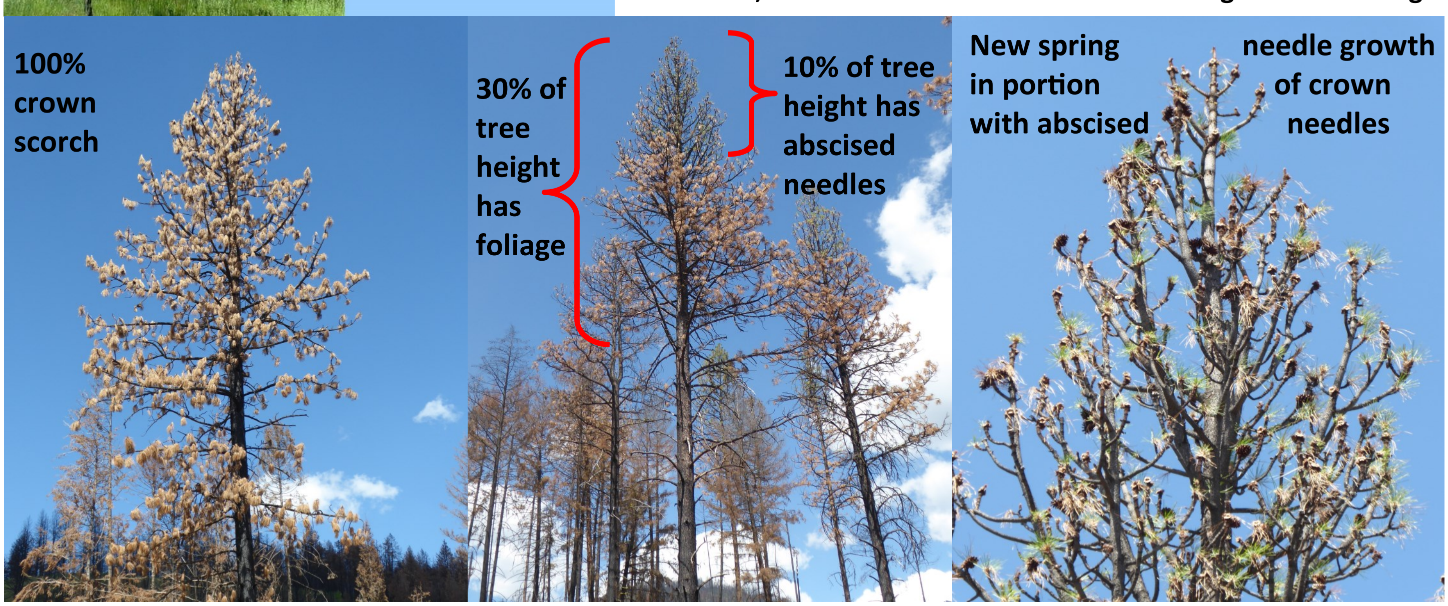
Picture 3. Different levels of crown scorch on Douglas-fir, grand fir, subalpine fir, spruce, lodgepole, limber, & white pines. These species have very thin bark and crown scorch is typically associated with cambium and root damage.

buds of ponderosa pine. In addition, the dense shade adapted foliage of these species traps heat more readily and is why these tree species tend to suffer more heat damage and often burst into flames more quickly than ponderosa pines. After an initial examination of the tree crown and level of scorch, it is helpful to look at branch tips and buds (Picture 5). Live conifer branch-buds contain tiny preformed needles that will elongate the following year and will provide new foliage for the tree to carry out photosynthesis. Scorched needles are dead and it is essential for the tree to retain the ability to grow new needles from intact buds. If both needles and buds are killed from the heat it is likely the tree will not recover and grow.



Picture 5. Tree buds on ponderosa pines are shielded from heat by surrounding needles, plus they are relatively large and robust. Those killed by heat (upper left) will be dried out and shrunken whereas live buds are green and juicy on the inside and often surrounded by inner green needles (upper right).

Picture 6. Severely scorched trees can be assessed based on whether or not branches abscise dead needles. Only live branches will drop scorched needles (left) whereas branches killed by heat will hold onto dead needles well into the winter months. Severely scorched trees (bottom left) will start dropping damaged needles within a month or two (bottom center) and resprout new needles the following spring (bottom right). Generally, if more than 10% of the crown shows needles abscission, typically on the top of the tree crown, the tree has a 50% chance of surviving and recovering.



Aside from live buds, the inner bark on smaller branches of trees exhibiting scorch can also be heat impacted. Particularly on taller and older trees that tend to be more heat resistant because their crowns are further from heat sources on the ground and because air circulation can keep them cooler, needles may be scorched but buds and twigs remain alive. On taller trees it can be difficult to get a close look at branch tips and buds. By tracking scorched trees we have learned that small branches that were not killed by the heat will remain physiologically active and drop (abscise) injured or dead needles as fall approaches (Picture 6) . This can be a useful tool to assess larger trees that have suffered from severe scorch. Those showing needle abscission on at least 10% of the crown might be worth giving a chance to regrow needles by the following summer. Such trees may require 3-10 years to develop full needle compliments as they rarely regrow lower branches and can only add needle area by live branches growing wider and taller.

Picture 7. Mid-sized trees are often the most resilient to wildfire damage.

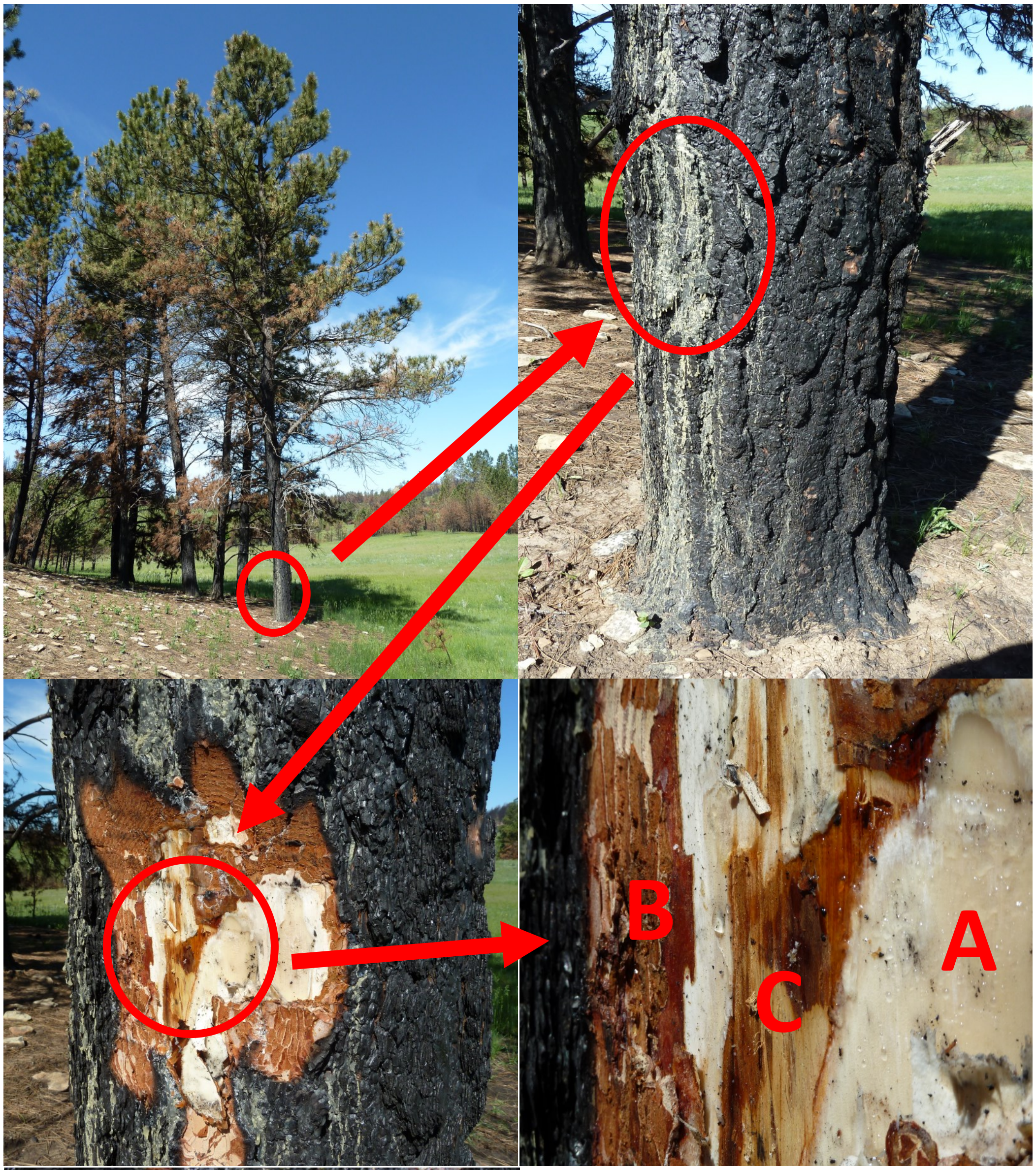
Tree size and age

Younger trees normally can sustain much more damage than older trees and make a full recovery. However, younger trees have thinner bark and are closer to the ground where heat from surface fuels can impact them more greatly than older trees. Often, all the smaller trees will be killed by wildfire and mid-sized and larger trees will survive because their thicker stem bark shielded living stem tissue and needles higher in the tree only experienced dispersed heat. However, not all older and larger trees are more fire resilient. Much depends on the health and vigor of the tree, and many older larger trees are not as healthy as they may appear and are suffering from diseases and have a diminished energy reserve that is essential for regrowing fire damaged needles and branches. Trees are no different than any other organism where the very young and very old are the least resilient to surviving disease or injury.

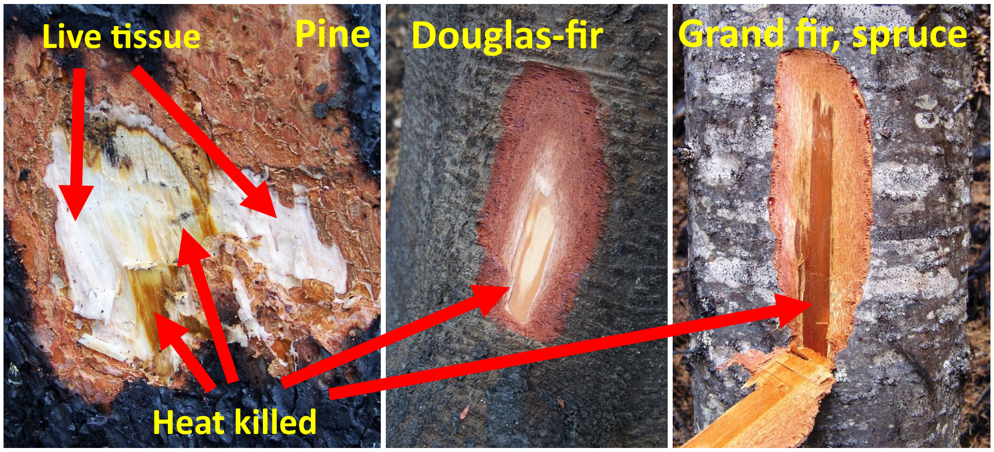
Picture 8. The general axiom that the oldest large trees are the most resilient to fire damage originates from the observation than older trees have thicker bark that shields them from heat and taller crowns that keeps them from being consumed by surface flames. Although older trees may stand a higher chance of initially surviving a fire, in many cases they succumb several years after a fire from fire related stress. The left picture shows the taller mature tree was the only one not consumed in a crown fire because of its tall and more isolated crown. The author has, however, observed that many times such trees do not survive the following decade (center) as well as mature trees that are younger and more vigorous (right). Much more research is needed on this topic.

Assessing stem damage

The thin cambium layer under the bark of a tree is comprised of the growth cells within the tree stem and they are very sensitive to heat. Prolonged fire next to the stem can provide enough of a heat load to damage this tissue that will result in tree death if the damage to the cambium extends around the circumference of the tree. In all species healthy cambium tissue is a creamy or slightly off-white color (Picture 9—A). The cambium annually produces a new layer of inner bark (middle left) that functions as a transport conduit of sugar from the needles to the roots (outer phloem layer). The cambium also grows a new layer of woody tissue (sapwood) toward the inside of the tree stem that has the function of transporting water from the roots to the needles. If the cambium is killed it cannot grow new sapwood or inner bark and this bottle neck causes the roots to starve, and needles to die from lack of water.



Picture 9. A tree may appear to have suffered minimal crown scorch (top left), however, it can sustain heat damage to its stem tissue that is also lethal. This can appear as pitch streaming (top right) through the bark because pitch is a defense substance that trees produce to seal off injuries. Fire impacted trees should have their stems carefully examined for such injury following exposure to a fire. A drought stressed tree may not be able to produce much pitch which is why suspected heat damage should be carefully examined by peeling away small portions of bark, perhaps 1/2 to 1 inch in diameter. More was peeled off in the picture for demonstration purposes. White or green spongy tissue just under the bark (A) indicates no damage. If the tissue is tan (B and C) or brown in color then more excavation may be warranted to see how much damage occurred. Pine species and larch can tolerate up to 50% of their stem girdled by heat and still survive because they can regrow cambium over the injury (bottom left). Douglas-fir tolerates damage to about 1/3 of the circumference and all other species less than 1/4, though such injury often allows for chronic stem decay to develop that will eventually kill the tree. Thin barked trees suffer from stem heat girdling more easily (Picture 10).

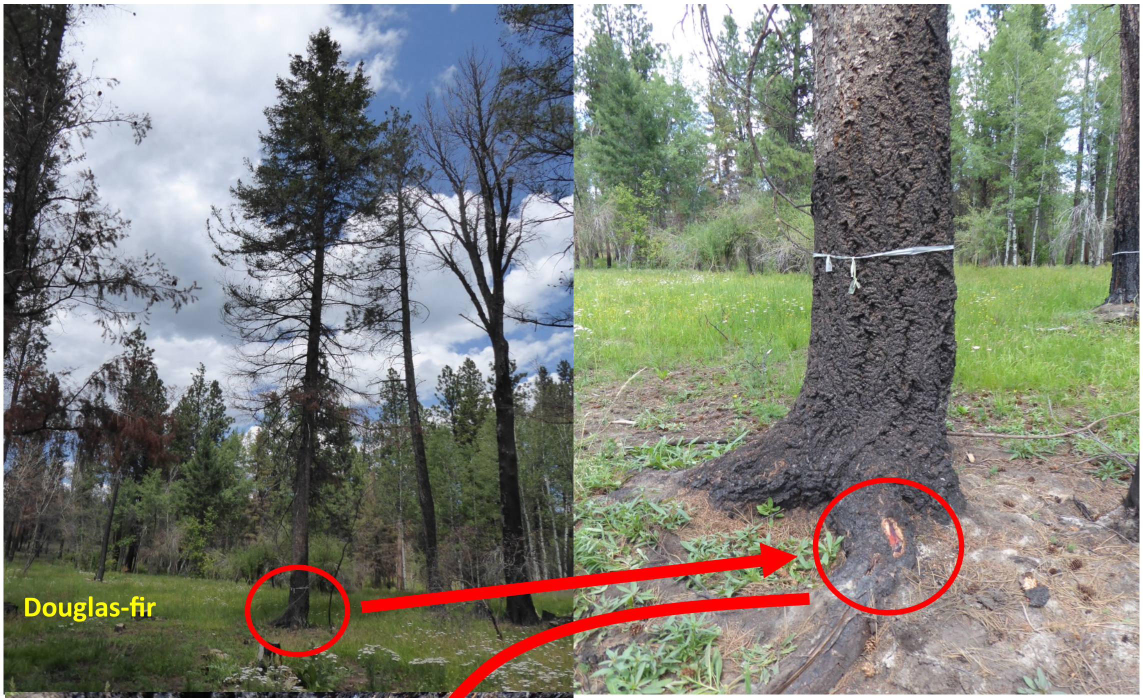


Picture 10. Thick barked trees (left) can survive significant heat whereas thinner barked trees such as Douglas-fir, grand and subalpine fir, spruce, lodgepole pine and limber pine are easily heat damaged.

Living inner bark will quickly create beads of pitch to seal the wound whereas heat damaged tissue will not.

Root crown damage

One of the most easily overlooked fire injuries to trees is heat damage to the top of the root flair. Most ponderosa pine and larch trees do not exhibit much root flair at the base of the stem, but most other tree species do, especially those found on wet sites such as spruce. When thick organic layers accumulate against the tree stem or on the soil surface, such material smolders for longer periods of time that imparts a lot of heat to the root crown. This causes a delayed death as this damage slowly impairs water flow to the needles, and allows root decay fungi to invade and kill the root system.



Picture 11. A Douglas-fir (left) that appeared to survive the fire had significant heat damage to the root crown where main roots egress from the stem. Such root damage can kill trees 1-5 years after the fire with survival rates similar to the degree of stem girdling.

Assessing forest understory vegetation and soils

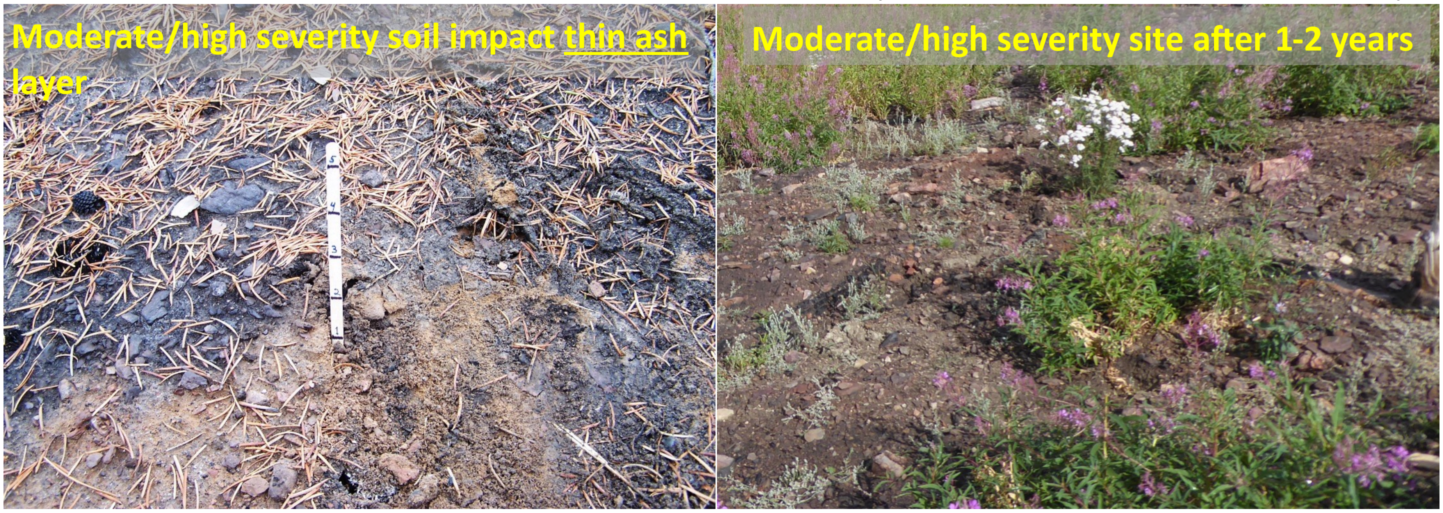
A fire blackened landscape can be overwhelming to look at until you learn what to look for. In general, black ash denotes a quick moving fire that consumes organic fuels but does not penetrate deeply into the soil. White ash indicates high temperatures resulting from heavy fuel accumulations where higher temperatures occurred and longer duration heat baked the soil and killed all vegetation. Such white ash zones have a higher erosion potential and are much slower to regrow vegetation.

Picture 12. A large dead log burned with high temperature baking the soil underneath (top left) compared to black ash where only the grass overstory burned away. Deep fuel accumulations at the base of a tree (top right) resulted in a white ash area where no understory plants survived and the tree base was killed.

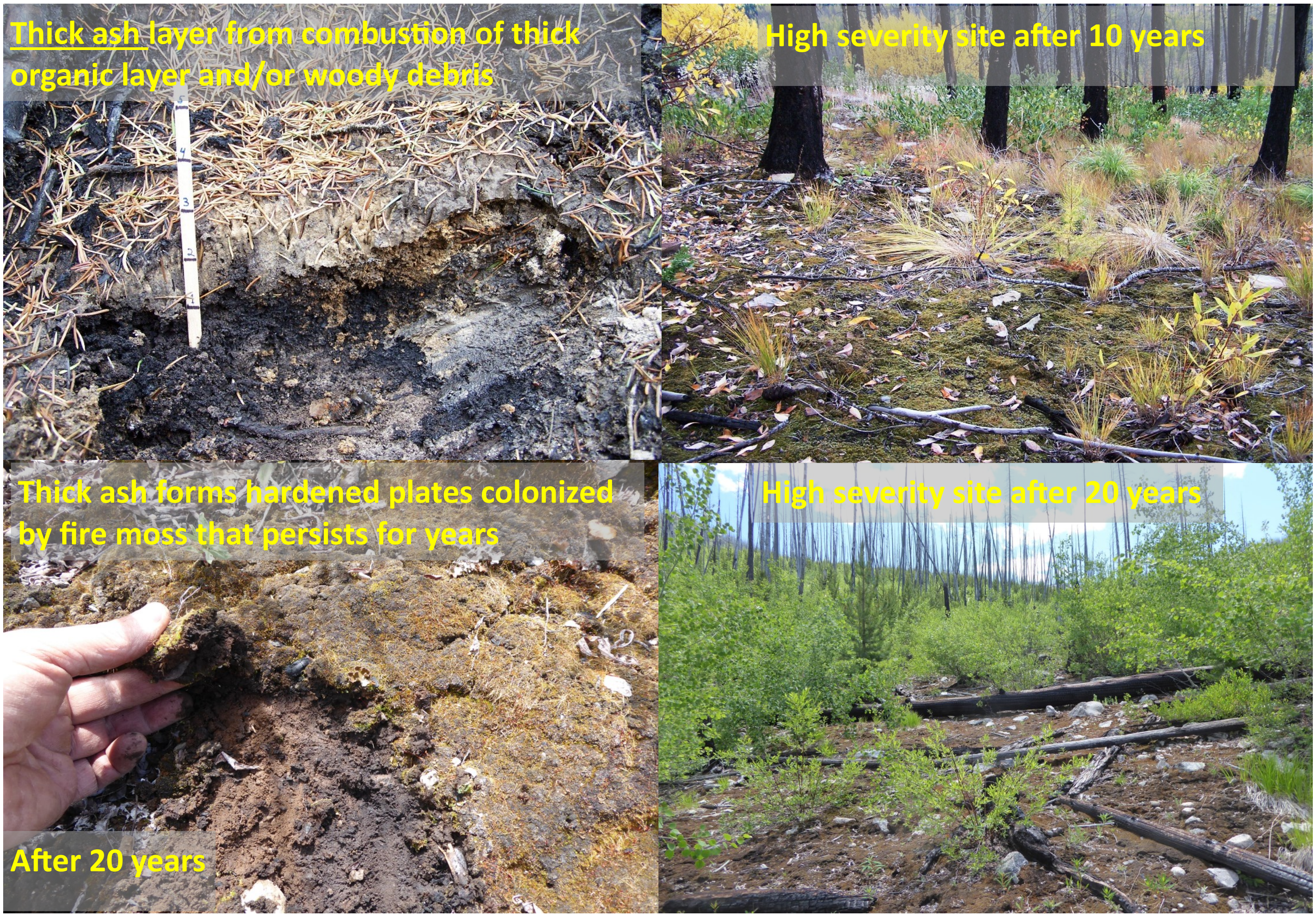
Picture 13. A surface fire with a damp soil surface will leave behind much of the decomposed surface organic matter where plant roots and seeds can survive (above left). Any rainfall event will stimulate surviving plants to quickly resprout (above right). Surface fires will generally stimulate denser plant and shrub regrowth in spring (below).

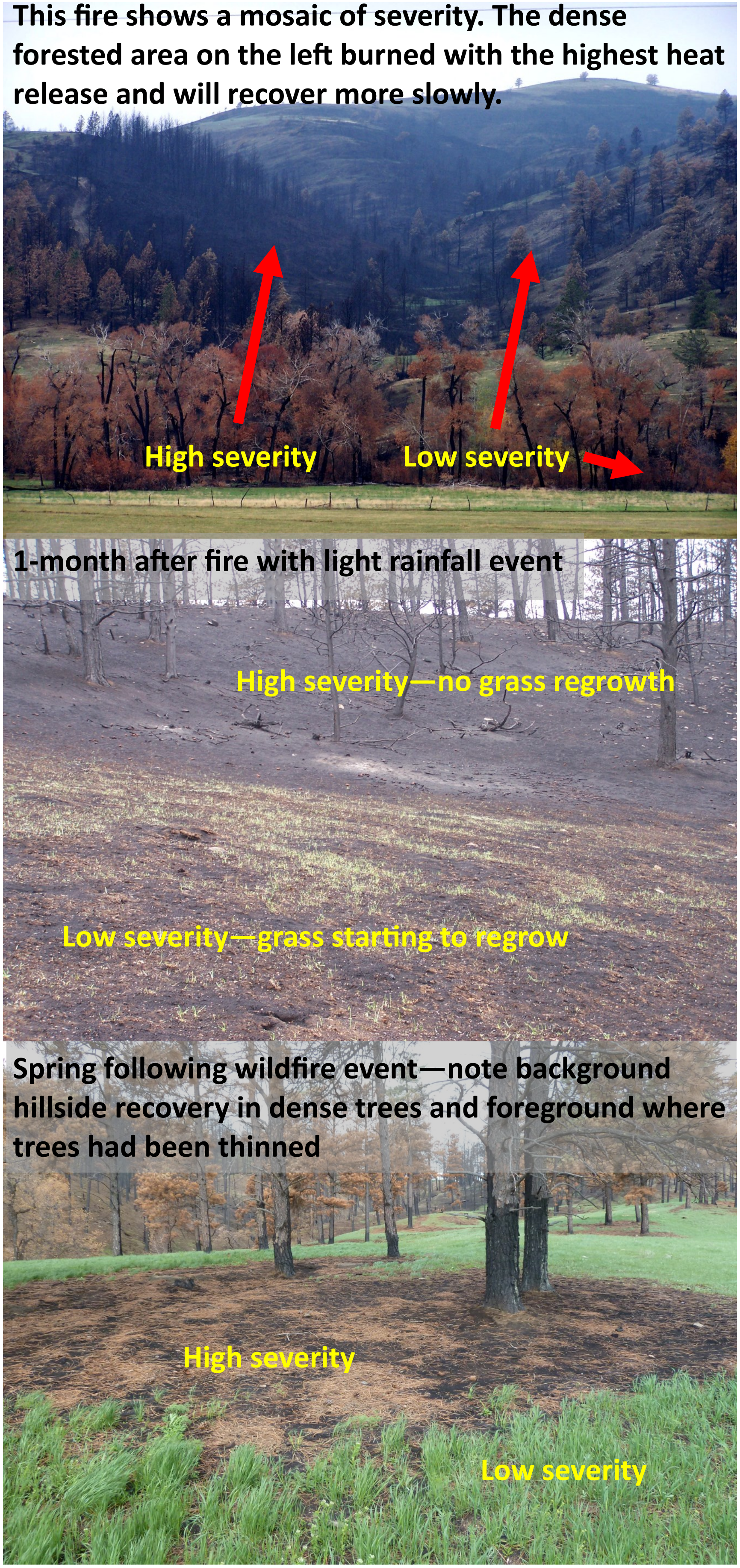
Low severity surface fires are considered by most resource managers as beneficial events that liberate dead organic bound nutrients. Such lightly burned areas often support higher biodiversity and better plant growth than unburned areas. They are not usually at risk from erosion and are sought out by wildlife because the regrowth seems more palatable. Any disturbed site is at a higher risk from noxious weed or invasive exotic plant invasion. Locating and treating invasives before they establish is important.

The impact of wildfire on surface vegetation is highly dependent on surface fuel accumulations and the density of overstory trees. Most non-forest range settings do not accumulate enough fuels to support a longer duration fire that imparts enough heat on the soil surface to kill plant roots or dormant seeds. A tree overstory can shade and suppress grasses, forbs and shrubs while also creating deep dead needle accumulations that burn with a lot of heat. Thinned forests not only inhibit severe crown fire behavior, they



Picture 14. When a fire consumes both the litter and decomposing organic materials on the soil surface the resulting soil surface can be considered severely impacted. Since plants also place a lot of their root system in the soil surface organic layer, significant mortality of grasses and forbs can be expected. Resprouting does occur though it may be patchy (above) and windblown seeds often are the major recolonizing plants. A site with thick ash remaining (below) is the result of high fuel loads being consumed. Such sites are very slow to recover with few resprouting plants.





Picture 15. This series shows the mosaic of fire behavior and severity based on preexisting plant communities and their recovery.

promote a healthier and more fire resilient understory plant community that recovers more quickly after a fire.

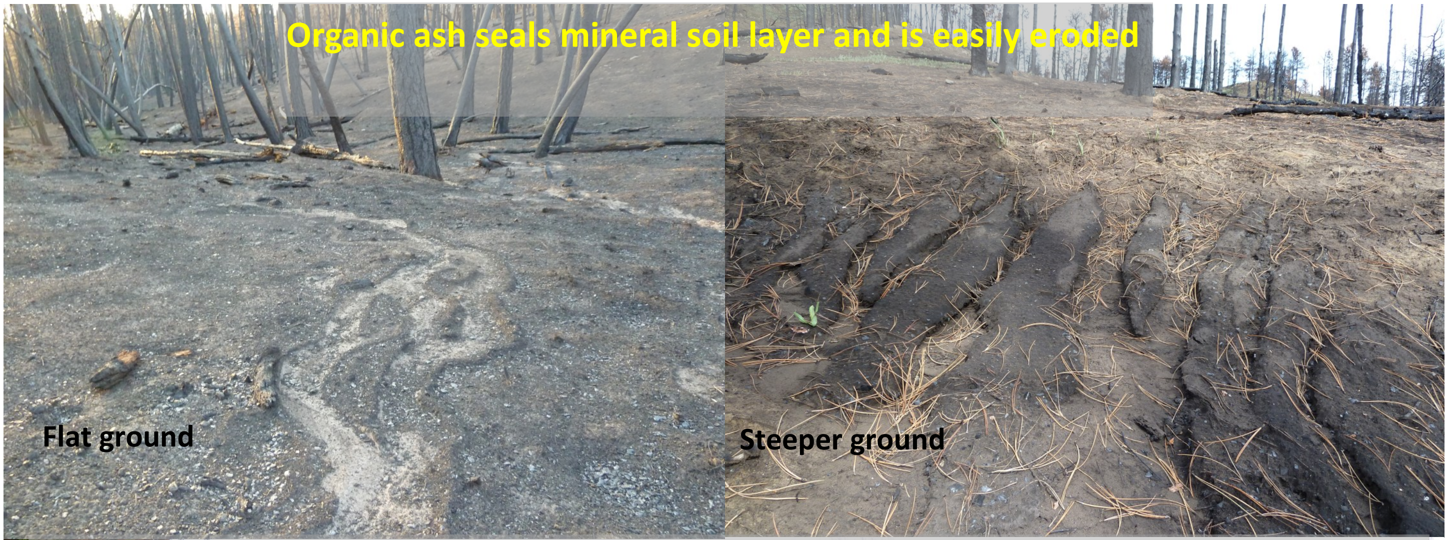
Assessing what part of a burned area is at risk from soil erosion, noxious weed invasion, and contributing to potential flooding and debris flows, is based on how much of the area suffered from severe fire effects—predominantly on the soil surface. The loss of a surface organic layer and vegetation allows for the impact of raindrops to loosen soil particles. In addition, organic ash quickly absorbs and is saturated with water that allows it to liquefy and plug soil pores. This can lead to poor soil water absorption and surface flow of water. Thick ash layers are also not the best seedbeds for beneficial pioneer plants, such as fireweed, to colonize.

There is some science literature that refers to soil "hydrophobicity" after a fire, defined as volatilized organic waxes and oils that have condensed on the soil surface making it water resistant. Although such phenomenon exists, typically organic ash is water loving, easily getting saturated with water that creates a "greasy" feeling surface to walk on. This water saturated ash creates what is called a "historesis" effect, similar to a water saturated sponge, that holds onto water very tightly and does not allow more water to pass through or leave the sponge. Such water saturated ash layers are very unstable. Additional water can create debris flows that combine with charcoal and small partially consumed organic matter to flow downslope (Picture 16).

The larger the impacted drainage, the larger the water accumulation and the more energy it has to move soils and partially burned woody debris that can plug culverts and bridges. Stabilizing such impacted slopes not only speeds up vegetation recovery, it can moderate flood events from occurring.

Water impacts

Rain and melting snow are one of the greatest post-fire concerns. Downpours or rapid snowpack melt in the spring can cause severe flooding and debris flows that typically cause more damage to homes and roads than fires. Stabilizing severely burned soils should be a primary objective of post-fire rehabilitation. The main goal is to increase soil water absorption and decrease soil surface water flow.



Picture 16. Increasing soil water absorption and decreasing surface water flow <u>in the upper reaches</u> of a drainage is critical to reducing fire related flood events. Accumulated water can break though lower drainage erosion barriers.

Picture 17. Fine partially burned organic matter (upper left) such as charcoal, is easily eroded by rainfall events. This material is essential for local soil building processes and needs to stay on site to help future vegetation growth. Water tends to accumulate on road surfaces, and moving organic matter and soil erosion plugs culverts causing washouts. Multiple upper watersheds can combine flows lower in the drainage with catastrophic results.

Picture 18. Creating barriers to soil surface water movement and dislodged soil particles is critical to prevent mass erosion and flooding. Contour felling of trees and placement of stems into the soil surface to create barriers is an effective tool. Simply falling trees is not as effective as only 10-20% of a fallen tree makes soil contact.

The salvage logging option

Logging is simply the act of removing tree stems for utilization elsewhere. It is neither good or bad as a landscape practice and is based on a landowners objectives for their forest. How logging is accomplished is the part of the practice that determines its impact on the soil and ecosystem. Salvage logging can aid in the recovery of a wildfire impacted landscape if the removal of trees is combined with soil stabilization methods.

Scenario **A** used a whole tree removal technique where trees were mechanically felled. The entire tree was dragged to a landing where it was processed for its merchantable wood and the unusable parts (branches, rotten stem segments, small diameter stems) are piled into a large pile and then burned. In this scenario, very little woody debris is left on the soil surface and downhill skidding of logs can result in soil surface water movement and erosion.

Scenario **B** is also using whole tree skidding but more branch breakage is created and left on the site, plus skid trails are water barred and covered with woody debris to slow soil surface water movement. In this case salvage logging is helping with soil stabilization—though a little more woody debris might be better.

Scenario **C** uses a logging technique called “cut-to-length” where trees are mechanically felled, delimbed and processed where they were felled. This process is extremely effective at leaving ample woody debris on site. Soil erosion and flooding risk are significantly reduced. Depending on the site, such processing can leave too much woody debris that might require some additional cleanup.

Scenario **D** shows 1-year after whole-tree harvesting where ideal erosion barriers were created by woody logging debris that has close soil surface contact.

Picture 18

Additional restoration tactics

Since wildfires became a larger landscape issue several decades ago, various restoration tactics have been tested. Examples include seeding preferred grasses, seeding cereal grains such as winter wheat, straw placement, straw wattles (picture 16), contour felling, logging slash placement, and even spraying a mixture of organic mulch with seeds (hydromulching) on exposed soils. All of them reduce the risks of soil erosion and flooding to varying degrees and costs. Some appear to be more effective than others, however, key to implementing any practice is applying it in the right place and time.

Direct seeding should be done once the site has cooled and preferably after a light rain. Early placement of seed can result in seed erosion and predation by displaced wildlife. In addition, grass seed that is a cool season species (can germinate and grow in cooler temperatures) is needed as warm season grasses that germinate towards the end of spring will not help curb erosion in the fall and early spring. Determining the right species can be difficult and depends on the objectives of the landowner—often if the grasses will be grazed or not. Seeding exotic grasses onto a site that had a low severity burn may be counter productive and interfere with native plant recolonization. All grass seed mixes should be certified as weed seed free, otherwise there is a risk of introducing an exotic unwanted weed. Some experimentation has been conducted using winter annual cereal grains or grasses that are quick to germinate but do not persist on the site because their seed is sterile or not competitive with native species. Ultimately grass seeding works best on severe burn impact areas where there will be few natives to recolonize the site and when combined with other soil stabilization tactics. Seeds are easily moved by water flow and soil/ash scarification improves grass seed germination and improves water infiltration. It is recommended that at least 40 seeds per square foot are applied (do not just go by pounds per acre because some species have big heavy seeds and some have small light seeds). Relying entirely on newly germinating grasses is not the best tactic for stabilizing burned soil surfaces the first fall and spring after a fire –which is when the worst erosion potential exists.

Straw mulch can also be effective for smaller areas, 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. In addition, without some soil surface scarification, broadcast seed may not germinate well on severely burned surfaces.

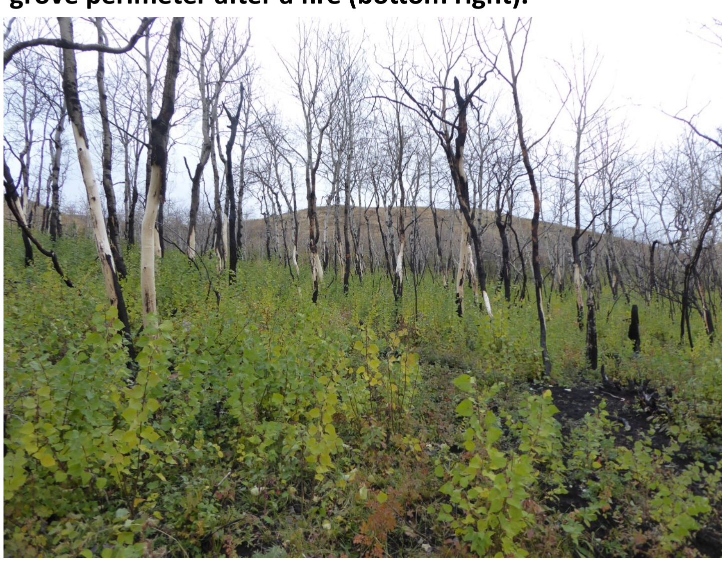
Picture 19. Straw mulch (left) applied 1-2 inches thick helps reduce rainfall impact and soil erosion. The mulch can be washed off site by soil surface water flow and works best in strategic areas on upland sites. It is essential that it is certified weed seed free. Direct grass or cereal grain seeding (right) can be beneficial on the most severely impacted soils and combined with some ash/soil surface scarification. Note: more severely impacted soil directly under trees did not provide for effective germination of grass species because no soil scarification was used. Make certain the grass species you chose meets with your management objectives as creating a wall of tall cured grasses in midsummer can be another future fire hazard!

Deciduous tree species

There are very few broadleaf tree species that have the ability for their above-ground stem to survive a wildfire, but most native broadleaf trees in Montana have the ability to resprout from the stem base (ash, willow, rocky Mountain Maple, hawthorn) or from root systems (aspen) . Aspen is one of the most fire adapted broadleaf trees and actually can benefit from wildfire. Its thin bark allows heat to easily kill the inner cambium layer and few, if any, stems will survive a surface fire. However, the fire darkened soil surface promotes higher soil temperatures that stimulate root suckering. An aspen grove often expands in size after it has been burned and neighboring conifers killed– with roots that extend outwards from individual trees and groves producing new shoots the spring after the fire. Many aspen grove are actually clones, with all stems sharing a common root system.

Most deciduous species are highly sought after as winter food sources by deer and elk. Depending on the location and abundance of broadleaf species, some protection from ungulates might be needed the first year after a wildfire. Electric fencing or repellants can be used to deter wildlife damage. Fire killed stems are also sought after food and nesting sources for a variety of birds. Decomposition of these stems tends to be relatively quick (most fall over within 10 years) and treating fire killed stems is usually not needed.

Picture 20. The thin bark of aspen is easily fire damaged (above) but the tree roots quickly produce new shoots from the roots and stem base (right and below). A healthy aspen grove will actually increase its size about 20-30 feet outward of the grove perimeter after a fire (bottom right).



Case study—ponderosa pine ecosystem

Wildfires can alter sites for 100's of years by eliminating some species and enhancing others. Although wildfires are a natural component of most Montana forest ecosystems, the transition between grasslands, shrublands and forest is a fluctuating boundary. For the dry forests of central and eastern Montana, wildfires almost always result in an overall loss of trees across the landscape. Thick barked ponderosa pine can tolerate surface fires, but crown fires kill mature trees and their seeds. Ponderosa pine has large heavy cones and seeds, and does not readily recolonize areas where trees have been killed. Pine seeds typically can spread downhill 100 yards and perhaps 30 yards uphill, thus their migration across the landscape is very slow.

Fire killed ponderosa pine decompose fairly quickly for dead trees in Montana, starting to decay and break off within 3 years after a fire. Their stem wood is salvageable for about 3-6 months after they have been fire killed and then becomes too decayed for any sawmill to be able to utilize them. Fire killed broken, yet standing, ponderosa pine stems are terrific habitat for cavity nesting birds such as chickadees, nuthatches and a variety of woodpeckers. When salvage logging occurs, 2-10 stems per acre might be left for cavity nesting birds. The tops will break off of almost every mature ponderosa pine and these fire killed forests can be very hazardous to walk through, especially when it is windy.

Replanting tree seedlings is required if a fire killed ponderosa pine stand is to be reforested—the spring immediately after a wildfire the best time to do so successfully. Once surface vegetation has reestablished planted pine seedlings may fail to survive because of water competition with grasses.

Before wildfire

2 months after the fire

5 years after the fire

Exotic cheatgrass often invades severely burned dry forest ecosystems

Picture 22. This fire killed mixed conifer forest was salvage logged the winter after the wildfire. Woody logging debris was placed to minimize soil erosion and logging roads were seeded with grasses.

Picture 23. The same site as the top picture 4 years after the fire and salvage logging. Natural tree seedling production was minimal so it was planted with container grown nursery stock.

Picture 24. 10 years after the fire and 7 years after seedlings were planted, the treated area is a recovering forest. Areas left to recover naturally have vastly fewer trees.

Mixed conifer case study

Mixed ponderosa pine, Douglas-fir, lodgepole pine and western larch forest ecosystems are common across most mid-elevation sites in western Montana. Larch is confined to the NW portion of the state. These forests commonly burn with mixed and high severity fire effects leaving a patchwork mosaic afterward.

Douglas-fir has a moderate capacity to initially survive a surface fire and can even tolerate some crown scorch. If the crown is consumed, the tree and its seeds are dead. If the crown is scorched the seeds may have survived. Douglas-fir can be a prolific seed producer after a fire, though seedling survival will require moderately mild summers as they are easily killed by drought and heat stress. Blackened soil surfaces exposed to direct sunlight can reach surface temperatures of more than 160 °F midday. South or west facing slopes are often too hot for Douglas -fir seedlings.

The wood of Douglas-fir remains valuable for sawmills for many years following a wildfire though the outer sapwood may start decaying within a year. Fire scorched trees are also susceptible to being colonized by Douglas-fir bark beetle that can grow into epidemic proportion within several years if enough mature fire damaged trees exist. Salvage logging is a technique to minimize such outbreak potential.

Fire killed Douglas-fir is a species that can be heavily utilized by woodpeckers and other cavity nesting birds, thus leaving some broken stems provides valuable wildlife habitat.

Mixed conifer forest—Douglas-fir and lodgepole pine case study

At slightly higher elevations Douglas-fir often coexists with lodgepole pine and subalpine fir. Lodgepole pine is a species that is easily killed by wildfire, but also has a unique adaptation to surviving as a species—serotinous cones. These cones stay tightly shut and can protect seeds within them for 30 years or

Picture 25. Typical lodgepole pine forest after a wildfire (above left). The same site the following summer after winter salvage logging (above right). Approximately half the green seen on the soil surface is from lodgepole pine seedlings that developed from seeds released by cones after the fire. Salvage logging had no impact on seedlings.

Picture 26. Severely fire impacted landscape 3 years after fire and salvage logging (left) and 13 years later (right). The majority of the fire killed trees that had been left have toppled over and well spaced seedlings are now 10 feet tall whereas crowded seedlings are 4-6 feet tall. No tree planting was needed but preferred grasses were seeded.

more. When wildfires burn through a lodgepole pine forest and kill all the trees, the heat from the fire causes the cones to open and disperse the fire protected seeds. All other tree species such as Douglas-fir and subalpine fir are killed by such a fire, leaving lodgepole pine as the only surviving species. Lodgepole pine seedling production after a wildfire can be extensive, sometimes with as many as 5-10 seedling per square-foot. Thus lodgepole pine gains a tremendous advantage through severe wildfires. Most lodgepole pine groves are the result of past severe wildfire.

Lodgepole pine wood is salvageable for several years after a wildfire, though as soon as the stem starts to crack its value for lumber significantly declines. Because it is a prolific seedling producer, salvage logging should be instigated immediately after a fire so as not to impact seedling germination and growth the following spring and summer. Dead lodgepole pine is a fairly poor wildlife species since it does not readily decay after a fire. Cavity nesting birds much prefer other species. If other species occur within a fire killed lodgepole pine forest, they are valuable to leave as wildlife trees.

Planting trees

Planting tree seedlings is a common and important practice for restoring a fire affected forest. Important plant nutrients are often tied up in dead organic matter across forests of the northern Rockies. These are released when fire consumes this material and studies have shown that available soil nitrogen, phosphorus and potassium are much higher for two years following a wildfire. Reforestation should be accomplished quickly after a wildfire. Pioneer tree species such as pines and larch are specifically adapted to grow on open disturbed locations, especially on south and west aspects as this is where blackened soil surfaces heat up from sunlight. More shade tolerant, but heat intolerant species such as Douglas-fir, spruce, grand fir and subalpine fir are better suited to plant on north and east facing slopes. Deer and elk predation can be significant issues on newly planted seedlings in burned areas the first year before other vegetation

Picture 27. Typical tree seedling available through forest tree seedling nurseries. To the left are bare root seedlings that are most often 2-years old and to the right are the variety of container seedlings available that are 1-year old. Size is often reflected in the price of the seedling. Most important is to match elevation and moisture of your site to the genetics and origin of the seedlings you are ordering.

starts to occupy the site. Tree seedlings should be ordered as soon as possible after a fire for spring planting. It takes a year to produce a container tree seedling and two years to grow a bare root seedling. Planted tree spacing should take into consideration your budget and land objectives. Do not confine yourself to only planting the tree species that existed before the fire. Consider all potential species that can survive on your particular location. The location and spacing of different tree and shrub species to be planted should be based on ecological site potential and the forest landscape you want to create—your property is your canvas, paint it to meet your land objectives!

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