After Wildfire

Section 4

Tree and Forest Restoration Following Wildfire

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After a wildfire has run across a landscape, it often appears as if the flames have destroyed all vegetation. However, many of our native trees, shrubs, forbs and grasses have some mechanism of coping with fire. Some will grow new leaves or needles; others will re-sprout from their roots, while others have fire resistant seeds that will sprout following a fire. Much of the response will depend on the intensity and duration of the fire. Fast moving fires such as those that occur on grasslands usually scorch leaves from trees but do not kill the woody stems or root systems. On the opposite side of the spectrum, fires that occur where heavy woody fuels have built up tend to burn for a longer duration around tree bases, releasing intense and direct heat that, in essence, cooks tree stems and root systems. Under the latter conditions the damage that fire causes to trees and shrubs can be more severe even though the tree may look as if it sustained less damage.

A secondary wildfire effect results from blackened surfaces absorbing more of the sun's energy. This causes severe increases of soil surface temperatures and plant stems, and may kill plants that had survived the initial fire. The following paragraphs will summarize some of the things that can be done to help trees and shrubs recover after a wildfire.

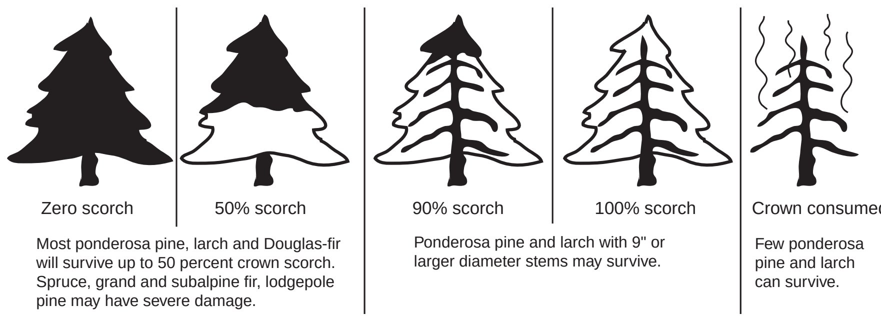

Figure 1.

Assessing trees

Although the temptation following a wildfire is to remove every blackened tree, it is important to first assess actual damage. Trees that look burned and have their leaves or needles scorched are not necessarily dead. Fire usually kills trees in two ways: by killing the cambium layer just under the bark of a tree, and by killing all of the leaves and buds. Often some of the cambium and some of the leaves have been burned, but not enough to kill the tree. How much damage was done will depend on how the fire behaved and what tree species burned. In most cases, if salvage logging is not being considered, it is best to wait until the following spring to determine if new leaves and needles reappear before deciding whether or not to cut down a scorched tree. If new leaves appear, the tree will survive and often will fill out to its former glory in 1 to 3 years. If no new needles or leaves appear by June, the tree is most likely dead.

There are several ways of assessing trees after a wildfire has damaged them. The first is to determine the extent of damage to the live needles on the crown of the tree. Needles that are intact but have turned orange or brown are referred to as "scorched." Needles that have been burned are referred to as "consumed." (Figure 1) Of all the conifers across Montana, two tree species, ponderosa pine and western larch, are the only species that can recover from a severely scorched crown. Ponderosa pine and Larch that have had over 90 percent of their needles scorched occasionally recover. Douglas-fir has an intermediate resistance, and may survive up to 50 percent crown scorch. The other common native tree species (lodgepole pine, grand fir, subalpine fir, hemlock, cedar and spruce) are often killed if their crowns are scorched more than 30 percent. If the needles in the crown have been completely *consumed* it is highly unlikely that any tree species will survive.

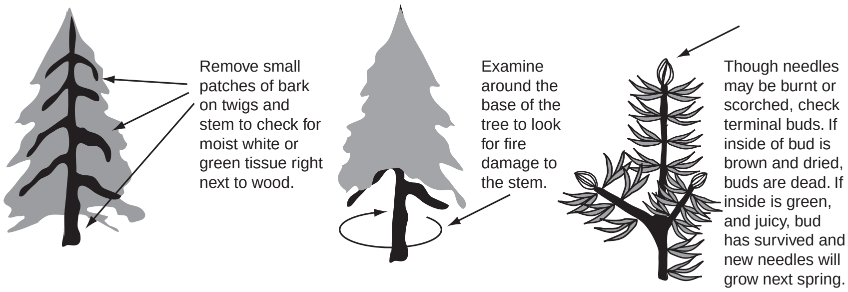

Figure 2.

Heat related injury to the tree's cambium layer is as important as foliar damage. This is the part of the tree that adds woody growth to the stem every year and is found just underneath the tree's bark. Some tree species have evolved a thick bark to insulate this layer. Ponderosa pine and western larch that have stem diameters greater than 9 inches are often characterized by bark that is 1 to 3 inches thick with a heat resistant plate-like structure. Older Douglas-fir can also have heat resistant bark, and are distinguishable from ponderosa pine and larch by bark that does not flake apart as easily. All of the other native conifers have a much thinner bark that is not fire resistant.

To assess a tree shortly after a fire, peel back the bark on twigs and the stem in a few strategic areas. Make quarter-sized or smaller cuts in the bark to determine if the cambium area has been killed. If the cambium under the scorched area is white or green and juicy-slimy looking, the stem has survived the fire and the tree has a good chance of re-sprouting leaves or needles. If the inner bark that lies next to the wood is dark brown, streaked and/or dried out, the stem area you are examining is probably dead. Fire resistant trees like ponderosa pine can have a portion of their cambium killed and still survive a fire. If the fire has killed more than 75 percent of the stem circumference, the tree will probably not survive to become a healthy tree.

Although stem assessments and percentage scorch are the best tools for assessing tree health, another assessment that can be made is to check for intact buds at the ends of branches. Buds that are still green and moist inside are alive, and if the tree stem has survived the fire the tree has a good chance of recovering. Be sure to check several branches and the main stem of the tree. Depending on the intensity of the fire, small twigs may be killed but larger branches left alive, or if there was a lot of fuel around the base of the tree, the stem adjacent to the ground may have been killed while the branches still look alive. It is important to check the entire tree (base of the main stem, cambium, larger branches and smaller twigs) to determine the extent of the damage. Or, wait until next spring for new leaves to form. (Figure 2)

Assessing soils

Wildfires usually travel quite rapidly over the surface of the soil. As the fire approaches, the intense radiated heat preceding the flames usually vaporizes a lot of the naturally occurring terpenes, resins and waxes that plants produce to protect their stems and needles. Although many of these vapors burn off, some condense on the cooler soil surface and form a water resistant layer. (These same substances are captured by wood processing plants and become major ingredients in the wood preservatives people apply to their decks.) Typically, the greater the intensity of a fire, the more gases condense on the soil surface and the more impermeable the soil surface will become to water. This results in what are called hydrophobic soils, which can significantly decrease the recovery of plant species on burned areas by excluding water recharge to the soil and promoting serious erosion.

Often hydrophobic soil conditions are only present in the upper 1/2 to 2 inches of soil and in patches across the burned area. On lightly burned areas where soil surface organic matter did not completely burn, hydrophobic conditions usually don't persist very long. (Figure 3) On sites where soil surface organic matter completely burned and mineral soil particles were baked, hydrophobic conditions can last up to a year. These areas are often identifiable by a layer of powdery white ash and orange colored soils. When possible, the latter conditions can be amended by lightly scarifying soil surfaces. This can be accomplished by dragging a shallow chisel implement over the area that does not penetrate the soil any deeper than 1 to 2 inches. Deeper penetration can result in serious tree root injury. Mulching scarified or hydrophobic areas will further help increase water absorption and reduce surface erosion.

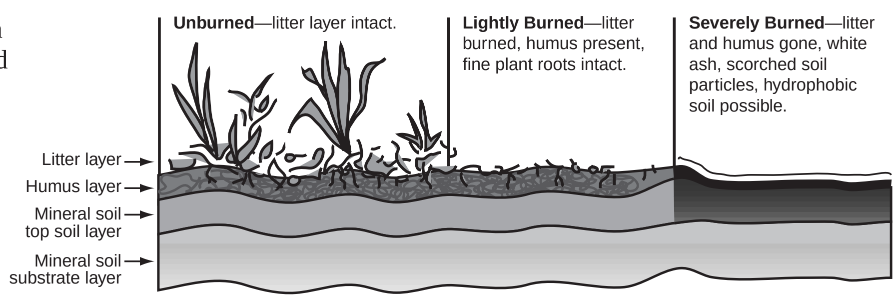

Figure 3.

Soil surface amendments

The black surface left by a fire absorbs almost all of the sun's energy, resulting in high soil temperatures, which can cause the soil to dry out more rapidly than normal. Both the increased temperature and dry soil conditions can harm the root systems of surviving trees. (An exception to this may be quaking aspen and cottonwood – warmer soil temperatures can stimulate root suckering if the mature trees have been killed). Since vigorous roots are required for a tree to recover from needle or leaf scorch, it is important to protect them. Soil temperatures can be kept cool by mulching lightly with straw around the bases of trees. The mulch should extend out from the tree stem 1-1/2 times as far as the longest branches. Straw mulch absorbs much less of the suns energy and keeps the soil cool and moist. Often, breaking up the black surface left by fire will also reduce excessive soil surface temperatures.

Applying grass seed to undisturbed burned soil surfaces often results in poor grass seedling survival. Black surfaces warm to lethal temperatures for grass seed when exposed to the sun and often do not retain enough moisture for good seed germination. If a site has been severely burned and has hydrophobic soil conditions, it is recommended to break up this type of surface condition. Shallow plowing, raking, or logging equipment operation can accomplish this. ***Note: this is the only circumstance where "heavy handed" soil disturbance is recommended!*** On sites where the organic layer on the soil surface is intact, only light disturbance is recommended to enhance the surface roughness and allow for a better seedbed. Take care to avoid losing the remaining organic layer to erosion. Take care to match the grass species to be seeded with the ecology of the site. It is recommended that an application rate of 40 seed/ft^2 be calculated and used.

Contour felling fire-killed trees has been shown universally to be the most effective tool for minimizing soil and ash surface erosion. The practice involves cutting down trees in a manner that lays them along the side of the hillside (Figure 4). Since a fallen tree stem normally only contacts the soil surface with 15 percent or less of its stem, it is also necessary to cut the entire lengths into approximately 4-foot sections. Often trenching soil on the uphill side and pounding stakes along the downhill side are necessary to stabilize logs. The greater the steepness of the slope, the more contour logs are needed. Another means of achieving the same objective is through contour orientation of logging debris from salvage logging.

Salvage logging: When and where is it appropriate?

Wildfires have been a natural component of inland northwestern U.S. ecosystems for at least 12,000 years. A theory that is gaining increased scientific support is that after such a time span, the plant, animal and fungal species of these ecosystems are adapted to and in cases, may be dependant on this type of disturbance. Therefore, wildfires are needed to maintain ecosystem processes, and the aftermath of wildfires (dead trees) will perform some function necessary for native ecosystems to be maintained. A fundamental question that arises is: "Are we doing harm by extracting wildfire killed trees?"

To attempt to answer this question, the current status of forest ecosystems of the Inland Northwest needs to be addressed. Assessments and research indicate that a large proportion of our forests are more densely occupied by trees than occurred historically. Furthermore, the tree species distributions across these forests tend to be skewed heavily towards shade adapted and fire-intolerant trees. These phenomenon are suggested to have occurred in part as a result of 90+ years of wildfire suppression activities. These data, when modeled using fire behavior models indicate that the forest wildfires that occur across the Inland Northwest tend to burn more severely than historically, which can also mean that a larger proportion of dead trees result. The severity of the fires that occurred in 2000 supports these modeled results.

Wildfires can be categorized into three types of forest fire severity:

1) Crown fires, which consume mature standing live trees and release enough heat energy to consume even soil organic mats;
2) Lethal understory fires, which stay out of the tree crowns but release enough energy to kill most of the mature live standing trees and consume a large proportion of the soil organic mat; and
3) Surface fires, which consume smaller diameter fuels but leave mature live trees and most of the soil organic mat intact.

Of these three types of fire behavior, crown fires and lethal understory fires tend to kill enough mature trees to warrant an economically feasible salvage logging operation.

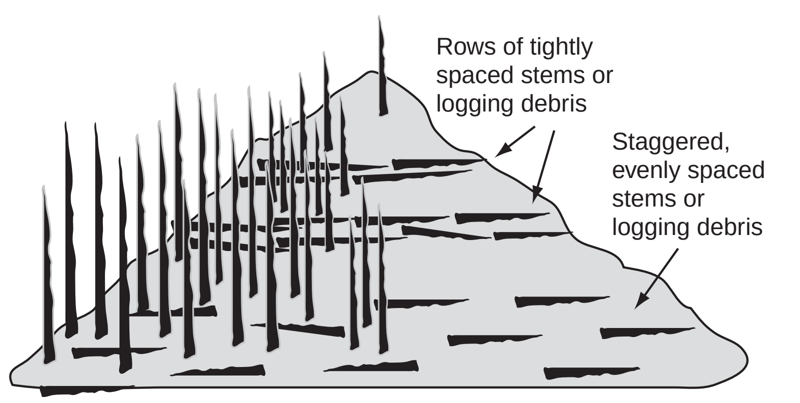

Figure 4.

Pros to salvage logging:

1) Severe fires create enough ash to plug soil pores and thereby significantly reduce water infiltration rates. Snow-melt and rainstorms result in more water than the soil can rapidly absorb. A high probability of massive soil surface erosion and sediment deposits in streams results. Management practices that result in an increase of surface organic debris in close contact with the mineral soil underneath the ash layer can impede surface water runoff. This allows greater water absorption by the soil and reduces erosion. Contour felling of trees is one of the most effective restoration processes used to achieve this objective, but is labor intensive and expensive. Salvage logging can achieve the same objective ***if*** logging debris is used in the same way as contour felling.
2) Ash layers create an environment that can be hostile to rapid recolonization by tree seedlings and other potentially desirable plant species. The black surface of burned areas can reach temperatures in excess of 170° F, which is lethal for many plant species. Disturbance of these black surfaces (logging activities) increases the albedo and reduces surface temperatures. In addition, woody debris creates shaded microsites that enhances tree seedling and native flora survival.
3) Amount of dead and dry fuel loading is reduced. Future risk of "reburns" is reduced.

Cons to salvage logging:

1) Logging increases surface erosion by further disturbing soils. The more a soil's structure is disrupted, the greater the potential for surface erosion.
2) Logging vectors noxious weed seeds. Severely burned soils are very susceptible to noxious and exotic plant invasion. Existing data indicates that noxious weed abundance can increase threefold following fires.
3) Logging removes standing trees that provide shade for microsites.
4) Logging removes biomass needed for soil nutrient recycling.
5) Removal of standing dead trees reduces habitat for cavity nesting birds and their potential food source (beetle larvae that feed on dead trees).

Pros and cons of salvage logging in perspective

Burned areas, particularly those with severe fire effects must be considered "ecologically sensitive," especially during the first several years following the fire. Water is the greatest source of soil erosion in Inland Northwest forests—therefore, the benefits of increased infiltration rates due to soil disturbance must be weighed against the potential of greater soil erosion. Logging activities immediately after a fire event have the greatest beneficial potential since this is also when water infiltration rates are lowest and erosion rates the highest. This is also when seed-bed modification may enhance recovery rates of desirable native plants. Logging during the growing season six months following fires may have the greatest detrimental effects by disrupting plant recolonization.

In the spring and summer following a fire, specific native "colonizer" species such as fireweed have been shown to rapidly invade severely burned areas. Surveys of lower elevation sites that burned in the Bitterroot during 2000 have shown that fireweed provides approximately 50 percent surface cover, helping to stabilize soils. Logging during the growing season on such sites can have significant detrimental soil effects, as the stabilization associated with such early successional plants will be disrupted. Logging on a snowpack or frozen ground in the years following a wildfire may alleviate some of these negative effects.

Although noxious weeds may be vectored by logging activities, proper treatment of equipment prior to transport into burned areas can be very effective at reducing this risk. Many members of the Montana Logging Association have participated in weed workshops where such practices are taught. Other factors such as human use (mushroom picking for example), wildlife and existing weed sources must also be taken into consideration.

Shading effects of dead standing snags and logging debris should theoretically increase colonization rates of native plant species and tree seedlings. Which has the greater effect is often debated. The commonly accepted average temperature lethal to plants is 125° F (55° C) for one minute. Since measured surface temperatures are commonly above 150° F on burned sites, beneficial effects of shade created by materials more than three feet above the soil surface is minimized due to the rapid movement of that shade with the sun. Logs that are horizontal across the soil surface will have a greater shade effect for the creation of microsites. This may be a positive aspect of salvage logging if logging debris is properly distributed.

Research indicates that roughly 90 percent of the nutrients incorporated by tree biomass are located in small diameter structures such as twigs and needles. Salvage logging removes larger diameter bole wood that is suitable for lumber production and leaves the finer materials. The role of larger diameter woody debris in soil development has also been recognized as important, and therefore, should be taken in consideration. Typically, logging results in a significant number of large diameter logs with too much defect for mills. Proper distribution of these materials across the landscape should be an important component of good slash management.

Woody organic matter becomes an important soil component when it has reached advanced stages of decomposition and is capable of retaining large quantities of moisture. At this point it is also a lesser contributor towards wildfire risk. In contrast, dry intact logs represent a considerable risk for severe fire effects. In any fire-prone ecosystem, the potential soil benefit from decomposed organic debris is offset by the high fire risk period while organic debris is decomposing. Depending on the forest type, a log may require between 20 and 200 years to reach an advanced stage of decomposition. During this time, the site is at risk of soil degradation from a severe fire. The higher the organic debris component, the higher the potential soil benefits but also the higher the risk of losing it all from fire.

There is substantial evidence that standing dead or dying trees resulting from wildfires do provide habitat for a variety of wildlife. Most of the species involved are categorized as fire "opportunists" that benefit from fires but are not dependant on the effects of wildfires. Nonetheless, leaving fire damaged/killed trees for wildlife habitat is an important consideration. In attempt to provide for this need, many salvage logging protocols call for certain numbers of large diameter leave trees per unit area. While this may be helpful for some species, other research indicates that wildlife such as Black-backed woodpeckers require dense stands of fire-affected trees. Therefore, leaving patches of fire killed trees along with other areas that have widely distributed snags may be the best approach. Much additional research is needed to answer questions of how much, in what distribution, and what species of trees are needed.

Based on this brief summary of the issues surrounding salvage logging, it is apparent that there are potential ecological benefits from salvage logging and potential ecological detriments. The ecological side of the question: "Should salvage logging occur?" is really one that revolves around the magnitude of the fire effects.

Removal of all trees killed by fire will have a potentially negative impact on wildlife and may reduce soil productivity in the long term. Removal of some of the trees coupled with sound slash management has the potential of decreasing soil surface erosion, decreasing future risk of severe wildfire effects and increasing recovery rates of desirable vegetation. No manipulation of severely burned areas will result in soil erosion risks, future severe wildfire risks and conversely, a large pool of organic matter for wildlife use and future soil amendments. The larger the area affected by fire, the greater the possibility of creating a mosaic of salvage and no-salvage logged areas that could enhance the benefits from both.

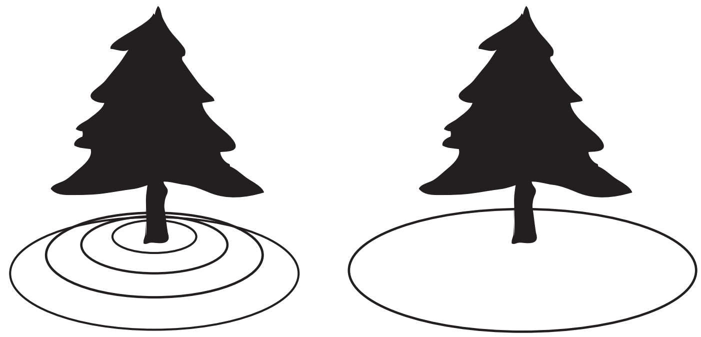

Figure 5.

What to do to help trees

Water and fertilizer

If the tree has survived the fire with some scorch damage it is important to help your tree recover. Loss of leaves or needles results in the tree not being able to produce the sugars and starches it needs to live. Depending on the time of year and the tree species, some trees will try to grow new leaves. Watering and fertilizing trees with ornamental value (such as those around your house) with a mild solution of balanced fertilizer (10-10-10: 1/4 lb dissolved in 3 gallons of water and applied in concentric circles around tree base, (Figure 5) will help trees re-grow leaves, either immediately after the fire or the following spring. ***If the fire occurred in August or later***, it is best to fertilize in the fall after freezing temperature has set in so as not to stimulate new growth that will not have time to become frost hardy.

Stem care and pruning

Fire blackened tree stems can absorb too much solar radiation, causing the living tissue under the bark to die. For trees that have ornamental value, it may be worthwhile to try and protect stems from getting too hot from the sun. Deciduous trees (most broadleaved trees) are most susceptible to this because of their thin bark. An application of lime or white latex paint on the south side of the tree will help keep the stem cooler. No oil based or petroleum products should be used, as they can kill the tree.

If your tree has survived the fire but suffered some damage, proper pruning will help it recover more quickly. Dead branches will remain on the stem for a long time and act as entrance areas for pests and pathogens. Any time a branch is removed, it should be cut off flush with the stem so that no "stobs" are left protruding (Figure 6). Any easy rule of thumb to follow is: if you can hang

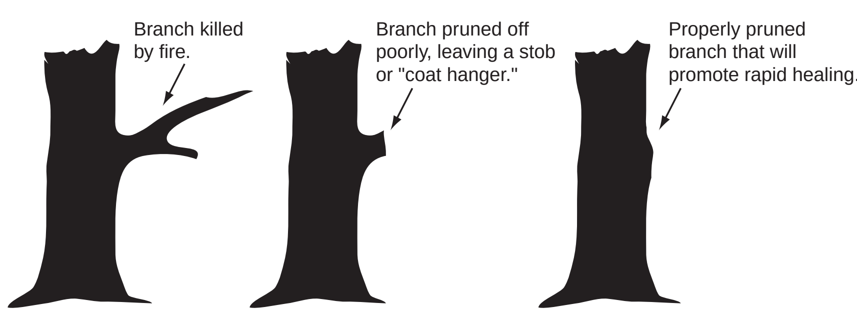

Figure 6.

a coat or hat from the residual branch stob, it is too long.

When pruning, it is important to recognize that conifers and deciduous trees will recover differently from fire damage. If the lower branches of a pine, spruce or fir tree are killed by fire, the tree will not re-grow these branches. A deciduous tree, on the other hand, will often re-sprout new branches either from where the dead branch attached to the stem or along the base of the tree. For both conifers and deciduous trees it is important to prune off dead branches (Figure 7). Deciduous trees will require subsequent pruning to encourage strong new branches to form. If no follow-up pruning is done the tree will not know which branch to put its energy into, resulting in clumps of weak and poorly formed branches.

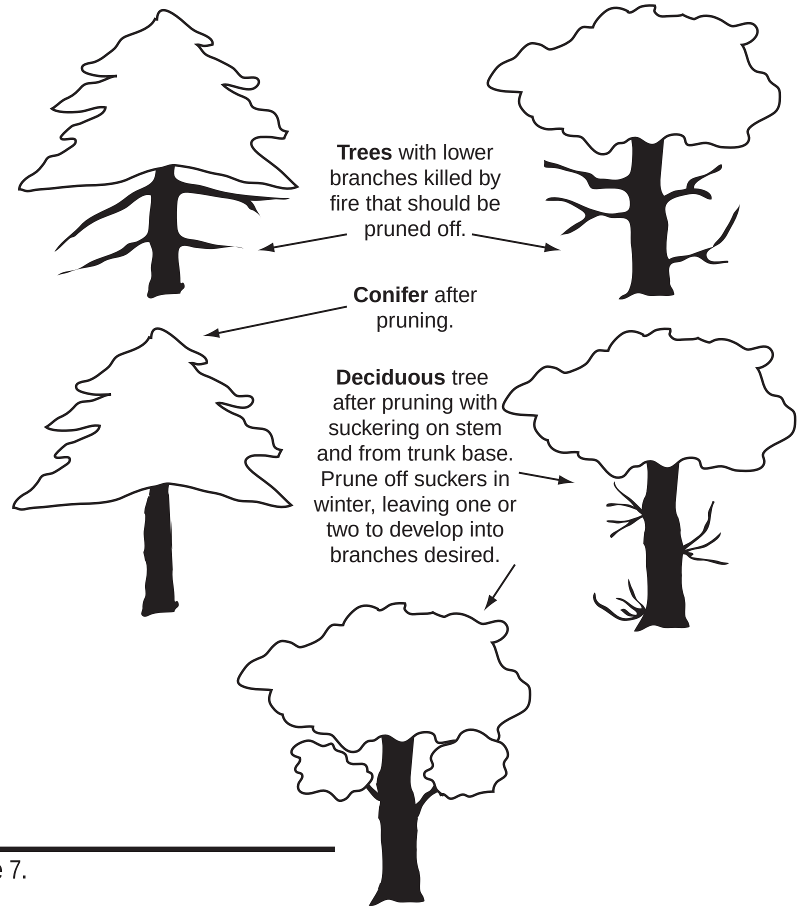

Figure 7.

AFTER WILDFIRE — Information for landowners coping with the aftermath of wildfire

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This book provides information to help landowners cope with the aftermath of future wildfires in Montana and in other states. Each section can be copied and distributed as needed. To obtain a copy of this publication or any of the following sections, please contact your local Montana State University Extension agent or download a PDF file at www.montana.edu/publications.

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