MANAGEMENT PRACTICES FOR FOREST HEALTH AND CATASTROPHIC WILDFIRE RESISTANCE

Forests are dynamic and complex assemblages of plant and animal species. Their defining characteristic, "trees," are both a reflection of and an influence on the physical properties of the local environment such as soils, temperature and moisture. A "healthy forest" must be defined by the natural history of the site, and the growth characteristics of the naturally occurring tree species. In general, a healthy forest has a majority of trees that are vigorous and resistant to insects and diseases, and the ability to sustain itself as a forest when affected by wildfire. "Forest Management," as referred to in this publication, is the human process of assessing a forest, and acting accordingly to provide for its sustainability.

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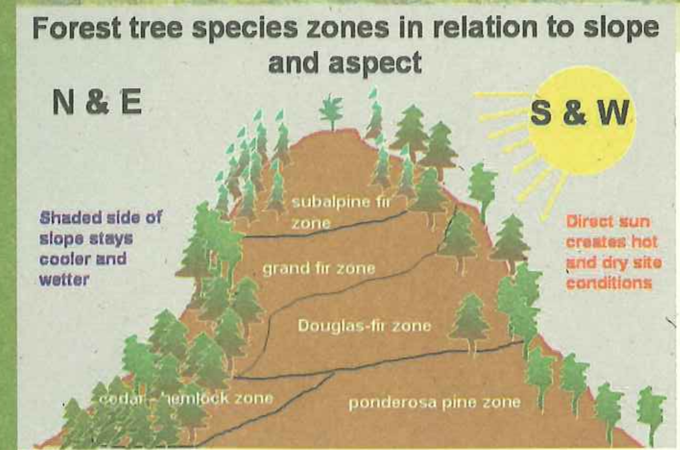
TREE SPECIES AND THEIR DIFFERENT NEEDS FOR DISTURBANCE



Which Forest Species Zone? Forests across Montana can be separated into five basic forest species zones. These zones are created by differences in temperature and moisture determined by precipitation patterns, elevational temperature gradients, and the effects of the sun's heating power. Each native Montana tree species is adapted to grow best across a specific moisture-temperature zone, although some tree species have a greater ability to adapt to the conditions of many zones. Similarly, each zone has evolved with different patterns of disturbance and, more importantly, the ability to survive those disturbances.

Hotter, drier sites historically were dominated by ponderosa pine, which is able to survive frequent surface fires but not high intensity crown fires. Alternatively, cool wet sites dominated by Douglas-fir, larch, and lodgepole pine developed with "patchy" infrequent fires that varied in severity from stand replacing crown fires to less severe surface fires. Species from these zones developed the ability to rapidly reseed and colonize severely burned areas. In fact, the most fire adapted of these, larch and lodgepole pine, rely exclusively on disturbances that create open areas with exposed mineral soil.

Grand Fir, Subalpine Fir, Cedar, Hemlock, and Spruce These forest zones occur where deep winter snow provides ample soil moisture, or in riparian areas. Trees grow well on the warmer of these sites, and species biodiversity can be quite high. Because of the normal cool-wet conditions, wildfires usually do not burn well. However, during drought years these forests typically burn intensely, killing large patches of trees and turning much of the understory litter into ash. The landscapes within these zones were historically a mosaic of different tree species patches ranging from a few acres to a thousand or more acres in size. The long lived pioneer species such as larch, white pine, and ponderosa pine depend on such larger disturbances to regenerate and persist on these wetter sites. Such a mosaic of species also creates a more resilient landscape to large and unstoppable crown fires.


Subalpine fir

Douglas-fir This species can grow on hot and dry sites as the shade tolerant replacement species, or on cool-wet sites as the pioneer species. It is the most versatile and common tree in Montana. It is moderately adapted to survive a wide range of fire severities and codominates with ponderosa pine on dry sites, and with larch, grand fir, and lodgepole pine on cooler and wetter sites. It has the tendency to regenerate in dense thickets under mature ponderosa pines or on cooler north and east slopes, which creates a high wildfire hazard.


Douglas-fir

Ponderosa Pine Defined as the warmest and driest of forest zones, the heat tolerance and tap root of ponderosa pine allows it to grow where few other native tree species can. This also allows it to colonize severely burned areas on wetter sites. Fires historically were frequent and kept these sites free of woody debris and dense pine regeneration. Soil disturbances timed with a good cone crop result in prolific seedling recruitment.

***Lodgepole Pine** With special heat resistant cones, these trees need severe stand replacing disturbances to regenerate. They commonly grow in dense even-aged stands across Douglas-fir, grand fir and subalpine fir sites where crown fires have predictably occurred every 50 to 200 years. This species is considered short-lived as it is often killed by bark beetles once it reaches an age close to 100 years.


Lodgepole pine


Ponderosa pine

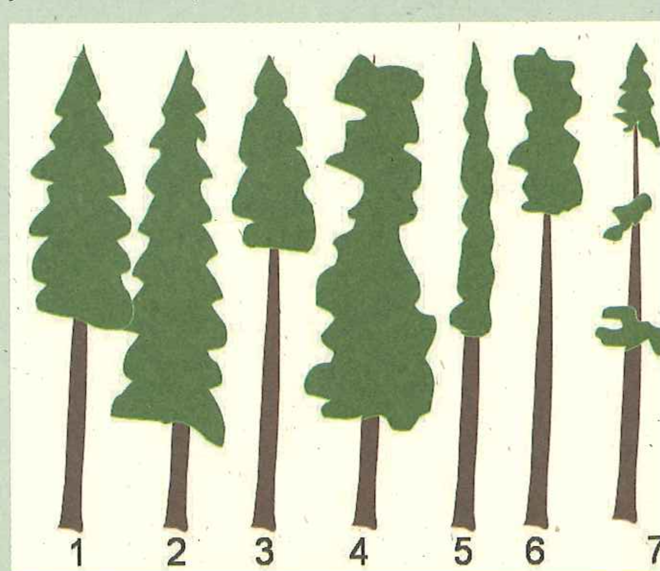
TREE SELECTION AND HARVESTING STRATEGIES

"...Management activities can help moderate the "boom and bust" natural cycles and if done correctly, still maintain the long term processes important for forest health..."

To Manage a Forest Forests change in response to the environment and their own built-in natural history. Sometimes the changes help sustain the forest, and sometimes the changes result in the conversion of the land to non-forest. Management activities can help moderate the "boom and bust" natural cycles and if done correctly, still maintain the long term processes important for forest health. With this in mind, management usually requires the harvesting of some trees. Which tree to cut and which tree to leave becomes the ultimate decision that should be made with an understanding of the basic biology and ecology of the forest as well as the personal objectives of the landowner.

All trees function with the same basic physiological relationship: Green needles use the sun's energy to convert CO_2 absorbed from the air into sugar, which is the basic building block for all other compounds and structures. Tree roots, stem and branches are the infrastructure the tree uses for this process to occur, and utilize the sugar that the needles produce for growth and maintenance. The more needles a tree has, the greater the potential for growth. The only drawback is that needles require large amounts of water when the air humidity is low, as occurs during much of the average Montana summer. Trees that have space for their crowns to absorb sunlight for photosynthesis and ample soil from which their roots absorb water tend to grow vigorously. As light becomes limited due to crowding, or root competition depletes soil water, trees ability to photosynthesize decreases and they may become energy deficient. This limits growth, and also the tree's ability to produce defense chemicals to ward off insects and pathogens. As trees become larger, they must also support a greater branch and stem area in proportion to their total leaf area, decreasing their overall vigor. It is thus important for trees to maintain a healthy needle area.

Using Tree Crown Shapes A tree's crown shape can strongly indicate its overall growth potential and longevity. Below is a silhouette representation of the tree crown shapes that reflect a tree's potential with #1 the best growth and longevity and #7 the worst. Pointy crowns indicate a tree is still growing in height. All trees have a maximum height they can attain based upon the local soil and climatic conditions. As trees near their maximum height, their top growth slows creating a rounded or flat topped appearance. Almost all native Montana conifers lack the ability to regrow lower branches, thus a tree that has attained its maximum height has little ability to increase its overall leaf area over what it already has. Trees growing in dense conditions often have leaf areas restricted to the very top of the crown. If they are younger, they will still have a pointy top and are capable of adding leaf area by growing taller. Giving these trees more space will result in a "release" or growth increase as more needle area is added. Rounded top trees with little leaf area cannot respond to more space by growing taller and adding needle area, and will remain energy deficient because of their small sugar production capacity. A rounded top tree that has a large needle area (4) has reached its maximum height but is still producing surplus energy for maintenance, root growth, defense and longevity.



Vigor Versus Health Native trees have evolved with their pests and pathogens and are therefore capable of defending themselves. In general, a vigorous tree will remain a healthy tree. Occasionally trees are stimulated to put all of their energy into growth and none into defense. This often occurs as trees that had space suddenly become crowded and are stimulated by light competition to put all their energy into height growth. These trees may become defensively weak and therefore attractive to pests. Drought can have the same effect.

Deciding on the Pattern of Harvest **Figure 1** Matching the type of harvest to the species zone, forest dynamics, and individual tree characteristics can be challenging. The more species and crown characteristics there are the more choices you have, none of which is wrong unless they do not meet your objectives. Typically leaving the best trees based upon crown character and species will guide the way. It is important to take into account the neighboring forest and the risks of unwanted disturbances such as wildfire or pests that may originate there.

On the previous page is a composite picture of a forest that is a mixture of ponderosa pine, Douglas-fir, and larch. All trees are approximately the same size and 100 years old with a few very large 300-year-old ponderosa pines that have fire scars indicating a wildfire every 5to 50 years from the year 1700 until 1890. Mountain pine beetles and Douglas-fir beetles are starting to kill trees and the risk from a catastrophic crown fire is very high. This scenario applies broadly across Montana forests and the addition or subtraction of other tree species should not greatly change potential management options.

Thinning From Below **Figure 2** The practice of thinning from below is designed to remove trees that are robbing the biggest trees of water, or to limit the regeneration of shade tolerant species. In addition, these smaller trees can easily allow for a surface fire to climb into a crown fire. Often many of these trees are not really younger but simply slower growing due to genetics or because they are located on a bad soil spot. This practice can help maintain "old-growth" characteristics and reduce the risk if a surface fire becoming a crown fire if most woody debris is removed or treated.

Comprehensive Thinning **Figure 3** Improving the vigor of residual trees and reducing the risk of both initiating crown fires and allowing one to spread is the objective of this treatment. The most fire resistant tree species (ponderosa pine and western larch) are preferred trees and spaced with a target of 15 feet between edges of residual tree crowns. The best shaped crowns are left which may result in a more natural "clumpy" spacing between some trees. Less optimal crowns may be left if they indicate potential longevity and are a preferred tree species. Thinning as a sole treatment tends to promote regeneration of only shade tolerant trees.

Group Selections or "Patch Cuts" **Figure 4** Larger openings are required to truly favor sunloving species. Wetter forest zones with a history of infrequent but severe crown fires, as well as north and east aspects that do not receive direct sunlight are the best scenario for this type of harvest. Larger openings provide fuel breaks where crown fires drop to the surface. Patches should have a minimum width equivalent to mature tree height but can be significantly wider. Sun loving tree species prefer some soil disturbance in order to regenerate.

Stagnant Forests Some forests are comprised of trees that are very uniform in size and crown shape. If all the crowns are small and suppressed, several very subtle thinning entries applied across decades may allow residual trees to regain vigor. For quicker results use patch cuts to initiate new seedlings. A sudden widely spaced thinning will stress remaining trees and result in significant mortality.

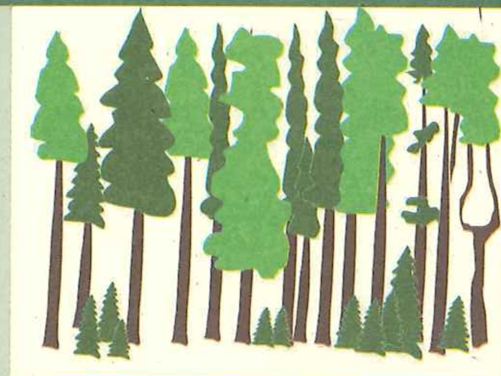


figure 1

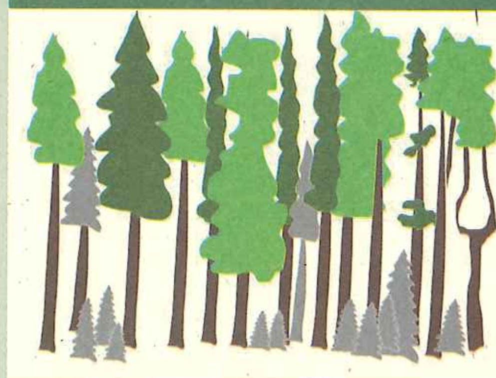


figure 2

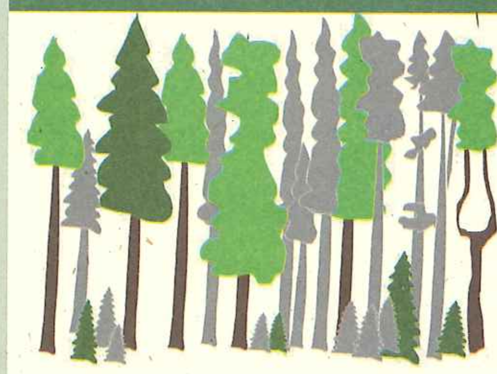


figure 3

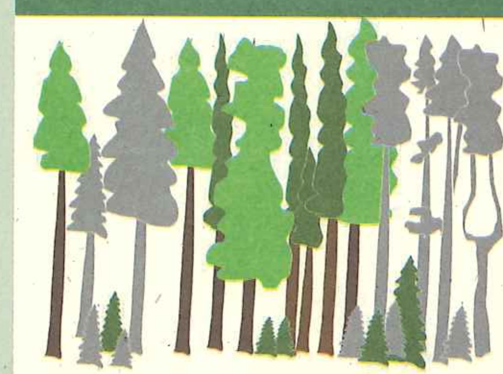
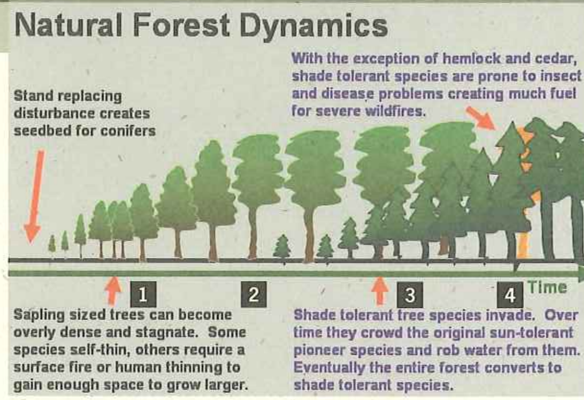


figure 4

NATURAL CHANGES WITHIN A FOREST



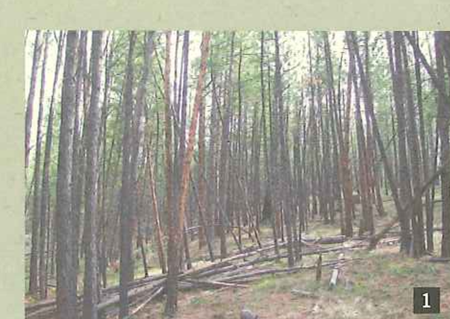
The Roles of Different Tree Species Each tree species has developed a strategy for survival. The most common adaptation is in response to changing sunlight conditions. Pioneer tree species are adapted to survive intense sunlight and the resulting heat and drought stress. They have needles that reflect sunlight and deep roots to avoid hot soil surface temperatures. These same adaptations don't allow them to grow well in low light conditions. Shade tolerant species seedlings are unable to tolerate full sunlight because they have needles designed to capture all light. This allows them to establish and grow in the shade of pioneer trees. They also typically have shallow roots that acquire rain water before it gets to the deeper roots of the pioneer species. Over time, as old age starts to to weaken the pioneer tree species, competition for soil and water and eventual overtopping from shade tolerant species causes a species conversion in the forest. Whereas pioneer species limit their density somewhat because their seedlings can't survive in the understory, shade tolerant species continue to reproduce underneath themselves, eventually creating a very dense and water stressed forest. This stress ultimately makes them more susceptible to pests and pathogens, which in turn creates significant woody debris. This is then the perfect condition for a wildfire to burn with great intensity, creating ideal conditions for pioneer species to establish once again. All of these forest stages are important for wildlife.

Seedling Competition Following a disturbance such as stand replacing fire, a large seed source from surviving pioneer tree species can cause prolific seedling establishment. Reoccurring surface fires, or tree pests can thin these dense stands. Often they naturally stagnate, creating a condition for a wildfire to become a lethal crown fire.

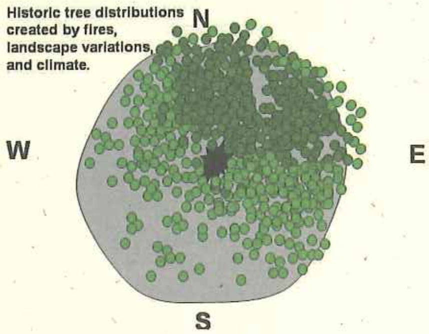
Sun Tolerant or Shade Tolerant—Which is Better? Without disturbances that open up spaces in the tree canopy for full sunlight, shade tolerant species will eventually dominate the site. With the exception of lodgepole pine, most sun-loving species are longer lived and more fire tolerant than shade species. This strategy allows them to wait until a wildfire kills the shade tolerant species, and once again gives them the ability to regenerate. Climate trends and human activities can strongly influence which species are favored and the magnitude of the landscape area affected. A 60-year cool-wet climate trend along with wildfire suppression resulted in large areas that converted to dense forests of shade tolerant species, with only the stumps of pioneer species remaining. A current warm-dry climate shift, along with disproportionately large areas of shade tolerant species, is allowing wildfires of uncharacteristic size to develop and consume all species.

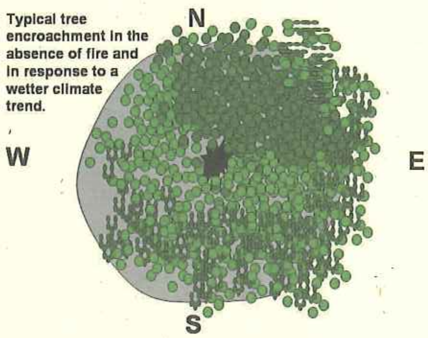
Pioneer Old-Growth If tree seedlings do not establish too densely, or if they naturally are thinned, most pioneer tree species are long-lived, reaching ages of 300+ years. Without frequent surface fires, or other similar disturbance agents, thinning shade tolerant species can invade and eventually dominate.

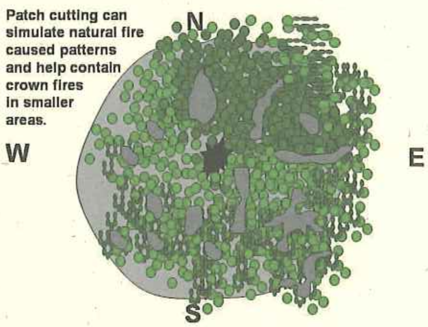
Shade Tolerant Old-Growth Forests dominated by shade tolerant trees have dense canopies that create mid-day twilight conditions. Competition among trees is intense, and with the exception of cedar-hemlock forests, these forests are typically short lived as they are at high risk from pests, pathogens, and wildfires.



THE BIG PICTURE

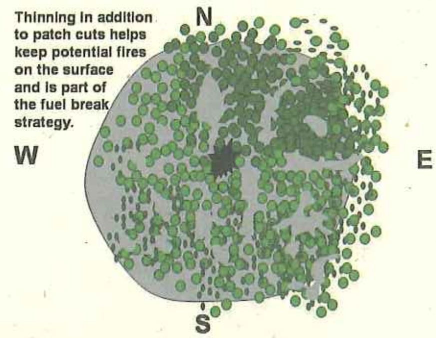




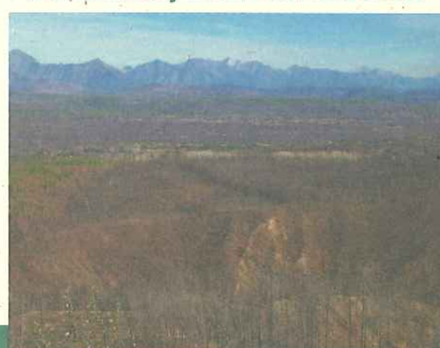


The Goal of Forest Management

should be to help forests adjust to changes in climate, wildfires, pests, pathogens, and landowner objectives. Whereas science can predict potential outcomes, forests simply react to changes. Often such reactions can have devastating consequences. According to historic evidence, our forests currently contain a greater density of trees than in prior centuries. This is due to climatic variations, human use, and variables we may yet discover. This scenario will change if left simply to nature. However, the results may be less than desirable to those who cherish the values that the current forests provide. A combination of thinning, group select and patch cuts that are used with regard to landscape characteristics, tree species, and forest structural attributes can help forests maintain their resilience to large scale disturbances. Forestry is a science and art. Science provides us with the ability to understand management options and their consequences. Art is required to appropriately apply management to paint the future forest landscape.



A dramatically wildfire-affected forest



A managed fire-resilient forest

For more assistance, download "Call Before You Cut" from www.montana.edu/wwwpb/pubs/4459.html or contact a DNRC Service Forester:

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Curt Tesmer	Bozeman Unit	406-556-4506	ctesmer@state.mt.us
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