Forest Restoration Guidelines in Ponderosa Pine on the Front Range of Colorado

Frank C. Dennis, Colorado State Forest Service, Colorado State University
Bob Sturtevant, Colorado Forest Restoration Institute, Colorado State University

In contemporary ponderosa pine forests throughout Colorado, the need to thin dense stands in order to reduce the risk of catastrophic fires has become evident. Numerous thinning prescriptions have been implemented. While many prescriptions focus solely on lowering fire risk by removing ladder fuels and reducing crown connectivity, others explicitly aim to alter both forest structure and function. Restoration treatments can lower fire danger while increasing the overall biological diversity and long-term health of treatment areas.

Restoration Treatments versus Fuels Treatments: What's the Difference?

Mechanical fuels treatments remove excess trees and ladder fuels to reduce the likelihood that a surface fire will become a crown fire. They also reduce the connectivity of tree crowns, which makes it more difficult for a crown fire to spread throughout the canopy. This usually is accomplished by using mechanical devices.

In the simplest situation, chainsaws are used to remove lower branches or entire trees. In larger and more complex projects, large mechanized equipment such as tree shears, rubber-tired skidders, mastication or mulching equipment similar to hydro-axes or Timbco's equipped with specialized mulching heads, or other equipment may be used. The cut wood is either harvested for saw logs, post and poles, fuel or other uses, or burned on site.

Restoration treatments also remove ladder fuels and reduce crown connectivity; indeed, fuels treatments can be an important step toward restoration. But restoration treatments are focused on long-term rather than short-term ecosystem health. Rather than focusing only on altering forest *structure*, restoration treatments also aim to alter forest *function*. For that reason, they have the potential to provide a long-term solution to the current wildfire problem, which is really only a symptom of a larger problem—namely, an unhealthy ecosystem.

Treatments that combine thinning with prescribed fire and that focus attention on a wide range of post-treatment conditions (including herbaceous vegetation, wildlife habitat, watershed benefits and recreation) do the best job of reducing fire danger and improving forest health in the long term.

Restoration treatments that focus on healthy forest structure allow low-severity fire to easily and inexpensively shape forest conditions in the future— and this, in turn, reduces the need for future maintenance thinning.

Restoration treatments, in other words, provide fire protection *and* additional benefits. Fuels treatments reduce fire danger, but only temporarily, and they do not emphasize these other benefits.

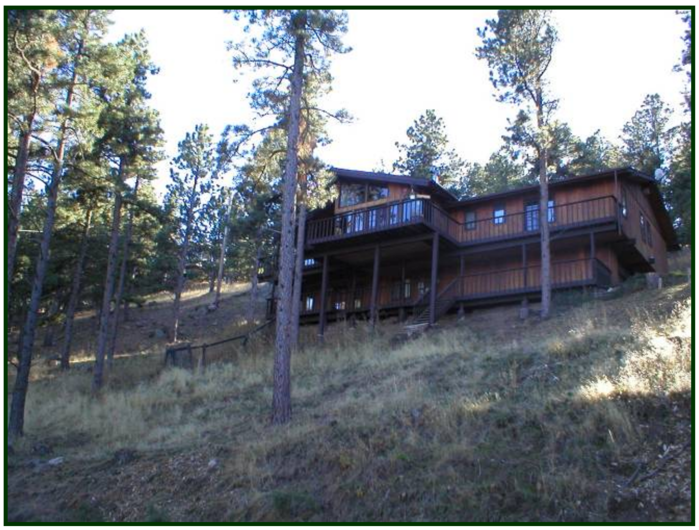

Photo by: Bob Bundy, Colorado State Forest Service

The photo above is an example of fuels treatment that was done to create defensible space around a home in Boulder County. Depending on species and design, such treatments may or may not meet restoration goals.

In the long term, restoration treatments are likely to be a far more cost-effective and ecologically sustainable solution to the current wildfire problem than fuels treatments alone.

Restoration Treatments Must be Informed by Reference Conditions

Reference conditions are conditions that existed before forest structure and function were altered by Euro-American settlers. They were not unchanging, but they sustained themselves. Colorado's ponderosa pine ecosystems were subject to frequent fires of varying severities. Some fires no doubt were ignited by indigenous peoples, but most were likely caused by lightning. Both types of fires had the same effect: they sustained forest structure by removing tree seedlings and cycling nutrients to plants.

After Euro-American settlement, that sustainable cycle was broken by livestock grazing, unregulated timber harvest, and active fire suppression. Grazing removed the fine fuels that carry fire, while timber harvesting removed larger trees and made way for dense stands of younger trees. Fire suppression created fuel accumulations and increases in fire intensity. Forests have grown much denser and understory productivity has declined. Today, ecosystem conditions in many places are unsustainable.

Reference conditions are useful tools because they show what a site's potential can be under self-sustaining conditions. They are determined by locating trees or tree remains that were present before Euro-American settlement, which generally include living pines or snags with yellow bark, as well as large downed logs, stumps, and stump holes. Tree-ring records help document past forest structure and fire history, as can historic photographs, land survey records, Forest Service records, and other written records. Relatively undisturbed sites nearby also can aid in understanding what reference conditions may have existed on a site to be treated, though the great differences in stand density and structure that can exist on even adjacent sites must be considered.

Incorporating the major characteristics of the historic forests into our treatment prescriptions can take us a long way toward more effective and sustainable treatments, from both an ecosystem health and cost standpoint.

Photo by: Bob Sturtevant, Colorado State University

Reference conditions are useful tools because they show what a site's potential can be under self-sustaining conditions. Land managers look for evidence of past forest structure when developing restoration recommendations.

Reference conditions are not necessarily the same as restoration goals. Social, economic, or other management considerations may make it impossible or undesirable to attempt to fully recreate reference conditions. But knowing how a site once looked is an important tool in deciding management goals and strategies. Incorporating the major *characteristics* of the historic forests into our treatment prescriptions can take us a long way toward more effective and sustainable treatments, from both an ecosystem health and cost standpoint.

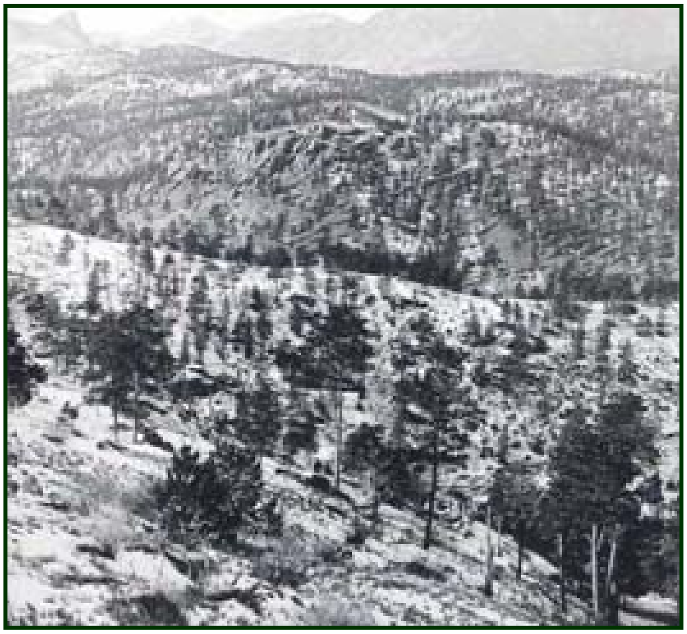

Photo courtesy of Denver Water

This historical photo of the Upper South Platte shows conditions that occurred prior to settlement. Such photos are used to help determine reference conditions in the area.

The treatment strategies described in this document were developed by Chuck Dennis, forester, Colorado State Forest Service, based on research conducted in Front Range forests and information gleaned through several years of on-the-ground project implementation and monitoring. The objective of this treatment prescription is to bring forest stand conditions more in line with the historical range of variability that existed prior to 1870 along the Front Range.

Because of differences in landscape histories, site conditions, and political and social realities, there is no one-size-fits-all recommendation for how mechanical thinning or prescribed fire should be used across the entire range of ponderosa pine in Colorado. Fire behavior is variable enough that it is impossible to precisely predict future fire behavior from a given stand density and structure. In addition, ponderosa pine landscapes across Colorado are, by nature, highly variable. This prescription provides a good example of the kinds of goals and strategies land managers consider in developing a fuels treatment or landscape restoration plan. Restoration treatments vary with location, funding, and management goals, but some general points are important and they usually share the following qualities.

Detailed Treatment Strategies

Save the oldest trees

Logging in Colorado forests that traditionally emphasized cutting large trees has resulted in a scarcity of old, yellow-barked ponderosa pines. These trees tend to be resistant to fire and often provide valuable wildlife habitat and aesthetic benefits. However, many of the oldest trees that remain are in declining health due to increased competition with younger trees. Restoration treatments preserve old, yellow-barked pines by cutting mostly younger pines, lowering competitive pressures around old trees, and protecting these trees from fire.

Photo by: Bob Sturtevant, Colorado State University

Restoration treatments often preserve old yellow-barked and larger pines, which tend to be fire-resistant and often provide valuable wildlife habitat.

When thinning, retain most trees that pre-date grazing and fire exclusion; trees approximately 150 to 200 years or more in age. Retain most trees of species other than ponderosa pine for diversity, except those shade-tolerant trees that create ladder fuels. Consider carefully whether to keep most Douglas-fir or white fir. In historic pine forests, Douglas- and white fir were found almost exclusively on north-facing aspects or moist sites.

Restoration treatments preserve old, yellow-barked pines by cutting mostly younger pines, lowering competitive pressures around old trees, and protecting these trees from fire.

Reduce Stocking Levels

Thinning both canopy and ladder fuels generally is needed to reduce crown fire potential. Though it can be expensive, thinning does not carry the risks of attempting to treat using prescribed fire alone, and can be carried out through much of the year.

Reduce tree densities to numbers more closely resembling pre-1870 conditions by thinning from below most post-settlement trees, except those needed to emulate or ultimately develop pre-settlement densities and diameter distributions. Trees-per-acre prior to European settlement are estimated at 25 to 50 or more.

Photo by: Bob Sturtevant, Colorado State University

Thinning canopy and ladder fuels generally is necessary to reduce crown fire potential. Historical stand densities generally are much more open than current conditions.

Distribute Trees in Groups

Ponderosa pines frequently grow in small clumps, often with interlocking crowns, which provide habitat for species that utilize tree trunks and crowns. The size, density, number, and location of such clumps profoundly affect both wildlife habitat and the future risk of crown fire. Finding a balance between wildlife habitat considerations, individual tree health, and future fire risk is a vital part of planning restoration treatments.

Because they are based on averages across an area, basal area measurements often are not very useful in quantifying the extent to which forested areas are comprised of clumps and openings.

Standing trees left after thinning operations should be grouped and clumped in a fashion that more closely resembles pre-1870 stand structures. Even spacing of trees is not desirable. Density should vary throughout forest stands from open pockets with no or few trees to dense pockets of trees with the equivalent of up to 150 trees per acre. Within forest stands or project areas, strive for and, over time, develop irregular stand structure and spatial arrangement. Historical stand structure appears to have been comprised of even-aged groups of trees that varied widely in size and shape. Often two, three, and sometimes more age and size groups were represented in a stand.

Photo by: Bob Sturtevant, Colorado State University

Standing trees left after thinning operations should be grouped and clumped to more closely resemble pre-1870 stand structures. Ponderosa pine naturally grows in groups and should follow that natural condition.

Keep Standing Dead Trees (snag retention)

In areas of general treatment, strive to save most standing snags, particularly those larger than 10 inches in diameter. Retention of snags within fuelbreaks, defensible spaces, along trail and road corridors, and within recreation areas must be evaluated on an individual basis.

Photo by: Bob Sturtevant, Colorado State University

Standing snags are important habitat for wildlife and birds of prey, and should be retained in areas of general treatment.

Create openings

Openings are areas with no to very few trees and a crown closure of 10 percent or less. Soils analysis has shown that some grassy openings in ponderosa pine forests were apparently in place for very long periods before young pines encroached on them in the 20th century. Research also has revealed that historic stands were extremely open and more than 90 percent of the landscape had crown closures of 30 percent or less. Openings of up to 40 acres or more were widely distributed across the landscape. However, most openings were small, in the two- to five-acre range, and only a few of the very large openings were present. Recreating such openings provides habitat for many wildlife species, and can greatly reduce the risk of crown fires.

Photo by: Bob Sturtevant, Colorado State University

Openings such as the one above were common prior to settlement; such openings provide habitat for many wildlife species.

Monitor Natural Regeneration

Research has shown that openings in the pre-settlement forest were persistent and long lasting. It is important to decide early in the management of an area which openings are to be maintained over time, as that will dictate maintenance needs. Generally, regeneration of other areas occurs by natural seeding. If regeneration is lacking, planting can be used to achieve the desired density. If too many young trees in an area survive prescribed fire, some can be removed to achieve specified density levels.

Photo by: Bob Sturtevant, Colorado State University

It's important to maintain openings over time, and that is best accomplished through regular monitoring and maintenance treatments such as periodic prescribed burning.

Avoid Leaving too Much Fuel Behind

New growth follows thinning or prescribed fire and puts a time limit on the effectiveness of these treatments. By itself, prescribed burning can be effective in reducing wildfire severity for up to 10 years. If management goals include reducing fire danger, then treatments that leave heavy fuels behind in the form of slash or living trees don't work—they waste resources and will force managers to implement more treatments in coming years. Only treatments that allow for the possibility of future low-severity fires to manage fuels represent a long-term solution to the problem of unnatural wildfire intensity. *Be sure to address slash treatments as part of any project design.*

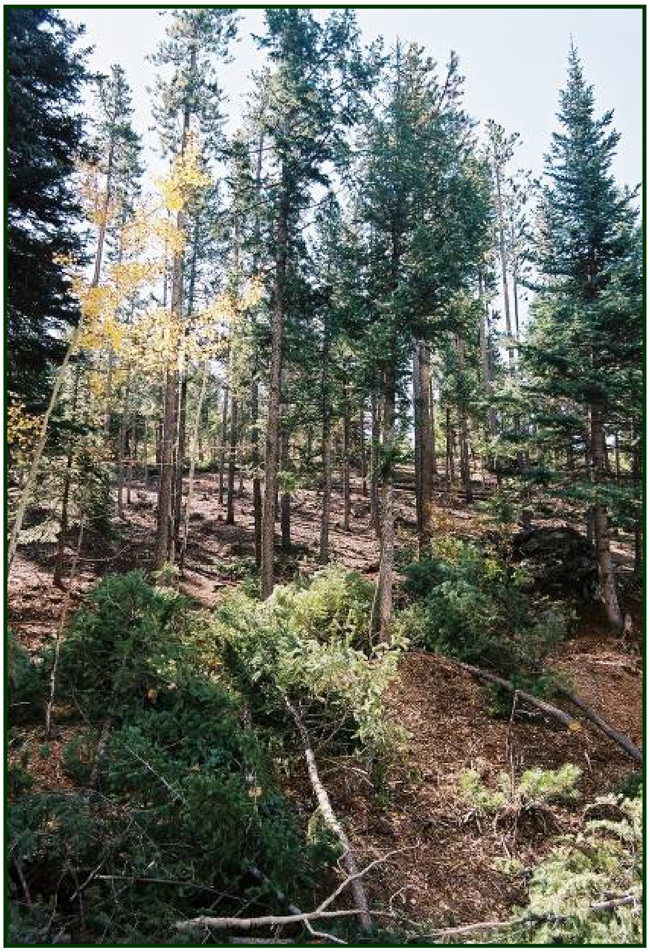

Photo by: Katherine Timm, Colorado State Forest Service

If management goals include reducing fire danger, then treatments that leave behind heavy fuels don't work because they waste resources and force managers to implement more treatments in the future.

Only treatments that allow for the possibility of future low-severity fires to manage fuels represent a long-term solution to the problem of unnatural wildfire intensity.

Conduct Prescribed Burning

It is well documented that fires played a primary role in maintaining the structure of Colorado ponderosa pine forests before fire regimes were interrupted by Euro-American livestock grazing and fire suppression. However, to reduce catastrophic fire risk and return fire safely to its historical role in the ecosystem, it often is necessary to reduce existing fuel loads prior to burning. Burning in combination with thinning may be the most successful fuels treatment combination. Once forests are thinned, fire is crucial to maintaining forest structure and more closely emulates natural fire regimes than thinning alone. Without fire, thinned forests quickly will become dense again.

Prescribed burning should be used, where appropriate, to reduce fuel loads, expose mineral soil, provide a nutrient flush for vegetation, reduce competition, and stimulate production of grasses and forbs that may have evolved under periodic fire cycles. Forest restoration focuses on reintroducing more frequent, primarily low-intensity fires, which provide these and other benefits.

Photo by: Jen Chase, Colorado State Forest Service

Where appropriate, prescribed fire should be used to reduce fuel loads, expose mineral soil, provide a nutrient flush for vegetation, reduce competition, and stimulate production of grasses and forbs.

Though initial fires after thinning often are hot and/or smoky, due to the large quantities of needles and woody fuel on the ground, future fires should burn mainly herbaceous vegetation and tree saplings, producing less heat and smoke. Prescribed burning for maintenance purposes typically is cheaper than conducting additional mechanical thinning. Maintenance burns likely will be necessary within three to 10 years of the initial prescribed burn to reintroduce a periodic fire regime to sites where such a regime previously existed. Future fires, whether prescribed or lightning-ignited, should be part of the restoration planning process.

Consider Understory Restoration

Grasses, forbs, shrubs, and other plants of the herbaceous understory comprise most of the diversity in ponderosa pine forests, and are important for wildlife food and cover and aesthetics. In addition, the understory provides fuel for the frequent low-intensity fires that are necessary to maintain forest structure. For these reasons, restoration treatments emphasize restoring the diversity and productivity of these plants. In some cases, this may require reseeding with native species or removal of invasive species.

- Grazing activity should be managed and monitored during one to three years following the initial treatment to help establish and spread grasses and forbs in the understory.
- Noxious weed problems should be addressed prior to thinning and prescribed burning to reduce their potential for spread. Learn and apply the proper cultivation and control tools, including grazing, proper timing of fire, and mechanical and chemical control that can reduce the spread potential of weeds.

Photo by: Bob Sturtevant, Colorado State University

Restoration treatments emphasize restoring the diversity and productivity of understory plants.

Size and Landscape Patterns Matter

Larger treated areas more effectively reduce fire behavior than smaller areas. Landscape-scale planning techniques such as those developed by Mark Finney, Thomas D. Sisk, and others can help assess where treatments should be concentrated to achieve the greatest degree of fire risk reduction and other corollary benefits, while also meeting forest restoration needs. Software tools and GIS technology can help assess where treatments are most important and where resources should be concentrated.

Photo by: Bob Sturtevant, Colorado State University

Larger treated areas more effectively reduce fire behavior than smaller areas. Large landscapes and timing of treatments should be considered in management plans.

Software tools and GIS technology can help assess where treatments are most important and where resources should be concentrated.

Incorporate Monitoring Programs and Adaptive Management Practices

Restoration is a new science, and we have much to learn about it. Reducing fuel loads is both a science and an art. Fire behavior and forest ecology are complex, and some effects of restoration treatments inevitably will deviate from the predicted outcome.

For that reason, monitoring of treatments and their effects is urgently needed to improve treatment planning and implementation, modify future treatments, and communicate progress to practitioners and stakeholders. The results of monitoring programs should be incorporated into the planning of future treatments through a flexible, adaptive management process.

With careful monitoring, the lessons we learn from current treatments will improve both our restoration practices and our overall management of these forests.

Photo by: Bob Sturtevant, Colorado State University

Monitoring of treatments is necessary to improve treatment planning, implementation, and effectiveness. Findings should be incorporated into the planning of future treatments.

This paper was compiled from information obtained from the Colorado State Forest Service 2004 Forest Health Report, and the Forest Restoration Institute at Northern Arizona University. Materials used with permission.

Colorado State Forest Service

FRFTP Front Range Fuels Treatment Partnership

Colorado Forest Restoration Institute