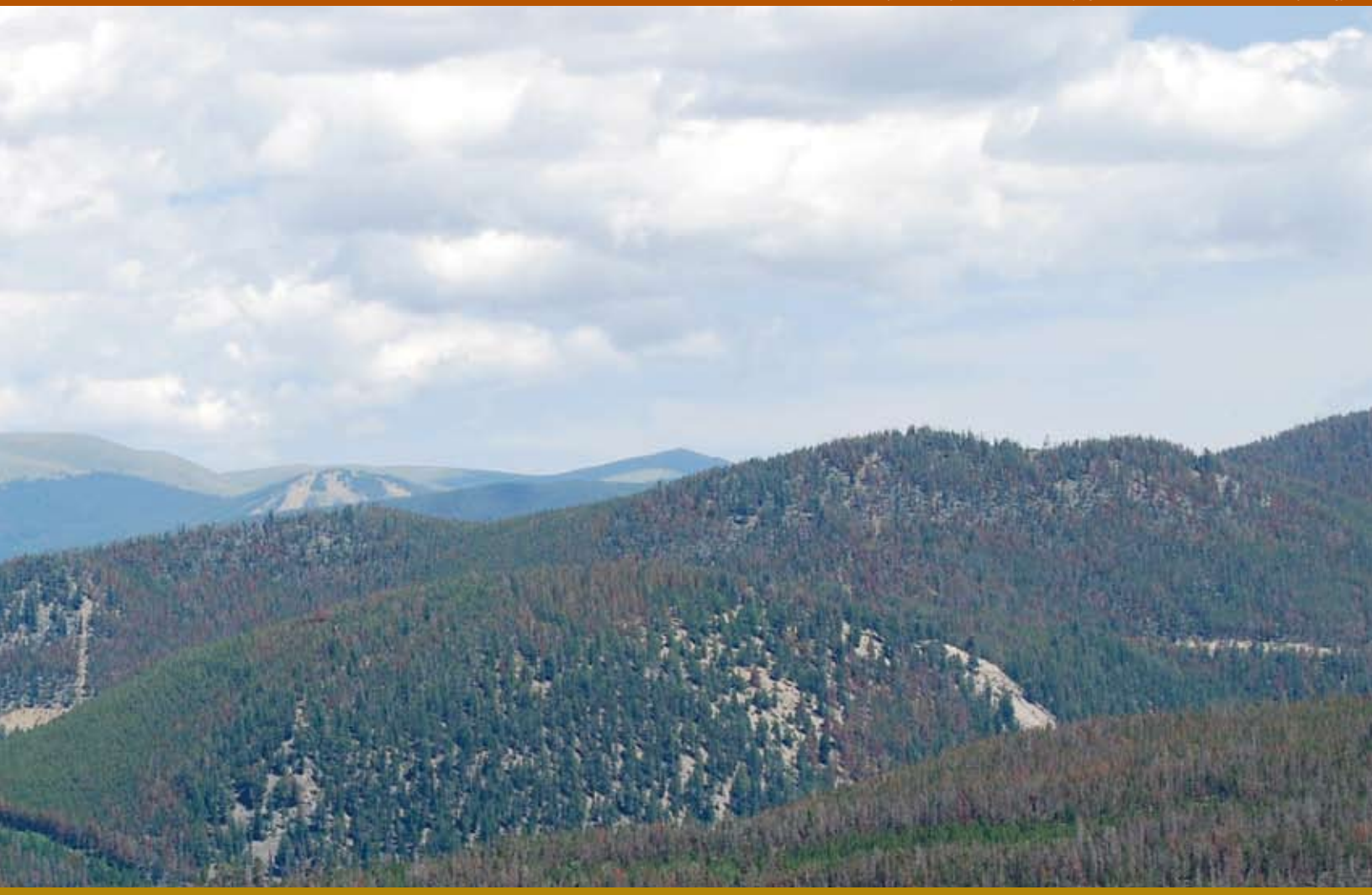

Lodgepole Pine Management Guidelines for Land Managers in the Wildland–Urban Interface

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Lodgepole Pine Management Guidelines for Land Managers in the Wildland-Urban Interface

As a consequence of the current mountain pine beetle epidemic, many landowners and land managers are concerned about how to actively manage lodgepole pine stands to:

1) ***treat the dead standing trees killed by the insects,***
2) ***protect homes and communities from wildfire, and***
3) ***ensure that the future forest is better structured to prevent widespread mortality from insect epidemics and wildfire.***

To start the process of defining management guidelines, we referred to the work of a group of forestry research scientists who met in early 2008 to discuss current knowledge about lodgepole pine ecology and potential fire behavior in stands affected by the mountain pine beetle (MPB). The scientists came to consensus on the following points, which are more fully described in *The Status of Our Scientific Understanding of Lodgepole Pine and Mountain Pine Beetles – A Focus on Forest Ecology and Fire Behavior*. (Kaufmann, et al, 2009)

Pockets of mountain pine beetle begin to spread through an unmanaged forest.

■ ***The ongoing mountain pine beetle epidemic is heavily impacting lodgepole pine forests.*** From British Columbia to Colorado, forests are experiencing high mortality of lodgepole pine trees from attack by mountain pine beetles. An insect epidemic with multiple outbreaks at this scale has not been observed during the last century of scientific study, though several smaller outbreaks have occurred. This mortality is changing forest structure and composition, and modifying fuels in ways that will affect fire behavior for decades.

■ ***Not all lodgepole pine forests are the same.*** Some forests are composed of pure lodgepole pine that was established following large fires that occurred decades or even centuries ago. Others are mixed with subalpine species such as Engelmann spruce, subalpine fir, and aspen at higher elevations, or with mixed conifer species such as ponderosa pine, Douglas-fir, and aspen at lower elevations. The ecology and fire behavior of each type of forest is unique. Lodgepole pine trees in all three types are vulnerable to attack by mountain pine beetles.

Lodgepole pine often is found mixed with other species at the upper and lower elevational limits of its range.

■ ***Forests are living systems that are subject to constant change.*** Many natural agents, including mountain pine beetles, fire, and wind, are normal and will change forests over time. Some changes are so gradual that we barely notice them, while others are relatively sudden and extensive. The forests that presently are losing many trees to insect attack will not look the same in our lifetimes, but healthy and vigorous forests will eventually return in most locations.

■ ***Lodgepole pine will continue to persist in the southern Rocky Mountains.*** The composition of our forests already is changing where mountain pine beetles cause high lodgepole pine mortality. However, this event will not cause the extinction or disappearance of lodgepole pine. And forests that are dominated by or include lodgepole pine will persist in the southern Rockies, though they may look different from those of the past due to changing climate. Future forests will continue to provide valuable ecological services, and aesthetic and recreational benefits.

■ ***Active vegetation management is unlikely to stop the spread of the current mountain pine beetle outbreak.*** Mountain pine beetles are so numerous and spreading so rapidly into new areas that they may simply overwhelm any of our efforts where trees have not yet been attacked, and no management can mitigate the mortality already occurring. *However, judicious vegetation management between outbreak cycles may help mitigate future bark beetle-caused tree mortality in local areas.*

■ ***Large, intense fires with extreme fire behavior are characteristic of lodgepole pine forests, though they are infrequent.*** Very dry and windy conditions can lead to large, intense fires in lodgepole pine forests. Such fires are a natural way to renew lodgepole pine and are largely responsible for extensive pure lodgepole pine forests.

■ ***Fires are more likely to occur in forests with large-scale mountain pine beetle kill. Large, intense fires that produce extreme fire behavior are again possible.*** Considerable uncertainty exists about fire behavior following a mountain pine beetle epidemic on this scale. In pure lodgepole pine forests, crown fires are possible before and after an epidemic while needles are still on trees. Intense surface fires are possible after most dead trees have fallen to the ground. The probabilities of such fires are uncertain, and more research is needed to determine in what ways and how long the fuels and fire environment are altered by the beetles. Nevertheless, protecting communities and other values at risk is imperative.

A rapidly building beetle population begins to overtake an area before all regeneration targets can be completed.

The 2007 Y Fire in Grand County occurred in MPB-impacted stands of lodgepole pine (photo courtesy of Paul Mintier).

■ ***Mountain pine beetle outbreaks are not likely to increase soil erosion.*** Neither soil disturbance nor reduced ground cover occurs as a result of mountain pine beetle kill in lodgepole pine. In fact, understory plants actually may grow more vigorously as a result of increased light and the higher available soil moisture and nutrients. Where tree mortality is high, annual stream flow may increase and the timing of water delivery may change due to reduced canopy interception of precipitation, and reduced water uptake by the trees.

■ ***Climate changes most likely will contribute to substantial forest changes in the decades ahead.*** Given the climate changes in the last several decades and projected changes for coming decades, large fires and other natural disturbances are anticipated in many ecosystems in Colorado and southern Wyoming. These large disturbances and other changes in growing conditions likely will contribute to the restructuring of many forest landscapes.

Using the previous points as a platform, a group of state, federal, and

non-governmental foresters gathered in April 2008 to develop guidelines for the management of Colorado's future forests. The objective is to promote the development of forests that are sustainable and resilient to future disturbances. The group agreed that such forests need to be diverse in age, size, and density with a variety of forest overstory and understory species.

These guidelines acknowledge that there is a difference in the management objectives of wildland-urban interface (WUI) areas within and adjacent to communities and areas outside of the WUI. Separate guidelines have been developed for these two areas. Due to the interest and concern generated by the current MPB epidemic, the management recommendations presented in this document apply to stands within the WUI prior to, during, and after a mountain pine beetle attack.

Wildland-Urban Interface Definition and Discussion

The WUI is defined as any area where human-made improvements are built close to, or within, natural terrain and flammable vegetation, and where a significant potential for wildland fire exists. The WUI is composed of both "interface" and "intermix" communities. Interface communities are defined as areas in which housing and other developments are adjacent to or within close proximity of continuous flammable vegetation. Intermix communities are areas in which housing and vegetation intermingle. In intermix communities, wildland vegetation generally is contiguous to many of the structures.

During the past few decades, population growth in the interface has increased dramatically. Homes, businesses, and subdivisions are being built on forested lands that historically and regularly have experienced fires. Wildfires in Colorado are a natural part of our ecosystems and often help restore and maintain healthy forests. In order to preserve human life and property, firefighters have worked hard to suppress and control fires; however, this may have had negative effects on some ecosystem functions.

unrecognized by the public—are contributing factors in these fires.

Recently, lodgepole pine forests in Colorado have been subject to or threatened by a mountain pine beetle epidemic that is unprecedented in Colorado's recorded history. Where expansive areas of trees have been killed by mountain pine beetles, future fires could be more intense and larger than fires that occurred before the outbreak, and extreme fire behavior is

Fire hazards to communities are complicated and change over time when mountain pine beetles are added to the equation.

Large, intense fires, though infrequent, are characteristic of Colorado's lodgepole pine forests, especially when conditions are hot, dry, and windy. Such fires provide a natural means for lodgepole pine renewal, and are largely responsible for extensive pure lodgepole pine forests.

Many recent wildfires in Colorado have been unusually large and destructive. Drought, high winds, and other factors have contributed to the severity of these fires. Landscape-level conditions characterized by homogeneous forests with older age classes and high densities—characteristics that often are

possible. Conditions for these intense fires will last longer throughout the summer months when dry needles are present on dead trees. After these needles are gone, and especially after tree boles begin to fall, the stands also will be more open to the drying effects of sun and wind. While more research is needed to understand in what ways and how long the fuels and fire environment are altered by beetles, protection of communities and other values at risk is imperative. What is understood and agreed upon is that if weather and fuel moisture conditions are conducive for ignition and fire spread, MPB-impacted forests can burn when (see following page):

During the current epidemic, beetles have killed most trees over a number of years as shown by the mix of grey, red, and green trees.

- Trees still have green, red, brown, or grey needles. This time period may last for 2-3 years following beetle attacks. Stands may be attacked over time and, thus, may remain in this hazardous condition for many years, as long as beetles are active. Fire behavior in these areas likely will be intense, crown fires are likely to occur, and fires can spread quickly.

- As the needles fall off the trees, fire hazard is actually lower for a period of time, as the stand will not sustain a crown fire under these conditions.

- At some point, probably beginning within five years after death, the likelihood increases that the trees will rot or blow over. This can begin to create a situation where high levels of heavy fuels (logs and large branches) accumulate. These fuels will likely be in contact with increased amounts of lighter, flashy fuels (e.g. grasses and forbs), including any seedling trees that have grown as a result of the increased sunlight and moisture available in the dead stands. Due to the openness of these areas, trees will be subject to the drying effects of sun and wind, which means fires can be intense, long, difficult to suppress, and may cause severe soil damage.

It is important that land managers, architects, city and county planners, and property owners work together to address the complicated issues of wildfire hazard reduction and building within the wildland-urban interface. Buildings and surrounding properties should be adapted so that when fires burn firefighters can safely do their jobs to protect human-made structures and infrastructure elements. Forests in these close-in WUI areas should be managed in such a way that they are more resistant to rapid fire spread and the effects and impacts of fire.

Paul Summerfelt, fuel management officer for the city of Flagstaff, Ariz., prefers a broader definition of this concept, based on community values. Summerfelt said, "…we look at the interface, and where we want to work is miles outside our community. This is because while the flames may not threaten us directly in town, all those other things will be affected." This view is shared by many in Colorado's fire services.

Buffer Distances for the WUI

It is equally important to manage the lands immediately adjacent to and around the communities themselves. Much discussion has occurred about how far from communities into surrounding wildland fuels these buffers should penetrate. The Healthy Forests Restoration Act uses default distances of ½ mile to 1½ miles for forest fuels and grasslands, if a community has not defined its WUI area. Some experts suggest only a ¼-mile buffer, while others say site-level treatments around structures is all that is necessary. Obviously, a wide variety of specific local conditions and a collaborative planning process should determine the minimum distance for any individual community.

Whatever buffer distance an individual community selects, the most effective and important treatments are those implemented immediately around individual structures. Similarly, the most important treatments are those implemented in and immediately around a community. In both cases, treatments close to structures and the community are high priorities. As one moves outward from the structures and community, the intensity of treatments can decrease to better blend with the surrounding forest.

The WUI area identified in a Community Wildfire Protection Plan (CWPP) should be sufficient to reduce wildland fire risk to all community values that, in addition to structures, should include utility systems, water supplies, and important forested landscapes and viewscapes.

This suggested buffer is comprised of two zones. The first is the community interior buffer that encompasses the area from the edge of any development outward. Treatment methods and standards are similar

to those utilized immediately around houses, structures, and the community itself. Treatments typically will be classified as site level, but gradually will transition to stand level as the outer edge of the interior buffer is approached.

The second zone, the community exterior buffer, encompasses the area from the outer perimeter of the interior buffer outward. Treatments typically will occur at stand levels, but gradually will transition to landscape level as the outer edge of the exterior buffer is approached.

A Community's Sense of Place

While operationally sound from the standpoint of fire behavior, structure protection, and fuels management, the implementation of site-level treatments around structures and within the minimum interface area as described above does not address an individual community's "sense of place." Based on past experience, experts agree that during large fire events, homes and structures with adequate defensible space can avoid direct impacts of wildfire. However, much of the surrounding vegetation may be burned and killed. When combined with degraded aesthetics and the typical post-fire impacts of flooding, erosion, sediment deposition, debris flows, and more, loss of vegetation can be devastating to communities.

As land managers, we usually are not well trained or equipped in the social aspects of working with communities. For the most part, we admittedly are uncomfortable in the role of defining a community's sense of place. However, we strongly encourage communities to carefully consider their sense of place — the values they share that make their community a true home — when defining their interface area.

Land managers and local residents must work hard to come to consensus on the community's sense of place, and management techniques and treatments.

Management Guidelines for Lodgepole Pine within the WUI

Lodgepole pine management in the WUI typically involves a combination of fuels management and forest health objectives. Management in this area is markedly different than that for lodgepole pine forests located away from houses, communities, and other developments. Normally, it is best to develop fuels management and hazard mitigation strategies that are informed and guided by the ecology of the tree species. Often, this is effective and accomplished relatively easily, for example, when managing ponderosa pine. This species is relatively easy to thin and manage in an open stand structure. Unfortunately, this is ***not*** the case with lodgepole pine. Such treatments tend to fly in the face of lodgepole pine ecology and ecosystem function. This is not to say that effective treatments cannot be designed and implemented, but that lodgepole pine fuels-management needs often supersede ecological concerns when working within the community's WUI.

Land managers recommend the implementation of intensive management strategies in lodgepole pine stands and, in some cases, even individual trees when working within the WUI. Individual trees around structures and the forest should be managed from the seedling stage through maturity to achieve desired outcomes regarding forest health and wildfire hazard reduction. To keep stand density low,* trees should be thinned on a periodic and regular basis.

(Thinning lodgepole pine to achieve low densities can best be accomplished by beginning when trees are small saplings, and maintaining those densities through time as the trees mature. Extensive thinning of dense pole-sized and larger lodgepole pine often results in windthrow of the remaining trees. To reduce windthrow risk, tree removal in these larger size-classes should be limited to 25 percent of the existing basal area. Initial thinning to achieve this level often does not effectively reduce the Crowning Index. Clearcut fuelbreaks or Finney's "SPOTS"* [Strategic Placement Of Treatments**] *may be the only effective treatment in mature lodgepole pine forests.)*

Intensive management over time is necessary to better maintain forest cover during periodic insect and disease outbreaks or other disturbances.

It is important to recognize that the most effective way to achieve the greatest increase in the safety of homes is to ensure that structures are built with materials that are fire resistant or noncombustible, *and* to thin, prune, and otherwise modify the forest and fuels immediately adjacent to and surrounding structures. Treatments generally should occur around and close to structures and communities first, and then move outward. However, it is understood that a community's CWPP specifically defines treatment areas, treatments to be applied, and their relative priority.

A common misconception when treating forests to reduce wildfire hazards in the WUI is that it will create a landscape that is largely deforested. This need not be the case, but given the ecology and special management needs of lodgepole pine within the WUI, careful planning, implementation, monitoring, and maintenance is imperative.

See pages 7-8 for general characterizations about such management.

Tree and Forest Characterizations in the WUI

The Defensible Space and Community "Interior Buffer"

- **Age Diversity** – Seek to maintain or create a variety of age classes within the various trees present on the site.
- **Size Diversity** – Seek to maintain or create a variety of size classes within the various trees present on the site.
- **Species Diversity** – Manage for a variety of native coniferous and deciduous tree species. Where they will grow, plant and/or retain native deciduous trees such as aspen, willow, maple, and narrowleaf cottonwood.
- **Low Densities** – Manage stands and individual trees to achieve a low per-acre tree density, thus reducing the ability of fire to spread from tree to tree (crowning). Minimize group and single-tree torching. Use management techniques such as thinning, group selection, and patch cuts to break up crown density.
- **Fuels** – Significantly reduce and maintain fuel loadings at low levels. Prune residual trees to remove ladder fuels and raise canopy base-height levels. Remove cut and/or downed fuels from the area, and chip or burn to reduce slash size.
- **Maintenance** – Annually inspect and maintain defensible space around structures. Inspect vegetation treatments within the inner buffer every five years to identify and schedule specific maintenance needs and additional treatments. Annually review and update the CWPP to reflect current conditions, and maintenance and treatment needs.

The Community "Exterior Buffer"

- **Age Diversity** – Seek to maintain or create a variety of age classes within the various trees present on the site.
- **Size Diversity** – Seek to maintain or create a variety of size classes within the various trees present on the site.
- **Species Diversity** – Manage for a variety of native coniferous and deciduous tree species. Where they will grow, plant and/or retain native deciduous trees such as aspen, willow, maple, and narrowleaf cottonwood.
- **Low Densities** – Manage stands to achieve low to moderate tree density per acre, thus reducing the ability of fire to spread from tree to tree (crowning). Use management techniques such as thinning, group selection, patch cuts and small clearcuts to break up crown density.

Areas around communities also must be managed to protect life, property, and community infrastructure.

- **Fuels** – Significantly reduce and maintain fuel loads at low to low-moderate levels. Prune residual trees in strategic areas to reduce ladder fuels and raise tree canopy base heights. Remove the majority of downed fuels from the area, and chip or burn to reduce slash size.

- **Maintenance** – Inspect vegetation treatments within the outer buffer every five years to identify and schedule specific maintenance needs and additional treatments.

- **Aesthetics** – To better blend with the surrounding forest, reduce treatment intensity when approaching the outer perimeter of the buffer zone.

Table 1
Lodgepole Pine Management Characterizations in the Wildland-Urban Interface

Increasing Elevation →

WUI LOCATION	*TREATMENT LEVEL*	*MIXED CONIFER*	*PURE LODGEPOLE PINE*	*SUBALPINE MIXED SPECIES*
In and immediately around housing, structures, and communities	Site level	Low densities Age diversity Size diversity Species diversity Low fuel-load levels	Low densities Age diversity Size diversity Species diversity Low fuel-load levels	Low densities Age diversity Size diversity Species diversity Low fuel-load levels
Community interior buffer	Site level gradually transitioning to stand level	Low densities Age diversity Size diversity Species diversity Low fuel-load levels	Low densities Age diversity Size diversity Species diversity Low fuel-load levels	Low densities Age diversity Size diversity Species diversity Low fuel-load levels
Community exterior buffer	Stand level gradually transitioning to landscape level	Low to moderate densities Age diversity Size diversity Species diversity Low to moderate fuel-load levels	Low to moderate densities Age diversity Size diversity Species diversity Low to moderate fuel-load levels	Low to moderate densities Age diversity Size diversity Species diversity Low to moderate fuel-load levels

Table 2
Acceptable Slash and Fuels Management Methods for Lodgepole Pine within the Wildland-Urban Interface

		Acceptable Methods of Large Diameter Material and Slash Treatment				
WUI LOCATION	*DESIRED FUEL-LOAD LEVELS*	*LOP AND SCATTER*	*PILE AND BURN*	*CHIPPING*	*MASTICATION*	*REMOVAL VIA SALVAGE OR COMMERCIAL SALE*
In and immediately around housing, structures, and communities	Low	Rarely; less than 12" deep	Yes, with caution	Yes (chip cover should be discontinuous and < 2" deep)	Yes, with caution (chip/chunk cover should be discontinuous; limit depth)	Encouraged and if possible
Community interior buffer	Low	Discontinuous and less than 12" deep	Yes	Yes	Yes	Yes
Community exterior buffer	Low to moderate	Yes	Yes	Yes	Yes	Yes

Management Guidelines for Colorado Lodgepole Pine Forests

Considerations in Mountain Pine Beetle-impacted Stands in the WUI

Discussion

Much of Colorado's lodgepole pine forests are at risk from attack by mountain pine beetle. Extensive areas in Grand, Summit, Jackson, and other counties have been under attack by this insect for several years. In such areas, nearly all of the larger diameter, more mature trees already have been attacked and killed. Even some small lodgepole pine trees and other tree species have been attacked in the beetles' effort to find a brood site and food source.

MPB -impacted lodgepole pine stands near Michigan Reservoir.

This epidemic has crested the Continental Divide, and significant numbers of dead and newly infested trees now are found in areas of Park, Clear Creek, Gilpin, Boulder, and Larimer counties. While lodgepole pine trees east of the divide tend to be of smaller diameter and height compared to those west of the divide, the current infestation appears to be following the pattern of the epidemic to the west. Most trees of susceptible size are being attacked and killed.

The lower elevation eastern lodgepole stands tend to be patchier and mixed with ponderosa pine, limber pine, Douglas-fir, and some aspen. Mountain pine beetles are moving into ponderosa and limber pines in these mixed stands. What remains unknown is whether this current epidemic will continue in force once it reaches stands composed primarily of ponderosa pine. The last MPB epidemic in Front Range ponderosa pine broke out during the 1970s and continued into the mid-1980s in some

areas. During that infestation, MPB moved readily from ponderosa to lodgepole pine in mixed stands; however, in most cases, the infestation did not continue to spread when the beetles reached pure lodgepole pine stands. Today, most Front Range ponderosa pine stands once again are dense, consist of susceptible age and size classes, and could support an epidemic.

This situation is of grave concern to forest landowners due to the high direct costs of preventive spraying, felling, and removal of infested trees. Also of concern are decreasing property values and poor aesthetics. Many landowners bought their land for what they perceived to be healthy, green forests. Consequently, forest management objectives should focus on forest health. And in the WUI, we also must consider wildfire hazard mitigation. Lodgepole pine management recommendations within the WUI must skillfully design and artfully apply treatments that blend these two management needs.

If followed and maintained over time, wildfire hazard reduction guidelines for the WUI will make lodgepole pine stands more resilient to future MPB attacks. Treatments should result in low-density stands that include trees of diverse species, ages, and sizes, and stands also should have minimal hazardous fuels. These stands should be intensively managed from seedling stage to old growth to improve forest health and reduce wildfire hazard. Stands should be thinned on a regular basis. Whether treating trees prior to MPB attack, during the epidemic, or when dealing with the aftermath of the epidemic, the following elements should remain constant:

- Avoid developing pure lodgepole stands when possible.
- Design cuttings to break up continuous stands across the landscape.
- Create a landscape with different age classes.

Thinning Lodgepole Pine

Older lodgepole pine stands generally do not respond well to selective thinning. Unlike other species, they tend not to make good use of the increased moisture, sunlight, and soil nutrients available after thinning. To achieve such results, the stands must be heavily thinned. Unfortunately, selective thinning of lodgepole opens the stand to severe windthrow and stem breakage. To ensure a positive response to thinning throughout the life of the stand, trees must be thinned early in their lives and no later than 20 to 30 years after germination. This investment must be maintained through periodic follow-up thinnings.

It is important to understand this ecological limitation when thinning lodgepole and, as noted in the previous section, the need to reduce hazardous fuels often supersedes ecology when working in the WUI. Such thinning of lodgepole in and around homes, other developments, and entire communities should have a positive impact when beetles do attack.

For example, Denver Water actively managed its forest stands in Grand County for many years prior to the current beetle epidemic. Stands were thinned in many areas and dwarf mistletoe-infected stands were clearcut and regenerated, as were some larger, older stands. This treatment strategy resulted in stands of trees that are too small and/or vigorous for the beetles to successfully attack. Larger trees in thinned stands responded to thinning in varying degrees, making them more resistant to beetle attacks. These were some of the very last stands in the area to succumb to the beetle. Stand life was marginally extended as a result of the thinning. If the epidemic had been less intense, it is likely that many of these trees might have survived. In addition, these managed stands existed for many years in the absence of wildfire hazards due to improved understory vegetation. Further benefits included wildlife habitat, aesthetics, and other values.

During the most recent MPB epidemic, some areas have experienced nearly 100-percent mortality of larger trees.

Management Guidelines:

A. Consider the following lodgepole pine thinning guidelines for use in the WUI *prior to* MPB attack:

1. Understand the limitations for thinning, but begin to actively manage stands as soon as possible in their life cycle, even if the trees are older than 30 years.

2. Thin existing mature stands to achieve density levels required for wildfire hazard mitigation and MPB resistance. This is difficult to accomplish in one entry due to windthrow and stem breakage, so plan on multiple entries. Remove no more than 25 percent of the stand's basal area during each cut, and carefully monitor stands to ensure proper timing of the necessary re-entries.

3. Follow guidelines to maximize resistance to MPB. Generally, maintain average stem diameters of < 8 inches and stand densities of < 80 square feet of basal area per acre. This requires more frequent use of silvicultural actions designed to regenerate lodgepole. To do so, incorporate small clearcuts or patch cuts when possible. This will achieve age and size diversity.

4. In stands of mixed species, retain species other than lodgepole pine. Use caution during treatments to avoid damaging the desired residual trees.

5. Avoid developing multi-storied stands. If this situation begins to develop:

   a. Remove the emerging understory to reduce ladder fuels, or

   b. Remove the overstory early enough to avoid damaging the developing understory, or

   c. Combine a and b above to achieve greater diversity across the landscape.

6. If an entire stand is infected with dwarf mistletoe, remove the most severely infected trees during each thinning entry. Retain alternate coniferous species and aspen. Create small openings and begin planting alternate species within the openings.

7. If only portions of the stand are infected with dwarf mistletoe, clearcut or patch cut infected areas.

8. Maintain aspen or encourage its development by taking the following actions:

   a. Remove conifers from within aspen stands or pockets of aspen.

   b. Remove conifers from around the edge of aspen pockets, particularly on the south and west sides. Remove conifers that are up to 1.5 times the height of nearby aspen trees to accommodate peripheral aspen sprouting.

Within the WUI, thinning of lodgepole pine should be carefully undertaken at any age to protect homes and other enhancements, and to improve forest health.

If lodgepole pine can be harvested prior to or soon after attack by beetles, it may be usable for many different forest products.

A strong forest industry is essential to help offset the cost of treatments necessary to develop and maintain the diverse forest structure desired in the wildland-urban interface.

c. If aspen stands or pockets are decadent, consider clearcutting or patch-cutting to encourage re-sprouting. Cut aspen during the dormant season to maximize sprouting.

9. To keep fuel accumulations at a minimum, remove trees that have been severely damaged by lightning, windthrow, and insect and disease infestations as soon as possible.

10. Remove larger woody material from the forest and use proper slash-disposal techniques such as piling and burning, chipping, or low-depth, discontinuous lop and scatter. This reduces fuel loading and helps prevent significant buildup of ips beetles that might attack and weaken or kill remaining trees (refer to Table 2).

In lodgepole pine forests, it often is possible and desirable to convert to, and maintain some areas as, aspens stands.

B. Consider these additional lodgepole pine guidelines for use in the WUI *during significant* MPB attacks:

1. Thinning will not guarantee lodgepole pine survival during a large-scale MPB epidemic, but increased vigor from thinning can help trees survive localized, low-intensity MPB outbreaks.

2. Retaining large areas of standing dead timber within the WUI is not desirable. Instead, focus on removing dead and newly infested trees.

a. Conduct sanitation cutting after beetle flight in the fall, and complete by early spring. If possible, avoid cutting during or shortly before beetle flight.

b. During cutting, protect and favor species other than lodgepole pine.

c. Reduce fuel loads by removing logs and woody debris (refer to Table 2) through:

i. Commercial utilization

ii. Mastication

iii. Chipping

iv. Piling and burning

v. *At the very minimum*, lop-and-scatter thoroughly to a discontinuous, low depth of 12” or less. The intent is to break up material and facilitate contact with the soil to aid decomposition of woody material.

3. Evaluate the situation honestly and recognize that it may be better to cut all susceptible trees rather than attempt to save a few, scattered live trees. Such specimens likely will be attacked within a year or two, or will blow over or break as a result of wind or snow.

In the WUI and surrounding areas, lodgepole pine should be intensively managed beginning at an early age; see photo of a regenerated stand, above. Doing so will help prevent the development of overly dense, stagnated stands of trees, as shown in the photo below.

4. Consider preventive spraying of high-value trees immediately around structures. Commit to spraying a few high-value trees for several years rather than spray many trees for only a couple of years.

   a. Remove larger, mature trees, and spray the smaller pole-sized trees. (It often is difficult to reach the tops of large trees with preventive spray. Beetles can and will attack tree tops above the spray line.)

   b. Don't create small "green islands," as they likely will blow over.

   c. See Appendix A for *Spraying Trees To Protect Against Mountain Pine Beetle: Common Questions For Landowners To Consider*.

   d. Lessons learned from the current epidemic:

      i. Landowners want to save their biggest trees, but beetles still hit the tops of those same trees. Although the trees are sprayed, the spray may not reach the top of the crown.

      ii. Remove the biggest trees; save those on which the entire bole and crown can be covered with spray.

      iii. Spraying only buys time unless you are committed to spraying throughout the entire epidemic, which may last several years.

      iv. Consider the pros and cons of the various preventive sprays available.

      v. Identify the trees you want to spray; don't rely totally on a contractor for tree selection. Mark the trees that ***you*** want to treat. Monitor and follow-up after treatment.

      vi. If spraying is not done by a licensed, trained applicator, it is likely to be ineffective and could cause unintended damage (see Appendix A).

5. Under-plant in existing openings or cut patches and then plant. Don't create ladder fuels.

6. Understand the financial situation:

   a. The window of opportunity for forest products utilization is limited due to checking and rotting of standing dead trees.

   b. Remove green trees while they still have value. After the trees are dead, you will pay to remove them.

   c. It is expensive to cut and remove trees. If you do this each year, you are piling expense upon expense. Consider implementing a complete cut at one time to avoid additional annual expense.

   d. Even where a market for sawlogs exists, removing only infested trees will result in a net cost for the landowner.

Lop and scatter slash with care and under limited circumstances within the wildland-urban interface.

Chipping is an effective method of slash disposal, but it is very labor-intensive and expensive.

e. Nails, bolts, hooks, and other metal objects often are driven into trees along roadsides. These objects pose a major safety threat to loggers and to those who process wood at sawmills. The presence of metal in trees also limits opportunities for financial recovery generated from the wood.

C. Consider these additional lodgepole pine guidelines for use in the WUI *after significant* MPB attacks:

1. Some areas have lost so many trees that they are at the clean-up and recovery stage.

2. It is not advisable to retain large areas of standing dead timber within the WUI. When the majority of the forest is dead, it is time to focus efforts on the future forest.

3. Conduct a survey:

   a. Which trees have survived? Are they likely to remain standing, or are they vulnerable to windthrow? Will they pose a threat to roads, trails, or structures if they break or blow over? Are they diseased, of poor health or form, or damaged?

   b. Is regeneration occurring? Seedlings or saplings? Where? How many?

4. Triage the project area to prioritize treatments:

   a. Remove hazard trees that are an immediate threat to people, structures, roads, utility lines, or other critical improvements or infrastructure. **Note:** *When identifying hazard trees, consider those that are within at least 1.5 times tree height of potential targets. This distance is recommended to provide an additional safety margin, and to avoid accumulation of broken tree tops and branches on or adjacent to improvements if the tree(s) fell. Actual distance for treatments in proximity to improvements should be determined through a collaborative process, and should be based on local conditions and experience.*

   b. Remove hazard trees that are a threat to recreationists on trails.

   c. Remove trees from any remaining lower-priority areas.

   d. Conduct slash treatments to reduce fuel loading (refer to Table 2):

      i. Remove as much material as possible; commercial utilization may be an option.

      ii. Mastication

      iii. Chipping

      iv. Piling and burning

Careful burning of slash piles during periods of adequate snow cover or moisture is an effective method of disposal.

Where markets for timber do not exist or trees are too small, equipment can grind, mulch, or masticate trees to accomplish desired treatments.

Grinding and mulching slash, called mastication, is an effective way to treat debris after thinning or other harvest methods. Avoid excessive depth or accumulation of chips and chunks.

v. *At the very minimum*, thoroughly lop and scatter to a discontinuous, low depth of 12" or less. The intent is to break up material and facilitate contact with the soil to aid decomposition of woody biomass.

5. Re-seed to establish ground cover on skid trails, landings, and other areas.

6. Carefully plan your new forest while considering desired forest structure; species, numbers, sizes, ages, and condition of any remaining trees; and any trees you will plant. Your design should incorporate the management guidelines shown in Table 1. (*This action step applies to individual homesites and properties up to and including a community's identified WUI area.)*

7. Early on, determine the desired areas for fuelbreaks based on values to be protected, topography, and dominant wind patterns. Capitalize on areas that have little or no regeneration, or that have aspen or grasslands, and maintain these areas for future wildfire protection. Maintenance of these grasslands and low-density timbered stands can be accomplished through periodic maintenance treatments using mastication equipment, prescribed fire, or other treatment methods.

Even areas of lodgepole pine that have been thinned can burn intensively during warm, dry, and windy conditions.

Appendices

SPRAYING TREES TO PROTECT AGAINST MOUNTAIN PINE BEETLE
COMMON QUESTIONS FOR LANDOWNERS TO CONSIDER

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Due to the current mountain pine beetle (MPB) epidemic in Colorado, landowners are concerned about protecting their trees. Aggressively searching out, removing, and destroying the brood in infested trees is the best way to slow the spread of MPB; however, it may not protect specific trees. Spraying trees to prevent attack is the most effective way to protect a small number of high-value trees from mountain pine beetle. Research indicates that other methods, including tree injections and pheromones, are either ineffective or less effective than spraying, especially when beetle populations are high. The following will provide additional information for landowners who are considering treatments to address MBP infestations.

How many trees should be sprayed?
Spraying is not recommended on a large scale for ecological and financial reasons. Selecting 5 to 10 high-value trees to spray is more realistic.

What trees should be sprayed?
A high-value tree is one that is important to you for a variety of reasons – perhaps it acts as a visual screen, shades a deck, or has emotional or aesthetic value. A high-value tree may not always be the biggest tree on your property. Large trees usually are more vulnerable to attack, while trees under 3 inches in diameter should be safe from attack. Only pine trees – lodgepole, limber, ponderosa and bristlecone – are susceptible to MPB, although some Engelmann and blue spruce were killed on the Western Slope when the infestation was at high levels. Before spraying, make sure the tree in question has not already been attacked by pine beetle. It also is important to remember that lodgepole pine trees are shallow-rooted, which means that surviving or protected trees may blow over if too many adjacent trees are removed because they are infested with beetles. Defending a small patch of trees may be the best option to provide protection from the wind.

How do I identify pine trees?
An easy way to identify pine trees is to look for needles that are attached in small bundles of 2-5. Needles on other tree species are attached singly.

When should I spray?
The best time to spray is close, but prior to, beetle flight in July. Spraying in May or June will yield the best results, and the chemicals are usually effective for at least one year. Be sure to call a licensed applicator in advance so you can reserve time on his/her schedule.

How many years will I need to spray?
You will need to spray every year for as long as the pine beetle epidemic lasts, which could be 10 years or more.

Who can spray?
Commercial licensed applicators are highly recommended. They have the necessary high-pressure equipment and personal protective gear, and are held to high public and environmental safety standards by the State of Colorado. If you choose to apply spray yourself, YOU MUST follow the label exactly, dispose of any leftover spray, and rinse with water according to directions. Only use insecticides that are labeled to protect trees from bark beetle attack. These insecticide formulations have additives that bind the active ingredient to the bark. If you hire someone to spray, that person must be a licensed applicator. To verify qualifications, ask to see her/his license and request references. It also is advisable to get a commitment to spray before the beetles fly in July.

In addition, make sure that the applicator:
- Sprays from ground level to the point where the tree tapers to less than 4 inches. It may not be possible to effectively spray a really tall tree.
- Sprays around the entire circumference of the tree and does not miss areas with large branches or forks, otherwise the unsprayed "windows" are open to attack.
- Does not spray trees if there is a chance it may rain within two hours after application. Once the insecticide dries on the tree bark, it will be resistant to wash-off.
- Uses a chemical that is specifically labeled for mountain pine beetle; it needs to have the right additives to bind the active ingredient to the bark.

How much does spraying cost?
Cost depends on the number of trees sprayed. It may be more economical to coordinate with your neighbors to increase the number of trees sprayed in a single visit, as this will bring down the cost.

How do I find a Commercial Licensed Applicator?
Look for "tree service" in the phone book or on the web, and ask if they are qualified to apply sprays that prevent mountain pine beetle, or talk to neighbors who may have had their trees sprayed.

What chemicals are used for preventive spraying?
Carbaryl (Sevin SL and XLR, and others) and Permethrin (Astro, Dragnet and others) and bifenthrin (Onyx) are registered for use in the prevention of pine beetle infestations. Only use insecticide formulations that are labeled to protect trees from bark beetle attacks. These formulations include additives that bind the active ingredient to the bark. The pH of the water mixed with the insecticide should be slightly acidic to near neutral. Do not use alkaline water with carbaryl without first neutralizing the pH. It seems that carbaryl is not stable under alkaline conditions.

Toxicity/ecological effects of the chemicals (for more detailed information: http://npic.orst.edu/)
Carbaryl (Sevin SL, XLR, or 4L)
- Carbaryl is a wide-spectrum carbamate that is used to control more than 100 species of insects.
- Acute toxicity: moderate to very toxic.
- The EPA considers carbaryl "likely to be carcinogenic in humans" due to increased tumor production in mice.
- Breakdown in soil: half-life of 7-14 days in sandy loam soils and 14-28 days in clay loam soils. It is not a high-leaching compound, but it is prone to runoff.
- Breakdown in water: half-life of about 10 days at neutral pH, but can vary depending on acidity in water; in river water, exposed to natural and artificial light, it degrades completely within 2 weeks.
- Fate in humans and animals: rapidly broken down, excreted in urine and feces at a rate of approximately 75 percent with initial exposure.
- Effects on birds: practically non-toxic to wild bird species.
- Effects on aquatic organisms: moderately toxic to highly toxic to aquatic species such as rainbow trout.
- Effects on other insects: lethal to many non-target species, including bees and other beneficial insects.

Permethrin (Astro or Dragnet)

- Permethrin is a broad spectrum synthetic pyrethroid insecticide.
- Acute toxicity: moderate to practically non-toxic via the oral route. Via the dermal route, slightly toxic
- Breakdown in soil: half-life of 30-38 days. Permethrin is tightly bound by soils, so little to no leaching occurs in groundwater.
- Breakdown in water: half-life of less than 2.5 days. Permethrin degrades rapidly in water, although it can persist in sediments.
- Fate in humans and animals: efficiently metabolized by mammalian livers. Quickly excreted with no significant persistence in body tissues.
- Effects on birds: practically non-toxic to birds.
- Effects on aquatic organisms: aquatic ecosystems are very vulnerable to the impact of permethrin.
- Effects on other organisms: permethrin is extremely toxic to bees and other beneficial insects if present during application, or within 24 hours thereafter.

Bifenthrin (Onyx)

- Bifenthrin is a member of the pyrethroid chemical class..
- Acute toxicity: moderately toxic to mammals when ingested.
- Breakdown in soil: bifenthrin does not move in soils with large amounts of organic matter, clay or silt, and has low mobility in sandy soils that are low in organic matter. Its half-life in soil is 7 days to 8 months depending on the soil type and the amount of air in the soil.
- Breakdown in water: relatively insoluble in water, so there are no concerns about groundwater contamination through leaching.
- Effects on birds: moderately toxic to many species of birds and is slightly more toxic than permethrin.
- Effects on aquatic organisms: aquatic ecosystems are very vulnerable to the impacts of bifenthrin.
- Effects on other organisms: bifenthrin is extremely toxic to bees and other beneficial insects if present during application, or within 24 hours thereafter.

On-line versions of the labels for these pesticides can be found: http://oaspub.epa.gov/pestlabl/ppls.home

I heard that carbaryl was found in the Blue River after preventative spraying occurred. Will spraying contaminate our groundwater?

Carbaryl was found in water, but not in the Blue River. It was detected in the surface water from the waste water treatment stream, which suggests misapplication or improper disposal of the pesticide. Again, it is imperative to apply all insecticide mix and rinse water to trees according to label directions. Do not wash equipment or dispose of left-over insecticide mix or rinse water into a waster water system. Do not draw water from a water source (pond or creek) into a mixing tank. Maintain a separate water supply and delivery system to prevent contaminating fresh water with mixed insecticide.

Because carbaryl is not a high-leaching compound, but is more prone to runoff, it is more likely to be found in surface water than in groundwater (wells). So far, it has been found in the surface water once, and again, it is probably due to improper disposal. None of the Colorado State University well-sampling programs have detected carbaryl in groundwater in Colorado.

For more information about preventive spraying, contact Colorado State Forest Service entomologist, at 970-491-6303.

For more information about health effects that could be related to the use of these pesticides, please contact the Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) of the Colorado Department of Public Health and Environment (CDPHE) toll free at 1 (888) 569-1831, extension 2617.

Table 3

Reference Documents for Lodgepole Pine Management in the Wildland-Urban Interface

WUI LOCATION	EXISTING REFERENCE DOCUMENTS
In and immediately around Housing, Structures, and Communities	**CSFS Fact Sheets:** 6.302; 6.303; 6.305; 6.306 **CSFS Publications:** "FireWise Construction: Design & Materials" "Colorado, Are You FireWise?" (Notebook) "Colorado Landowner Guide to Thinning"
Community "Interior Buffer"	**CSFS Fact Sheets:** 6.302; 6.303; 6.305; 6.306 **CSFS Publications:** "FireWise Construction: Design & Materials" "Colorado, Are You FireWise?" (Notebook) "Colorado Landowner Guide to Thinning" "Fuelbreak Guidelines for Forested Subdivisions"
Community "Exterior Buffer"	**CSFS Publications:** "Colorado, Are You FireWise?" (Notebook) "Colorado Landowner Guide to Thinning" "Fuelbreak Guidelines for Forested Subdivisions"

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