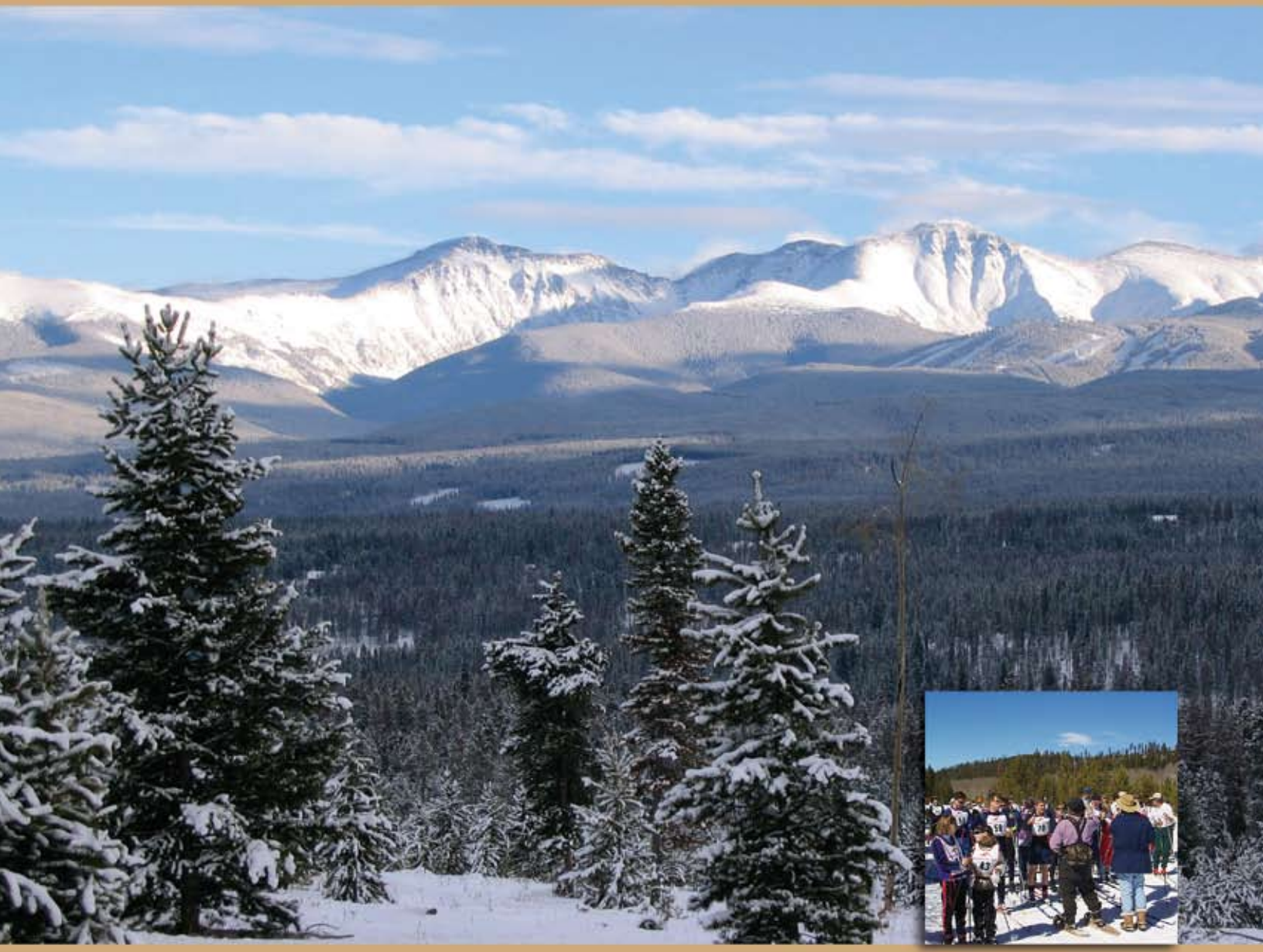

2006

Report on the Health of Colorado's Forests

Special Issue:
Lodgepole Pine Forests

February 2007

It is with a sense of urgency that we present the *2006 Report on the Health of Colorado's Forests.* This is the sixth in a series of reports developed by the Colorado State Forest Service with the guidance of the Colorado Forestry Advisory Board. The 2000 legislation requiring this report proved to be timely since the forests in Colorado have experienced a series of significant ecological events over the past decade, including the dramatic fire season of 2002 and the ongoing bark beetle epidemics.

Each report covers the overall condition of Colorado's forests in addition to a special focus area. The 2006 report looks in depth at lodgepole pine forests and the bark beetle epidemics which continue to grow over hundreds of thousands of acres, killing trees and affecting communities throughout the state. Beetle-killed forests reduce scenic values, impact the economy, increase fire danger, and are therefore a major concern for many Coloradans.

The dead and dying trees do not need to be a story with a sad ending. Rather, the situation can be a call-to-action for residents and lawmakers, providing an opportunity to shape the "next forest." Long-term forest stewardship efforts can increase forest resilience and diversity and help protect our communities and the critical natural resources that Coloradans depend on and enjoy.

Thank you for your interest in Colorado's forests.

Sincerely,

Nancy M. Fishering
Chairperson, Colorado Forestry Advisory Board

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Executive Summary

Forests are of great value to all Coloradans and have regional and national importance as well. They provide beautiful views, world-class skiing, forest products, wildlife habitat, and clean, plentiful water. Streams flowing from Colorado's forests contribute to the state's water-dependent economy and that of 18 other states and Mexico.

However, many of Colorado's forests are old, crowded, weakened by drought and very susceptible to forest insects, diseases, and wildfires. Their ability to sustainably produce a full range of public benefits is compromised because they are not as healthy or resilient as they could be. Mountain pine beetle and wildfire are shaping Colorado's forests and, without forest management, will continue to determine how these forests look and function in the future.

Ron Cousineau

Lodgepole pine forests, which grow abundantly in Colorado's mountains, are the focus of this year's report. These high-elevation forests provide the setting where people ski, hike, bike and ride off-road vehicles and horses. Currently, vast expanses of beetle-killed trees are bringing this backdrop to the forefront of people's attention.

Bob Sturtevant

Mountain pine beetle populations have exploded into Colorado's most severe outbreak on record. In 2006, more than 650,000 acres (over 1,000 square miles) were infested with mountain pine beetle. The landscapes and high-value resort areas of Grand, Routt, Summit, Eagle and Jackson counties are the most affected. Damage caused by the mountain pine beetle epidemic re-emphasizes the need to proactively manage for diverse and healthy forests.

Most of the mountain pine beetle activity is located at the headwaters of Colorado's drinking water supply, which is also used for irrigation and snowmaking. Many other western states also depend on this water. While intense fires occurred historically in these areas, today they have far-reaching economic and environmental impacts.

Record-breaking temperatures and high-risk forest conditions across the West contributed to the largest wildfire season in the nation since 1960, when wildfire recordkeeping began. In Colorado, over 90,000 acres burned, with many fires occurring earlier than normal.

Wildfire hazard reduction efforts and clean-up of dead trees from the mountain pine beetle epidemic have cost Colorado landowners millions of dollars.

Jen Chase

Wildfire Hazard from Beetle-kill

Fire managers are concerned about the huge swaths of dead trees and the fire hazard because:

- Dead, dry trees catch on fire and burn more easily than wet, green trees.
- Fires become extremely hard to control when there are large accumulations of dead wood on the ground.
- When dead and downed logs burn they can cause soil damage and impact watersheds.
- After the dead trees have fallen and a new forest is growing, there is more fuel than before. This arrangement of surface and standing fuels can feed more destructive wildfires.
- Wildfires would put citizens and firefighters at risk in many high country communities.

Rocky Mountain Interagency Management Team Bravo

The Mato Vega fire burned over 13,000 acres south of the Great Sand Dunes National Monument in June.

Fire ecologists predict that if current warming temperature trends continue, fires throughout the nation will become even more frequent and active. Some contend that these changes have already begun.

Those who own forest land or influence how it is managed have the opportunity today to shape what Colorado's forests will look like tomorrow. Forests can be managed sustainably for a wide variety of public benefits and values. Clean water, recreation opportunities, wood products, habitat for wildlife, and safer communities all add to the quality of life in Colorado. To achieve these goals, the entire landscape, including communities, must be considered.

Colorado's Forests: How Did We Get Here?

Colorado's forests are *disturbance driven*; they are dependent upon change for maintenance and renewal. Fires, insect and disease outbreaks, and forest management can add diversity and resilience to forest stands or bring about entirely new forests from old ones. However, many of Colorado's old forests have not recently experienced disturbance because of fire suppression and very little tree cutting.

Fire suppression has arguably had a greater impact on Colorado's forests than any other human action.

From 2000-2004, a severe drought occurred that further weakened Colorado's old, crowded forests. The drought was not an anomaly, but a naturally recurring process. Future dry periods will also weaken forests and influence wildfires. While forest managers cannot impact the weather, they can improve forest conditions by reducing competition for sunlight, nutrients and water.

Drought is a recurring natural event that will continue to weaken forests and exacerbate wildfires. It is important that Colorado's forests are as vigorous and resilient as possible to mitigate future landscape-sized insect outbreaks and wildfires.

Ironically, excluding wildfire from the landscape to protect life and property actually resulted in forest conditions that often make wildfires more dangerous, costly and intense. Trees grow every year, and can become very crowded without fire, tree cutting or other disturbance. A forest that is dense with growth can burn hotter and create precarious conditions for people, property, and the environment.

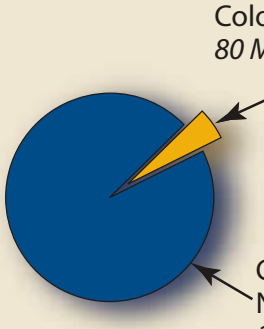
What the next forests look like, and the benefits they produce, will depend on actions that are taken now. Without proactive management, wildfires, insects and other forces will continue to shape Colorado's forests. The resulting landscapes may not meet society's desires and needs and could be even less appealing than those created by the current mountain pine beetle epidemic.

Jen Chase

In 2002, fires in Colorado burned over half a million acres and cost over $152 million to suppress. Many of these fires occurred in the state's old, fire-dependent forests where conditions were worsened by drought.

Forest Growth

The growth of all of the trees in the state is called Colorado's net annual forest growth. About 5% of Colorado's net annual forest growth is harvested each year. This does not include the trees' wood that existed before the annual growth. It is akin to withdrawing interest from a savings account. If only 5% of the annual interest is taken out, the "principal" and the "interest" continue to grow.



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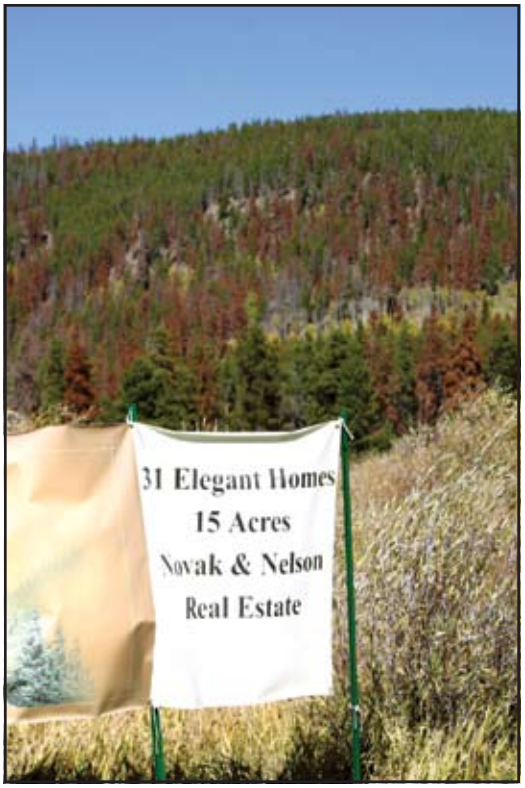
Managing for the Next Forest

Current forest conditions in Colorado demand that all relevant stakeholders proactively work together to improve forest health and protect communities from wildfire.

About a million people live in six million acres of Colorado's high fire hazard forests.

In Colorado, there are 22.5 million acres of forest land. It is neither economically feasible nor even desirable to treat all of this land. Factors such as visual quality, forest diversity, minimizing runoff, and road density all must be considered in deciding where and how to manage. It is critical that the relatively small percentage of Colorado's forests that can be managed is strategically located to provide social and ecological benefits.



Jen Chase

Real estate agents in Summit County are now including mountain pine beetle in their disclosure reports to property buyers.

Jen Chase

Thinning and harvesting forests improves growing conditions by making more light, nutrients, and moisture available.

Forest management is a commitment over time, not a one-time fix.

To make forest management decisions, it is important to consider what the individual landowners need (community scale) as well as what the landscape needs (ecosystem scale). Coloradans benefit from management of both.

At the community scale, protection of life and property is the top priority. Other values may include privacy, scenic views, watersheds, and wildlife observation. Around homes and in

subdivisions, it is not as critical that forest management techniques mimic ecological processes to achieve these objectives. By protecting themselves from wildfire, communities also help prevent firefighter injuries and reduce financial burdens to fellow taxpayers for fire suppression costs.

On the ecosystem scale, a mix of forests with species and age diversity, meadows, and riparian vegetation can result in a more resilient landscape. Maintaining diversity in landscapes can help retain areas of older forests.

Research shows that thinning, commercial timber harvesting and prescribed burning can make forests more resilient, and reduce the adverse effects of wildfires and insect and disease epidemics. For maximum effectiveness, these activities must be implemented across ownership boundaries at a landscape scale and continued over time.

How Can People Manage for the Next Forest?

- Adding diversity to forests can provide a kind of insurance policy against future large-scale multi-landscape disturbance events.
- Thinning around homes and communities helps reduce fire risk in communities and watersheds.
- Creating naturally-shaped openings in lodgepole pine forests over time reintroduces age and spatial diversity.
- Removing conifers from aspen stands provides excellent wildlife habitat and helps prolong aspen on the site.
- Thinning and creating openings in ponderosa pine forests improves vigor in remaining trees, enabling them to better resist damage from wildfire, insects and disease.
- Maintaining forests over time helps keep them resilient.

Ron Cousineau

Lodgepole pine forests with age diversity, pictured above, are more resilient to insects and wildfire.

Insect and Disease Activity Update[1]

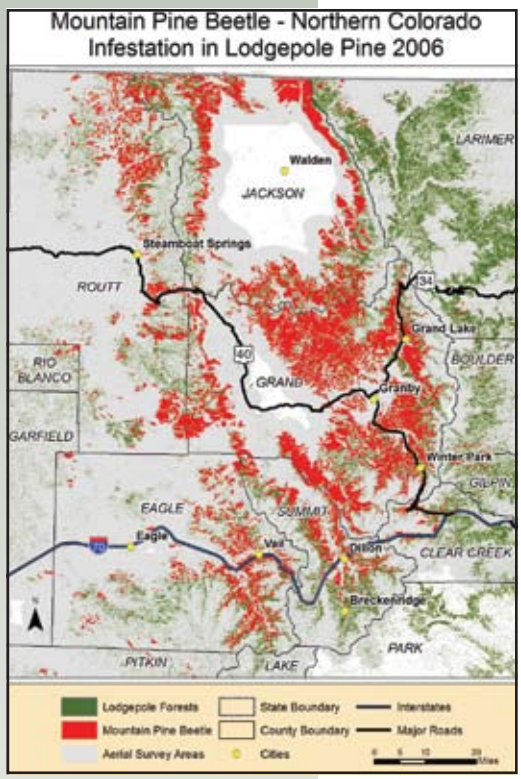
The continued infestation and mortality of forests from bark beetle outbreaks dominated the news with regard to insect and disease activity in Colorado during 2006. Both mountain pine beetle and spruce beetle continue to turn high country forests from green to red, a trend that is being repeated to a lesser extent in the Front Range. In western Colorado, the persistent aspen die-off continues to puzzle researchers.

Mountain Pine Beetle

Colorado is experiencing the largest outbreak of mountain pine beetle in its recorded history. In 2006, this forest insect infested over 660,000 acres in the state, up from 500,000 acres in 2005. There were about four times as many recently killed trees per acre in 2006 than 2005.

Mountain pine beetle is killing pine trees throughout the West. The unusually large and intense outbreaks are spreading further north and in higher elevations than seen before. In Canada, the epidemic is far more intense and extensive than anything previously witnessed by forestry officials.

The current epidemic started in Colorado's high country in the mid-1990s. When the drought of 2000-2004 occurred, it enabled beetle populations to rapidly expand in both infested and new areas.



CSFS

Red areas represent varying degrees of mortality.

Hans Rinke

The green trees in the foreground are too young to provide mountain pine beetle a food source.

There is concern that the vast populations of mountain pine beetle will spread from north-central Colorado to the Front Range. Overcrowded Front Range forests are indeed in the early stages of a slower-growing mountain pine beetle epidemic, although their insect populations are growing independently from those of the high country.

Additional information about mountain pine beetle can be found in the *Lodgepole Pine Agents of Change* section on page 14.

Spruce Beetle

Because they primarily affect more remote high-elevation forests, Colorado's current spruce beetle outbreaks are not as well known as the mountain pine beetle epidemic. However, older Engelmann spruce forests near Carbondale, South Fork, and from Steamboat Springs north to the Wyoming border have experienced extensive mortality from spruce beetles. The northern Colorado activity resulted from a large spruce forest blowdown in

[1] Acres and tree mortality estimates in this section were derived from the 2006 aerial survey of insects and diseases in Colorado. For bark beetles, the survey quantifies the areas that were infested in 2005 and turned red in 2006. It does not include the green trees that became infested in 2006 as these are not discernible from airplanes.

1997 at the Routt National Forest. About 68,000 acres were infested in 2006. Although this is less than the 119,000 acres infested in 2005, the reduction is partially due to previous years' activity which has left few live spruce trees to infest.

In recent years, warmer temperatures have changed the spruce beetle's life cycle from two years to one, allowing them to spread more quickly. This bark beetle is also affecting other western states. Utah has experienced extensive spruce mortality in recent years, and Wyoming is currently in the midst of an outbreak in the advanced stages. In Colorado, this epidemic is changing the face of today's old spruce forests.

Bob Sturtevant

With the large areas of standing dead trees, officials are concerned about future threats of falling trees to roads, trails, powerlines, buildings and campgrounds.

Bill Ciesla

In some of Colorado's aspen forests, mature trees are dying without new, younger trees growing to replace them.

Aspen Decline

For the second year in a row, unexplained aspen decline occurred in western Colorado. Despite many on-site inspections, experts have not determined what is killing the trees and their root systems. Common culprits such as animal grazing and conifer encroachment are not responsible for this ongoing die-back. About 138,000 acres of aspen decline and mortality were observed from 2006 aerial survey flights. The extent of dying roots is unknown.

Researchers are currently designing an investigation that will attempt to determine specific symptoms and causes. If aspen root systems are unable to produce new aspen suckers, aspen clones that have existed for millennia will be lost. Preliminary assessments have shown many different causal agents, from decay fungi to aspen bark beetles, in different areas. In some cases, the decline is occurring on low-elevation, marginal aspen sites.

Ron Cousineau

Mountain pine beetle in Grand County.

Subalpine Fir Decline

Decline of subalpine fir is attributed to western balsam bark beetle, root diseases and other unknown factors. This decline is found sporadically throughout Colorado's high-elevation forests. More than 370,000 acres were affected by subalpine fir decline in 2006. Near Telluride, there are concerns about wildfires due to the large areas of standing dead trees on steep slopes surrounding the town.

Piñon Ips

The major piñon pine mortality from piñon ips that peaked in 2003 continues to subside in southwest Colorado. This is due to both increased moisture and lack of live piñon trees. Infestations on the Uncompahgre Plateau and Glade Park are still active, although areas that received more moisture appear to be recovering.

In the southern Front Range, piñon ips increased. Over 19,000 acres were infested with piñon ips in 2006, much of which was south and west of Colorado Springs.

Western Spruce Budworm

Western spruce budworm outbreaks can cause heavy defoliation that weakens or kills Douglas-fir, true fir and spruce trees. About 93,000 acres were infested statewide in 2006. This insect has infested large areas on the eastern slopes of the Culebra Range south of La Veta Pass and on the northern slopes of the Spanish Peaks. A hot year exacerbated western spruce budworm infestations at the Uncompahgre National Forest, where defoliation continues in both subalpine-fir and Engelmann spruce, with a three-fold increase from 2005 in Engelmann spruce defoliation.

Fir Engraver Beetle

Archuleta and La Plata counties in southwestern Colorado experienced an increase in fir engraver beetles. These beetles have killed many white firs that were first weakened by root disease. The scenario is a classic result of fire suppression as white firs have proliferated in areas where they would have been burned by periodic natural fires.

Lodgepole Pine

Overview

Lodgepole pine is a widespread species, growing throughout the Rocky Mountain and Pacific Coast regions. This report will focus on the Rocky Mountain variety found in Colorado.

Most of today's lodgepole pine forests regenerated after widespread fires and some logging activity in the mid to late 1800s and early 1900s. As a result, many of these forests are filled with trees of roughly the same age, from 100 to 150 years old.

Relatively few new stands have become established since the turn of the twentieth century, leaving very little age diversity in Colorado's lodgepole forests.

Lodgepole pine's tall, straight and strong wood makes it valuable for a variety of uses, from rustic fences to commercial timber. The lodgepole pine forest type provides breathtaking mountain views and recreational opportunities. Many of Colorado's premiere ski destinations, including Winter Park and Vail, are located in lodgepole pine forests.

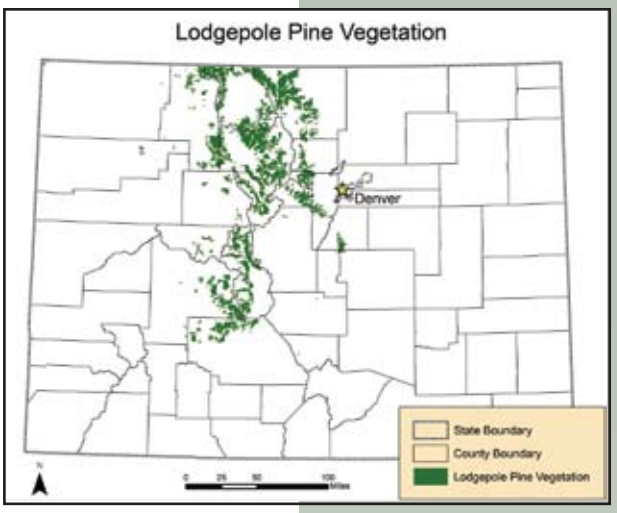
By providing habitat for elk and deer, these forests also contribute to many rural economies during fall hunting seasons. In Colorado, hunting and fishing is a $1.6 billion industry. High-elevation forests, including lodgepole pine, also provide habitat for lynx, a federally listed threatened species.

Characteristics and Ecology

Lodgepole is a two-needled pine that grows at elevations from about 8,000 to 10,500 feet. Mature trees have a very straight trunk, a narrow crown, and no lower branches. The average lodgepole pine in Colorado is about 40 to 80 feet tall, 8 to 12 inches in diameter, 130 years old and has a 160-year life span. The oldest known lodgepole pine in Colorado is over 350 years of age.

Lodgepole pine primarily grows in pure, dense, even-aged stands but is sometimes mixed with other conifers. It overlaps with ponderosa pine and Douglas-fir at the low end of its elevation range and with Engelmann spruce and sub-alpine fir at its upper limits. It also competes with aspen in many locations. Like aspen, lodgepole pine is shade intolerant and grows best in full sunlight, often on northern and eastern slopes.

Lodgepole pine is one of the most aggressive and hardy of western forests. It has an amazing potential to



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Forests dominated by lodgepole pine cover about 50 million acres in Canada and about 15 million acres in the U.S. There are about 1.5 million acres of lodgepole pine forests in Colorado.

Lodgepole pine seeds germinate and survive best in a harsh, exposed environment.

Bob Sturtevant

Kathryn Hardgrave

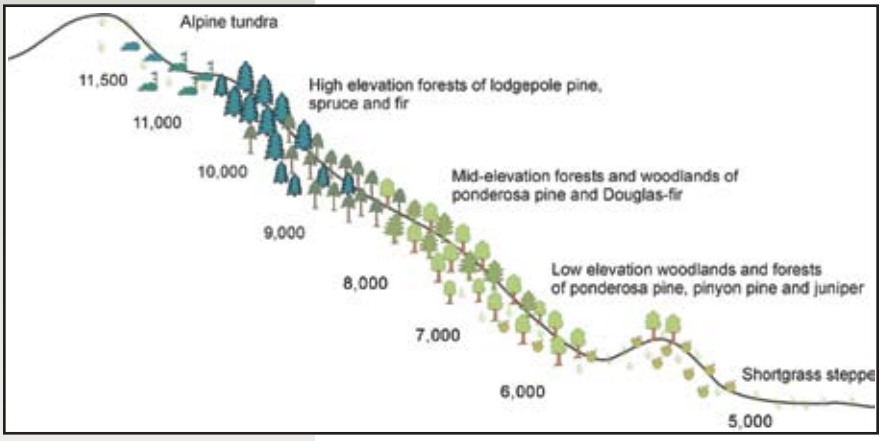
Stagnated lodgepole pine stands are sometimes referred to as "doghair" because they are thick and dense like hair on a dog.

pioneer and invade disturbed sites and meadows.

The Life Cycle of Lodgepole Pine

Lodgepole pine has rapid early growth and abundant seed production. The species is sometimes said to "live fast and die young" because it grows vigorously at first and then naturally overcrowds itself. It is usually killed by wildfire or mountain pine beetle before it reaches 150 years of age.

Lodgepole pine is an upper-montane forest.



Laurie Huckaby

Wildfire has been the primary regenerating force for Colorado's lodgepole pine. Historically, wind-driven crown fires up to tens of thousands of acres would kill the entire forest canopy and expose bare mineral soil, providing an optimal seedbed.

Lodgepole pine's cones have a noteworthy adaptation to wildfire that has helped propagate the species. The *serotinous*, or closed, cones have resin that holds seeds and protects them during wildfires. This provides an aerial seedbank that is viable for decades. Fire's heat melts the resin, opening the cones and releasing their seeds where they can grow in full sunlight. Within several years after a fire, a carpet of seedlings will re-establish lodgepole pine in the burned area. This natural regeneration process can be similarly achieved with a timber harvest.

Wildlife Associated with Lodgepole Pine

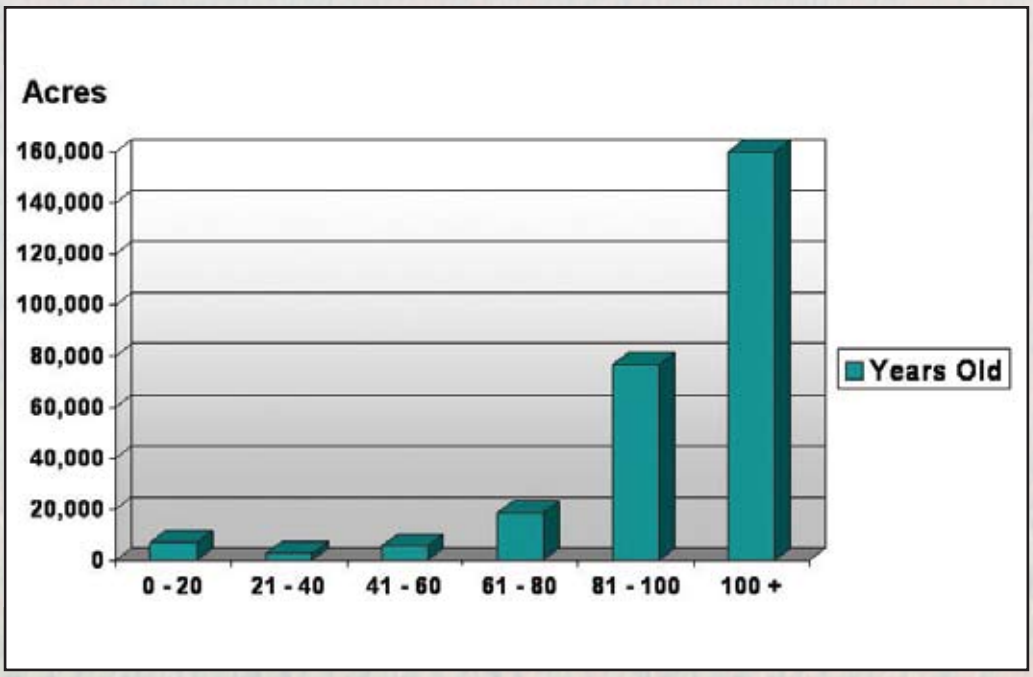
Plant and animal diversity is usually low in mature lodgepole pine stands, but these dense forests provide cover for elk, deer and bears as well as for squirrels and other small mammals. Richer flora and fauna are associated with young lodgepole forests.

Elk

Elk need *security cover* or screening at the base of trees. An aggressively thinned 20- to 40-year old lodgepole stand is good elk habitat because individual tree canopies remain full. The animals will also use older, dense lodgepole stands for cover, especially where there are nearby meadows with grass to eat. Forest openings of 10 to 30 acres are optimal for elk, providing both cover and feeding areas.

Why Are Colorado's Lodgepole Pine Forests so Uniformly Aged?

From the mid-1800s to early 1900s, wildfires burned in many of Colorado's lodgepole pine forests. In 1851 alone, wildfires burned thousands of acres in what is today Rocky Mountain National Park. At around the same time, timber harvesting and some prospecting fires further changed the landscape. The subsequent regeneration led to today's vast swaths of 100- to 150-year old forests. These mature lodgepole pine forests, even those that have not been killed by forest insects, are very susceptible to wildfire.



USFS

Lynx and Snowshoe Hare

Colorado is in the most southerly edge of snowshoe hare habitat and thus Canada lynx range. Although spruce/fir forests are preferred by these animals, young lodgepole pine forests can provide suitable habitat. Lynx is on the state's endangered species list and is federally listed as threatened.

Snowshoe hare eat buds, including those of lodgepole pine, for a large part of their diet. They also need security cover from birds of prey. Trees with branches reaching the snowline can provide this cover and food source. As lodgepole pine forests mature, they self-prune their lower branches, and no longer provide enough cover or food to support the hare. In unmanaged forests, 20- to 40-year old lodgepole pine stands can meet snowshoe hare's habitat requirements. If thinned when young, lodgepole pine forests can provide critical food and cover for far longer than unmanaged stands.

Ron Cousineau

Lodgepole pine's closed cones remain on trees and release seed after a fire or timber harvest.

Terry Spivey

Because the vast majority of Colorado's lodgepole pine forests are old, suitable stands for snowshoe hare habitat are rare.

Terry Spivey

Since the Colorado Division of Wildlife began reintroducing moose to North Park from Utah and Wyoming in the 1970s, a successful population has grown. Moose primarily eat willow and aspen, and use lodgepole pine forests for hiding cover.

Fires in lodgepole pine typically burned thousands of acres of forest at a time. These naturally intense fires can threaten mountain communities, whether or not surrounding forests have been killed by mountain pine beetle.

Pine Marten

Where they mix with spruce/fir, older lodgepole pine forests provide habitat for pine marten, a mammal in the weasel family. The pine marten is an *old forest obligate*; it needs older forests with downed logs for its habitat.

Agents of Change

The interactions of mountain pine beetle, diseases, and wildfire add complexity to the seemingly simple lodgepole pine forest ecosystem.

Wildfire

Stand replacing crown fires are an integral part of lodgepole pine forests. These fires consume an entire forest, making room for the next generation of trees to grow.

Colorado's lodgepole pine forests have historically burned about every 100 to 300 years, with forests in the highest elevations burning less frequently. In Colorado, these large fires ranged from several hundred to tens of thousands of acres. The state's topography and rocky outcrops break up forest fuels, and thus lodgepole pine fires did not typically grow as large as those in Oregon, California and Wyoming.

There were extensive fires in Colorado's lodgepole pine forests in the second half of the 1700s and the second half of the 1800s. Despite this pattern, Colorado's high elevation lodgepole pine and spruce/fir forests have been known as "asbestos forests," because in recent memory they have rarely burned.

When subjected to lightning, an older forest with dead and down wood is more likely to catch fire and burn than a young forest with less woody material.

However, wildfire in lodgepole pine forests is always a very real threat that grows increasingly likely the longer it has been since fires burned. Colorado's lodgepole pine forests are already laden with fuel, and if warming temperature trends continue, this fuel will become

Lodgepole Pine Crown Fire

Pat Rastall

Ponderosa Pine Surface Fire

Jen Chase

While most fires in ponderosa pine historically burned on the forest floor, lodgepole pine fires naturally burn as a crown fire. Crown fires burn in the forest canopy, spreading from treetop to treetop. These wind-driven fires often occur in the driest conditions and are almost impossible to control.

The Aftermath of Wildfires

Jen Chase

In the four years following the 2002 Hayman Fire, the Denver Water Board has spent over $7.8 million to remove debris, replace culverts, build sediment dams, stabilize slopes, and improve water quality. Additional sediment removal from Strontia Springs, one of Denver's reservoirs, will cost many additional millions of dollars. These expensive efforts include combating effects from the 1996 Buffalo Creek Fire, which burned in the same watershed.

very dry making fires almost certain. The effects of these intense fires on life, property, and water supplies can be costly in many ways.

One of the most intense types of wildfires in lodgepole pine forests can occur when a growing forest has a large build-up of logs lying on the ground. Digging fire line through downed logs is arduous, making the fire hard to control. Heavy fuels can increase a wildfire's severity and result in damage to soil and watersheds, depending on summer rains and snowmelt following the fire. Cleaning up drinking water reservoirs after these intense fires can cost millions.

Hans Rinke

Fire intensity in lodgepole pine is its most extreme in forests with fallen logs.

Mountain Pine Beetle

Mountain pine beetles are the most aggressive insect affecting mature pines in western North America. Within a year of successful attack, the infested tree is dead, and the next generation of beetles flies to new host trees.

Mountain pine beetles are always present in Colorado's pine forests, normally attacking weak and injured mature trees. However, when forest and weather conditions are suitable for population growth, large outbreaks can occur. This may happen about every 10 to 30 years. During epidemics, one attacked tree may produce enough beetles to attack multiple trees the following year, resulting in an exponential increase in dead trees.

Beetles attack green trees, where they chew through the bark to lay eggs. The eggs hatch, eat the tree's inner bark, and infect the tree with

Stand Conditions Susceptible to Mountain Pine Beetle

- Trees at least 80 years old
- Trees at least 8 inches wide (pictured, right)
- Crowded stands
- Many old trees in a stand
- Many trees in the stand that are over a foot wide

Jeff Hicke

microorganisms, including a distinctive blue-stain fungus, which eventually blocks the tree's water movement. The tree's needles won't turn red until the following spring and summer. It is about this time that the next generation of beetles exits its dead host tree and flies to reproduce in living trees.

Mountain pine beetles in Colorado have crossed an elevational threshold that has not been seen before. Until the recent warmer weather, mountain pine beetles have not been able to withstand the cold temperatures above 9,500 feet. But at the USDA Forest Service's Fraser Experimental Forest (elevation 9,000-12,800 feet), some of Colorado's oldest lodgepole pine trees are now being killed by these beetles. Although these stands have been at a susceptible age for over two centuries, they have not been impacted by mountain pine beetle until the current outbreak.

Mountain pine beetle is a significant cause of fuel buildup in lodgepole pine forests and can result in very intense fires. Initially, the dead, dry needles on a tree can catch fire easier and spread the fire more quickly than green needles with more moisture. After 10 or 15 years, beetle-killed trees will fall and can burn very intensely.

Ron Cousineau

Mountain pine beetle in larval stage.

When pine trees reach eight inches in diameter, as shown here, they are large enough for mountain pine beetle to successfully infest. It takes lodgepole pine trees at least 80 years to grow to this size.

Bob Sturtevant

At ski areas, live trees provide aesthetics, wind protection and a quality experience. Years after they are dead, however, lodgepole pines' notoriously shallow roots will give out, and trees will pose a safety risk to skiers and boarders.

Dwarf Mistletoe

Dwarf mistletoe is the most damaging disease agent to the pine species, causing severe growth loss, tree deformity and increased tree mortality. It is widespread in lodgepole pine of all ages, but its effects build over time. Dwarf mistletoe weakens the trees' resistance to mountain pine beetle as well as contributes to fuels for future fires.

Dwarf mistletoe infection leads to:

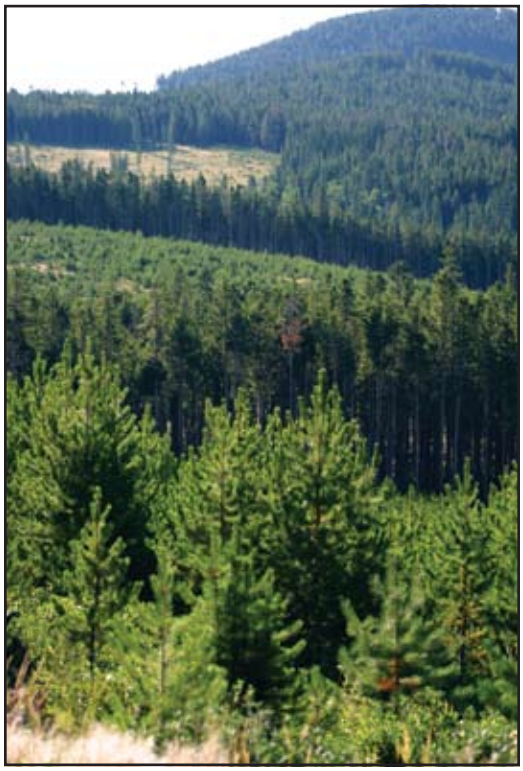
- Abnormal branching and "witches' brooms"
- Tree mortality by increasing trees' susceptibility to other damaging agents
- Decrease of host trees' seed production
- Losses in wood production and quality

Lodgepole Pine Management

Management activity in lodgepole pine forests can reduce fire risks to homes and communities, produce commercial wood products and restore diversity and resilience across a landscape. Management techniques include thinning of young forests, cutting large openings in the mature forest to create age and spatial diversity, and allowing naturally ignited fires to burn. It is important to understand what outcome is desired prior to outlining a forest management strategy.

Despite its relatively small diameter, lodgepole pine can grow large enough for commercial timber. Its thin bark, coupled with its straight form, gives the tree a higher volume of wood for its diameter and height than many other trees.

Lodgepole pine can be sustainably produced and can play an important role in local economies. It is a species that is easily managed and responds well to forest treatments. Despite its many potential benefits and uses, far



Jen Chase

Different aged forest stands can provide visual variety in an otherwise homogeneous landscape.

more lodgepole pine is being killed by mountain pine beetle than is currently harvested for either forest products or fire risk reduction. Although Colorado uses over 1.1 billion board feet of lumber every year, only about 7% of that is harvested in the state.

Some reasons why mountain pine beetle killed trees are not commercially in-demand include:

- Beetle killed lodgepole pine trees deteriorate and lose their value as lumber very quickly.
- The bluestain fungus introduced by the beetle discolors the wood. Although this doesn't affect the strength of the wood, the staining is a visual defect that lowers its timber value.
- Small, local mills are at their capacity to process the large available volume of logs.
- Dead logs weigh less than live ones, and loggers selling by weight may not make enough money to haul dead logs to distant mills.
- There may not be enough awareness to create a demand for Colorado wood products.

Thinking globally and buying wood locally not only provides local jobs, it reduces the pollution generated by shipping wood from other states and countries. By purchasing local forest products, citizens can also reduce the costs of forest treatments needed to make Colorado's forests healthier. See **www.coloradoforestproducts.org** for more information.

Forest Products from Lodgepole Pine

- Telephone poles
- 2 x 4s
- Fencing
- Decking
- House logs
- Log furniture and railing
- Tongue and groove paneling
- Structural plywood

Ron Cousineau

Lodgepole Pine: Part of Colorado's History

In the late 1800s, much of Colorado's demand for railroad ties was supplied in lodgepole pine forests. Men would hand-fell and hand-hue the railroad ties, skid them by horses with sleds, and stack them by streambanks to later be sent downriver.

CSFS

Isolated yet self-sufficient communities of "tie camps" dotted Colorado's river valleys from about 1870 to 1930, especially in the Summit County and Leadville areas. Cabins, a store, a cookhouse, some skill shops and a school accommodated hundreds of workers and some families in these isolated towns.

Unlike ponderosa pine, which has a deep taproot, shallow-rooted lodgepole pine can blow over easily when mature stands are thinned.

Management Techniques

Clearcutting or Even-Aged Management

A clearcut is an area where all trees have been removed. This technique is often used in *even-aged management* because it is an excellent means of regenerating even-aged species like lodgepole pine. A clearcut area can be designed to provide optimal habitat for wildlife, and can be shaped to blend naturally with topographic or other features.

Bob Sturtevant

Foresters may specify that some large woody debris remain in contact with the soil to foster nitrogen storage in resulting decayed wood and to promote beneficial microbial activity in the soil.

Harvest operations mimic, on a smaller scale, the disturbances that naturally regenerate lodgepole pine. Equipment exposes the mineral soil that lodgepole pine needs as a seedbed. Closed cones fall to the forest floor and cone-bearing branches are scattered during harvest operations, releasing their seeds in the following summer's heat and leaving an open, sunlit area for them to grow.

Thinning Young Lodgepole Pine Forests

Thinning young lodgepole pine stands increases tree vigor and postpones self-pruning, the natural loss of lower tree branches that happens when trees grow into each other. Thinning young stands can also result in wildlife habitat enhancement and improved future timber harvests.

Thinning Mature Lodgepole Pine Forests

Thinning in mature lodgepole pine forests is not recommended for many reasons. Unlike when young trees are thinned, the vigor and growth of older trees does not improve significantly with the increased sunlight, nutrients and water. Many older lodgepole pine stands are infected with dwarf mistletoe, and trees left in the cut area will quickly infect the new seedlings. Additionally, shaded areas result in poor regeneration.

Other considerations for managing lodgepole pine include windthrow, or blowdown. Trees in dense lodgepole forests depend on neighboring trees to buffer strong winds. If stands are suddenly opened by excessive thinning, trees may blow over due to lodgepole pine's shallow roots.

Thinning mature lodgepole pine forests is an appropriate way to reduce wildfire hazard near communities.

Fire Use

Unlike prescribed fire, *Fire Use* is a fire that starts by lightning and is managed for natural resource benefits. Wilderness areas, where natural processes are intended to take their course, are places where natural ignitions are sometimes managed as Fire Use fires.

Although managing wildfire would most closely mimic natural processes, it can be complex, dangerous and expensive near communities. In these cases, Incident Management Teams, also called fire teams, may help manage Fire

Use fires. These teams direct firefighter crews to protect structures and cultural and natural resources in advance of the fire; monitor fire behavior; and suppress the fire in areas where managers want to keep it from burning. There are less than ten National Fire Use Management Teams, including the Rocky Mountain Team that is primarily based out of Colorado.

Prescribed Fire

Although it can be done, extensive planning and preparation work is required to use prescribed fire in lodgepole pine forests. Because they naturally burn as crown fires, instituting control measures on burn unit boundaries ahead of time is critical. Under specific circumstances, prescribed fire can be a safe, effective means of managing lodgepole pine forests, but it is a rarely employed, difficult technique. The only place in Colorado that has had a long-term prescribed crown fire program in lodgepole pine is at the Gunnison National Forest. For more detail on this program, see *Areas of Lodgepole Pine Management* on page 21.

Fuels Reduction around Communities

Wildfire mitigation is critical in all forested communities because fire is a fact of life in Colorado, with or without beetle-killed trees. Wildfires historically burned in lodgepole pine forests during extremely dry and windy conditions.

Increased development in high risk forests also increases the need for wildfire mitigation activities.

Protecting communities from crown fires requires extensive thinning around homes and communities as well as building with fire resistant materials.

When homes have defensible spaces and the forests surrounding communities are thinned, not only will the communities be better protected, but firefighters will be safer too.

Clearcutting: The Ugly Duckling of Forest Management?

No silvicultural practice is more controversial than clearcutting. Indeed, clearcuts may appear stark and barren for several years before new growth provides a more vibrant look. One glance at an unsightly or ill-planned clearcut area can convince people that the practice is devastating, regardless of evidence to the contrary.

In even-aged, disturbance-dependent forests like lodgepole pine, clearcutting can effectively emulate wildfire. It regenerates the forest, creates diversity on the landscape and provides wildlife habitat. Economic benefit can also be gained by harvesting this renewable resource rather than burning it up.

Ron Cousineau

In the midst of the huge swaths of brown and red beetle-killed trees, clearcut areas of live, young, green trees are greatly appreciated.

Areas of Lodgepole Pine Management

Colorado State Forest

The Colorado State Forest is a unique state trust property located about 80 miles west of Fort Collins in North Park. Stretching along the western slopes of the Medicine Bow Mountains, it is known for its spectacular scenery and for being situated at the headwaters of the North Platte River. It has a long, rich history of multiple-use management that continues today.

The Colorado State Forest is currently one of the most intensely managed lodgepole pine areas in the state. A variety of state agencies cooperate in its management. The Colorado State Forest Service manages forest resources, the Colorado State Parks manages recreation, the Colorado Division of Wildlife manages wildlife, and the Colorado State Land Board oversees grazing leases and coordinates the overall management of the property.

CSFS

The Colorado State Forest was created in 1938 through state legislation that encourages harvesting timber in accordance with good forestry practice.

Like many other state trust lands, the 71,000-acre state forest generates revenue for Colorado's public schools. Timber harvesting contributes to those revenues while also enhancing forest health, wildlife habitat, recreation opportunities, the local economy, and other values.

As part of its stewardship mission, the Colorado State Forest Service conducts a variety of monitoring activities at the State Forest. These include water quality, wildlife and aquatic insects. Monitoring and baseline information are key components in *adaptive management,* where activities on the ground are continuously evaluated and adjusted based on feedback.

Mountain pine beetle is the current priority at the Colorado State Forest. Although past forest management has created some young, resistant forest stands, many of the lodgepole pine forests at the state forest are old and susceptible to this pervasive forest insect. As the mountain pine beetle effects enormous change in northern Colorado's forests, the need for long-term sustainable forest management is greater than ever. Years of adaptive management at the Colorado State Forest provide an excellent example of forest stewardship in action.

Northern Colorado Bark Beetle Cooperative

The Northern Colorado Bark Beetle Cooperative, formed in October 2005, consists of county and municipal governments in Grand, Eagle, Jackson, Routt, and Summit counties; Colorado State Forest Service; the Bureau of Land Management; and the U.S. Forest Service. All of these entities are seeking funding and resources from all available sources to respond to the bark beetles and the long-term fire hazards that result from widespread beetle-killed trees.

The cooperative's top priorities are to help protect life and property, infrastructure, and watersheds

from bark beetles and wildfire. Fire mitigation, tree spraying, and removing infested trees are being expedited in residential subdivisions, ski areas, business areas, and scenic corridors. Over 35,000 acres were treated in 2006 and additional work is planned in these high-priority areas. Additional efforts include researching socio-economic impacts of the bark beetle epidemics and preparing wildfire prevention and suppression strategies.

Gunnison National Forest

Incorporating stand-replacing crown fire into a prescribed burn program requires years of careful planning and preparation and the fire managers in Gunnison have an excellent track record of doing just that. From 1983 until 1999, the U.S. Forest Service had a burn plan that included 50,000 acres of lodgepole pine and spruce/fir forests in the Gunnison National Forest. The plan's primary objectives were to improve bighorn sheep habitat and kill the snail that carries lung-worm, a disease that can weaken or kill sheep. Meeting these objectives also reduced fuel build-up, protected watersheds, and allowed crown fire to return to fire-dependent forests.

Bighorn sheep prefer exposed areas where they can see predators, and benefit from the openings created by crown fires. They also eat the succulent, nutritious plant growth that follows. When there are many open areas with ample, low-growing vegetation, the herd spreads out. This reduces the chances that an illness might wipe out all of the sheep at once.

Depending on weather and safety conditions, between 50 to 2,500 acres within the Gunnison National Forest's burn plan area were burned each year. First, experienced firefighters created fire unit boundaries by burning vegetation along topographic breaks and snow-covered areas. These buffer areas were from a half mile to several miles wide. Later, during drier conditions, the forested interior was lit on fire by helicopter and from the ground. Crown fires then burned from treetop to treetop and via spotting. Spotting occurs when winds carry burning embers in front of a fire, allowing it to spread to unburned areas. The boundary areas were designed to be wide enough to prevent embers from starting a new fire outside the prescribed fire unit.

Fire managers are currently writing a new burn plan that would continue earlier successful efforts to improve bighorn sheep habitat. Although there are risks and smoke management concerns, if these areas are not managed, consequences are grave for bighorn sheep. If they stop migrating, they will become more susceptible to stresses and illnesses, and the success of the herd may be jeopardized.

Colorado State Forest

Bighorn sheep are magnificent yet sensitive animals that are subject to population crashes under certain conditions.

Conclusion

Coloradans have both the opportunity and responsibility to shape the state's forests for the next 5, 50 and 100 years. If these forests are not carefully considered, planned for and appropriately managed, future wildfires and insect outbreaks will continue to create more burned, overcrowded and beetle-killed trees than most people would like.

The need to manage vital forest resources becomes more critical as land is increasingly developed and fragmented at the same time that society's demands on these resources are growing.

Just as warming temperature trends, drought, and old, crowded forests are a recipe for a widespread mountain pine beetle outbreak, warmer weather and a relatively long fire-free interval in Colorado's lodgepole pine forests make a perfect storm of conditions for wind-driven crown fires. Proactive forest management activities can limit impacts to communities and watersheds from these events.

The current interest in healthy forests generated by the massive mountain pine beetle mortality has provided a window of opportunity for broader consideration and better management of Colorado's forests.

Well-planned forest management, however, is a long-term endeavor and an investment in time and resources. It has taken years for forests to become old and overcrowded, and it will take years to create resilient, vigorous forests. But by making a long-term commitment in these renewable natural resources, Coloradans' economies and quality of life will benefit tremendously, today and tomorrow.

Jen Chase

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