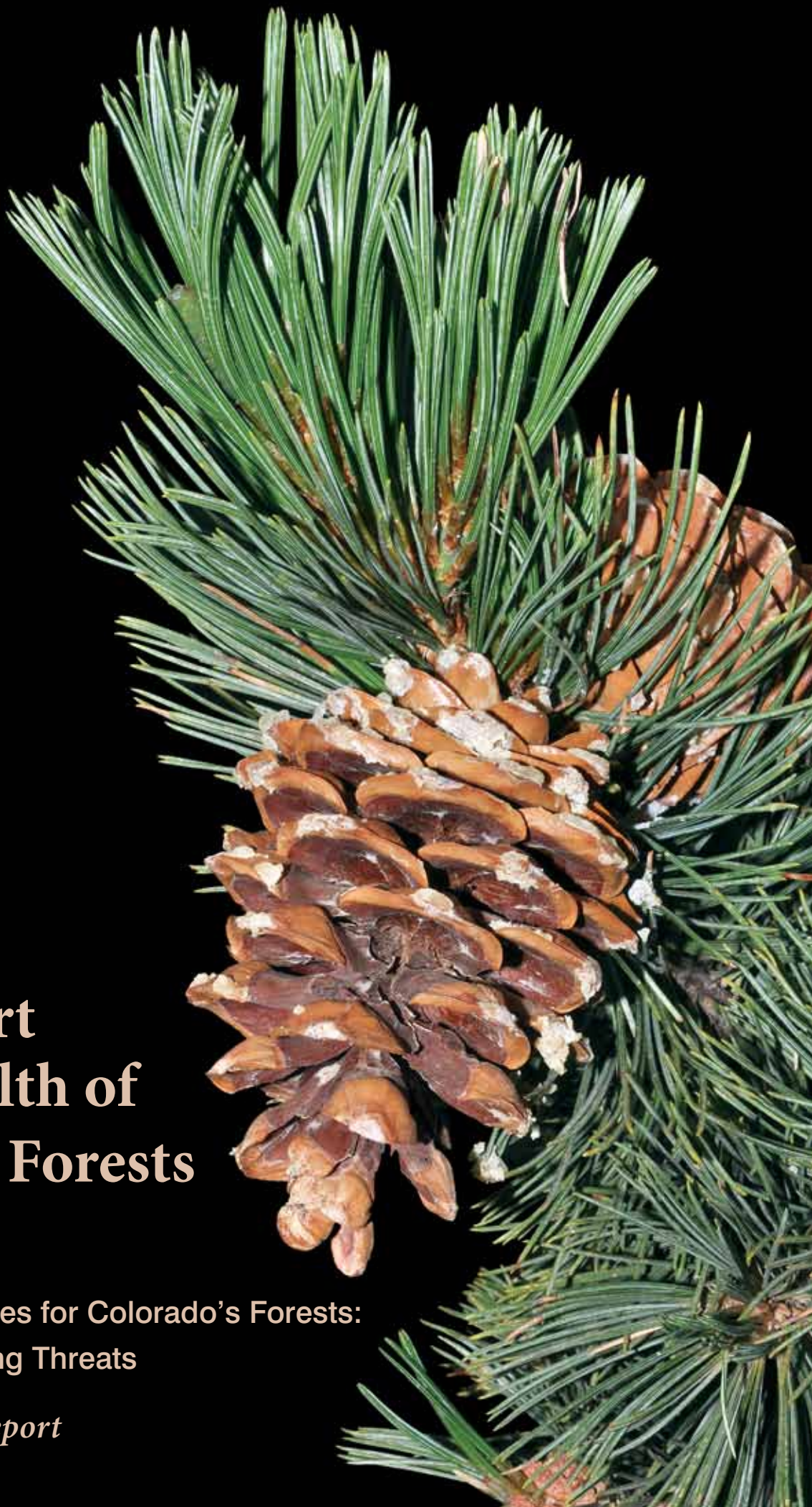

2010 Report on the Health of Colorado's Forests

Continuing Challenges for Colorado's Forests: Recurring & Emerging Threats

10th Anniversary Report

ACKNOWLEDGMENTS

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All photos by Bill Ciesla unless otherwise noted.

January 2011

The 2010 Report on the Health of Colorado's Forests, *Continuing Challenges for Colorado's Forests: Recurring & Emerging Threats*, provides an overview of the current health and conditions of Colorado's forests. This report documents the status of established forest pests, such as mountain pine beetle, spruce beetle and western spruce budworm, as well as several emerging threats to our forests, including walnut twig beetle/thousand cankers disease, white pine blister rust and gypsy moth.

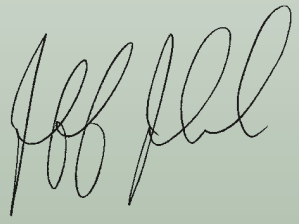
This report is the tenth annual report prepared by the Colorado State Forest Service (CSFS) on the health of the state's forests. Information sources include the forest health aerial survey, a cooperative project of the CSFS and the USDA Forest Service (USFS), and on-the-ground observations of CSFS field personnel. The CSFS has a team of trained aerial observers who work in partnership with a USFS aerial survey team to collect data on the location and intensity of insect and disease damage throughout Colorado's forests. In 2010, more than 95 percent of the state's forest lands, excluding piñon-juniper forests, were included in the survey.

Forest health information gathered by CSFS district personnel throughout the year is compiled annually and provides on-the-ground assessments of insect and disease activity and overall forest conditions and trends.

In partnership with forest landowners, other cooperators and stakeholders, the CSFS works to reduce the ecological, social and economic impacts of forest insect and disease pests, primarily through technical assistance to landowners and long-term management of the state's forests. This includes timely harvesting of mature trees, prescribed burning and forest thinning.

Two additional sources of information that will drive forest management efforts for the next several years are the *Colorado Statewide Forest Resource Assessment* and *Colorado Statewide Forest Resource Strategy*. The assessment is the first geospatial analysis of forest conditions completed by the Colorado State Forest Service. The strategy, which accompanies and builds on the assessment, was completed in 2010 with input from stakeholders throughout Colorado. The assessment and strategy also provided a foundation for development of the CSFS five-year strategic plan that was completed in 2010. All of these documents will be instrumental as we develop a clear vision of our future forests and work with our partners to direct resources that will achieve that vision.

I hope you will find the information contained in this report to be helpful. Please contact any CSFS office to learn more about Colorado's forests and what you can do to manage and protect this vital resource.



Jeff Jahnke
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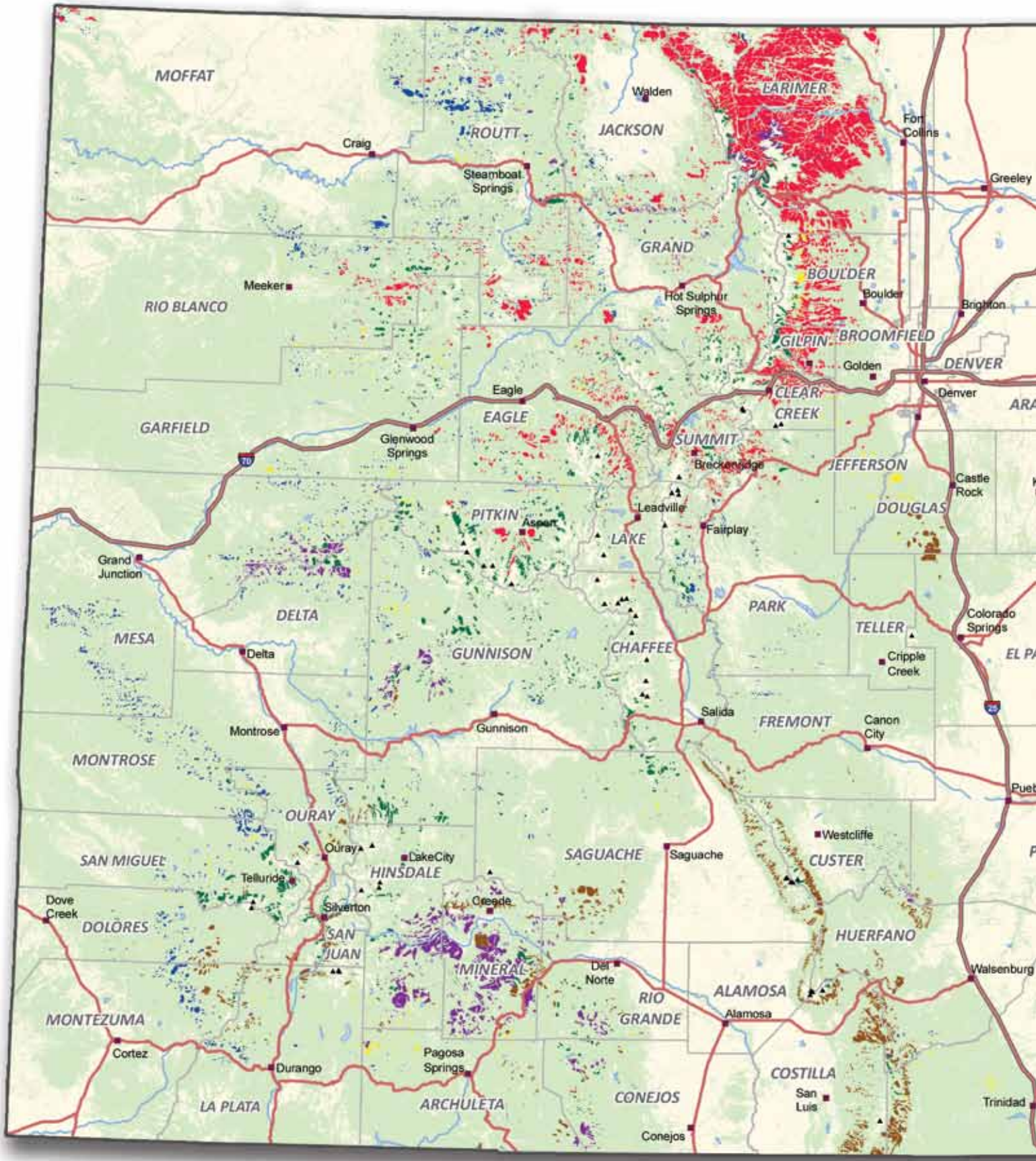
Colorado State Forest Service

Colorado State FOREST SERVICE

2010 Insect and Disease Ac



ctivity in Colorado Forests

- Mountain Pine Beetle — *878,000 acres*
- Spruce Beetle — *208,000 acres*
- Western Spruce Budworm — *213,000 acres*
- Sudden Aspen Decline — *190,000 acres*
- Subalpine Fir Decline — *265,000 acres*
- Other Insects and Diseases — *89,000 acres*
- Interstate
- U.S. Highway
- Lakes
- Rivers
- 14,000' Mountains

Aerial Survey Data

Due to the nature of aerial surveys, the data on this map will only provide rough estimates of location, intensity and the resulting trend information for agents detectable from the air. Many of the most destructive diseases are not represented on the map because these agents are not detectable from aerial surveys. The data presented on this map should only be used as a partial indicator of insect and disease activity and should be validated on the ground for actual location and causal agent. Shaded areas show locations where tree mortality or defoliation were apparent from the air. Intensity of damage is variable and not all trees in shaded areas are dead or defoliated.

The insect and disease data represented on this map are available digitally from the U.S. Forest Service, Region Two Forest Health Management group. The cooperators reserve the right to correct, update, modify or replace GIS products. Using this map for purposes other than those for which it was intended may yield inaccurate or misleading results.

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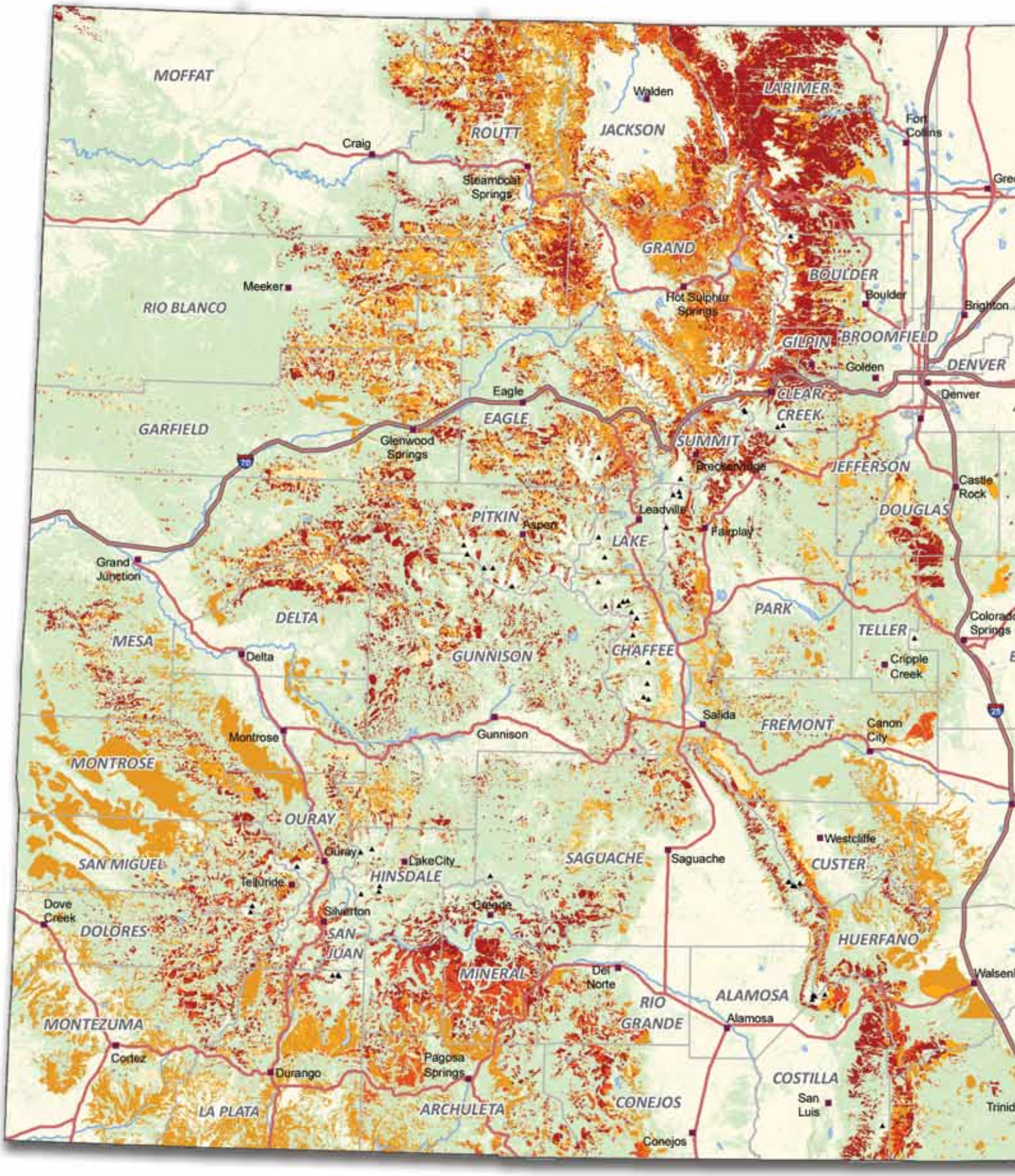
Map created January 2011
For more information:
www.coloradoforests.co

Colorado State Forest Service

Forest Insect and Disease Progres



ssion in Colorado from 1996 - 2010

1996 - 1998

1999 - 2001

2002 - 2004

2005 - 2007

2008 - 2010

Interstate

U.S. Highway

Lakes

Rivers

▲ 14,000' Mountains

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Colorado State Forest Service

Executive Summary

The objective of the annual Colorado forest health report is to inform state legislators and other stakeholders about the condition of Colorado's forests. The report provides a basis from which to engage in public dialogue about the future of Colorado's forests. It is in this arena that the needs and values of our forests will be evaluated. Our current forest management actions must be designed to provide future forests that meet these expected needs and values.

Each edition of the annual forest health report examines critical forest health issues, including the identification of priority areas across the state where timely management actions are needed. Information contained in this report builds on the foundation laid in previous reports and updates forest managers and other stakeholders about issues of current concern. Past reports in this series can be viewed on the CSFS website at http://csfs.colostate.edu/pages/pub-csfs2.html.

This year's forest health report complements the information contained in the *Colorado Statewide Forest Resource Assessment* and *Colorado Statewide Forest Resource Strategy*. Development of the assessment and strategy evolved as a result of decreased availability of resources, including funding, and threats to forests that are posing challenges at the state and national levels. The assessment provides an overview of Colorado's important forest landscapes. The strategy provides information on how to address threats to our forests and identifies opportunities to effectively leverage additional resources.

In addition, the CSFS recently completed development of a five-year agency-wide strategic plan. The statewide forest resource assessment and strategy, and information contained in other recent assessments, helped guide development of the strategic plan.

The 2010 forest health report provides an overview of a number of insect and disease pests in Colorado's forests. Photos included illustrate the impacts of insects and diseases and the results of forest management practices.

The current mountain pine beetle outbreak continues to be the predominant ongoing forest health issue in the state. The resulting change in forest conditions threatens human safety, communities and critical infrastructure, as well as wood products, recreation and tourism, wildlife habitat, watersheds, water supplies and Colorado's economy. Damage caused by this outbreak will be a focus of the CSFS and other land-management agencies for the foreseeable future.

In 2010, active mountain pine beetle (MPB) infestations occurred on 878,000 acres of forests, compared to 1,046,000 acres in 2009. The reduction in affected acres is due in part to the fact that a significant portion of Colorado's lodgepole pine forests already have been severely impacted by mountain pine beetle. In areas west of the Continental Divide, where the outbreak has been ongoing since 1996, most of the mature lodgepole pines already are dead and the outbreak has collapsed due to mortality of the suitable host type. At least two additional bark beetle species remain active in these areas and, in association with the mountain pine beetle, are attacking and killing young trees.

In 2010, the heaviest mountain pine beetle activity in lodgepole/limber pine forests occurred along the Front Range in Boulder, Clear Creek, Gilpin and Larimer counties. The number of acres (229,000) of ponderosa pine attacked by mountain pine beetle on the Front Range intensified for the second successive year, especially along the Wyoming border.

Spruce beetle infestations continued in high-elevation spruce forests in several areas of the state, with a total of 208,000 acres affected in 2010 – almost twice the area affected in 2009. The outbreak that already has decimated most of the mature spruce forests in the Weminuche Wilderness and upper Rio Grande Basin now is spreading eastward. New spruce beetle infestations also were detected in the Wet Mountains, where a blowdown event occurred in 2007. Infestations intensified in the upper Laramie and Cache la Poudre basins, Never Summer Range in northern Colorado

Most mature lodgepole pine forests in Grand and Summit counties now have a gray cast due to the large number of trees killed by mountain pine beetle.

and Grand Mesa on the Western Slope.

Western spruce budworm continued to defoliate Douglas-fir, white fir, subalpine fir and Engelmann spruce forests in southern Colorado, including portions of the Culebra and Rampart ranges, and the Sangre de Cristo and San Juan mountains. In 2010, aerially visible defoliation occurred on 213,000 acres, compared with 382,000 acres in 2009. In addition, for the first time since this outbreak began in 1998, infestations were detected in the Wet Mountains.

Special surveys again were conducted for early detection of two exotic pests: gypsy moth and emerald ash borer. In addition, the walnut twig beetle/thousand cankers disease complex has continued to kill black walnut trees in many of the state's communities. Several states east of Colorado with native populations of black walnut already have established quarantines against shipment of walnut logs from areas of known infestations.

Aspen decline continues to be a concern, especially at the tree's lower elevational limits. This is a complex disease, caused by several interacting factors, and likely was precipitated by drought during 2001-2002. In 2010, the area of aspen decline detected via the forest health aerial survey was significantly lower than the previous two years. Part of this reduction is believed to be the result of aspen regeneration in the understory of many affected stands. In addition, dead and declining trees have fallen in stands where natural regeneration has not occurred, making damage no longer visible from the air.

Although insect and disease outbreaks are a dynamic component of Colorado's forests, they can affect recreation, aesthetics, watershed health, and the goods and services that forests provide. The CSFS and its cooperators and stakeholders will continue working to minimize the adverse impacts of these agents.

Colorado's Forests: A Vital Resource

Photo by Ron Cousineau

Forests and woodlands account for approximately 24.4 million acres of Colorado's land area. These highly diverse forests range from stately cottonwood stands along the river banks of the Eastern Plains, transitioning to piñon, juniper and Gambel oak woodlands in the foothills of the southern and western portions of Colorado, and culminating with intermixed pines, spruce-fir and quaking aspen in the mountains.

Colorado's forests have provided goods and services to society for centuries and, in turn, humans have influenced the character of these forests. Indigenous tribes, who established cliff dwellings on the edges of mesas in the southwestern area of Colorado, have long harvested piñon pine seeds, a staple food source. On the other side of the state, nomadic tribes who roamed the plains and mountains once harvested lodgepole pine trees for their tepees, and depended on these forests for wild game and fruit, and to obtain fuel wood for heating and cooking.

With the arrival of European settlers, greater use was made of Colorado's forests. Fur traders trapped beaver in mountain streams, while miners panned for gold. Ranchers used high-mountain forests as summer range for cattle and sheep, a traditional land use that continues today. They also built homes and barns in mountain meadows out of local timber – many of which still stand. But with the arrival of these settlers, wildfires soon were suppressed and, as a result, the natural fire cycle changed.

Today, these same forests provide lumber for homes and other structures, posts and poles, and many other wood products. They also continue to provide critical habitat for large native mammals such as bighorn sheep, mule deer and elk, and are home to smaller species such as the indigo-hued Steller's jay and hummingbird moths that collect nectar from wildflowers. Colorado's forests also are important for recreation and provide a welcome escape from day-to-day pressures for Colorado's urban residents. In summer, our forests are popular for hiking, mountain biking, camping, fishing, hunting and other activities. In winter, recreation opportunities abound with world-class skiing and snowshoeing.

In Colorado's semi-arid climate, water is a scarce resource. Undoubtedly, the most easily overlooked but vital forest product is the fresh water we use for domestic and agricultural purposes. Our rivers and lakes also provide places for

recreational activities such as fishing and boating. The cover and shade high-mountain forests provide helps regulate spring snowmelt and ensures a steady supply of water for human consumption, not only in Colorado but also in neighboring states. The headwaters for four major river basins in the United States originate in Colorado's high mountains.

Colorado's forests are dynamic and constantly changing. The changes often are subtle, such as the gradual replacement of a mature aspen forest by young spruce and fir, but also can occur quickly due to wildfire or insect and disease outbreaks. These events can cause dramatic changes, in a matter of just a few hours or days in the case of wildfire, or over succeeding years in the case of insect outbreaks. Change is an integral part of forest dynamics and helps set the stage for replacement of old, mature forests by young, healthy stands.

If these change agents affect the availability of goods and services that forests provide, they may be considered threats. Active forest management is an effective way to mitigate the detrimental effects of these change agents and to capture the value of the forest products before or after stand mortality has occurred. Forest management practices, such as fuels reduction, stand thinning and timely harvesting of old and mature forests, can reduce the impact of catastrophic wildfires or insect and disease outbreaks. Sound forest management provides for sustainable outputs of the goods and services that forests provide and upon which society relies. In addition, forest management supports local economies directly through the creation of jobs and indirectly by conserving, protecting and enhancing forest resources, which generates revenue as visitors enjoy a variety of recreational activities.

In 2010, the CSFS completed the *Colorado Statewide Forest Resource Assessment*, which identified important forest landscapes categorized by three main themes: conserve working forest lands, protect forests from harm, and enhance public benefits from trees and forests. The assessment was followed by development of the *Colorado Statewide Forest Resource Strategy*. With input from a broad group of Colorado stakeholders, strategies were developed to address recognized threats to our forests and identify opportunities for effectively leveraging resources to produce the best possible outcome. Implementation of the strategies will provide numerous and significant benefits to Colorado's forest landowners and the public at large. The assessment and strategy are available online at http://csfs.colostate.edu/pages/statewide-forest-assessment.html.

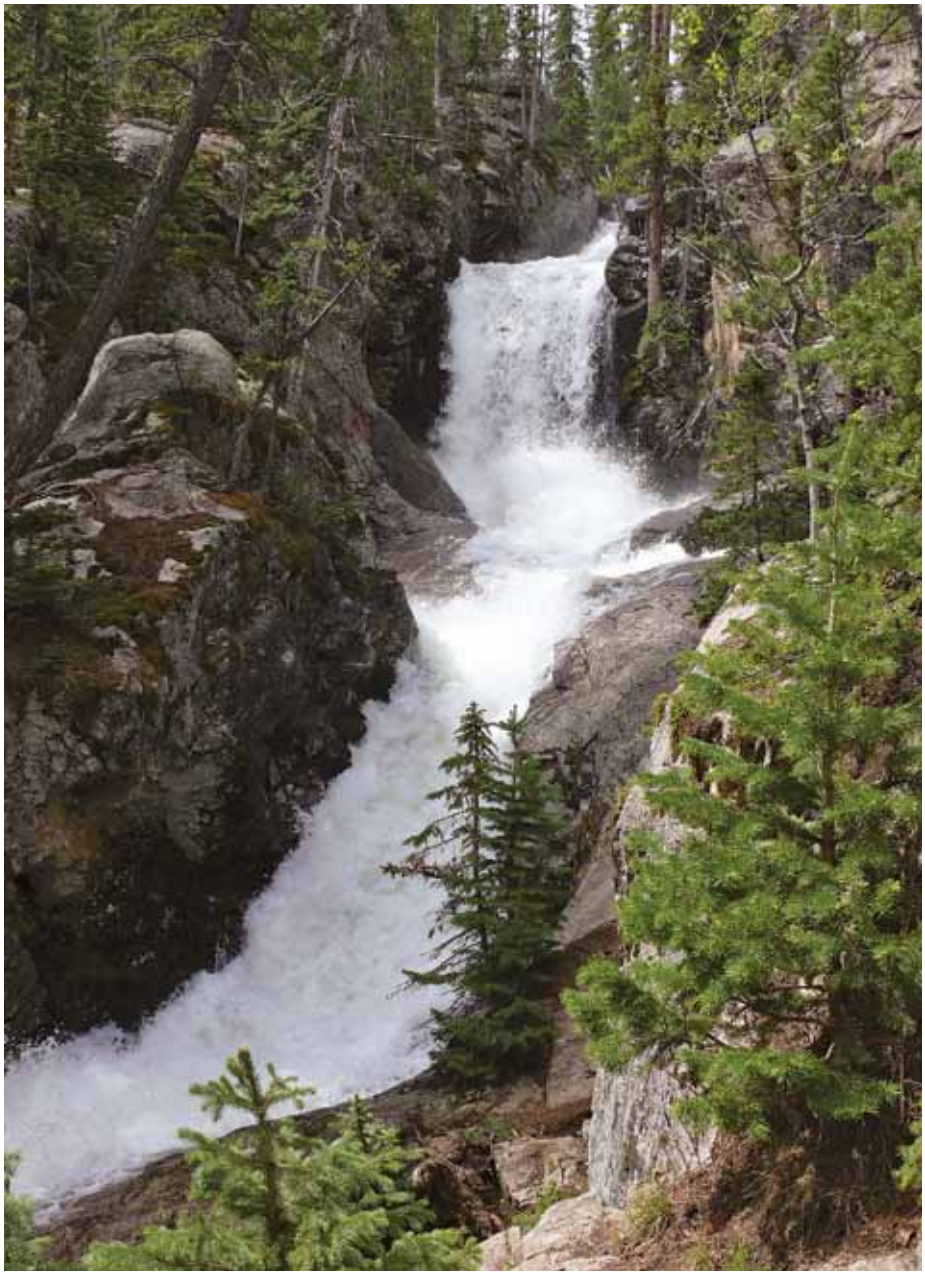


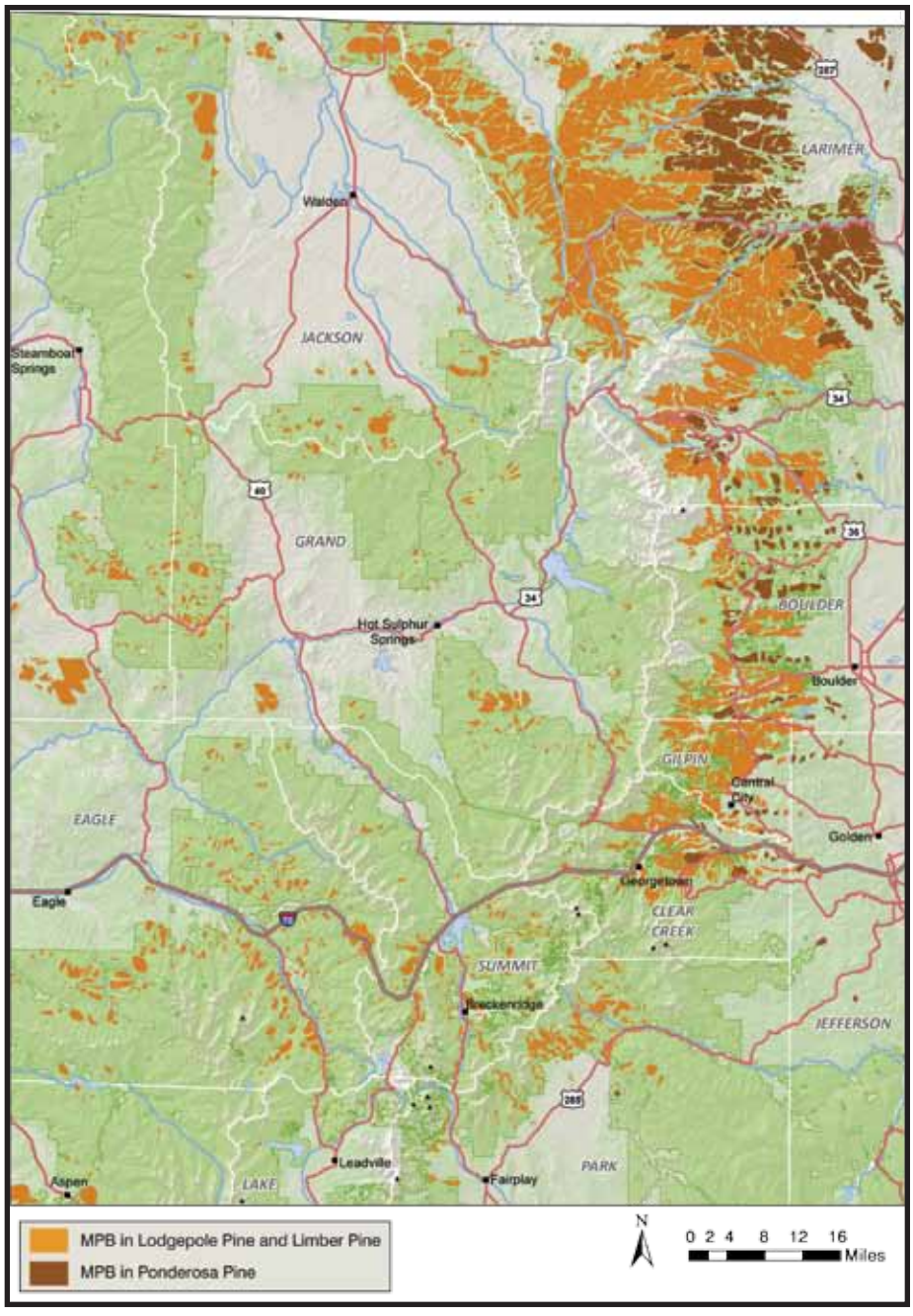
Photo by Joy Jackson

Mountain Pine Beetle

The mountain pine beetle (*Dendroctonus ponderosae*) continued to be the most damaging insect in Colorado's pine forests in 2010. Despite widespread areas of new infestation, the total area of active infestations is declining statewide because large areas of susceptible forests were impacted during previous years. In 2010, active infestations were mapped on 878,000 acres during aerial forest health surveys, compared to 1,046,000 acres in 2009. Mountain pine beetle (MPB) outbreaks were most severe in lodgepole pine (*Pinus contorta*) and limber pine (*Pinus flexilis*), totaling 730,000 acres, with up to 10 new trees attacked per acre. Infestations were observed along the Front Range and from Guanella Pass and Mt. Evans south along the Continental Divide to Fairplay in South Park. Active infestations also occurred on the slopes of the Aspen-Snowmass ski area, in several neighboring drainages and on the western slope of Smuggler Mountain near Aspen.

MPB infestations continued to decline in many areas west of the Continental Divide, especially in Grand and Summit counties, due to the mortality of most of the susceptible trees. Most lodgepole pine stands that have survived through the outbreak consist of younger trees, generally those less than 40 years old, many of which developed following earlier timber harvesting operations.

Infestations in ponderosa pine (*Pinus ponderosa*) increased significantly along the northern Front Range for the second successive year. In 2010, approximately 229,000 acres of mountain pine beetle infestations



2010 Mountain Pine Beetle Activity by Host Species

Mountain pine beetle infestations in both lodgepole and ponderosa pine in the Moraine Basin of Rocky Mountain National Park. In an MPB infestation, lodgepole fade to red and ponderosa fade to yellow.

Mountain pine beetle infestation in lodgepole pine.

Mountain pine beetle infestation in ponderosa pine.

were mapped, compared to 22,000 acres in 2009 – a more than tenfold increase. Most ponderosa pine stands in affected areas now exhibit a scattering of smaller infested areas with 10-15 dead and dying trees in each stand. The heaviest damage occurred near the Wyoming state line, especially east of Virginia Dale, where infestations doubled in size from an average of 50 trees per area in 2009 to more than 100 trees in 2010. Heavy infestations also occurred along the entire Front Range at elevations where mixed stands of ponderosa and lodgepole pines occur, especially in the Moraine Basin of Rocky Mountain National

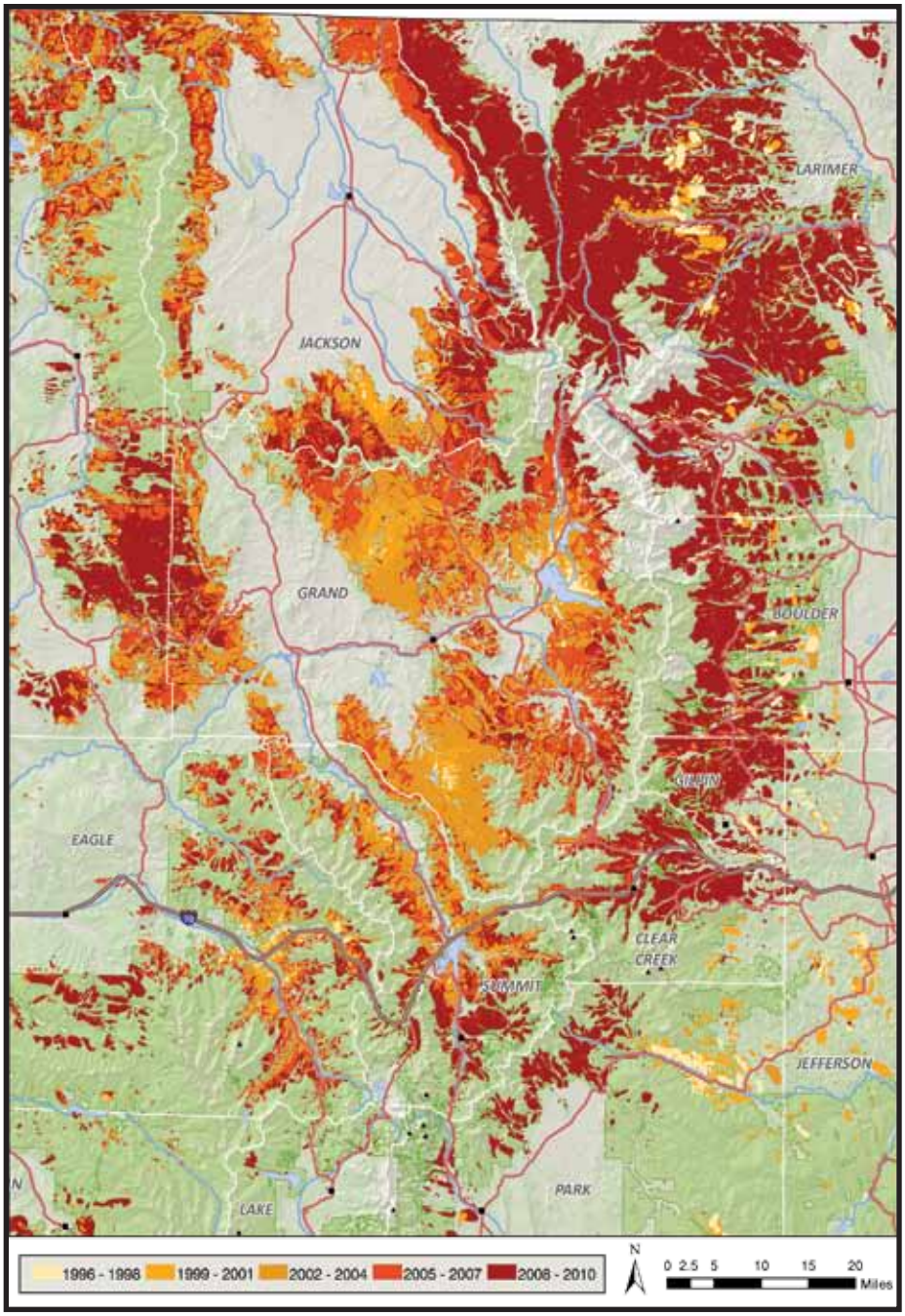
Clearcut timber harvests conducted between 1988 and 1998 at the Colorado State Forest near Gould created pockets of young green stands, between 10 and 20 years of age. These young stands are surrounded by gray beetle-killed mature lodgepole pine stands between 70-90 years of age. The active forest management practices employed 10 and 20 years ago have improved the resiliency of these lodgepole pine stands. (Photo by Joe Duda)

Park. Mountain pine beetle activity in Front Range ponderosa pine is expected to continue to increase over the next several years.

The major concerns about the mountain pine beetle outbreak and its aftermath are the large number of dead trees near communities, which present a serious threat as they begin to fall, and the need to manage increased fuel levels. Several projects are underway to reduce fuel loads and blowdown hazards, especially in developed recreation areas and along roads and trails.

The CSFS currently is administering a project funded through the U. S. Forest Service by an American Recovery and Reinvestment Act (ARRA) grant and other grant funds that is aimed at reducing fuels in and around Steamboat Springs where severe mountain pine beetle damage has occurred. Representatives of federal, state and county agencies, with the help of affected property owners,

Mountain Pine Beetle Progression 1996 – 2010



have identified priority treatment areas where cutting will take place. The project will reduce fuel loading and protect critical infrastructure such as watersheds, power lines, roads and trails from blowdown and wildfire hazards.

In Boulder and Gilpin counties, several wood sort yards have been established as a result of a partnership between the counties and the Peak to Peak Wood Program (http://www.peaktopeakwood.org), which is supported by the CSFS, USFS and Colorado State Parks. Private forest landowners can deliver merchantable logs and wood residues from fuels management, thinning and bark beetle mitigation activities to these sites. Merchantable products, such as fence posts and poles, are sorted on-site and sold to help fund these services. Residual logging slash, composed of branches, limbs and tree tops, is burned in a high-temperature air curtain burner to reduce the fuel to fine ash.

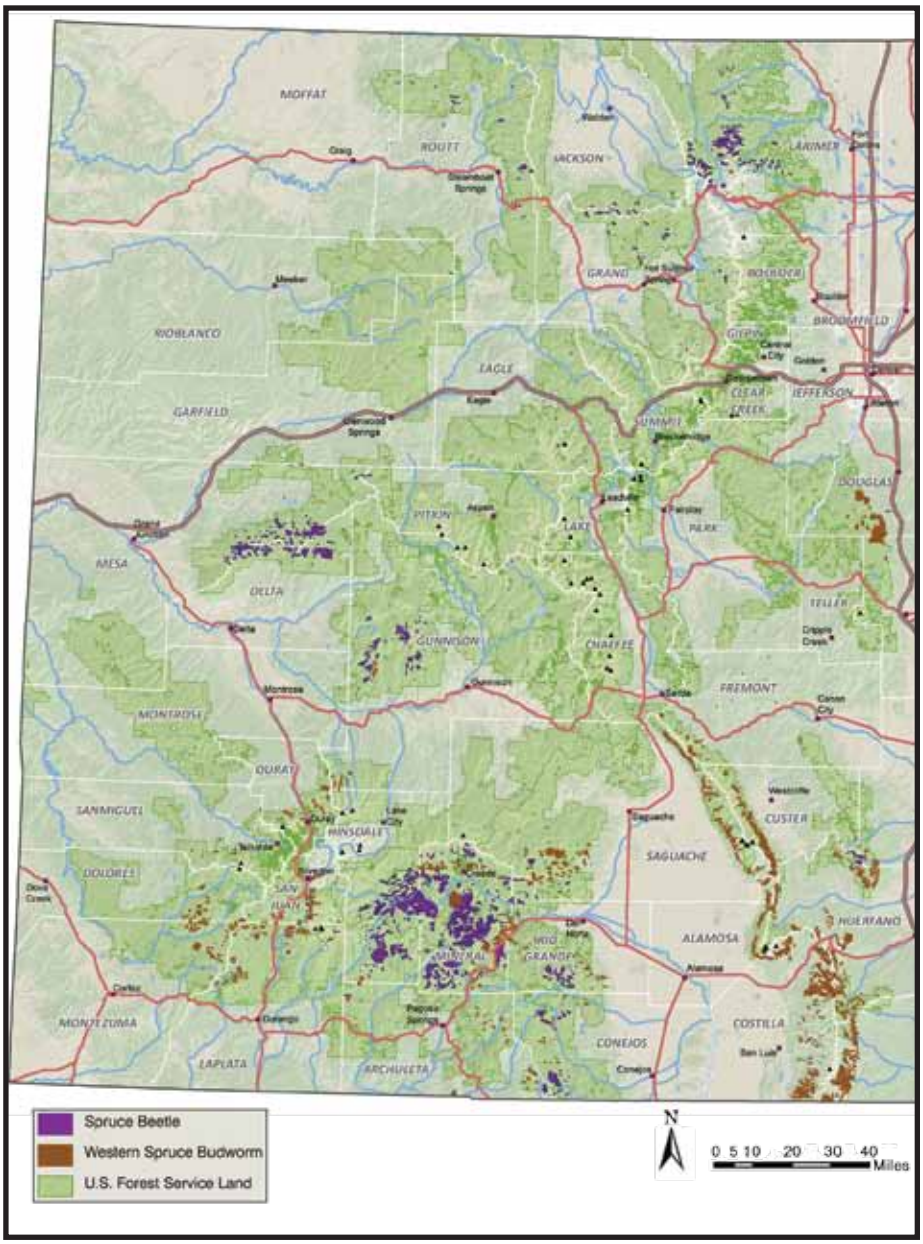
Spruce Beetle and Western Spruce Budworm

The current outbreak of mountain pine beetle, which has affected most of northern Colorado's lodgepole pine forests and now ponderosa pine forests along the Front Range, has overshadowed other forest health concerns for the past decade. However, spruce beetle (*Dendroctonus rufipennis*) and western spruce budworm (*Choristoneura occidentalis*), presently are at epidemic levels and are a growing concern to many Colorado forest landowners.

Spruce Beetle
(Dendroctonus rufipennis)

The spruce beetle was Colorado's second most damaging forest pest in 2010. Areas affected by spruce beetle outbreaks in Colorado increased significantly from the previous year, with approximately 208,000 acres infested in 2010, compared to 114,000 acres in 2009.

A close relative of the mountain pine beetle, the spruce beetle can reach outbreak levels in mature spruce forests and, under the right conditions, kill large numbers of trees. In Colorado and neighboring states, these conditions are created when high winds cause extensive windthrow in spruce forests, providing ideal host material for the development of outbreaks. Large numbers of beetles can develop under the bark of windthrown trees; subsequent generations attack and kill standing live trees in the surrounding area. In most cases, spruce beetle requires two years to mature and reproduce.



2010 Spruce Beetle and Western Spruce Budworm Activity

Spruce beetle outbreaks tend to be less conspicuous than those caused by mountain pine beetle. One reason is that in the Rocky Mountains, Engelmann spruce (*Picea engelmannii*) forests occur at high elevations, generally between 9,000 and 11,000 feet, making them relatively inaccessible. Many outbreaks occur in designated

wilderness areas, visited only by the most avid of backcountry adventurers and seen by relatively few people. In addition, when Engelmann spruce that are attacked by spruce beetle die, their foliage turns a dull yellow-green color instead of the highly recognizable, bright red-orange of lodgepole pines killed by mountain pine beetle.

Since 1999, prominent spruce beetle outbreaks have developed in many of Colorado's high-elevation Engelmann spruce forests. One of these outbreaks originated in 1997, when high winds caused extensive windthrow (approximately 32,000 acres) in spruce forests in the Mount Zirkel Wilderness north of Steamboat Springs. Several years later, spruce beetles that developed in the windthrow area attacked and killed most of the mature spruce in the wilderness and surrounding areas.

Spruce beetle infestations continue in forests in the San Juan Mountains and upper Rio Grande Basin, where the outbreak was first detected in 2003. While most of the mature spruce trees in the Weminuche Wilderness have been killed, new attacks were detected in high-mountain areas outside the wilderness, from the town of South Fork south to Wolf Creek Pass. In addition, mature spruce forests in the vicinity of Lake City and Lake San Cristobal in Hinsdale County are immediately threatened by this outbreak. Only younger spruce stands, which have developed in areas where mature spruce stands were harvested in the past, have survived the current outbreak. In some locations, however, the outbreak has become so severe that even small krummholz trees (stunted trees near timberline) growing at the edge of timberline also have been attacked and killed.

Large numbers of new spruce beetle attacks also were detected in 2010 on the forested slopes of Greenhorn Mountain, the highest peak in the Wet Mountains. These forests were subject to a blowdown event in June 2007. While much of the accessible windthrow timber has been salvage-logged and utilized, the inaccessible stands provided sufficient host material for development of an outbreak. Where spruce stands are accessible for management operations, removal of windthrown trees can be an effective method to prevent the buildup of large spruce beetle populations that could spread to standing trees.

Another notable spruce beetle outbreak was first detected in the Rawah Range in northern Colorado in 2005 and, over a period of three years, killed most of the mature spruce in this area. The outbreak has since spread south to the upper Laramie and Cache la Poudre River basins and portions of the Never Summer Range.

Heavy damage to Engelmann spruce forests by spruce beetles in the headwaters of the Rio Grande Basin, where most of the mature spruce trees have been killed. Note that even small krummholz trees near the edge of timberline have been attacked and killed. (Photo by Joe Duda)

Spruce regeneration, more than 40 years old, near the upper Rio Grande River in an area affected by spruce beetle. (Photo by Joe Duda)

On the Grand Mesa in western Colorado, a significant increase in spruce beetle activity has occurred over the last two years, where extensive stands of mature spruce are especially vulnerable to this insect. Plans are underway to salvage and sanitize as much of the affected area as possible; the relatively flat terrain and the existing road system on top of the Grand Mesa will facilitate the process. Such proactive forest management will help improve forest health and provide forest products for local businesses.

Western Spruce Budworm
(Choristoneura occidentalis)

Western spruce budworm larvae feed in the buds and on new foliage of several conifer species. In Colorado, Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), subalpine fir (*Abies lasiocarpa*) and spruce (*Picea* spp.) are the main hosts. During outbreaks, damaged forests turn a dull reddish-brown or gray color by early July. Western spruce budworm outbreaks can develop over large areas, sometimes defoliating millions of acres of forest. For example, this insect defoliated more than 1 million acres per year during an outbreak that occurred in Colorado between 1980 and 1986, which peaked at 2.6 million acres in 1983. Defoliation over successive years weakens trees and causes reduced growth and top dieback, and eventually can cause tree death. Defoliation also increases the susceptibility of trees to attack by bark beetles, such as Douglas-fir beetle and fir engraver beetle.

Beginning in 1998, an outbreak of western spruce budworm developed in southern Colorado in portions of the Culebra Range, and the Sangre de Cristo and San Juan mountains; the outbreak has continued at various levels of intensity since that time. Defoliation also has been detected in the Rampart Range north of Colorado Springs. Repeated defoliation has been a major concern to forest landowners in areas affected by this current outbreak.

Western spruce budworm defoliation of white fir near North La Veta Pass in the Culebra Range.

In 2010, approximately 213,000 acres of Douglas-fir, spruce and white fir forests were defoliated by western spruce budworm. Defoliation was less widespread and intense than in 2009 when 382,000 acres were defoliated, but the area affected in 2010 still is considered significant. Areas of widespread, heavy defoliation occurred on the eastern slopes of the Culebra Range south of Cucharas Pass, and on the eastern slopes of the Sangre de Cristo Mountains. Aerial surveys detected defoliation by western spruce budworm on Douglas-fir and white fir in portions of the Wet Mountains for the first time since the current outbreak began in 1998, with aerially visible defoliation mapped in southern portions of the Wet Mountains.

The adult stage of western spruce budworm: a small, mottled, light-brown moth.

The larval stage of western spruce budworm.

Confronting a Growing Threat: Spruce Beetle and Private Land

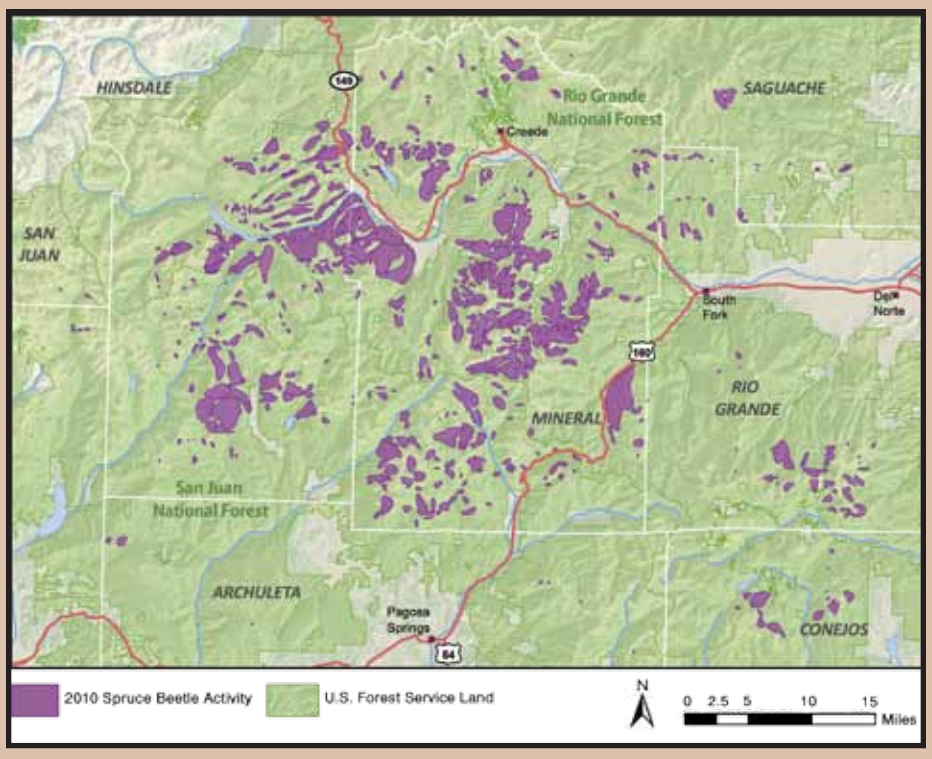
Next to mountain pine beetles, spruce beetles are the most destructive insects in Colorado's high-elevation forests, and are of special concern to landowners living in the southwestern part of the state. Based on the 2010 aerial survey, the active footprint of the spruce beetle outbreak has nearly doubled in size over the past year to more than 200,000 acres, bringing the total number of acres impacted by the beetle in Colorado to nearly 600,000 acres since 1996. The spruce beetle is a natural component of subalpine forest ecosystems, but a combination of factors contributed to this widespread spruce beetle outbreak, including uniform stand maturity, years of drought and multiple windthrow events.

One of the goals the Colorado State Forest Service specifies in its 2010 *Colorado Statewide Forest Resource Strategy* is to protect forests from harm by identifying, managing and reducing threats to forest health, including bark beetle epidemics. Although the current spruce beetle outbreak is confined largely to public lands, the CSFS already has begun to inform and educate private landowners in mountain communities about the potential impacts this bark beetle may cause in the coming years.

In May 2010, the CSFS Durango District held a workshop at the Vallecito Community Center in northeast La Plata County to discuss the potential advancement of the spruce beetle on private land, as well as management strategies local landowners can take to protect their trees and mitigate damage from the beetles. Although the area near Vallecito Reservoir has not yet been impacted by the spruce beetle, the adjacent Rio Grande and San Juan National Forests account for approximately 65 percent of the current spruce beetle activity in Colorado.

The CSFS Alamosa District held a similar workshop in a remote Hinsdale County subdivision in July, closer to the heart of the outbreak. During the meeting, the CSFS provided landowners with information about the life cycle of the spruce beetle, potential impacts of the current outbreak, signs of infestation and steps to protect high-value trees. Many landowners have since taken vigorous steps to prepare for the potential arrival of the spruce beetle on their properties.

The CSFS will help ensure that landowners in southwestern Colorado and elsewhere in the state remain prepared to mitigate spruce beetle damage in the event that the outbreak spreads from public lands onto lower-elevation spruce forests. On a longer-term scale, only proper forest management can restore ecosystem function and create healthy, resilient forests that are resistant to such large-scale spruce beetle outbreaks in the future.



2010 Spruce Beetle Activity in Southwestern Colorado

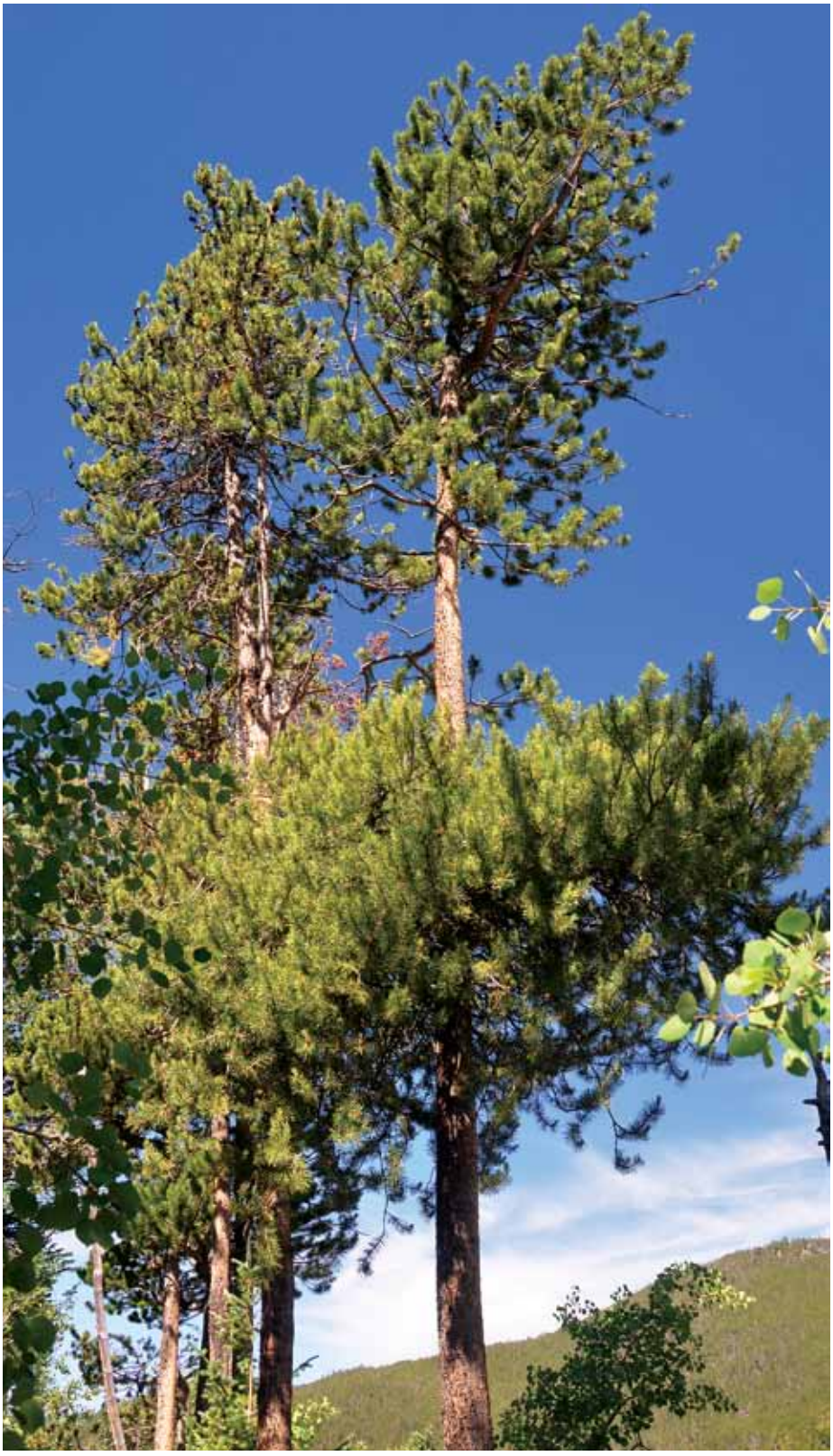
Dwarf Mistletoe: Damaging Parasitic Plants

Forty-two species of dwarf mistletoe are known worldwide; five species are found in Colorado's forests. Most dwarf mistletoes are native to western North America, from Alaska south through the western United States, Mexico and Central America. Dwarf mistletoes are parasites of native conifer forests that can cause severe damage. These plants tend to confine their attacks to one species of tree, with only occasional attacks on other species. Dwarf mistletoe infections can retard growth and reduce seed production and wood quality; heavy, long-term infections can kill trees. Some dwarf mistletoe species induce abnormal tree growth at the point of infection, and produce a structure known as a witches' broom, which disrupts the typical branching structure.

Piñon dwarf mistletoe.

Dwarf Mistletoes of Colorado's Forests

Dwarf Mistletoe Species	**Lodgepole Pine Dwarf Mistletoe** *Arceuthobium americanum*	**Douglas-Fir Dwarf Mistletoe** *Arceuthobium douglasii*	**Southwestern Dwarf Mistletoe** *Arceuthobium vaginatum cryptopodum*	**Limber Pine Dwarf Mistletoe** *Arceuthobium cyanocarpum*	**Piñon Dwarf Mistletoe** *Arceuthobium divaricatum*
Range in Colorado	Widespread; roughly 50% of lodgepole pine in Colorado have some degree of infection	Southwestern Colorado and the Western Slope	Spotty distribution throughout host range in Colorado	Rocky Mountain range throughout Colorado, primarily along the Front Range	Throughout host range in Four Corners region and western Colorado
Primary Host Species	Lodgepole pine	Douglas-fir	Ponderosa pine	Limber pine and Rocky Mountain bristlecone pine	Piñon pine
Plant Characteristics	Olive-green to yellow, 2-4 inches long	Olive-green, less than 1 inch long	Orange, reddish-brown to black, 4-6 inches long	Yellow-green, 1-3 inches long	Olive-green to brown, 3-5 inches long
Host Response	Conspicuous witches' brooms, heavily infested crowns appear thin	Fan-shaped and spherical witches' brooms	Small but conspicuous brooms on branches	Small and compact witches' brooms	Small and compact witches' brooms
Impact	Infestations can significantly reduce growth by 80-90% and predispose trees to other insects and diseases	Witches' brooms may weigh in excess of several hundred pounds and cause severely swollen branches	Reduced growth, foliage discoloration and dieback reduce vigor of host tree	Considered second most important disease of high-elevation five-needle pines, causing severe mortality	Can cause increased mortality of piñon pines and significant deformation of host



Dwarf mistletoe infection in lodgepole pine is easily recognized by the occurrence of large witches' brooms.

Limber pine dwarf mistletoe.

Southwestern dwarf mistletoe produces robust plants that range from orange to black in color.

Long-term, heavy infestations of dwarf mistletoe can kill host trees.

Witches' brooms appear as a dense tangle of misshapen branches and thick foliage on a tree. According to one estimate, dwarf mistletoe causes an annual loss of about 3 billion board feet of wood annually in the western United States.

Dwarf mistletoes are obligate parasites that can only survive on a living host. Should the host tree die, the dwarf mistletoe plants also die. They lack true leaves and contain only a small amount of chlorophyll in their stems, making them unable to manufacture sufficient nutrients on their own. Dwarf mistletoe occurs as both male and female plants; only the females produce large quantities of seeds, and possesses one of the most effective means of seed dispersal among flowering plants. As seeds mature in late summer-early fall, pressure slowly builds up. When mature, any disturbance causes the pressure to release the seeds and disperse them an average of 30 feet. The seeds are coated with a sticky substance that allows them to attach to almost any surface. If seeds land on the stem of a host tree, a new infection develops.

Naturally occurring fires can regulate the distribution and severity of dwarf mistletoe. Wildland fires severe enough to kill large areas of infected trees eliminate the parasites from the stands, except where an occasional infected tree may survive. Trees typically will re-establish themselves in burned areas much more rapidly than dwarf mistletoe. An increase in the incidence and severity of dwarf mistletoe infection in many western forests corresponds to increased fire suppression, a change in natural fire cycles and overly dense stands of trees. Forest management provides a controlled method to reduce the amount of mistletoe in an area by removal of infected trees.

This ponderosa pine forest, in southern Colorado near Stonewall, was thinned in 2000 to manage for dwarf mistletoe. (Photo by CK Morey)

Witches' broom, a byproduct of dwarf mistletoe infestation, in an unmanaged ponderosa pine stand; the stand is located in the same part of the forest as the top photo. (Photo by CK Morey)

Wildfire in the Wildland-Urban Interface

When the 6,000-acre Fourmile Canyon Fire destroyed 176 homes and outbuildings in Boulder County in September 2010, it understandably made national headlines. The fire was the most destructive and expensive* wildfire in state history, responsible for more than $200 million in insurance claims and more than $10 million in suppression costs. This fire was not alone – strong winds, low humidity and dry vegetation fueled multiple Front Range wildfires in 2010.

In June, the Parkdale Canyon Fire destroyed one home, damaged five others and burned more than 600 acres in Fremont County. In September, after a late-summer lull, the Reservoir Road Fire destroyed two homes and charred 700 acres in Larimer County while the Fourmile Canyon Fire still burned. And a month later, in October, the Dome Fire caused an estimated 1,800 Boulder residents to evacuate as it approached the city limits, while the Church's Park Fire consumed almost 500 acres of beetle-kill timber in Grand County and put 18 subdivisions on evacuation alert. Despite the devastating losses, no deaths or serious injuries were attributed to any of these fires – due in part to the role of the Colorado State Forest Service in wildland fire preparedness and suppression.

The recurring threat of wildland fires in the wildland-urban interface (WUI) is of primary concern to the CSFS, with lives, property, watersheds, critical infrastructure

** In terms of combined property damage and suppression costs.*

Aftermath of the Fourmile Canyon Fire in Boulder County, September 2010. (Photo by Ryan Lockwood)

and forest resources all at risk. This threat will not go away; in fact, the population in the WUI is projected to continue growing over the next three decades. The 2010 *Colorado Statewide Forest Resource Assessment* and *Colorado Statewide Forest Resource Strategy* address this concern, providing information to help communities and land managers identify forest landscapes of primary concern for wildfire and leverage limited resources.

Although wildland fire is an essential, natural process in Colorado's forest ecosystems, a long history of fire suppression has altered historic fire cycles and led to dangerously dense forests in some areas. Due to this build-up of fuels and increasing populations in the WUI, wildfires that exceed the control efforts of local and county resources are becoming more common and increasingly complex. As a result, proper forest management in this overlap between forests and urban sprawl is vital to reduce wildfire risk. Over time, proper forest management treatments may bring Colorado forests in line with historic fire cycles. While this will address the health of ecosystems adapted to wildland fire, wildfire risk in the WUI will continue because of the close proximity of homes and other property to wildland fuels. Protection of values at risk from wildfire can be achieved by preparing for and responding to destructive wildfires.

The CSFS serves a leading role in fire preparedness and suppression in the state. In addition to providing organizational framework, personnel, engines and strategic support to fight wildland fires, the CSFS:

- Maintains 140 fire engines throughout the state through the Federal Excess Property Program (FEPP);
- Manages the Single Engine Air Tanker (SEAT) program;
- Authorizes increased levels of management and funding when fires outgrow local suppression capacity;
- Provides training, equipment, technical assistance and funding to county sheriffs and fire departments;
- Facilitates interagency cooperative fire management agreements and annual operating plans;
- Helps Coloradans develop and implement Community Wildfire Protection Plans that prioritize fire

The CSFS Fort Collins engine crew helps protect homes at the Fourmile Canyon Fire in Boulder County. (Photo by Matt Branch)

An air tanker drops retardant on the Dome Fire in Boulder County in October 2010. (Photo by Jason Brock)

mitigation actions to maximize the benefits of limited resources; and

- Assists landowners in implementing fuels mitigation treatments by providing technical assistance and funding support.

The role of the CSFS in fighting wildland fires is possible largely because of the state's Wildfire Preparedness Fund. The fund allows for consistent coordination, resource availability and framework for volunteer fire departments, fire protection districts, county sheriffs, emergency managers and federal agencies. Because of the fund, the CSFS is able to provide expert technical assistance, secure aerial fire resources, hire engine crews, equip inmate hand crews, support National Guard resources, train volunteer fire departments and fire protection districts, and support interagency incident management teams.

The Wildfire Preparedness Fund also enables the CSFS to maintain 140 wildland fire engines at fire departments all over Colorado. The initial attack role smaller city and county fire departments play in fighting wildfires is significant, yet their budgets often are prohibitively low to acquire and maintain fully equipped fire engines. Through the FEPP program, the CSFS fire equipment shop obtains retired vehicles from the Department of Defense and other federal entities. Although title to these vehicles is retained by the U.S. Forest Service, the CSFS controls their placement and management with local fire departments in Colorado. The Wildfire Preparedness Fund provides the means to convert FEPP vehicles into fire engines for rural fire departments, offer ongoing major vehicle maintenance for the fleet and upgrade or replace vehicles as needed. Several fire engines that responded to the Fourmile Canyon Fire were FEPP engines based in Boulder County's highly populated WUI.

The state legislature authorized the Wildfire Preparedness Fund in 2006 and appropriated $3.25 million annually through state fiscal year 2011. Continuation of this critical funding will require the 2011 Colorado Legislature to re-appropriate funds for the next five years (2012 through 2016), to take effect in July 2011.

Federal excess vehicles in the CSFS "boneyard" waiting to be converted into wildland fire engines. (Photo by Ryan Lockwood)

CSFS Fire Shop Mechanic Nate Taggatz starts the process of transforming a federal excess vehicle into a wildland engine. (Photo by Ryan Lockwood)

An Update on the Health of Colorado's Aspen Forests

Quaking aspen (*Populus tremuloides*) undoubtedly is Colorado's most popular tree, especially when its brilliant hues of yellow, gold and orange grace our mountains in autumn. As one of Colorado's few native broadleaf trees, aspen adds diversity to forests otherwise dominated by dark-green conifers. The open character of aspen forests allows many wildflowers, including the Colorado columbine, to thrive. Aspen forests provide cover and forage for wildlife, including large mammals such as mule deer and elk. They also are subject to a variety of pests, some of which can cause widespread damage.

Young aspen stands, generated by previous harvesting activities, are healthy and vigorous, compared to the older unmanaged stands impacted by SAD. (Photo by Jim Worrall)

Sudden Aspen Decline

The condition known as sudden aspen decline (SAD) is a continuing concern in Colorado and neighboring states where aspen is an important component of native forests. This condition began to capture the attention of forest landowners, professional foresters and the general public in 2004, when its impacts became apparent. SAD is characterized by the rapid death of large, mature aspen stands, especially those growing at the lower elevational limits of the aspen's range. It is believed to be triggered by severe stress – such as a drought, late spring frost or insect defoliation – on older, weakened aspen stands, which then causes dieback and decline. Affected trees become susceptible to invasion by secondary pests such as fungi, bark beetles and wood-boring insects that attack and kill the already weakened trees. A dense cover of aspen seedlings already may be growing in the understory of some affected stands. Provided that these seedlings receive adequate moisture and are not subject to overgrazing by deer, elk or domestic livestock, they eventually may replace the dead mature trees in the overstory and establish a young, vigorous forest.

Areas where aspen decline has been especially common include portions of the Western Slope; the San Juan Mountains; Middle, North and South parks; and the Laramie River Basin. Fortunately, in Colorado, SAD has been trending downward in recent years. In 2008, sudden aspen decline and mortality were mapped on 542,000 acres during the annual aerial forest health survey. A smaller area consisting of 342,000 acres was mapped in 2009, and in 2010, a total of 190,000 acres of SAD were mapped. It is important to note that aspen stands harvested and replaced by younger trees have not been as severely impacted by SAD.

The reduced area of SAD detected during 2009 and 2010 may be the result of two factors. In some areas, aspen regeneration in the understory of affected stands has grown and the trees now are 3 to 4 feet tall. Aspen regeneration also has benefited from moisture provided by heavier snowpack and a return to more normal levels of precipitation during the past three growing seasons. Where overstory trees have fallen in aspen stands that still lack regeneration, the damage no longer

Rolled aspen leaves are characteristic of infestation by large aspen tortrix.

Aspen-Defoliating Insects

In 2010, additional areas of aspen defoliation, specifically believed to be the result of insect outbreaks, were mapped in Colorado. As in past years, all affected areas were in the southern part of the state, including portions of the Culebra Range, and the Sangre de Cristo, Wet and San Juan mountains. In Colorado, at least two species of defoliating caterpillars can reach epidemic levels and cause extensive damage in aspen forests: western tent caterpillar (*Malacosoma californicum*) and large aspen tortrix (*Choristoneura conflictana*).

Western tent caterpillar is the more commonly occurring insect defoliator of Colorado's aspen forests. Outbreaks tend to be cyclical and can last multiple years; the current cycle began in approximately 2005. In southern Colorado, outbreaks can strip foliage from large areas of aspen forests. In addition to aspen trees, this insect also feeds on a variety of flora, sometimes defoliating woody plants and shrubs, including mountain mahogany, bitterbrush, wild currant and chokecherry.

Larvae of the large aspen tortrix generally are associated with western tent caterpillar outbreaks, but this insect also is capable of causing large-scale outbreaks on its own.

Heavy defoliation of aspen trees by western tent caterpillar in the North Purgatory River drainage of the Culebra Range.

is noticeable from the air. In these stands and in other areas, particularly dry lower-elevation sites, aspen may not regenerate following the mortality of the mature trees, and the site likely will convert to brush, forbs and grass vegetation.

Despite the apparent recovery of many aspen stands, SAD remains a continuing threat to Colorado forests, especially when episodes of abnormally hot, dry weather occur.

Marssonina Blight of Aspen

Marssonina blight of aspen is the result of a fungus (*Marssonina populi*) that causes dark brown flecks, often with yellow margins, to form on the leaves. Affected leaves usually are smaller than normal, turn a bronze color and are shed earlier than healthy leaves. This leaf disease is most common when seasonal temperatures and rainfall are above normal – conditions that favor the development of fungi. During 2009, a number of aspen forests were affected by marssonina blight, largely due to heavier than normal rainfall. In 2010, however, these outbreaks were not considered severe, as conditions were somewhat drier and few occurrences of this disease were reported in Colorado.

Other Forest Insects and Diseases

Pine Bark Beetles

At least two other types of bark beetles currently are active in Colorado's pine forests and often occur in association with mountain pine beetle. These beetles currently are attacking and killing trees in young lodgepole pine stands that previously survived the mountain pine beetle outbreak.

Pine engraver beetle (*Ips pini* and other *Ips* species) typically attack the tops of lodgepole and ponderosa pine trees. They often are found in smaller-diameter materials, such as the tops of trees that have been infested by mountain pine beetle. When pine engraver beetle populations increase, they can impact standing trees less than 5 inches in diameter at breast height (dbh) without assistance from mountain pine beetle. Pine engraver beetle recently has been observed in young lodgepole pine stands in Boulder and Gilpin counties.

Another bark beetle, *Pityogenes plagiatus knechteli,* which lacks a common name but has been referred to simply as a twig beetle, is commonly associated with both mountain pine beetle and pine engraver beetle. As the name implies, twig beetle usually is found in the smallest diameter twigs and branches. The twig beetle is much smaller than either mountain pine beetle or pine engraver beetle individuals, and typically is a secondary invader. During the current mountain pine beetle outbreak, all three species have been observed together in infested trees.

Douglas-fir Beetle *(Dendroctonus pseudotsugae)*

Douglas-fir beetle, another close relative of mountain pine beetle, attacks and kills large, mature Douglas-fir trees. This beetle typically kills groups of trees and when large outbreaks occur, tree mortality within groups can exceed 100 trees. In 2010, active infestations were detected on 37,000 acres statewide, compared to 23,000 acres in 2009. Particularly heavy damage occurred in portions of the upper San Miguel River Basin, several drainages northeast of Ouray, the southern slopes of the San Juan Mountains, the Crystal River and several of its tributaries near Marble, the Rampart Range, and areas south and west of Gore Canyon near Kremmling.

In many areas, new attacks occurred near dead trees that previously had lost their needles, indicating that the outbreaks likely had been active for at least two to three years.

Western Balsam Bark Beetle/Root Disease Complex

Tree death as a result of attacks by the western balsam bark beetle (*Dryocoetes confusus*) in combination with at least two species of root decay fungi (*Armillaria* sp. and *Heterobasidium annosum*) continued in the high-elevation subalpine fir (*Abies lasiocarpa*) forests of Colorado. This multi-faceted attack sometimes is referred to as subalpine fir decline. In 2010, western balsam bark beetle affected approximately 265,000 acres, compared to 184,000 acres in 2009 and 344,000 acres in 2008.

Bark beetle damage in young lodgepole pine stands, visible as red patches above, in Grand County may be due to attacks by a combination of ips engraver beetles, mountain pine beetles and/or "twig beetles."

Fir Engraver
(Scolytus ventralis)

The fir engraver beetle attacks and kills only true firs; in Colorado, the beetle attacks white fir (*Abies concolor*). Outbreaks of this beetle can reach epidemic levels and kill large numbers of trees, although in some cases, attacks are confined to the upper crown and only a portion of the tree dies. In 2010, fir engraver infestations were detected on the northern slope of West Spanish Peak and along the eastern slopes of the Wet Mountains. Instances of top-kill and total tree mortality occurred in these impacted areas.

Spruce blowdown above the Rio Grande Reservoir. (Photo by Joe Duda)

Pine Sawfly
(Neodiprion autumnalis)

Activity in ponderosa pine by pine sawfly, which has been active along the eastern-most fringes of ponderosa pine forests in Elbert County for several years, declined to low levels in 2010. Forest landowners reported no new infestations or damage.

Ponderosa Pine Needle Miner
(Coleotechnites ponderosae)

Discoloration of ponderosa pine by the ponderosa pine needle miner was detected for the second successive year west of Walsenburg and in and near Rye, at the base of Greenhorn Mountain. Damage also was reported in several Buena Vista subdivisions.

Heavy hail-damaged aspen trees and conifers near the Eldora Ski Area in late July 2010.

Other Concerns

Several recent blowdown events ranging from approximately 10 to 50 acres in size were detected in spruce forests west of Lake City and in the Ute Creek Basin above the Rio Grande Reservoir. Windthrow observed in the Ute Creek Basin is located in areas that already have suffered from heavy spruce beetle damage. As previously mentioned, recently fallen spruce trees create conditions favorable for the buildup of spruce beetle infestations.

In addition to blowdown concerns, a type of twig beetle, *Pityophthorus* spp., damaged the branches of many subalpine fir trees in several locations in the Flat Tops area of the White River National Forest.

Also, an unusually heavy hailstorm that occurred northwest of Nederland in Boulder County during late July 2010 stripped foliage from aspens and affected some conifers in an area between County Road 130 and the road to the Eldora Ski Area. At least 100 acres were damaged by the hail.

On Aug. 19, 2010, a significant wind event described by the National Weather Service as a "macroburst" from a severe thunderstorm affected a 4- to 5-mile wide swath of central Delta County from Hotchkiss to Paonia. Sudden, violent winds in excess of 70 miles per hour caused widespread damage to native and community forests in the area.

ARRA Projects Assist with MPB Aftermath

Potentially more threatening to people and infrastructure than the current bark beetle epidemic are the natural changes that will occur in the forest after the epidemic subsides. Rot develops in the base and roots of beetle-killed trees. As rot increasingly compromises wood strength in individual trees, the trees may fall during strong winds – or on a calm, sunny day. The myriad lodgepole pine killed by mountain pine beetle in northern Colorado pose a safety risk along transportation corridors, utility lines and recreation trails – and near public venues and homes.

As rot develops, beetle-killed trees are increasingly subject to windthrow. (Photo by Paul Cada)

In 2009, the Colorado State Forest Service was awarded two American Recovery and Reinvestment Act grants through the U.S. Forest Service. The emphasis of the grants is jobs, but the CSFS also required on-the-ground accomplishments from the organizations that successfully competed for ARRA funds.

In Steamboat Springs, the city teamed up with private landowners to remove dead trees adjacent to roadways and around homes. The steep terrain required special equipment. ARRA funding paid a local contractor to cut and remove the dead trees. The chance of a full or partial road closure and the risk of exposure to motorists, cyclists, pedestrians and homeowners have been reduced. The tree removal project also improved safety should there be a wildfire.

Windthrown beetle-killed trees cover a hillside near Steamboat Springs. (Photo by Kathryn Hardgrave)

Dead and downed trees were removed from areas around Steamboat Springs using cable logging equipment. (Photo by Kathryn Hardgrave)

North of Steamboat Springs, in the rolling terrain of Pearl Lake and Steamboat Lake State Parks, mountain pine beetle killed the tall lodgepole pines. Last year, the graying trees were removed in and around the campgrounds. While alive, the trees provided sun and wind protection to sapling-sized subalpine fir and Douglas-fir. Now, the small trees are sun scorched and blowing down. As the Rocky Mountain Youth Corps cut and chipped the small blown-over trees, additional trees toppled over like an unraveling garment.

The same was true at Steamboat Lake, so the tall, dead trees in the campgrounds were removed. One Saturday in June 2010, approximately 150 volunteers planted thousands

Winter Park cleared beetle-killed trees from 3.1 miles of railroad easement. Top photo, before treatment. Bottom photo, after treatment. (Photos by Kathryn Hardgrave)

of lodgepole pine seedlings in the park's campgrounds as part of a ReTree Colorado project. Rocky Mountain Youth Corps members were among the volunteers. The planting will jumpstart the natural regeneration process.

In Grand County, the town of Winter Park used ARRA funds to clear beetle-killed trees from the 3.1 miles of railroad easement through town. The project not only provided safe passage for daily freight and passenger trains, it created an effective fuelbreak. Aspen trees already are taking advantage of the new space, and ground cover is flourishing.

The Rocky Mountain Youth Corps removed dead, dying and fallen trees around campgrounds. (Photo by Kathryn Hardgrave)

Aerial Surveys: A Fundamental Tool for Monitoring Forest Health

Damage caused by many forest insects and diseases, such as groups of recently killed trees or areas of thin or brown foliage, can readily be seen from the air. Therefore, much of the information describing location, intensity and areas affected by these agents is obtained from forest health aerial surveys. In Colorado, these surveys are conducted through a cooperative effort of the USFS Rocky Mountain Region and the CSFS. Flights occur during July, August and September when visible damage signatures peak.

In Colorado, aerial detection data now are recorded on touch-screen computers equipped with mapping software and linked to Global Positioning System (GPS) receivers via Bluetooth technology. The resultant data are entered directly into a Geographic Information System (GIS) that displays the location of damaged areas and stores the data in digital format for future analyses. Data collected during forest health aerial surveys are analyzed and made available to foresters, forest landowners and the public at large via an internet site maintained by the USFS at http://www.fs.fed.us/r2/resources/fhm/aerialsurvey/.

For additional information on the annual forest health aerial survey in Colorado, please see the *2008 Report on the Health of Colorado's Forests*, p. 18, located online at http://csfs.colostate.edu/pdfs/894651_08FrstHlth_www.pdf

CSFS Gunnison District Forester Tim Cudmore briefs Pilot John Moffet, on the day's aerial forest health survey mission.

Thousand Cankers Disease: Threatening One of America's Most Valuable Trees

Walnut trees are not native to Colorado; however, black walnut trees have been planted in many communities across the state, where they have become popular as shade trees. Now, thousand cankers disease of black walnut (*Juglans nigra*) and other walnut trees in the western United States is threatening Colorado's black walnut trees. This disease is caused by a recently discovered fungus, *Geosmithia morbida*, which is spread from tree to tree by a tiny bark beetle known as the walnut twig beetle (*Pityophthorus juglandis*).

Walnut twig beetle is native to portions of Mexico, Arizona, New Mexico and Southern California, where it acts as a secondary beetle that attacks and breeds in the twigs of already-stressed Arizona walnut trees (*Juglans major*). Beginning in approximately 2001, reports indicated that groups of black walnuts were dying near Española, N.M., and later in several other western states. Declining and dead black walnuts also have been reported in some Colorado Front Range communities since 2001, and the presence of the twig beetle was first confirmed in the state in 2004. Once established in an area, the walnut twig beetle can fly short distances and attack neighboring walnuts. The insect and its associated fungus also can spread over long distances via the transportation of infested wood.

Pest management specialists examine walnut twig beetles and symptoms of thousand cankers disease during a workshop sponsored by Colorado State University in June 2010.

A black walnut tree in the advanced stages of thousand cankers disease.

The walnut twig beetle spreads the fungus from tree to tree when it invades the tree's branches and trunk. The fungus first develops around the galleries produced by the beetles and later spreads to other areas in the tree's bark, where small cankers occur. After the cankers appear, they expand rapidly along the length of the tree and increase in number until their presence results in the dieback of branches and eventual death of the entire tree.

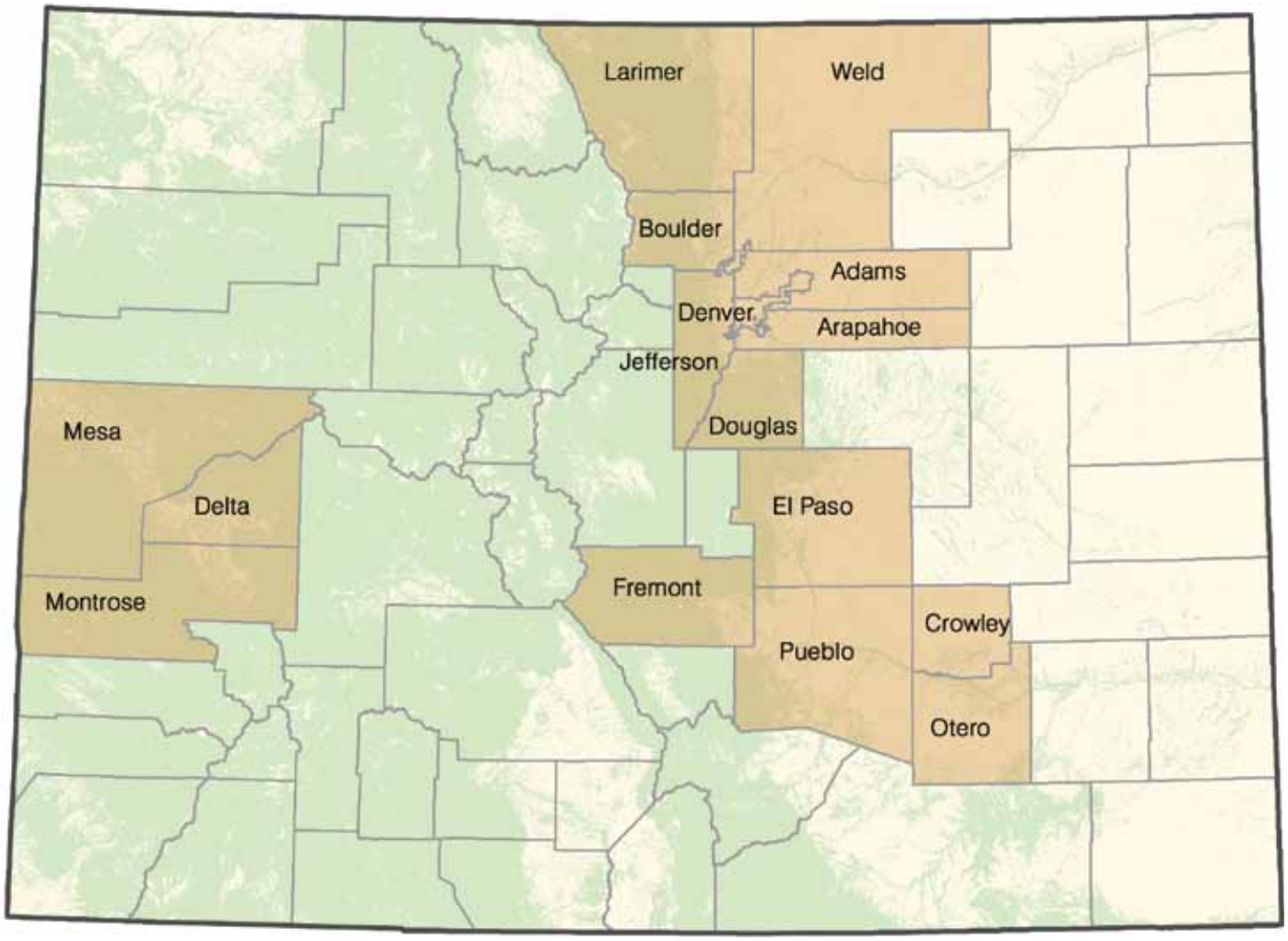
Both the walnut twig beetle and thousand cankers disease are widespread in Colorado and, since their initial discovery in the state, have killed thousands of trees. Heavy damage has occurred in portions of the Denver Metro area, including the communities of Arvada, Aurora, Brighton, Denver proper, Golden and Wheat Ridge. Losses also have occurred in the City of Boulder and, more recently, in Longmont, Lyons and Berthoud. On the other side

Walnut twig beetle galleries in a black walnut tree branch. (Photo by Whitney Cranshaw)

of the state, the disease has been present in Grand Junction for several years and infected trees also have been detected in Delta. In addition, thousand cankers disease has been observed in several locations along the Arkansas River Valley and other sites in southeastern Colorado.

The spread of thousand cankers disease can be slowed by removing infected trees, preferably by late July before the walnut twig beetles have completed development and dispersed. Infected wood should be taken to an approved storage site located in an area where the risk of potential spread to other walnut trees is minimized, or where treatments exist to kill the beetles and fungus. Small-diameter trees may be chipped to prevent the spread of the disease, but these chips also must be disposed of at an approved storage site. For more information, visit http://www.thousandcankersdisease.info.

Colorado Counties in which Thousand Cankers Disease has been Detected



Unwelcome Visitors: Non-Native Pests

One of the consequences of our interconnected global society is that increased international trade and travel intensifies the risk of introducing exotic insects, diseases, plants and other organisms to new areas. Should these exotic species find suitable habitat in which to develop, they have the potential to cause widespread damage.

International trade in plant and wood products provides a pathway for the introduction of exotic forest pests. Over the past two decades, a significant increase in forest pest introductions worldwide has occurred. For example, two destructive wood-boring insects – emerald ash borer (*Agrilus planipennis*) and Asian longhorned beetle (*Anoplophora glabripennis*), which are both native to Asia – have become established in North America. Conversely, red turpentine beetle (*Dendroctonus valens*), native to western North America, has become an established pest in portions of China's pine forests.

Several non-native forest insects and diseases that have become established in North America, including gypsy moth, emerald ash borer and white pine blister rust, pose a direct threat to Colorado's forests. These exotics are the subject of special monitoring and detection programs designed to manage infestations before they cause widespread damage.

Gypsy Moth
(Lymantria dispar)

Larvae of the gypsy moth, which is native to both Europe and Asia, feed on the foliage of more than 100 species of broadleaf trees and conifers. Several subspecies of the moth are known to exist, including a European subspecies with adult females that do not fly and an Asian subspecies with females that have fully functional wings. The European subspecies was introduced into North America in 1868 or 1869 and now is established as far north as eastern Canada, south to North Carolina and west to parts of West Virginia, Ohio, Indiana, Illinois, Michigan and Wisconsin. In areas where gypsy moth is established, large areas of broadleaf forests are defoliated annually, and high numbers of larvae associated with outbreaks have become a nuisance, especially in urban forests.

Female gypsy moths can lay their eggs on almost any surface, including lawn furniture or inside the hubcaps of motor vehicles. This allows for easy, unsuspecting human transportation of egg masses over long distances, with an accompanying high risk of gypsy moth establishment in new areas. In addition, introduction of the Asian subspecies of the moth into the West Coast states is a constant threat as a result of regular trade with Russia, China and other Asian countries. The Asian subspecies, which will feed on conifer trees, poses a more significant threat to Colorado forests than the European species due to the abundance of evergreen trees in the state. Isolated infestations of the European gypsy moth already have occurred in several central and western states, including Colorado. Should either subspecies of gypsy moth become established in the state, urban trees and native forests could be severely damaged.

The CSFS, in partnership with the USDA Animal and Plant Health Inspection Service (APHIS) and the Colorado Department of Agriculture, participates in an ongoing program to monitor gypsy moth in the

CSFS Forest Entomologist Sky Stephens places one of many traps baited with gypsy moth attractant to ensure early detection of the infestation in Colorado.

state. Monitoring efforts involve deployment of small traps coated with a sticky substance and baited with a synthetic version of the female moth's sex attractant. If male moths are present in an area, they are attracted to the traps.

More than 1,700 gypsy moth monitoring traps were deployed, monitored and collected across Colorado in 2010. The traps were installed at a density of approximately one trap per square mile, with additional traps placed in high-risk communities or heavily populated urban forests, including Boulder, Denver and some communities in Jefferson, Larimer and El Paso counties. In 2010, in an attempt to restrict the boundaries of a possible introduction, trapping was intensified in Commerce City, Westminster and western Pueblo, where male gypsy moths had been trapped in 2009.

During 2010, a single male gypsy moth was trapped in Longmont; no additional moths were trapped in areas where moths were detected in 2009. In 2011, ground surveys and delimitation trapping will occur in Longmont, in addition to the routine statewide monitoring.

An emerald ash borer larva in the inner bark of an ash tree. (Photo by David Cappaert)

Emerald Ash Borer
(Agrilus planipennis)

The emerald ash borer is native to Asia, where it attacks and kills ash and other broadleaf trees. In 2002, this insect was discovered in southeastern Michigan, where it was associated with dying ash trees. Since its initial discovery there, infestations have been detected in 12 eastern and central states and in Ontario, Canada, resulting in the death of millions of ash trees. This borer likely was introduced via raw wood crating or pallets used to ship products imported from Asia. Since its establishment, long-distance overland spread has been facilitated by interstate transport of ash firewood and tree nursery stock.

All species of ash (*Fraxinus* spp.) native to North America are susceptible to attack by emerald ash borer, including the green ash (*Fraxinus pennsylvanica*) and white ash (*Fraxinus americana*) that serve as popular shade trees in many of Colorado's urban forests. For example, approximately

Panel traps, baited with a manuka oil attractant, are used for early detection of emerald ash borer.

White pine blister rust causes branch flagging on a limber pine near Mosca Pass in the Sangre de Cristo Mountains.

Cankers and aeciospores caused by white pine blister rust on the branches of a limber pine near Mosca Pass.

20 percent of landscape trees in Fort Collins are ash. Should emerald ash borer become established in the state, it could eliminate a prominent, fast-growing and attractive tree from our urban forest ecosystems.

The CSFS, in partnership with the Colorado Department of Agriculture and APHIS, conducts a statewide monitoring program to ensure early detection of emerald ash borer. Prism traps, baited with an attractant that mimics odors emitted by stressed ash trees, are used to lure emerald ash borer adults. In 2010, traps were placed at 100 sites across the state. To date, no individuals have been caught and this insect is not yet considered to be present in Colorado.

White Pine Blister Rust

White pine blister rust, a devastating disease of five-needle or white pines, was one of the first exotic forest pests introduced into North America. The disease is caused by a rust fungus, *Cronartium ribicola*, which is native to Asia. The fungus spread to Europe during the late 1800s and was first introduced into New York State in 1906 on white pine nursery stock imported from Germany. A second introduction into western North America occurred in 1921 on white pine nursery stock imported from France.

The white pine blister rust fungus requires two separate hosts to complete its life cycle – white pines and one of the various species of currants or gooseberries (*Ribes* spp.). The fungus initially causes cankers on the branches of susceptible five-needle pines; branches die back and eventually the entire tree dies. The primary method of management is selective breeding of pines that are genetically resistant to the fungus.

White pine blister rust first arrived in Colorado in 1998 when it was discovered on limber pines (*Pinus flexilis*) near the Wyoming border in Larimer County. In October 2003, the disease was discovered in the Sangre de Cristo Mountains on both limber pine and Rocky Mountain bristlecone pine (*Pinus aristata*); and on limber pine in the Wet Mountains. In 2009, isolated infestations were detected in Rocky Mountain National Park and on the north slopes of Pikes Peak.

Long-Distance Transportation of Wood: A Pathway for Introducing Invasive Forest Pests

Plant materials such as nursery stock, lumber, logs and other wood products provide effective pathways for the introduction of exotic insects and diseases that have the potential to cause severe damage once introduced into a new environment. Firewood, essential to Coloradans who rely on it as a primary heat source, and often used by those who camp in the state's forests, also is a potential source of new pest introductions.

Several pests potentially spread by wood or plant products can infest many of Colorado's tree species:

- Ash firewood transported from the central United States could harbor emerald ash borer.
- Nursery stock can be a vector of numerous insects and diseases, including emerald ash borer.
- Oak firewood and logs transported from California could be infected by the organism that causes sudden oak death, a disease of unknown origin that is devastating California's oak and tanoak forests.
- Walnut logs and lumber with bark strips transported from western states where thousand cankers disease has become established could be a source of additional infestations.
- Elm firewood can harbor at least two species of exotic bark beetles: the smaller European elm bark beetle (*Scolytus multistriatus*), a vector of Dutch elm disease, and the banded elm bark beetle (*Scolytus schevyrewi*). Both of these bark beetles already are established in Colorado, but numbers can be kept low by refraining from storing fresh elm firewood.
- Transportation of firewood, poles and logs containing bark may increase the risk of spreading mountain pine beetle.

A recent survey of campers and visitors to state and national parks in the West revealed that a significant percentage of out-of-state visitors brought firewood with them. The study, conducted by Dr. William Jacobi, plant pathology professor in the Department of Bioagricultural Sciences and Pest Management at Colorado State University, provides some clues to the potential dangers associated with transporting firewood.

In another aspect of Jacobi's study, the team conducted a survey of retail firewood sellers in four western states – Colorado, New Mexico, Utah and Wyoming – and found that a large percentage of the sampled firewood contained live insects.

In California, an especially alarming example of the threat of transporting damaging insects via firewood occurred in July 2010 when ash firewood, infested by emerald ash borer, was intercepted at a California border station.

The above examples illustrate the need to inform and educate out-of-state visitors about the risks associated with introducing invasive forest pests through the transportation of firewood. The CSFS advises those who use firewood to obtain it from a local source, and encourages them not to move firewood commercially or recreationally.

Transportation of firewood can introduce invasive forest insects into Colorado.

Protecting Colorado's Forests and Plains from the Impacts of Wildfire

Colorado's plains communities are not immune to wildfire. This photo shows the aftermath of the Ordway Fire in April 2008. (Photo by Shelly Simmons)

As Colorado's population continues to grow, significant and rapid construction also is expanding in the wildland-urban interface. The increasing number of homes and traffic in these areas heightens the risk of wildfires in our forests and grasslands.

Protecting property is every landowner's responsibility, and the Colorado State Forest Service has developed a proactive approach to help landowners address wildfire risks before a wildfire occurs. Through Colorado's *Are You FireWise?* and *Are You Plains FireWise?* programs, landowners can learn about mitigation measures they can take to protect themselves and their property from wildfires.

The FireWise program has been successful with homeowners, landowners, fire protection districts, natural resource agencies, local governments and other interested groups. Program participants learn what steps they can take to help protect their property from wildfire. They also learn about longer-term steps they and their neighbors can tackle together to help protect their subdivisions and communities.

Are You Plains FireWise? has been particularly important in eastern Colorado, where dry grasses can ignite and burn quickly throughout much of the year. Plains residents often do not have access to some of the emergency services available in urban areas. Many rural fire departments are run by volunteers who are not always at the fire station when a wildfire occurs. Such resources as water, equipment and the number of firefighters available to respond to wildfires often are limited. In addition, response time can be delayed if the fire is difficult to access. FireWise training provides landowners with steps they can take to improve the chance that their structures will survive when a wildfire does occur.

Are You FireWise? training also can jumpstart development of a Community Wildfire Protection Plan (CWPP). CWPPs represent the best opportunity to address the challenges associated with living in the wildland-urban interface in a way that results in comprehensive and locally supported solutions. Collaboration with local, state and federal partners, and other interested stakeholders is essential to the successful development and implementation of CWPPs. Collaboration also offers a positive, solution-oriented environment in which to address challenges such as local firefighting capability, the need for defensible space around homes and subdivisions, and where and how to prioritize land management on both federal and non-federal land.

Currently, more than 150 CWPPs have been developed in Colorado that cover areas as small as homeowners associations or subdivisions and as large as counties. A list of CWPPs is available at http://csfs.colostate.edu/pages/CommunityWildfireProtectionPlans.html.

In addition to providing technical assistance to communities during the development of CWPPs, the CSFS also reviews each CWPP to ensure that it meets development guidelines and minimum standards before giving it final approval.

Through Colorado's *Are You FireWise?* program and CWPP development and implementation, the Colorado State Forest Service provides landowners with important tools to help mitigate wildfire risks and protect themselves and their properties from wildfires.

Forestry-Related Legislation in Colorado, 2010

Coloradans value healthy, resilient forest landscapes, and the Colorado General Assembly continues to invest funds in the stewardship of these vital resources. In 2010, the state legislature passed eight bills addressing forest health, fuels mitigation and public safety. The level of legislative support over the past several years is evidence of the importance and value Coloradans place on our forests. The legislation focuses on promoting healthier, more diverse forests that are resilient to insect and disease epidemics for the benefit of present and future generations.

Summary of 2010 Forestry Legislation

Bill Number	Bill Name	Bill Summary
SB 046	Boundaries of Forest Improvement Districts	Allows for the creation of a forest improvement district whose boundaries do not necessarily coincide with a county or municipality. Further, the district boundary may consist of noncontiguous tracts or parcels of property.
SB 102	State Forester Prescribed Fire Certification Standard	Requires the Colorado State Forest Service to establish standards for training and certification of prescribed fire users.
SB 177	Promote Biomass Energy Development	Requires biomass energy facilities to be valued for the purpose of property taxation in the same manner in which wind or solar energy facilities are valued. Provides a property tax exemption for forestry equipment that is used in the production of woody biomass. Designates silviculture as an agricultural practice for tax purposes.
SJR 037	Colorado Forest Products	Recognizes the economic and environmental importance of Colorado's forests.
HB 1071	Elimination of the Forestry Experience Requirement	Eliminates the requirement that persons employed in a technical forestry capacity by the Board of Governors of the Colorado State University system have at least two years of experience in forest practice.
HB 1131	Colorado Kids Outdoor Grant Program	Provides grants for programs that allow Colorado youth to participate in outdoor activities in the state, including but not limited to, programs that emphasize the environment and experiential, field-based learning.
HB 1223	Sunset Repeal Forestry Advisory Board	Allows for the repeal of the seven-member Forestry Advisory Board. In 2008, Governor Ritter created the 24-member Colorado Forest Health Advisory Council to provide input and guidance on Colorado forest policy, making the board redundant.
HJR 1024	Bark Beetle Wood Industry Incentives	Supports bark beetle mitigation efforts, and develops marketing and incentive programs; encourages development of properly sized, sustainable wood industries.

What Does the Future Hold for Colorado's Forests?

Many Colorado citizens are concerned about what our forests will look like after the current bark beetle outbreaks have run their course. A look at areas across the West affected by earlier mountain pine beetle outbreaks provides clues as to what Colorado's lodgepole pine forests may look like in the future.

Rates of decay are slow in the semi-arid climate typical of western forests. Therefore, beetle-killed and windthrown trees will remain for many years. Lodgepole pine forests affected by mountain pine beetle outbreaks during the late 1930s and early 1940s in portions of northern Idaho and western Montana still contain dead and windthrown trees with easily recognizable mountain pine beetle galleries on the trunks. The forest canopy in these stands is more open, with a scattering of both young lodgepole pine and subalpine fir in the understory.

The current mountain pine beetle outbreak already has run its course in Grand and Summit counties, where most of the mature lodgepole pines over 60 years old have died. While these forests now exhibit an overall gray cast due to the large number of dead trees, a closer look reveals that many young trees have survived the beetle outbreak. This is especially true in areas where mature lodgepole pine were harvested several years ago and have since been replaced by young, vigorous stands in which trees are too small to provide good breeding sites for attacking beetles. These younger trees eventually will develop into the forests of the future. If we fail to manage these new forests, they easily could develop into large, homogenous stands similar to those that existed prior to the current bark beetle outbreak, thus setting the stage for a new epidemic.

Young, vigorous lodgepole pine trees are thriving in an area where the mature forest was harvested.

Although some trees have survived the current epidemic, the very character of these conifer forests has changed due to the outbreak itself and human activities associated with managing the impacts. An immediate concern is the hazard of falling beetle-kill trees. These trees pose a

Thinning dense ponderosa pine forests can increase the remaining trees' resistance to insect and disease infestations and reduce the risk of wildfire.

safety risk for campers, hikers and other outdoor recreationists, as well as communities and the increasing number of homeowners who live in or near beetle-infested forests. The dead trees also threaten important infrastructure such as roads, power lines, communication equipment and water supplies.

Several land management agencies are working to remove dead trees from campgrounds and roads in lodgepole pine forests affected by mountain pine beetle. Many campgrounds, originally located in closed forests that shaded and screened adjacent campers, are now devoid of trees. Other developed recreation sites also have been closed to the public because of the dangers associated with falling trees. In addition, landowners have removed large numbers of dead trees

around homes in the wildland-urban interface to provide defensible space in the event of wildfire.

Falling trees are not the only risk associated with the aftereffects of bark beetle epidemics. Some forests affected by bark beetle outbreaks also will burn. Fire intensity may increase due to changes in forest fuels; a combination of fine branches and needles on recently killed trees; windthrow; and standing dead trees with ladder fuels in the understory.

Mature lodgepole pines produce some serotinous cones that only open when exposed to high temperatures. These cones provide an abundant seed source to establish young, vigorous forests in areas that have recently burned. For example, many areas in Yellowstone National Park, which suffered a mountain pine beetle outbreak during the early 1970s and burned during the massive wildfires of 1988, now contain extensive stands of young lodgepole pine. The serotinous lodgepole pine cones that opened as fire passed through served as the seed source for regeneration of the burned areas.

Sound forest management is necessary to create conditions that inhibit large-scale bark beetle infestations. Methods such as the timely harvesting of mature lodgepole pine and Engelmann spruce stands creates a mixture of stands composed of different age classes and tree species, resulting in young, diverse stands that can withstand insect and disease attacks.

Removing recently windthrown trees in spruce forests can reduce the risk of widespread spruce beetle outbreaks.

Thinning our ponderosa pine forests currently impacted by the mountain pine beetle reduces stand density and increases resistance to mountain pine beetle attack.

Fuels treatment work in the Pan Ark subdivision at Twin Lakes in Lake County. The need for the work was identified by homeowners in the Lake County CWPP. Top photo, before treatment; bottom photo, after treatment. (Photos by Damon Lange)

Active forest management, combined with programs that help create markets for wood products from Colorado's forests, can reduce the impacts of future bark beetle outbreaks and other insect and disease issues before they become epidemics.

In addition, the *Colorado Statewide Forest Resource Assessment*, *Colorado Statewide Forest Resource Strategy* and CSFS strategic plan will help guide the CSFS and other forestry stakeholders as we take a landscape-level approach to leveraging limited resources where they will achieve the greatest benefit.

Treatment work at Dalla Park near Durango was supported by Colorado's Forest Restoration Pilot Grant Program. The photo above is representative of local conditions prior to restoration treatments. Below, restoration practices included removing Gambel oak and Rocky Mountain juniper understory, thus encouraging historic ponderosa pine ecosystem conditions. (Photos by Ryan Lockwood)

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