

2015 Report on the Health of Colorado's Forests

15 YEARS OF CHANGE



Director's Message

January 2016



▲ Michael B. Lester, State Forester and Director. Photo: Society of American Foresters

This year marks a milestone in tracking forest health and management in Colorado, with this publication representing the 15th annual report on the health of Colorado's forests. Throughout this period, we've witnessed many landscape-level changes across Colorado. The forces and circumstances that have come together – climate and weather events, insects and diseases, wildfire and human impacts – have contributed to dramatic changes in the age and structure of our forests. And substantial growth is predicted in our wildland-urban interface, where human habitation intersects with natural vegetation and undeveloped land – an area currently only about 20 percent developed in Colorado. Increased development will make forest management even more challenging than in the past.

The focus of these reports has varied over the years. Broader themes have included overarching topics such as forest stewardship and active management. Other, more focused reports provided readers with detailed descriptions of emerging and recurring threats, and specific forest types, such as high-elevation forests, lodgepole pine, aspen,

ponderosa pine and urban and community forests. In this year's report, you will read about not only the current condition of our forests, but reflections on changes since the first report in 2001.

Much has been accomplished during the past 15 years. Perhaps most important, forestry-related legislation ratified by the Colorado General Assembly has had positive impacts on the health and diversity of Colorado's forests. Many essential forestry-related bills have passed through the State Legislature, enabling community-based forest restoration, providing guidelines and criteria for counties to prepare Community Wildfire Protection Plans, and fostering intergovernmental cooperation. The Colorado Healthy Forests and Vibrant Communities Act of 2009, which still provides resources to the Colorado State Forest Service to address wildfire risk, augment outreach efforts and provide forest treatment solutions, has had particularly significant impacts.

The complexity of forests and forest ownership underscores the need for us all to work together. Bringing a broad range of perspectives, individuals and organizations together, we can best pursue forest management solutions, funding sources and outreach to achieve public support. Collaboratives and partnerships with numerous governmental and non-profit agencies give a wider voice to promote the health of Colorado's forests. Too numerous to mention are many more collaborative groups that allow us to be effective locally, regionally and throughout the state.

Reports on the health of Colorado's forests continue to provide credible, scientifically based information from which to launch a public dialogue regarding the future of our forests. The first edition of the report articulated, regarding our forestlands, that

“we are all accountable for promoting the responsible stewardship of this valuable natural resource.” That remains true today, and although Colorado's forest environments are continually evolving, our commitment to their care and stewardship is constant. Thank you for building on your knowledge and awareness of our forests, so that you too can advocate for their stewardship and the benefits they provide.

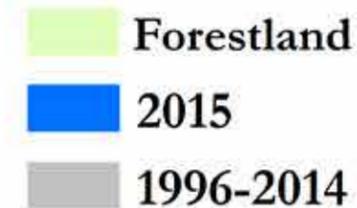
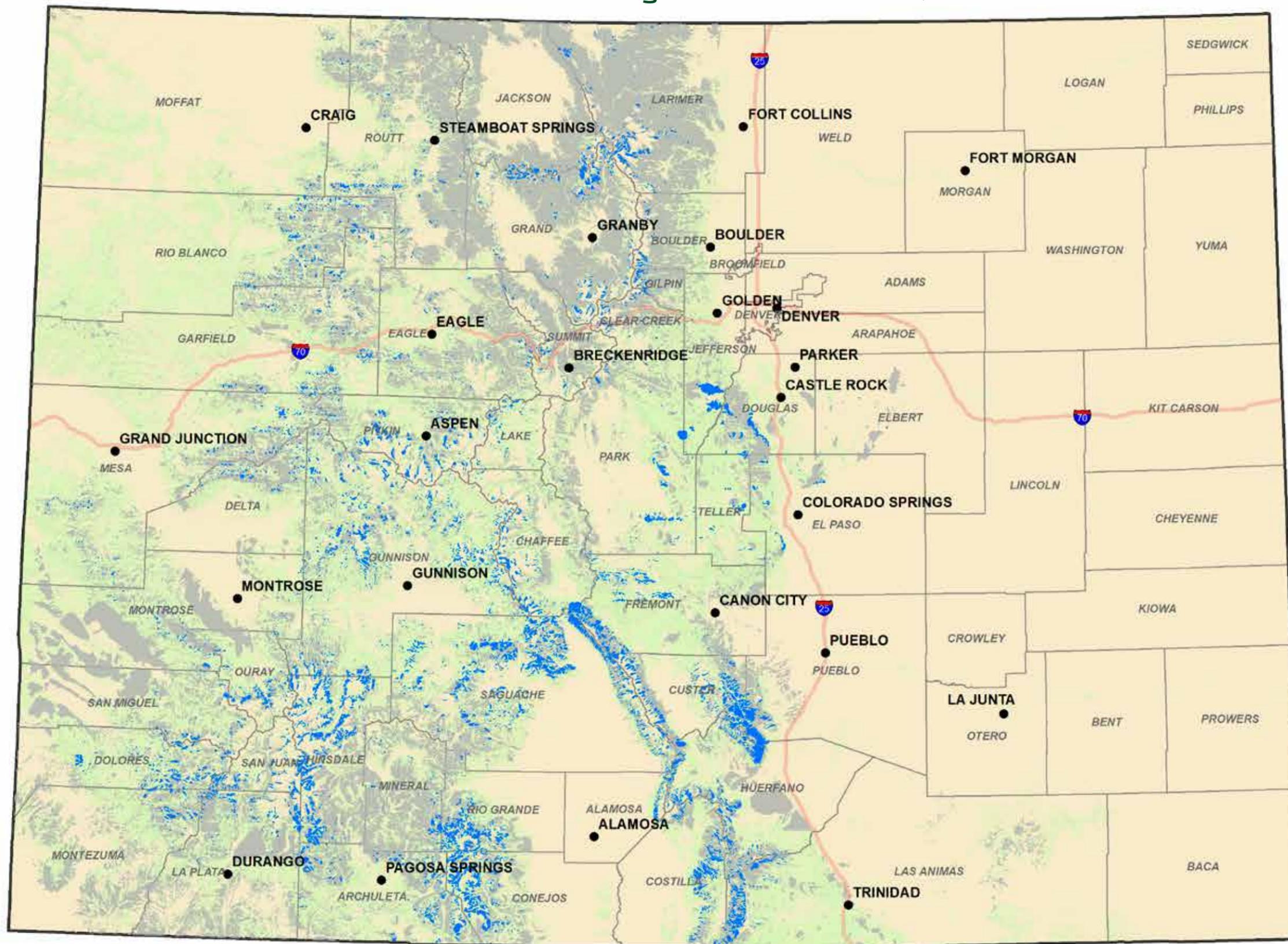
Michael B. Lester
State Forester and Director
Colorado State Forest Service

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Front cover photo: Autumn on the Poudre River, Larimer County. Photo: Nancy Dadisman, CSFS

Forest Insect and Disease Progression in Colorado, 1996-2015



Aerial Survey Data

Due to the nature of aerial surveys, the data on this map only provide rough estimates of location, intensity and the resulting trend information for agents detectable from the air. Some 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 an 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 USDA Forest Service, Region 2 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.

Map created December 2015

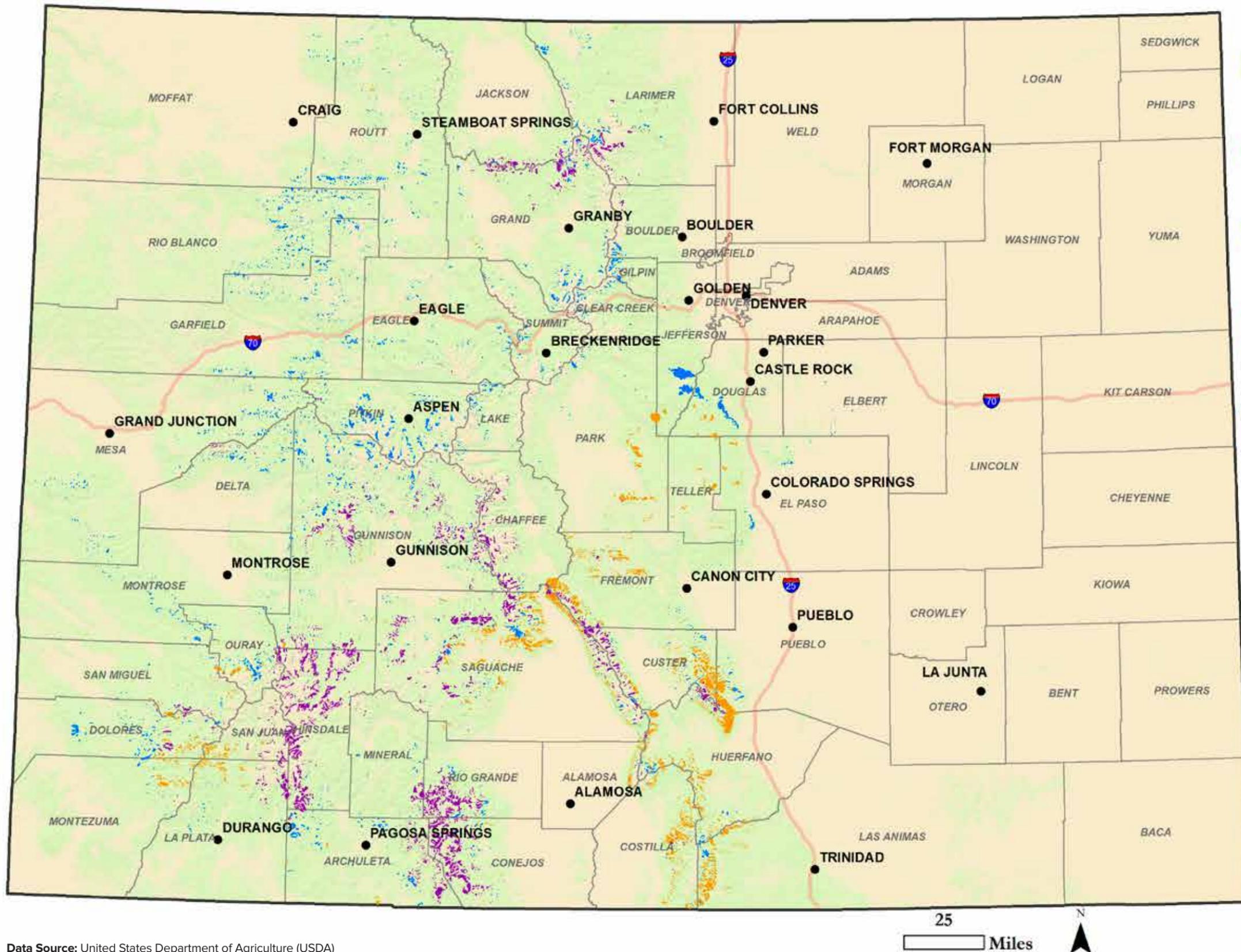
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2015 Insect and Disease Activity in Colorado Forests



- Forestland**
- Spruce Beetle**
409,000 acres
- Western Spruce Budworm**
312,000 acres
- Mountain Pine Beetle**
5,000 acres
- Other Insects and Diseases**
335,000 acres

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Colorado State Forest Service: Caring for Colorado's Forests

The mission of the Colorado State Forest Service is to achieve stewardship of Colorado's diverse forest environments for the benefit of present and future generations.



Headquartered in Fort Collins, the Colorado State Forest Service (CSFS) is a non-regulatory service and outreach agency that provides technical forestry assistance, wildfire mitigation expertise and forest management. The agency is part of the Warner College of Natural Resources at Colorado State University and also provides staffing for the Division of Forestry within the Colorado Department of Natural Resources.

Approximately 105 full-time and 30 seasonal employees provide stewardship of Colorado's forests and serve Coloradans from 19 district and field offices throughout the state. Annually, the CSFS helps treat more than 17,000 acres of forestland, and assists landowners and communities to improve forest health. CSFS accomplishments are made possible by bringing stakeholders together collaboratively to engage everyone in a dialogue on the future of Colorado's forests.

CSFS programs include forest management; insect and disease detection; nursery trees and shrubs for conservation; fuels reduction and wildfire mitigation assistance; invasive species planning and response; wood utilization assistance; and



▲ State Forester Mike Lester and CSFS Grand Junction District Administrative Assistant Sharon Lassiter plant a ponderosa pine. Photo: CSFS

information and education for landowners and communities. The organization also provides forest management and fire mitigation assistance for state lands.

CSFS funding is obtained from the USDA Forest Service, the state general fund and state

service-based revenues, self-generated and other revenues, and severance taxes.

In 2015, the CSFS celebrated its 60th anniversary – providing six decades of timely, relevant forestry information and service.



▲ Aspens showing fall color in southwestern Colorado. Photo: Dan West, CSFS

Executive Summary

The 15th annual report on the health of Colorado's forests, prepared for the Colorado General Assembly, citizens and others, provides credible, scientifically based information to encourage public dialogue regarding the future of our forests. As always, this year's report describes the current condition of Colorado forests. This year the report also reflects on changes and accomplishments since the first report in 2001.

Colorado's 24.4 million acres of forestland offer a reliable source of wood products and provide fresh water, wildlife habitat and many forms of outdoor recreation. They also cleanse the air and remove carbon dioxide from the atmosphere. Besides native forests in the mountains and on the Eastern Plains, trees in urban and community forests offer billions of dollars in benefits. To ensure that these forests

continue to provide numerous benefits, and to minimize wildfire and other risks within them, requires ongoing management. Management results in forests more resilient to insects and disease and other agents of change, and less prone to destructive wildfires.

Landscape-level changes have occurred in forests across Colorado over the past few decades – due to factors including climate and weather phenomenon, insects and diseases, wildfires and human impacts – but much has been accomplished during those years. Of vital importance in facing these challenges has been forestry-related legislation and funding made possible by the Colorado General Assembly, ensuring the health and diversity of our forests.

Regular monitoring for damage caused by forest pests is a key part of forest management. In Colorado, the primary source

of information to monitor forest conditions is the annual aerial forest health survey – a cooperative program of the USDA Forest Service (USFS) and Colorado State Forest Service (CSFS). Aerial surveys provide data that forest managers can use to track trends and take immediate actions against damaging forest pests. Information obtained for this report largely comes from these surveys, supplemented by CSFS field visits and special cooperative surveys with the USFS, Colorado Department of Agriculture, USDA Animal and Plant Health Inspection Service (APHIS) and other agencies.

For the fourth successive year, the aerial survey indicated that Colorado's most widespread and damaging forest insect pest was the spruce beetle. A total of 409,000 acres of active infestation occurred in

high-elevation Engelmann spruce forests throughout the state. Spruce beetle has now impacted more than 1.5 million acres in Colorado over the past two decades.

Mountain pine beetle infestations remained at low levels following the outbreak that impacted more than 3.4 million acres of Colorado forestland from 1996-2013. However, western spruce budworm defoliated 312,000 acres of fir and spruce in central and southern Colorado in 2015. Also, Douglas-fir tussock moth defoliated fir trees on 26,000 acres, in what was the most widespread outbreak of this insect ever recorded in Colorado. Infestations were observed in highly visible areas from Boulder to portions of the South Platte River Basin and Cheyenne Mountain.

Besides a number of other insect and disease agents impacting Colorado's native forests in 2015, the exotic pest emerald ash borer (EAB), which was detected in the City of Boulder in 2013, was confirmed in several new locations within the city limits, though to date has not been detected elsewhere in the state. Colorado must actively plan for this pest's imminent spread. The potential economic impacts of EAB in the Metro Denver area alone could be as high as \$82 million, based on a loss of annual services provided by the canopy cover, and not including potential costs for ash tree removal, treatment and replacement. This pest has the potential to be the most devastating insect Colorado's urban forests have ever seen.

Insect and disease concerns, along with wildfire and human impacts, also can impact Colorado watersheds. Healthy forested watersheds are key to providing clean water, and nearly 64 million people obtain drinking water derived from Western forests. But when forest health declines, so does the quality of the water yield flowing through those forests. The CSFS helps protect water supplies by providing Forestry Best Management Practices (BMPs) that address the risk of nonpoint source pollution. The CSFS also has recently engaged

with organizations that include Denver Water and The Nature Conservancy to launch a coordinated effort to accelerate landscape-scale forest treatments focused on private lands within the South Platte River watershed.

The CSFS helps treat thousands of acres of forestland annually, which is only possible because of diverse funding sources. Colorado's Forest Restoration and Fuels Mitigation grant programs, funded under the authority of the 2009 Healthy Forests and Vibrant Communities Act, are two critical sources of funding. For years, these programs have provided financial assistance to help protect Colorado's forested watersheds and communities from threats such as wildfire. To date, more than \$8 million in funding from these programs, combined with matching funds, has allowed for the treatment of 18,000 acres in Colorado. Funding from the Healthy Forests and Vibrant Communities Act ends in 2017.

Many forest treatments occur in the wildland-urban interface (WUI) – the area where human developments meet with wildland vegetation – in ecosystems adapted to wildfires. Colorado's WUI population grew from 980,000 people in 2000 to more than 2 million people in 2012, and continues to grow. To address wildfire risk in the WUI, the CSFS offers many programs and resources for landowners and communities working to become fire-adapted, including guidance in the development of Community Wildfire Protection Plans (CWPPs), leadership in the Firewise Communities/USA® program and maintenance of the Colorado Wildfire Risk Assessment Portal (CO-WRAP) – an online mapping tool that provides access to wildfire risk information.

Forest management work, whether to address wildfire risk, bark beetles or other forest health concerns, is most effectively accomplished alongside a dependable forest products industry. Creating a demand for Colorado wood incentivizes landowners and

timber harvesters to help land managers meet forestry objectives. Yet more than 90 percent of wood-based products Coloradans use are imported. To help address this concern, the CSFS maintains the Colorado Forest Products™ Program to help increase awareness about the state's wood products industry, and the Forest Business Loan Fund to provide lending capital to forest-based businesses that help improve forest health.

Approximately 90 percent of Coloradans participate in some form of outdoor recreation each year, and 100 percent utilize the air and water coming from our forests. Recognizing the many benefits our forests provide, the Colorado General Assembly has generated more forestry-related legislation in Colorado over the past 15 years than in the previous half-century. While legislative actions will always be vital to meeting the state's needs, everyone has a responsibility to take care of Colorado forests before legislation is ever necessary. By working together, 15 years from now this annual report will describe numerous future accomplishments in Colorado forests.



▲ Aspen leaves in summer. Photo: CSFS

Statewide Insect and Disease Update

While variables such as climate, wildfire and human activity significantly impact forest conditions, the primary factors impacting forest health at a landscape scale are insects and diseases. Forest insects and diseases play an essential part of the natural dynamics of forests. Outbreaks of native bark beetles, for example, kill trees in mature forests, setting the stage for the replacement of old, unhealthy stands with young, vigorous ones. These outbreaks, on the other hand, can damage many of the values that humans place on forests, including forest products, wildlife habitat, recreation and watershed protection.

Because of their fundamental role in influencing forest health, regular monitoring for damage caused by forest pests is a key part of forest management. In Colorado, the primary source of information on forest pest conditions is the annual aerial forest health survey.

This is a cooperative program that involves specialists from the USDA Forest Service, Rocky Mountain Region, and the Colorado State Forest Service (CSFS). Trained aerial observers representing both agencies fly over the state's varied forest types in small, fixed-wing aircraft to map and classify the intensity of the current year's damage. Data on the location, intensity and causes of forest damage are recorded using mapping software and analyzed using geographic information system (GIS) technology. Some areas detected during the aerial survey also are ground-checked to verify the agent responsible for the damage and/or the severity. Aerial forest health surveys provide information that forest managers can use to take immediate action against damaging forest pests.

Another key source of information for this update is field visits made by CSFS foresters, who identify and assess forest pest activity while advising landowners on how to manage their forests. In addition, the CSFS, in cooperation with other agencies including the USDA Forest Service, Colorado Department of Agriculture and USDA Animal and Plant Health Inspection Service (APHIS), is involved in the design and implementation of special surveys to ensure early detection of exotic invasive species that threaten both urban and native forests.

The following sections summarize the status of insect, disease and other observed damage to Colorado's forests – both in natural

and community settings – in 2015. Of note is that the winter preceding these observations produced a reasonably good snowpack, followed by an exceptionally wet spring; May 2015 was the wettest May since weather data have been recorded in Colorado, with some areas receiving more than 15 inches of precipitation. This moisture helped end long-term drought conditions that persisted for several years, especially in the southern part of the state. It also increased tree resistance to attacks from bark beetles and some other pests, while at the same time amplifying the effects of other concerns, such as fungal leaf spot diseases of aspens and cottonwoods.

Indigenous Pests

Conifer Forests

Spruce Beetle

(Dendroctonus rufipennis)

Spruce beetle was the most widespread and destructive forest pest in Colorado for the fourth successive year. In 2015, mortality occurred on 409,000 acres of Colorado's high-elevation Engelmann spruce forests, compared with 485,000 acres in 2014. Although the number of acres impacted by this beetle declined for the first time in seven years, it

continues to expand its footprint by spreading from acres that no longer offer susceptible host trees to new acres not previously impacted. The slight reduction in acreage impacted in 2015 is thought to be a result of spruce forests becoming depleted of suitable host trees.

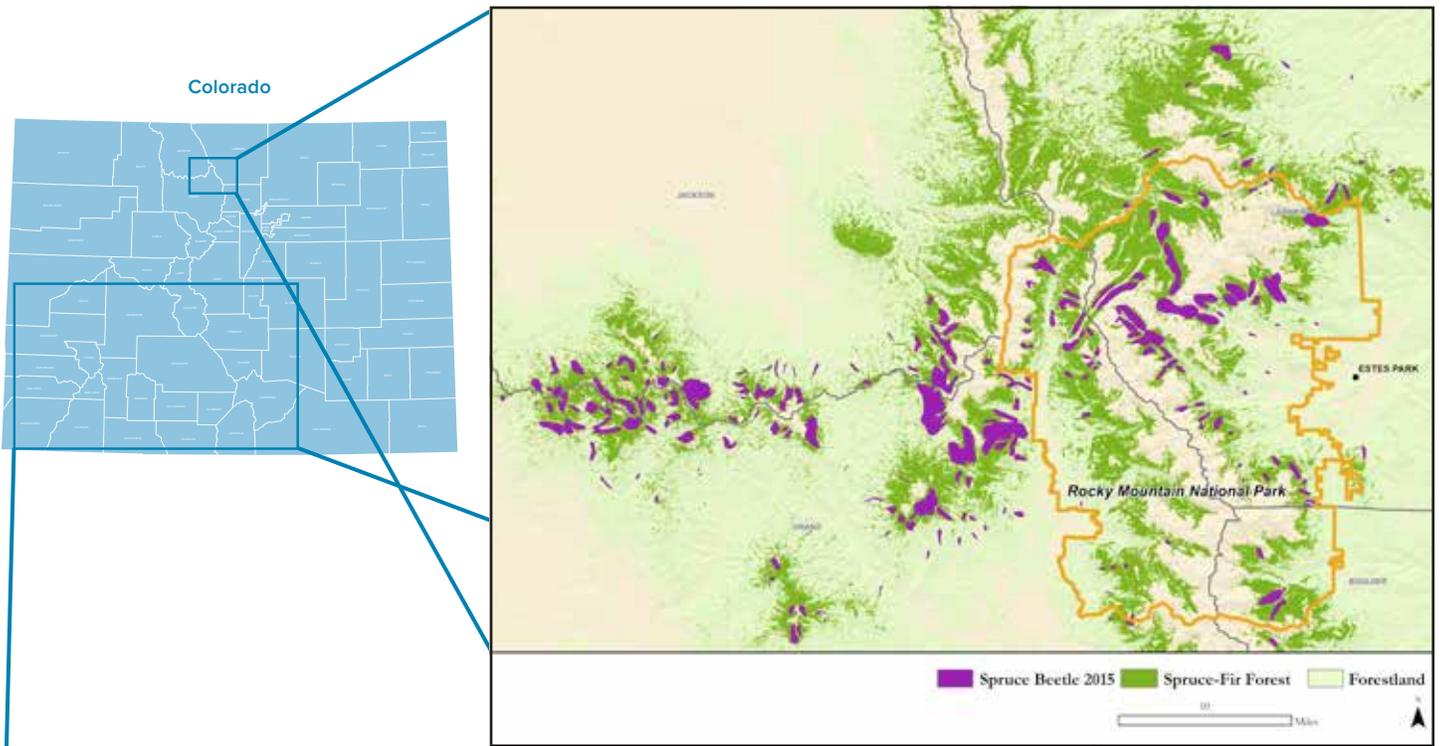
Outbreaks continued in portions of the San Juan Mountains/La Garita Range, Grand Mesa, Sangre de Cristo Range, Wet Mountains and portions of northern Colorado, especially in and around Rocky Mountain National Park. Infestations continued to expand north and east in the lower-elevation hills of Saguache County, and spruce mortality occurred as far north as Monarch Pass in the Sawatch Range. Localized infestations of spruce beetle also were detected in the Culebra Range and at the southern edge of South Park.

As of 2015, a cumulative total of more than 1.5 million acres have been impacted by spruce beetle outbreaks in Colorado since 1996. Extensive forests of pure or nearly pure Engelmann spruce in the southwest part of the state have been decimated by the outbreak, and in many areas even stunted forests of spruce *krummholz* – deformed subalpine trees shaped by freezing winds near timberline – have been killed. These forests now have a gray cast that is visible for many miles.

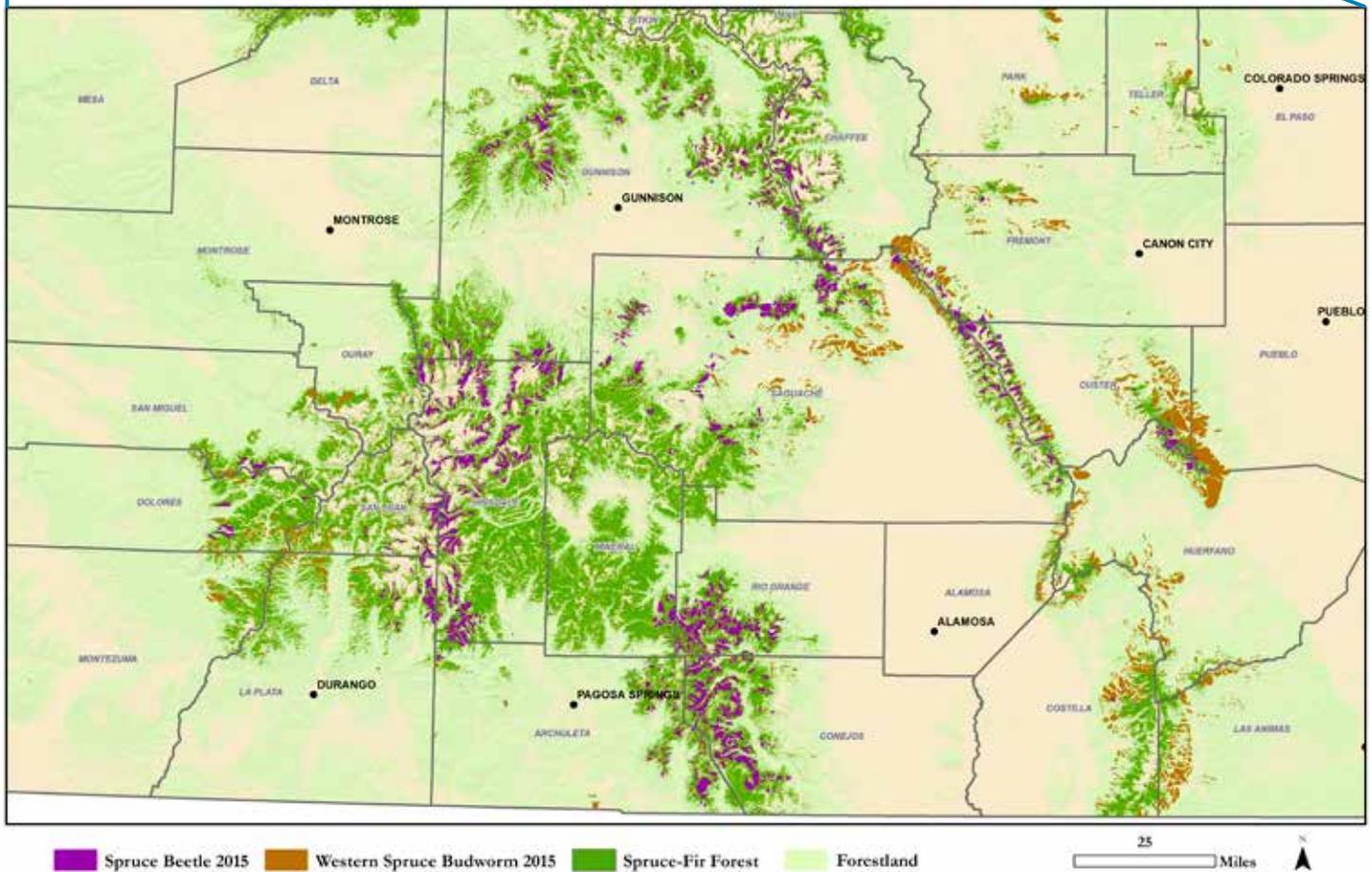


▲ An adult spruce beetle and eggs underneath the bark of an Engelmann spruce tree. Photo: Dan West, CSFS

Spruce Beetle in and Near Rocky Mountain National Park



Spruce Beetle and Western Spruce Budworm in Southern Colorado



Mountain Pine Beetle

(Dendroctonus ponderosae)

A massive mountain pine beetle outbreak, which occurred across much of northern Colorado's lodgepole, ponderosa and limber pine forests primarily from 1996 to 2013 and affected nearly 3.4 million acres, has collapsed. Many of the pine forests impacted by the outbreak, especially in portions of Middle Park and North Park, now have a gray cast due to the large numbers of dead trees.

Some localized activity by mountain pine beetle did occur in the state in 2015, however. Infestations in both ponderosa and limber pines continued at moderate to low levels on the eastern slopes of the Sangre de Cristo Range, and large groups of limber pines were killed in portions of the western slope of the range from the Cottonwood Creek Basin north to Hayden Pass. Mountain pine beetle infestations also occurred on the southern slopes of the San Juan Mountains near Durango, and localized attacks were observed in lodgepole pine stands in the Cochetopa Hills west of Saguache. A total of 5,000 acres of active mountain pine beetle infestation were detected in the state in 2015.

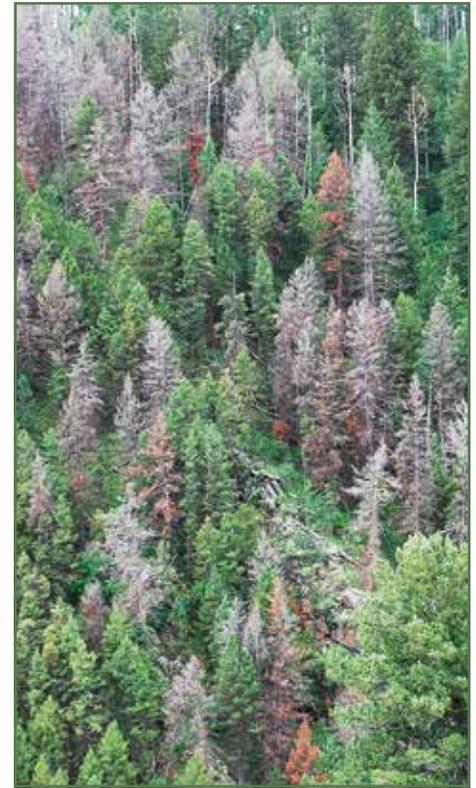
Douglas-fir Beetle

(Dendroctonus pseudotsugae)

Douglas-fir beetle, a close relative of spruce beetle and mountain pine beetle, is a significant pest of mature Douglas-fir forests across most of the West. In 2015, tree mortality attributed to Douglas-fir beetle was mapped on 12,000 acres in Colorado, compared with 34,000 acres in 2014. Active infestations occurred in portions of the Rampart and Sangre de Cristo ranges; through most of the Gunnison Basin in Gunnison, Hinsdale and northern Saguache counties; in and around the communities of Ridgway and Ouray; and on the southern slopes of the San Juan Mountains.

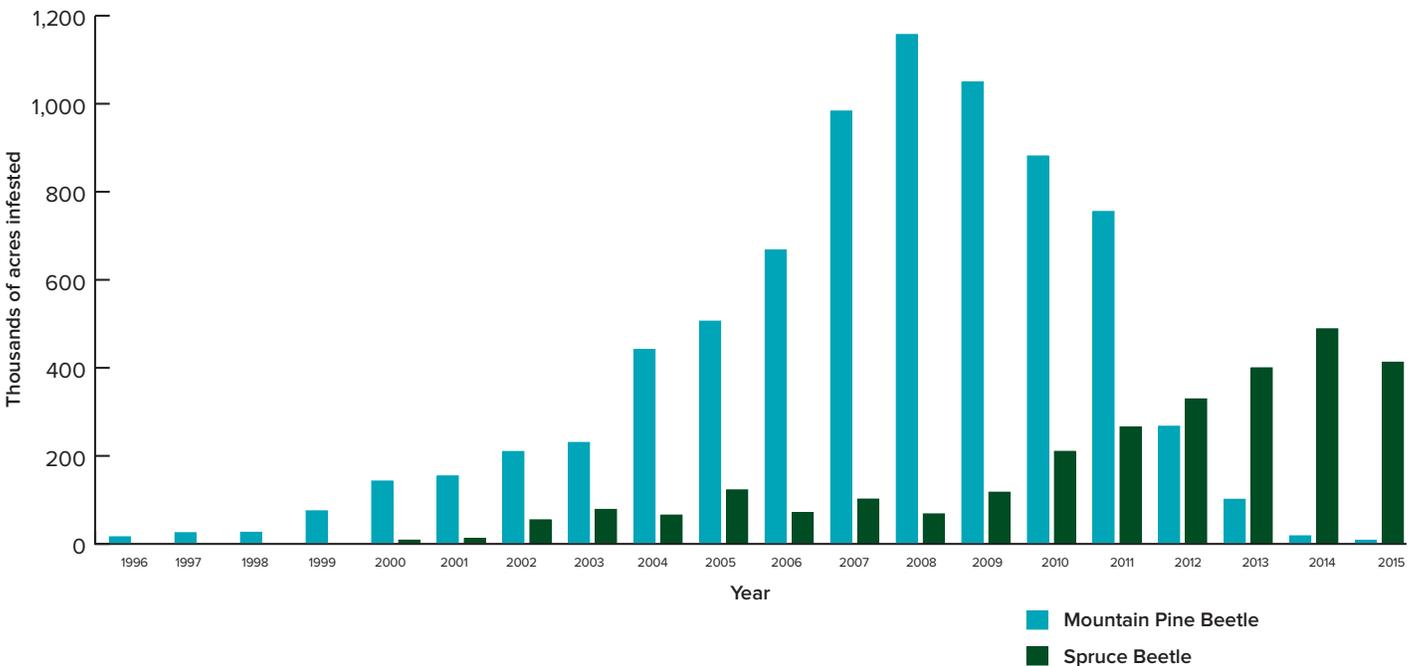
Western Balsam Bark Beetle/ Root Disease Complex

Damage caused by western balsam bark beetle (*Dryocoetes confusus*) and several species of fungi that cause root decay in subalpine fir trees was at lower levels than in past years, but affected 122,000 acres in 2015. Several areas of significant damage occurred, including the basin surrounding Brainard Lake north of Nederland, the upper Ophir Creek Basin in the Wet Mountains, near the Williams



▲ Douglas-fir beetle-killed trees in the Black Canyon of the Gunnison. Dan West, CSFS

Area Infested by Mountain Pine Beetle and Spruce Beetle in Colorado, 1996-2015



Fork of the Colorado River and associated tributaries, and portions of the West Elk Mountains south of Aspen.

Fir Engraver Beetle

(Scolytus ventralis)

Fir engraver beetle continued to cause tree mortality in several areas of southern Colorado where white fir occurs in mixed-conifer forests with Douglas-fir. Aerially visible damage occurred on 19,000 acres in southern Colorado. Areas affected included the eastern slopes of the Culebra Range, especially between North La Veta Pass and Cucharas Pass, and on the eastern slopes of the Sangre de Cristo Range and Wet Mountains. The counties of Ouray and Archuleta were heavily impacted in 2015. An epidemic-level outbreak near Ouray, which has been underway for two years, continued to impact susceptible trees in the area. This beetle is estimated to have now killed 85 percent of the white fir in the Uncompahgre River Gorge around the town of Ouray and in the Cow Creek drainage to the east. Outbreaks that caused significant damage to white fir stands in the Four Mile Creek Basin and Phantom Canyon north of Cañon City in 2014 declined significantly in 2015.



▲ Fir engraver beetles continue to cause tree mortality in white fir trees in southern Colorado. Photo: Dan West, CSFS

Utilizing Beetle-kill to Boost Colorado's Wood Products Industry



▲ Nearly all the mature spruce trees on Wolf Creek Pass have been killed by the spruce beetle. Photo: Dan West, CSFS

Since 1996, spruce beetle populations have caused tree mortality on more than 1.5 million acres in Colorado, and over the past several years this insect has been the state's most widespread forest pest. Many of the challenges Colorado previously faced with mountain pine beetle in lodgepole pine forests are likely to now occur as a consequence of the spruce beetle; these include public safety, protection of transportation and utility infrastructure, and recreational access in forests dominated by standing dead trees.

Colorado's forest products business community is necessary to increase the capacity to harvest, process and manufacture wood products from dead Engelmann spruce trees. Harvesting dead trees achieves immediate benefits in recreation and tourism, wood products manufacturing, employment in our local communities, and competitiveness of Colorado wood products here and in national markets.

But immediacy is crucial to utilizing and recovering product value in these forests, as over time the wood deteriorates to an extent that it can no longer be safely harvested or profitably processed into wood products.

Spruce is a preferred tree type for many wood products, due to its high strength-to-weight ratio. Besides its potential for construction lumber, dead spruce can have significant value in house log and log home construction. Once a leading state for log home construction, Colorado's house log manufacturers have declined from a high of almost 50 businesses to now less than a dozen statewide. The current widespread spruce mortality affords Colorado's log home builders a significant opportunity to rebound.

Billions of dollars have been spent over the past decade in response to Colorado's forest health and wildfire challenges, and these costs can be expected to continue long after bark beetle populations have dropped to normal levels. But with the current spruce beetle outbreak our Western Slope communities have an opportunity to more proactively manage these forests, not just in response to a specific biotic agent, but as a means to achieve more resilient forests across the landscape. The contributions of a viable forest products business community and efficient wood utilization will be necessary to not only mitigate the effects of the spruce beetle, but to make our forests more resilient to future wildfire, insects and diseases.

For more information about wood utilization and marketing efforts in Colorado, go to www.csfs.colostate.edu/cowood.

Western Spruce Budworm

(*Choristoneura freemani*)

This insect has been Colorado's most widespread forest defoliator for a number of years. Larvae of western spruce budworm feed in buds and on new shoots of Douglas-fir, true firs and spruce trees. Approximately 312,000 acres of aerially visible defoliation were mapped in 2015, compared with only 178,000 acres in 2014 and 156,000 acres in 2013. Saguache, Huerfano, Custer, Costilla, Fremont and Las Animas counties experienced the most widespread defoliation.

Damage occurred over portions of the San Juan Mountains, Sangre de Cristo/Culebra ranges, Spanish Peaks and Wet Mountains. Especially heavy damage occurred in Douglas-fir forests in the upper San Luis Valley near Poncha Pass and in the vicinity of Marshall Pass in the Sawatch Range. Defoliation also occurred on Waugh Mountain and Thirty-nine Mile Mountain, at the southern and eastern portions of South Park, respectively, and in the upper Four Mile Creek Basin between the communities of Cripple Creek and Divide. Defoliation also continued for the second successive year in the southern Rampart Range.

Douglas-fir Tussock Moth

(*Orgyia pseudotsugata*)

Douglas-fir tussock moth, a defoliator of Douglas-fir trees, true firs and spruce trees, has cyclic populations, with isolated outbreaks occurring at seven- to 10-year intervals in Colorado. During outbreaks, larvae can strip all the foliage from infested trees and leave them weakened and susceptible to bark beetle attacks. Outbreaks generally last two to three years and then collapse due to a viral disease commonly known as "wilt disease." Human exposure to the larvae and cocoons can cause an itchy skin rash in some individuals, a condition known as "tussockosis."

Outbreaks that began in 2014 expanded significantly in 2015, with approximately 26,000 acres defoliated across three isolated areas. These outbreak areas together comprise the most widespread single-year acreage of Douglas-fir tussock moth infestation ever recorded in Colorado. The largest previous outbreak occurred in 1993-96, when more than 18,000 acres were defoliated in two areas east of Deckers in the South Platte River Basin.

On the eastern slopes of Cheyenne Mountain, near Colorado Springs, an outbreak first detected in 2014 expanded from 300 acres to 1,600 acres in 2015. Outbreaks



▲ Western spruce budworm fed on the new growth of trees on Poncha Pass in 2015. Photo: Dan West, CSFS

also occurred along the eastern edge of the Rampart Range from Dry Gulch, north of Perry Park, south to Butler Canyon, and in the South Platte River Basin, where approximately 24,000 acres of Douglas-fir forests suffered varying intensities of defoliation. Portions of the outbreak in the basin also had large numbers

of western spruce budworm present, and both insects contributed to the defoliation. Affected communities included Buffalo Creek, Ferndale and Foxton. In addition, aerially visible defoliation occurred on just under 200 acres in a forested community west of Boulder, and individual ornamental Colorado blue spruce trees in the City of Colorado Springs also suffered defoliation by this insect.

Pine Sawfly Spp.

An outbreak of the pine sawfly *Neodiprion autumnalis*, which caused severe defoliation on 7,400 acres of ponderosa pine forest in Elbert and northern El Paso counties in 2014, declined in 2015. The reasons for the decline include low rates of egg hatch in some locations; severe temperature fluctuations in November 2014 and May 2015; high larval mortality due to heavy rains at the time of egg hatch; and spraying of insecticides by a number of landowners. Scattered, aerially visible defoliation of approximately 780 acres occurred in pine stands across portions of Elbert County in 2015. Areas of moderate defoliation also occurred northeast of the community of Kiowa and on planted pines in residential areas north of Elizabeth.

Another sawfly, known as the bull pine sawfly (*Zadiprion townsendi*), was locally abundant in the Stove Prairie/Rist Canyon area of Larimer County, west of Fort Collins, in pockets of ponderosa pine that survived the 2012 High Park Fire.



▲ Douglas-fir tussock moth larvae can be identified by four cream-colored tufts with orange-red tops. Photo: Dan West, CSFS



▲ Pine sawfly larvae feed on pine needles, which over time can cause defoliation and even tree death. Photo: Dan West, CSFS

Pine Needle Scale

(*Chionaspis pinifoliae*)

Pine needle scale continued to be the most damaging insect to private lands in Grand County in 2015. Portions of Summit and Eagle counties also had isolated pine needle scale activity affecting both pines and Engelmann spruce. This is a native insect that feeds on the needles of most species of pine, spruce and fir trees, and while periodic needle scale infestations are a common occurrence in Colorado's mountain forests, they typically have minimal impacts and very limited geographic scope. This insect has been active in many areas throughout the Fraser Valley for the past several years, where lodgepole pines of every size and age, from small saplings to mature trees, are heavily infested with the scale. If pine needle scale infestations are heavy enough, and long enough in duration, they can potentially cause tree mortality with no additional insect influence. Assessments conducted in the fall of 2015 indicated the infestation is leveling off, or slightly declining in some areas.

Lodgepole Pine Needle Cast

(*Lophodermella* Spp.)

Lodgepole pine forests in the Taylor River Basin northeast of Gunnison were discolored by a needle cast disease in 2015, causing the older needles to turn red/brown and subsequently prematurely drop off. An epidemic of needle

cast also occurred in this area between 2008 and 2011, then caused by two species of fungi of the genus *Lophodermella*.

Deciduous Forests

Defoliating Insects of Aspen

Two insects, western tent caterpillar (*Malacosoma californicum*) and large aspen tortrix (*Choristoneura conflictana*), can develop into outbreaks and defoliate Colorado's aspen forests. Both species have damaged aspen forests in recent years, and in 2015, approximately 58,000 acres of aspen defoliation occurred in Colorado – a figure similar to those observed in the past few years. Aspen defoliation was mapped statewide, primarily in Archuleta, Saguache, Mesa, Montrose and Ouray counties.

An outbreak of western tent caterpillar that has occurred annually in the North Purgatory River Basin of the Culebra Range since 2006 collapsed in 2015. However, the affected area now has extensive aspen mortality due to successive years of defoliation. Another outbreak of the caterpillar underway since 2012, spanning from the old mining community of Bonanza (Saguache County) north to Poncha and Marshall passes, continued in 2015. Defoliation by large aspen tortrix again occurred in several aspen stands on the eastern slopes of the Wet Mountains.

Leaf Diseases of Aspen and Cottonwoods

Thinning and discoloration of aspen and cottonwood foliage by several species of leaf fungi were common throughout the state in 2015. An unusually wet spring provided ideal environmental conditions for these fungi. Areas of aspen leaf discoloration and early leaf drop, followed by foliage thinning from loss of diseased leaves, were attributed to Marssonina blight, caused by the fungus *Marssonina populi*. Discoloration of the foliage of cottonwoods, caused by a combination of Marssonina blight and Septoria leaf spot disease (due to *Septoria* spp.), was common throughout much of the state. Another leaf disease known as "inkspot," caused by the fungus *Ciborinia whetzeli*, was prevalent on aspen on the Uncompahgre Plateau.

Oak Leafroller

(*Archips semiferanus*)

Defoliation of Gambel oak was detected in several areas in and around La Veta and Cuchara (Huerfano County), including along the Cucharas River, Chaparral Creek and upper Wahatoya Creek, north of the Spanish Peaks, and on the west slope of Big Sheep Mountain, north of La Veta Pass. These stands were defoliated by an insect identified as the oak leafroller.

Thousand Cankers Disease/ Walnut Twig Beetle

Black walnut trees have continued to die off along the Front Range as a result of thousand cankers disease (TCD), caused by a fungus (*Geosmithia morbida*) carried by the walnut twig beetle (*Pityophthorus juglandis*). Two trees were confirmed to have TCD in Fort Morgan in 2014, and the disease has now moved throughout that community, with many more symptomatic trees observed in 2015. Additional specimens of the walnut twig beetle also were collected in the town of Swink, west of La Junta.



▲ Pine needle scale on a lodgepole pine, Grand County. Photo: Dan West, CSFS



▲ Aspens defoliated by an outbreak of western tent caterpillar appear as though they have dropped their leaves. Photo: Dan West, CSFS

Exotic Pests

The introduction and establishment of exotic insects, fungi, diseases and plants threaten forests worldwide. These pests are spread, often by accident, by human activities such as international shipping. Invasive species can cause severe damage in their new habitats, where the native host trees may have little or no resistance to the introduced pest, and natural enemies may not be present in the new habitat that could help keep populations in check. Once established, invasive pests will spread on their own and also can spread over longer distances because of human actions like the transport of firewood, nursery stock and other raw plant materials. Several exotic, invasive insects and diseases pose a threat to both native and urban forests in Colorado.

Emerald Ash Borer

(Agrilus planipennis)

Emerald ash borer (EAB) is an insect native to Asia, introduced into North America sometime during the 1990s. Since its initial discovery in Michigan in 2002, this insect has killed millions of ash trees (*Fraxinus* spp.) throughout the Midwest and eastern United States and Canada. It is now considered the most destructive tree insect ever to be introduced into North America.

Infestations were detected in Colorado for the first time in 2013, in the city of Boulder. An estimated 15 percent or more of the trees in Colorado's urban and community forests are ash, making this insect a major threat statewide.



▲ Adult emerald ash borers are approximately ½-inch long and leave D-shaped exit holes when they emerge from ash trees. Photo: Dan West, CSFS

Surveys to determine the zone of infestation in and near Boulder were initiated in 2013, and subsequent surveys in 2014-2015 targeted ash trees exhibiting symptoms of EAB, such as branch dieback and thin crowns. As of December 2015, EAB is presumed to have infested ash trees throughout the entire City of Boulder, but this insect has not been detected outside of the city limits. Early detection of this pest is difficult, so continued detection efforts in and near Boulder County will remain critical in 2016.

An interagency Colorado EAB Response Team has been organized to coordinate surveys, outreach and pest management activities to slow the spread and reduce the potential impacts of this extremely destructive insect. Agencies and organizations represented on this team include the Colorado State Forest Service, Colorado Department of Agriculture, Boulder County, City of Boulder, Colorado State University Extension, Colorado Tree Coalition, Green Industries of Colorado, University of Colorado and USDA Animal and Plant Health Inspection Service (APHIS).

Representatives of this team have been instrumental in placing and evaluating traps designed to attract flying adult beetles, for early detection of infestations; releasing three species of parasitic wasps that target EAB, to try and help limit future populations of the pest

The Potential Costs of Emerald Ash Borer

With emerald ash borer (EAB) now firmly entrenched in the City of Boulder, entomologists expect this invasive tree pest to naturally spread throughout the northern Front Range and northeast Colorado – and potentially the entire state, due to human transport of infested wood. As EAB leaves thousands of dead ash trees in its wake, how much can communities expect to spend on protecting healthy trees, or removing and replacing those killed by the borer?

Estimates are possible based on Colorado’s ash tree numbers and the calculated benefits of these trees. A 2013 urban tree canopy analysis of 29 Metro Denver communities estimated that 1.45 million ash trees comprise 15 percent of the tree canopy. The study calculated overall environmental and property values of the canopy cover in these communities. The table below illustrates the potential economic impacts of a 15 percent loss in service of the tree canopy cover in the Metro Denver area alone, due to losses of ash trees to EAB:

Potential Economic Impacts of EAB in Metro Denver Area

	Current Annual Benefit	15% Service Loss
CO ₂ storage and avoidance	\$1,722,719	\$258,408
Rainfall interception	\$90,980,000	\$13,647,000
Property values	\$436,500,000	\$65,475,000
Energy saved	\$21,786,677	\$3,268,000
Totals	\$550,989,396	\$82,648,409

The estimate of more than \$82 million in services lost annually doesn’t include even larger potential costs for tree removals (\$300/tree, or \$432 million), tree replacements (\$400/tree, or \$576 million) and additional costs of insecticidal treatments to indefinitely preserve valuable ash trees.

Exotic insect threats, including EAB, are less impactful in areas with higher tree species diversity.

Colorado’s ash trees aren’t just found in Denver. Staggering costs for EAB management will impact communities from the Eastern Plains to the Western Slope. Colorado Springs ash tree treatment and removal costs are estimated to be approximately \$3 million and \$10.5 million, respectively, and the City of Brighton’s recent tree inventory data suggest that EAB could lead to nearly a half-million dollars in removal costs. Also, City of Grand Junction inventory data indicate that ash trees make up 28 percent of the canopy, which could equate to approximately \$144,000 in treatment costs or over \$500,000 in removal costs.

EAB has the potential to be the most devastating insect Colorado’s urban forests have ever seen, vastly overshadowing the state’s bout with deadly Dutch elm disease. Communities are encouraged to plan for EAB now, and protect and manage their ash populations sooner rather than later.

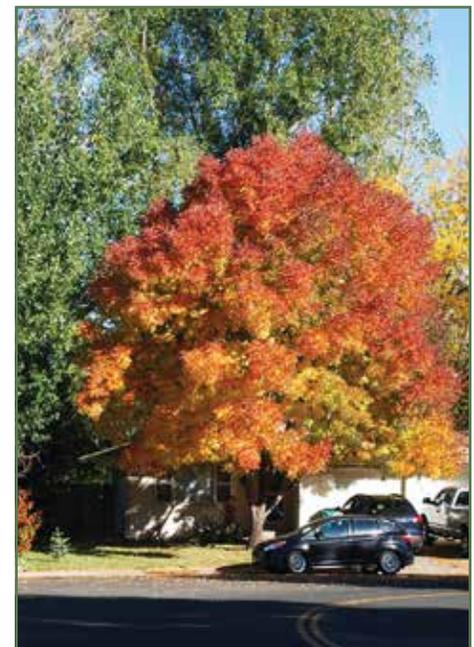
More information about EAB is available at www.eabcolorado.com.

in the state; maintaining a quarantine zone in Boulder County and adjoining areas, to restrict movement of plant material that could house EAB eggs or larvae; and providing up-to-date information on the insect’s status, and the most effective ways to protect trees, to landowners, communities and municipalities.

White Pine Blister Rust

(Cronartium ribicola)

White pine blister rust, caused by the fungus *Cronartium ribicola*, is a disease of five-needle pines – which in Colorado include limber and bristlecone pines. Besides these trees, the fungus requires an alternate plant host, most typically wild gooseberries (*Ribes* spp.), to complete its life cycle. *Cronartium* is native to Asia, but was spread to Europe and North America via infected pine tree nursery stock. Infected trees were first detected in northern Colorado in 1998, and white pine blister rust has since been found in several locations in both limber pine and bristlecone pine in Colorado. In 2014, limber pines infected with the rust were detected in the vicinity of Allenspark, south of Estes Park. In 2015, several additional infected pines were found near this same location.



▲ An estimated 15 percent or more of Colorado’s urban and community trees are ash. Photo: Ryan Lockwood, CSFS

15 Years of Accomplishments

CSFS Continues Decades of Forest Stewardship

The Colorado State Forest Service (CSFS) is the lead state agency providing forest stewardship and wildfire mitigation assistance to private landowners in Colorado, helping treat tens of thousands of acres of forestland annually. These successes, which allow the CSFS to fulfill its ongoing mission to “achieve stewardship of Colorado’s diverse forest environments for the benefit of present and future generations,” are only possible because of diverse funding sources dedicated to providing effective forest management.

Because of its broad perspective on natural resource issues across the state, the CSFS is able to work with a variety of private landowners and state and federal agencies to ensure that land management treatments, large or small, meet the needs of the forested landscape. Treatments to protect forests from insects and diseases or wildfire hazards, when planned at the larger watershed scale, can be much more effective than when addressed as smaller unrelated projects. The land management activities of a landowner with only five acres can have amplified and lasting benefits when combined with similar activities on adjacent lands. Foresters at the CSFS continually facilitate cross-ownership

collaboration on forest management actions to increase the landscape-level impacts.

Over the past 15 years in particular, the CSFS has provided intensified land management assistance on private lands, State Trust Lands and even federal lands – thanks in part to a cross-boundary agreement with the USDA Forest Service (USFS) called the “Good Neighbor Authority.” The USFS and CSFS recently finalized this expanded federal-state partnership to indefinitely enable and increase management efforts on federal lands, through a Master Good Neighbor Agreement signed in November 2015. This made Colorado only the fourth state to finalize the forest management agreement between state and federal forestry agencies. The agreement allows effective sharing of limited resources to mitigate fire risk and improve forest health at a landscape scale.

CSFS services for cross-boundary and other projects include developing management plans to address insect and disease concerns, meet wildlife habitat needs, protect water supplies and achieve other resource objectives, such as noxious weed control. The CSFS provides private landowners and others with necessary technical forestry assistance



▲ Kent Grant, district forester for the CSFS Durango District, takes field data. Photo: Dan West, CSFS

and outreach through workshops, publications, online resources, consultations and site visits.

The Colorado Tree Farm Program is just one example of how the CSFS provides on-the-ground advice to private landowners to help them meet personal goals for their property. A tree farm is a tract of privately owned land that is voluntarily dedicated by its owner to the growing of renewable resources, while protecting environmental benefits and increasing public understanding of sustainable forestry. The Colorado Tree Farm Program is part of the American Tree Farm System, a

Cold Snaps Damage Community Trees on Front Range, Plains

Many tree species along the Front Range and Eastern Plains suffered from a one-two punch of dramatic temperature declines that caused significant mortality and damage in 2015. Both deciduous and evergreen tree species were slow going into dormancy in the fall of 2014, after weeks of unusually mild temperatures. In early November, green leaves were still attached to hardwoods like pear, oak, elm and linden, and excess moisture likely still remained in the needles of some evergreen trees and shrubs.

Then came record-breaking cold, with temperatures in some locations dropping more than 80 degrees F, from highs in the mid-70s to lows around minus 10 degrees, in just a few days. The severe and sudden cold hit trees that had not yet gone dormant, causing damage that impacted their health in the next growing season.

Many of the same trees were hit with another cold snap on Mother’s Day weekend in 2015 – this time during what had been an unusually warm and wet spring. Northeastern Colorado had experienced high levels of precipitation, resulting in abundant early-spring growth; trees that had budded or leafed out prematurely lost most or all of this new growth during the hard freeze.

As a result of the weather extremes, tree death and damage were visible in 2015 from Fort Collins to La Junta. While many of these damaged trees have already died, those that survived the year are likely to persist into 2016.



▲ Even though tree damage remains visible, trees that are still alive will most likely survive the cold snaps of 2014-2015. Photo: Dan West, CSFS

program of the American Forest Foundation. Under this program, CSFS foresters work with landowners of 10 or more forested acres to develop and implement resource management plans. While tree farms must be managed in part to provide sustainable forest products, they also recognize the importance of water, wildlife and recreational resources.

“The dedicated and enthusiastic foresters with the Colorado State Forest Service provide practical, science-based information to help landowners manage their forests effectively,” said Wes Rutt, outreach and education chair for the Colorado Tree Farmers. “But perhaps even more importantly, they provide inspiration and motivation so important for landowners who are often faced with daunting challenges, such as drought, insect infestations and wildfire.”

Other examples of specific services the CSFS provides Colorado landowners include:

- Forest Ag Program planning and inspections
- Timber sale preparation and administration
- Tree selection, planting and care advice
- Sick tree assessment and care guidance
- Invasive species planning and response
- Wildfire defensible space assessments
- Fuels reduction and wood utilization assistance

The CSFS receives funding from a variety of sources to carry out this important work. Nearly 45 percent of the agency’s funding comes through partnerships with the USDA Forest

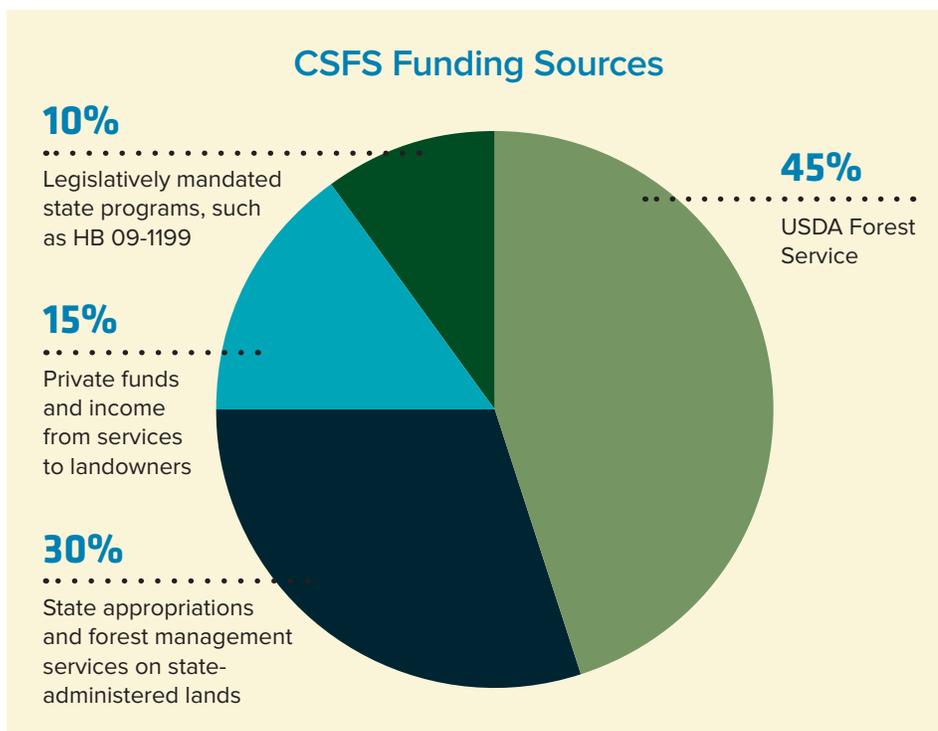


▲ A moose browsing at the Colorado State University Mountain Campus. Photo: Lisa Mason, CSFS

Service via grants to provide assistance to private landowners. Another approximately 30 percent of agency funding comes directly from state appropriations and other state funding for forest management services on state-administered lands, from other state agencies such as Colorado Parks and Wildlife and the Colorado Department of Transportation. A full 10 percent of CSFS funding currently comes from one-time legislatively mandated programs, such as HB 09-1199, the Colorado

Healthy Forests and Vibrant Communities Act of 2009. The remaining funds are mostly private, received for services provided directly to landowners.

Although CSFS funding amounts and sources vary some from year to year, the CSFS has been able to achieve its successes because of a continued recognition by federal agencies, partners, decision-makers, landowners and other concerned citizens of the need for active forest management.



▲ Aaron Rector, CSFS Cañon City District assistant district forester, teaches a Master Volunteer Forest Steward how to measure the height of a tree. Photo: Dan West, CSFS

Protecting Communities, Watersheds with State and Federal Grants

Colorado's Forest Restoration and Fuels Mitigation grant programs are funded under the authority of House Bill 09-1199, the Colorado Healthy Forests and Vibrant Communities Act of 2009. Both programs provide financial assistance to landowners, communities and organizations to help protect Colorado's forested watersheds and communities from threats such as wildfire.

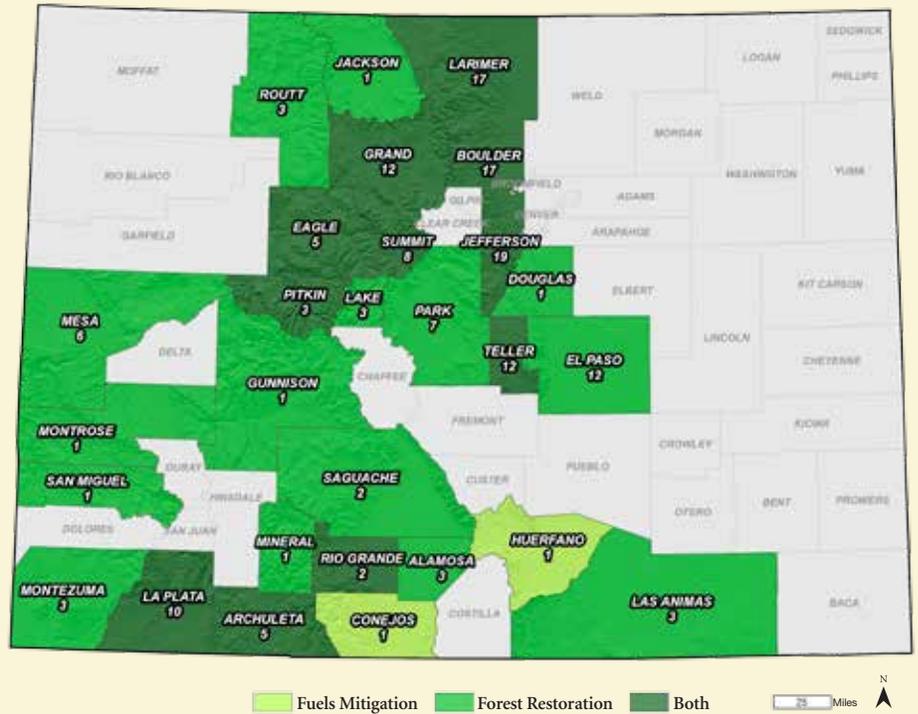
To be considered eligible for funding through these programs, projects must be located in an area with an approved Community Wildfire Protection Plan (CWPP), as well as demonstrate a community-based approach to forest management. Forest management efforts for the Fuels Mitigation Grant Program include forest thinning activities that reduce hazardous fuels, create defensible space around homes and structures, and create fuelbreaks. Projects funded by the Forest Restoration Grant Program focus primarily on protecting water supplies and related infrastructure, chiefly from catastrophic wildfire. Additionally, Forest Restoration Grant projects help to restore ecosystem function in forested watersheds through a range of activities, such as thinning, replanting trees and riparian forest restoration.

The history of the longer-running Forest Restoration Grant Program precedes HB 09-1199, with the authorization of a pilot program through House Bill 07-1130 in 2007 and Senate Bill 08-071 in 2008. Another House Bill in 2012 authorized continued funding for HB 09-1199, including the Forest Restoration Grant Program, through 2018.

To date, the state's Forest Restoration Grant Program has awarded 129 projects more than \$8 million to treat 17,894 acres. Communities and partners have contributed more than \$14 million in matching contributions to accomplish their respective management objectives. As for the Fuels Mitigation Grant Program, more than \$340,000 was awarded to 21 projects to treat 434 acres, with another \$335,000 leveraged by communities and their partners.

In addition to state-funded grant programs, over the past 15 years more than \$27 million in USDA Forest Service grants have leveraged non-federal funds to mitigate wildfire risk, protect people and property, and add to the stewardship of Colorado's forests.

Forest Restoration and Fuels Mitigation Grant Projects in Colorado, 2007-2015



Legislation/Funding Cycle	# of Projects Funded	Total Awarded	Leveraged Match	Acres Treated
CFRPG ¹ HB 07-1130 2007/2008	12	\$977,345	\$1,355,004	3,115
CFRPG SB 08-071 2009	28	\$800,000	\$4,500,000	6,000
CFRPG HB 09-1199 2010	17	\$970,000	\$2,000,000	1,500
CFRPG HB 09-1199 2011	12	\$1,132,825	\$1,188,629	1,482
CFMG ² HB 09-1199 2011	21	\$340,880	\$335,858	434
CFRPG HB 09-1199 2012	17	\$815,365	\$853,442	1,205
CFRG ³ HB 09-1199 2013	15	\$1,084,557	\$1,476,947	2,057
CFRG HB 09-1199 2014	14	\$1,007,467	\$1,554,848	1,130
CFRG HB 09-1199 2015	14	\$1,362,010	\$1,285,902	1,405

¹CFRPG: Colorado Forest Restoration Pilot Grant

²CFMG: Colorado Fuels Mitigation Grant

³CFRG: Colorado Forest Restoration Grant

State Grant Funds in Action: Safeguarding a Southwest Colorado Watershed

Amid the spectacular San Juan Mountains near the headwaters of the San Juan River sits Pagosa Springs, where residents and visitors take time to breathe in the fresh mountain air and appreciate all that the river and forests have to offer. Much of this enjoyment can be attributed to the San Juan Headwaters Forest Health Partnership and its proactive efforts to improve forest resiliency through education and forest management.

The partnership is a place-based collaborative that includes citizens, ecologists, ranchers, educators, forest-related businesses, firefighting and emergency services personnel, homeowners associations, conservationists,

non-profit organizations and representatives from federal, state and county governments. This collective group of stakeholders learns together, raises awareness of important local forest health issues, and applies science-based treatments to sustainably manage the forested watersheds and essential community resources including and surrounding the San Juan River.

Facing the San Juan River just southeast of Pagosa Springs is Reservoir Hill, a site for local festivals and recreation. In addition to being a vital component of Pagosa Springs' economy, Reservoir Hill demonstrates the benefits of sound forest management. In 2014 the partnership, in concert with the Mountain Studies Institute, was awarded Colorado Forest Restoration Grant Program funds to implement 52 acres of forest thinning, some of which are being treated by the Southwest Conservation Corps (SCC).



▲ Homeowners examine the growth rings on a tree cut to improve resilience and forest health. Photo: CSFS

The SCC also was contracted to help implement the Four Mile Forest Collaborative Project northwest of Pagosa Springs, which was awarded Forest Restoration Grant funds in 2013. The SCC is part of the Colorado Youth Conservation Corps (CYCC), which provides a unique opportunity for young adults to learn about how active forest management enhances public benefits from trees and forests, including clean air and water, and to help protect forests from threats such as insects and wildfire.

The San Juan Headwaters partnership embodies the essence of what it means to unite and support each other by leveraging resources to make a greater impact on the landscape. As a result, the partnership received additional funds through the Healthy Forests and Vibrant Communities Act to promote awareness about the need to reduce wildfire risk in the community, as well as USDA Chiefs' Joint Landscape Restoration funds and other federal funds, to extend the network of forest treatments across the landscape in the Four Mile area, northwest of Pagosa Springs. As a result, more than 500 acres have been treated across both project areas on private, federal and city-owned lands. Additionally, both projects utilized small-diameter woody material to support a local biomass facility operated by Renewable Forest Energy.

Leveraged resources in these projects also include teachers and students. For example, AP science students were trained to conduct monitoring of the project areas before and after treatments to help validate forest ecosystem benefits and inform future treatments.

As the Pagosa Springs community continues to work and learn together, its members will enhance the efficacy of treatments strategically placed to directly protect water resources and infrastructure.

Why Do We Need Forest Management?

Ongoing management ensures that Colorado forests continue to provide numerous benefits, and minimizes catastrophic wildfires and other risks. Many forested areas, such as Wilderness Areas, have been set aside to allow only natural processes to occur. But in other areas, active management ensures that from a broad perspective our forests are more resilient when facing insects and disease and other agents of change, and less prone to destructive wildfires. Forest management, based in science, promotes forest health and resiliency; mitigates wildfire risk; identifies and enables benefits and other outputs of highest priority; and establishes the measures needed to attain forest stewardship objectives.



▲ This ponderosa pine forest has been thinned, reducing competition between trees and making them more resilient to wildfire, insects and diseases. Photo: CSFS

Making a Difference in a Growing Wildland-Urban Interface

Many Coloradans live in the wildland-urban interface (WUI) – the area where human developments meet or intermingle with wildland vegetation. These ecosystems are adapted to naturally occurring wildfires, but the people living in them may not be. Now more than ever, WUI residents need to take actions that will help them be prepared for wildfires. Because for those living in the WUI, it is not a matter of *if* a wildfire will occur, but *when*.

The Challenges

Colorado's WUI population has grown from 980,000 people and 6.3 million acres in 2000 to more than 2 million people and over 6.6 million acres in 2012; thus the WUI area hasn't changed significantly, but the population within it has doubled. Also, a 2007 research

study by Theobald and Romme projected Colorado's WUI area to increase by 300 percent from 2000 to 2030.

On top of a growing WUI, wildfires are now bigger, burning longer, costing more to suppress, causing more damage, and threatening more lives than ever before. The length of the annual wildfire season in the United States has actually increased by more than two months since the 1970s. Other long-term impacts and costs from WUI wildfires include post-fire flooding and erosion, air and water quality damages, healthcare costs, lost revenues to local businesses, and infrastructure shutdowns (such as highways, airports and railroads).

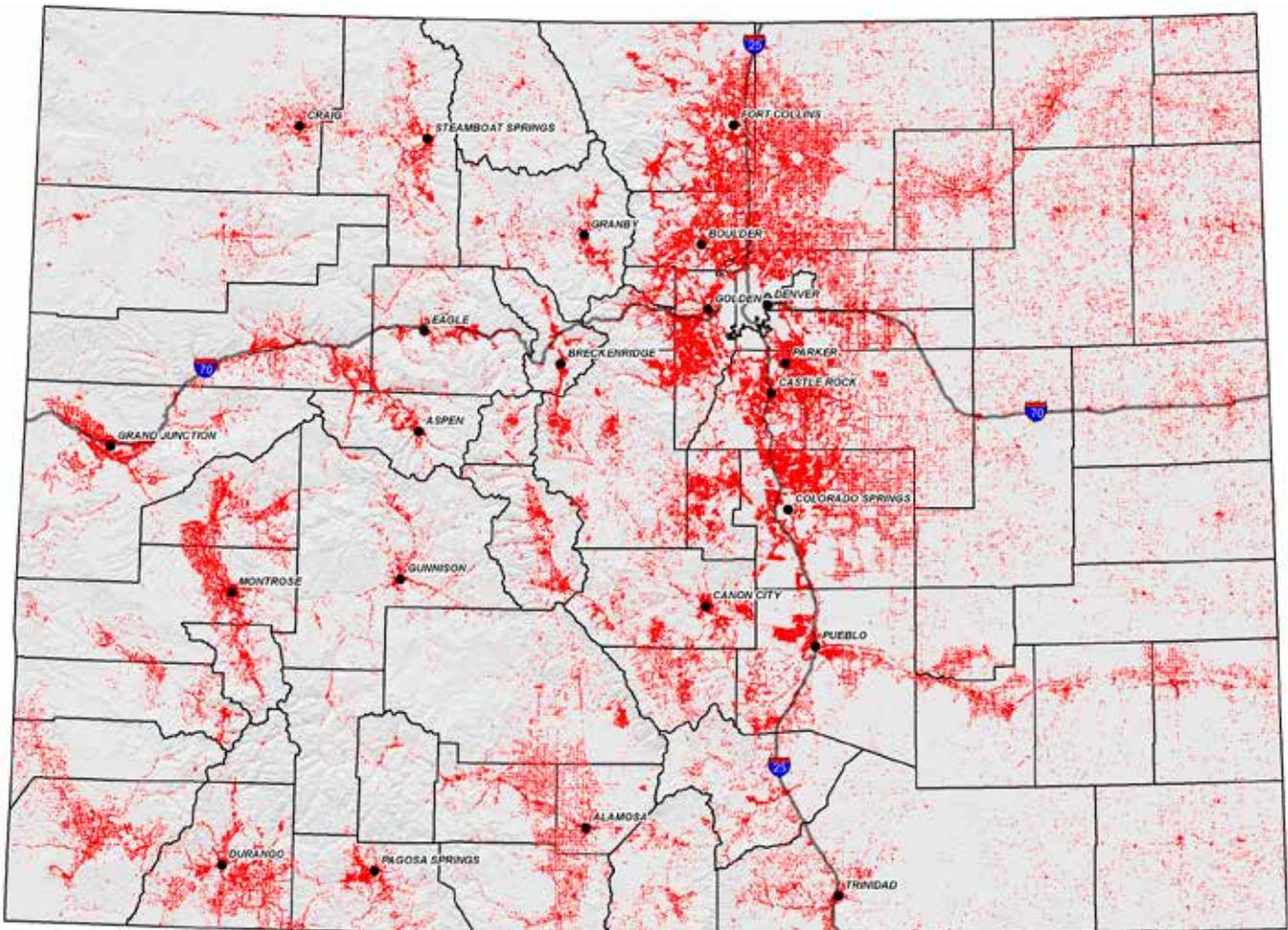
A recent study by Headwaters Economics found that only 16 percent of the WUI in the West is now developed, with Colorado's WUI only 20 percent developed. If the remaining WUI land becomes populated without considering the risks of wildfire, this will have serious implications on future firefighting costs.

"There's a lot we can do to help communities plan for wildfire," says Ray Rasker, executive director of Headwaters Economics, a nonprofit research group working to improve land management decisions in the West. "Planning does not mean telling people what not to do. Good planning means permitting subdivisions with conditions attached, so that they are safer and defensible from wildfire."

The Solutions

The Colorado State Forest Service (CSFS) offers many programs and resources for landowners and communities working to become fire-adapted. A Fire Adapted Community® assumes responsibility for its wildfire risk and takes appropriate actions. These communities consider people, developments, businesses, infrastructure, cultural resources and natural resources in planning efforts to prepare for the effects of wildfire. Actions residents take not only reduce

Colorado's 6.6 Million-Acre Wildland Urban Interface, 2012



*Data from the Colorado Wildfire Risk Assessment



▲ The aftermath of the West Fork Complex, a combination of three different wildfires near Pagosa Springs and South Fork in 2013. Photo: Lisa Mason, CSFS



▲ Firewise of Southwest Colorado worked with residents of Montezuma County to chip and remove slash generated from mitigation efforts to reduce the community's wildfire risk in 2015. Photo: Rebecca Samulski, Firewise of Southwest Colorado

their wildfire risk, but also increase forest health through sound forest management practices.

A primary goal of the state's 2010 Forest Action Plan was to "protect forests from harm." This goal included encouraging the creation of fire-adapted communities through the implementation of forest management to increase forest resiliency. Programs and resources offered by the CSFS to assist landowners and communities to become fire-adapted include:

- technical assistance and education for landowners
- on-the-ground implementation of fuels reduction projects
- guidance in the development and implementation of Community Wildfire Protection Plans (CWPPs)
- Firewise Communities/USA® assistance
- the Colorado Wildfire Risk Assessment Portal (CO-WRAP), which is an online mapping tool that provides access to wildfire risk assessment information
- assistance helping landowners meet the requirements for a wildfire mitigation measures tax subtraction of up to \$2,500
- a Natural Resources Grants and Assistance Database
- publications on how to reduce wildfire risk

The CSFS provides the minimum standards for CWPPs, which bring together diverse local interests to discuss mutual concerns for public safety, community sustainability and natural resources. Colorado Senate Bill 09-001 required all counties to identify wildfire hazard areas in unincorporated areas by Jan. 1, 2011, leading to the development of county-wide CWPPs. Currently 47 counties in Colorado have a county-wide CWPP; there also are smaller-scale CWPPs for fire protection districts and subdivisions or homeowners associations. Colorado has a total of 228 CWPPs, all of which can be found on the CSFS website.

The CSFS also is the state liaison for the Firewise Communities/USA national recognition program. The program provides instructional resources to inform homeowners how to adapt to living with wildfire, and encourages neighbors to work together and take action to reduce their wildfire risk. Colorado currently has a total of 128 Firewise Communities/USA, ranking second in the nation.

"This is an opportunity to get it right," says Rasker. "[Planning for wildfire] is not an unsolvable problem."

Partnerships to Protect the Upper South Platte Ongoing Since 1998

The Upper South Platte watershed is of critical importance in Colorado because it transmits nearly 80 percent of the water used by millions of residents in the Metro Denver area. Unfortunately, the watershed also faces a relatively high risk to uncharacteristically large and damaging wildfires, such as the 1996 Buffalo Creek Fire and 2002 Hayman Fire. Wildfires of this nature result in devastating post-fire flooding, erosion and debris-flow events, along with many other negative impacts to people, water and wildlife.

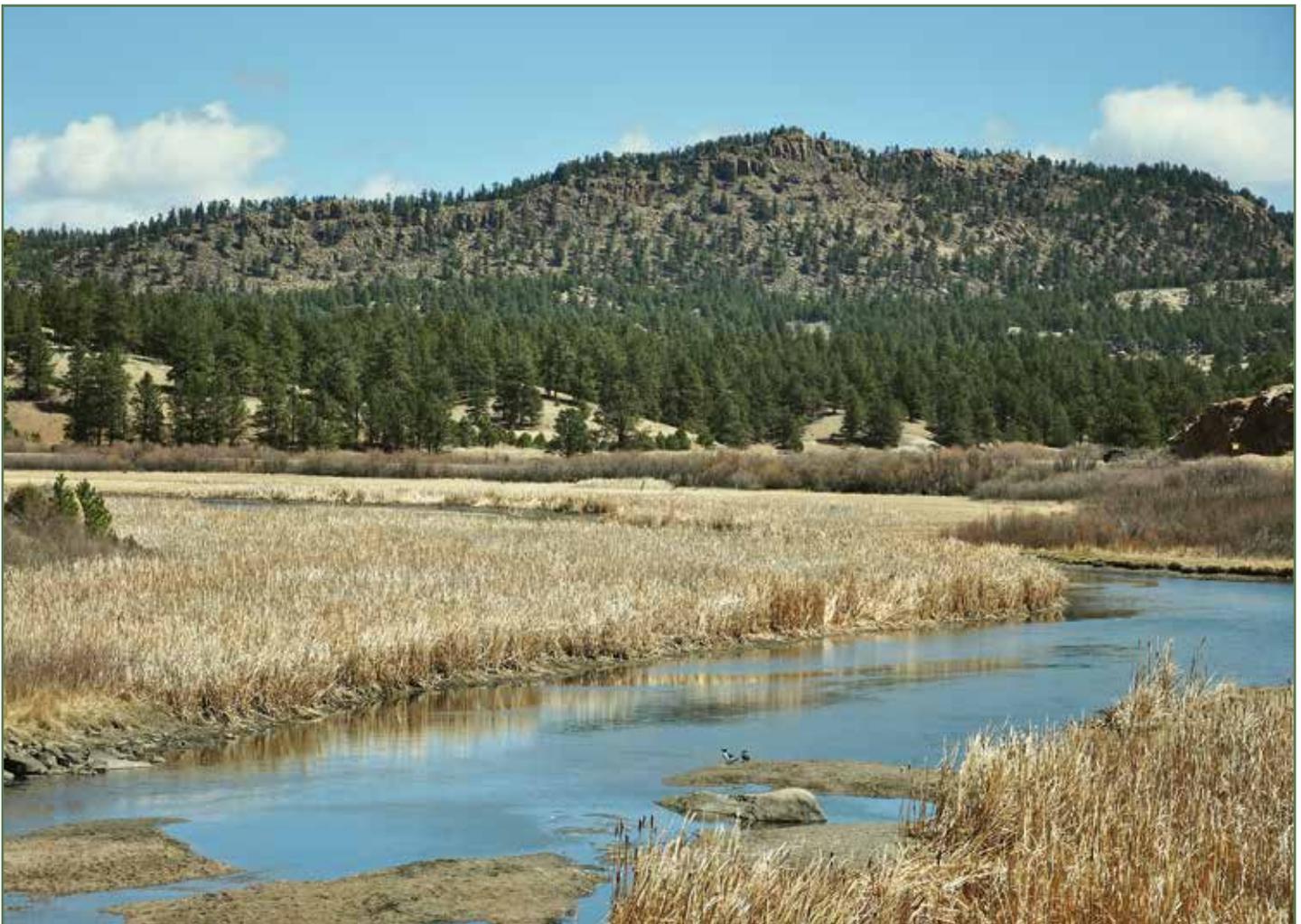
To address this concern, in 1998 the Colorado State Forest Service (CSFS), Denver Water, USDA Forest Service (USFS) and other partners first launched a focused treatment effort to improve forest conditions and

reduce wildfire risks in the Upper South Platte drainage, primarily on federal lands. Additional treatments have occurred over the years on both federal and non-federal lands in the watershed, particularly through the financial support of Denver Water and through the Front Range Fuels Treatment Partnership. The result: over 40,000 acres of on-the-ground treatments. These include forest management activities on Denver Water lands managed by the CSFS, and on federal lands managed by the USFS.

In late 2014, Denver Water and The Nature Conservancy (TNC) brought forward new funding to initiate a collaborative, landscape-scale forest management effort focused on accelerating strategic forest treatments within the watershed, with emphasis on non-federal lands. Additional matching funds and other resources were soon brought to the table by a number of other partners, resulting in the formation of the Upper South Platte Partnership

(USPP) which currently includes Denver Water, TNC, American Forest Foundation, CSFS, USFS, Coalition for the Upper South Platte, Colorado Forest Restoration Institute at Colorado State University, Jefferson Conservation District, Natural Resources Conservation Service (NRCS) and the CSU Center for Managing WUI Wildfire Risk. Included among these matching investments were funds from state grant programs, highlighting the importance of these dollars to act as seed funding that stimulates additional private, non-profit and federal investment.

In early 2015, the USPP began using new data, modeling and spatial analysis tools, combined with local knowledge, to identify areas across the watershed where forest management can most effectively contribute to watershed and wildfire risk-reduction objectives. The partnership plans to collectively design, implement and monitor



▲ Forest management in the Upper South Platte watershed helps protect the water supply from wildfire. Photo: CSFS

Forest Business Loan Fund Helps Prevent Soil Erosion

The Forest Business Loan Fund, administered by the CSFS's Colorado Wood Utilization and Marketing Program (CoWood) and established by Colorado House Bill 09-1199, provides lending capital to businesses that "harvest, remove, use and market beetle-killed and other timber taken from private, federal, state, county or municipal forestlands as part of wildfire risk reduction or fuels mitigation treatment." The fund helps retain forest-based businesses, maintain local jobs, contribute to the stability of local economies, and improve the health of Colorado's forestlands.

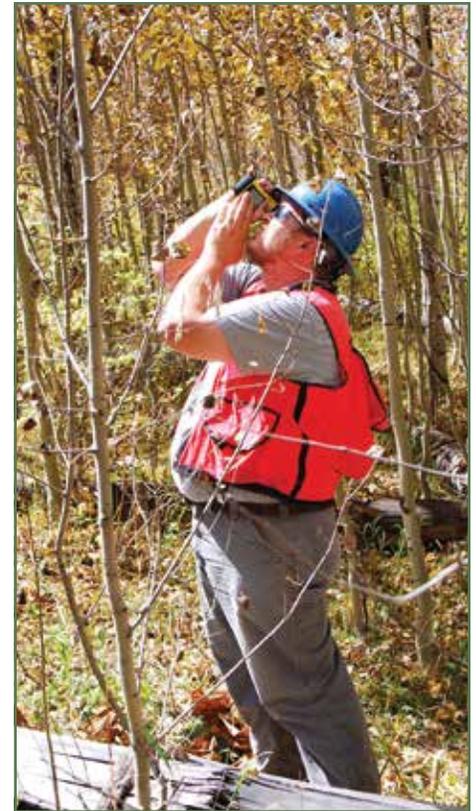
Thanks to financial support from the HB 09-1199 Business Loan Fund and the ShadeFund – a national loan program of The Conservation Fund – Mountain Pine Manufacturing, Inc., is turning beetle-kill pine into an environmentally friendly, cost-effective erosion mitigation product. The venture also provides jobs in Routt County, and helps reduce wildfire risk through the removal of standing dead fuel.

"The Forest Business Loan Fund was the core financing arrangement behind our startup company and is the reason we have a successful WoodStraw® Erosion Control Mulch production facility in the Rocky Mountain Region today," said Trent Jones, controller for Mountain Pine Manufacturing.

Since 2012, WoodStraw® produced by the company has been used throughout the West for rehabilitation of wildfire burn scars, abandoned mine lands, roadwork, and oil and gas pads, and also for river restoration and wetlands habitat.



▲ Land rehabilitated using WoodStraw® from beetle-killed trees, Rabbit Ears Pass, Routt County. Photo: Trent Jones



▲ Ryan Cox, forester on the CSFS Durango District, measures the height of an aspen tree. Photo: Dan West, CSFS

forest management projects that result in a cumulative treatment footprint large enough to influence future fire behavior, and reduce the potential for detrimental impacts to the watershed.

The USPP could potentially become a model for other organizations to work together to protect communities and water supplies. The partnership has even been recognized by the USFS as one of only a handful of pilot projects across the nation integrated in the agency's new Cohesive Wildland Fire Strategy – bringing the USPP additional federal funding to expand its efforts.

"The USPP is really excited about this new funding," said Paige Lewis, deputy state director/director of conservation for The Nature Conservancy in Colorado. "It will allow us to reach out to local officials, emergency responders, businesses and others to foster the development of fire-adapted communities that can work in concert with fire-adapted landscapes to safely and effectively co-exist with fire."

Forest Management: Essential for Healthy Forests

Colorado's 24.4 million acres of forestland offer a reliable source of wood products and provide fresh water, wildlife habitat and many forms of outdoor recreation. They also cleanse the air and remove climate-altering carbon dioxide from the atmosphere. Whether in the mountains or on the plains, our forests provide an essential escape for urban residents and out-of-state visitors. Tourism is a \$17.3 billion industry in Colorado, with opportunities that include hiking, camping, wildlife viewing, snowboarding and snow skiing – which is alone a \$2.2 billion industry in our state – and harvest-based activities like hunting and fishing. These same forests also provide habitat for elk, moose, black bears, lynx, raptors and countless other wildlife species.

With its broad assortment of coniferous and broadleaf tree and shrub species, Colorado's forested landscape is one of the most complex of any in the Intermountain West. The basis for this diversity is a rugged landscape that ranges from high plains and plateaus to 14,000-foot peaks, narrow canyons and rolling foothills. Besides our native forests, millions of invaluable shade and ornamental trees offer billions of dollars in benefits in urban and community settings.

The state's diverse forests span across multiple ownerships, with approximately 68 percent managed by federal agencies including the USDA Forest Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs and Department of Defense. Another 30 percent of the state's forestland is privately owned, with the remaining 2 percent located chiefly on municipal and state lands. Because of this mosaic of ownerships and jurisdictions, everyone from land managers to private landowners to industry professionals and non-governmental organizations plays a critical role in helping achieve healthy forests.

How Colorado Forests Are Managed

The first step to successful forest management is understanding the current state of our forests. Quantifying forest conditions, including the insects and diseases impacting them, helps foresters identify the potential benefits of a stand or other forested area, and the best way to mitigate threats to it. Two programs managed in Colorado through collaborations between the Rocky Mountain Region of the USDA Forest



▲ Aspen trees, like many of Colorado's native trees, are adapted to thrive after wildfire or other major disturbance. Photo: Bill Cotton, Colorado State University

Service and the Colorado State Forest Service (CSFS) allow land managers to capture current forest conditions at a broad scale. The annual aerial forest health survey and Forest Inventory and Analysis (FIA) programs, along with on-the-ground observations of field foresters, make it possible to also effectively monitor long-term forest conditions and track agents of change over time.

Forested areas have the potential to provide multiple benefits. While some forests in Colorado are managed primarily for products, many are best suited for a focus on multiple-use recreation, wildlife habitat, water yields or other ecological or social benefits. Additionally, wilderness and roadless areas exist on some federal lands to protect and preserve remote, uninhabited areas and minimize human impacts.

Despite millions of acres of Colorado wilderness being intentionally off limits to timber harvesting or other forest management, a large percentage of our state's forestlands remains available for active management. Colorado's 2010 Forest Action Plan identified 5.5 million acres of forestlands best suited to management, with a high to very high potential for proactive efforts to mitigate damage from forest insects, diseases and wildfires. The management method most often used to achieve these goals is selective stand thinning to reduce individual tree stress

and competition within the stand. Other management options may include patch cutting, clear-cutting or forest restoration activities, depending on the forest type and primary objectives.

Each forest type, from ponderosa pine to subalpine spruce-fir to plains riparian, possesses unique characteristics that include where its dominant tree species will grow, the plants and animals likely to inhabit it, and

Colorado's Wood Products Industry: By the Numbers

- **90+:** Percentage of wood-based products Coloradans use that are imported from out of state.
 - **\$4 billion:** Estimated amount that Coloradans spend on wood products each year.
 - **5.5 million:** Acres of forestland in Colorado with high to very high potential for the proactive use of forest management.
 - **75:** Percentage of total wood used in Colorado for the housing and construction industry.
-

how it will respond to major disturbances like wildland fire or insect epidemics. Because of this, different forest management techniques are applied in different forest types.

For example, both lodgepole pine and quaking aspen prefer abundant sunshine; are thin-barked and prone to fire, insect or disease damage; inhabit similar elevation ranges in Colorado; and as pioneer species are adapted to rapid regrowth after a wildfire or major disturbance. Thus the best management option to ensure the health of these species is similar – clear-cutting of mature, even-aged stands in patches across the landscape. This method mimics the loss of entire stands to major natural disturbances and sets the stage for a healthy new generation of trees. On the other hand, ponderosa pines grow at lower elevations and have relatively thick bark and deep roots, making them ideal for coping with dryer conditions and frequent, low-intensity fires. They usually grow in uneven-aged stands, and the best management option for this forest type is selective tree harvesting, or forest thinning.

Forest management is also a good way to reduce wildfire risk to people, property and ecosystems. Wildland fire is a necessary and natural process in Colorado's forest environments, but decades of fire suppression have altered historic fire cycles in some areas. The result: many Colorado forestlands have become unhealthy and overly dense, especially near human development. These forests are now prone to large-scale insect and disease outbreaks that cause a high degree of tree mortality and, regardless of whether they contain large swaths of insect-killed trees, can set the stage for devastating wildfires due to the higher fuel loads.

Having a dependable forest products industry is essential to the state's long-term forest management efforts.

Forest management work, including thinning or otherwise harvesting trees to reduce fuel loads and create fuelbreaks, can alter fire behavior. Less fuel means that if a fire starts, it will generally spread more slowly and burn at a reduced intensity, making it more manageable for firefighters.

Having a dependable forest products industry is essential to the state's long-term forest management efforts. Creating a demand for Colorado wood incentivizes landowners



▲ Harvesting trees is a forest management strategy to reduce fuel loads, increase forest resiliency and enhance the economy through the wood products industry. Photo: CSFS

and logging professionals to help land managers meet forestry objectives. The wood products yielded from our forests are diverse, and include sawlogs, landscape timbers, posts and poles for fencing, construction-grade lumber, wood mulch and pellet-stove fuel. Having a sustainable forest products industry:

- reduces forest treatment costs through revenues from timber sales
- increases forest resiliency through improving age-class diversity
- provides necessary wood products
- enables land management treatments to improve wildlife habitat
- contributes to local economies

To promote Colorado's wood products industry, the CSFS maintains the Colorado Forest Products™ Program – a companion campaign to Colorado Proud™ – to increase awareness about our forests and the wood products industry by promoting the use of Colorado wood, encouraging the

development of businesses dedicated to its use, and educating Colorado citizens about the economic, environmental and social consequences that imported wood has on our state's economy. For more information, go to www.csfs.colostate.edu/cowood.



Healthy Forests for Clean Water

Water is arguably the most critical resource in the western United States – where the importance of clean, sustainable supplies for people and the environment cannot be overstated. Promoting healthy watersheds and water supplies is vital to ecosystem health and to providing the resources essential for human health, fisheries, agricultural production, industry, recreation and energy providers. And with 19 states deriving their water supply from the headwaters of seven major river systems in Colorado, our state is in essence the nation's water tower.

Healthy forested watersheds are key to providing this clean water. Nearly 64 million people in the West obtain drinking water derived from Western forests – those both publicly and privately owned. Forests naturally filter and store precipitation from rain and snow, keeping runoff water clear and regulating stream flow. But when forest health

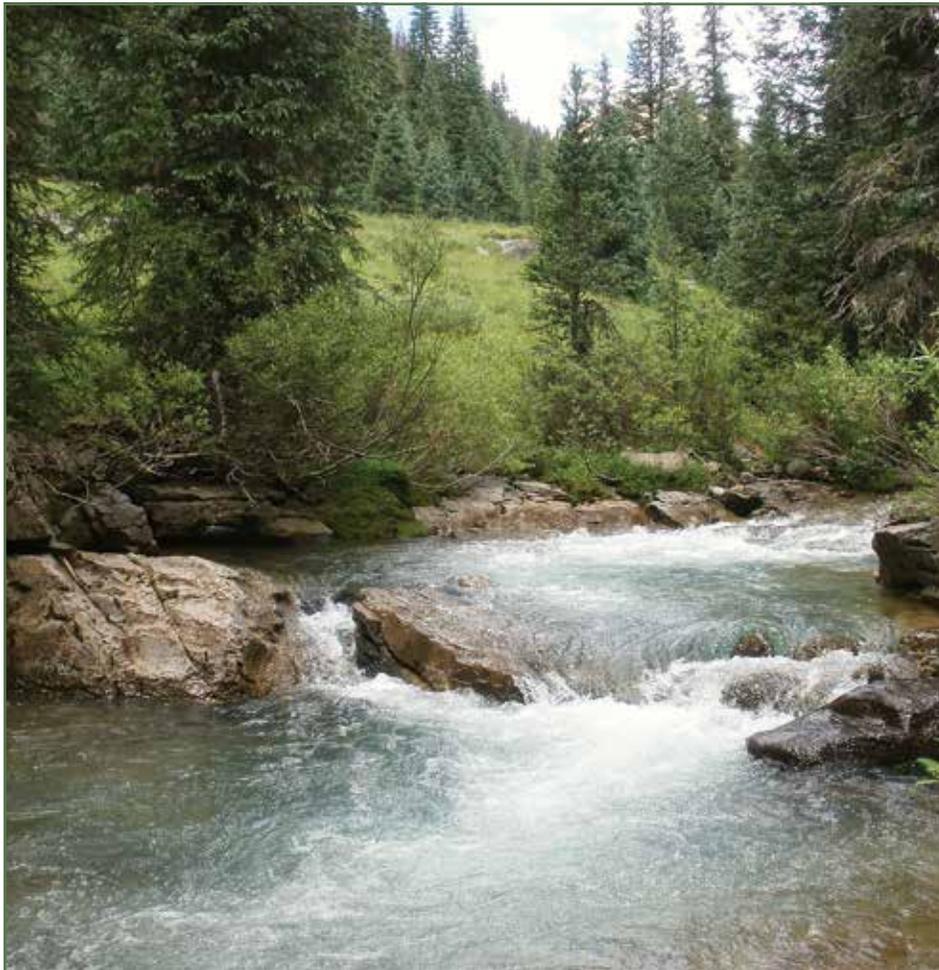
declines, so does the quality of the water yield flowing through those forests.

In Colorado, many forests have become unhealthy and overly dense, setting the stage for exceptionally large, intense wildfires. These fires significantly increase risks for dangerous flooding, extreme erosion and heavy sediment loads that endanger life, damage property, degrade water quality and reduce water storage capacity. They also can alter seasonal flow regimes, and post-fire rainstorms can introduce ash, sediment and other matter into streams, degrading water quality.

Besides the threat of wildfires, Colorado water supplies can be adversely affected by nonpoint source pollution – that which comes from multiple diffuse sources and enters the water supply via runoff after precipitation events. This pollution may include sediment-laden road runoff due to inadequately constructed roads in forested areas, lack of proper site rehabilitation after logging or other activities, or improper storage and handling of fuel/oil products.



▲ A smoke plume rises on the southwestern flank of the High Park Fire in 2012. Photo: Bill Cotton, Colorado State University



▲ Colorado's forested watersheds provide water to 19 states. Photo: CSFS

Watersheds and Wildfire

High-severity wildfires eliminate trees and other vegetation that intercept falling rain and hold together soil with root systems. Intense heat on and below the surface also often causes soils to become water-repellent. Numerous studies illustrate that post-fire conditions can increase sediment flows downstream and degrade water quality. For example, in mid-elevation forests on Colorado's Front Range, hillslope sediment production rates after recent, high-severity wildfire and subsequent rainstorms can be up to 200 times greater than for areas burned at low severity.

These sediment yields can impact reservoir storage capacity. Downstream sedimentation due to heavy rains following the 1996 Buffalo Creek Fire, which burned southwest of Denver, reduced the water storage capacity of Strontia Springs Reservoir by roughly one-third. And after the Hayman Fire – the largest fire in Colorado's recorded history – Denver Water's reservoirs filled with sediment, leading to an estimated \$28 million in removal costs.

These sort of high-severity burns are more common in un-thinned forests with heavy fuel loads than in forests that have

experienced naturally recurrent, low-intensity wildfires or prior forest management. Forest thinning treatments have the potential to reduce the chances of high-severity wildfires, by offering less available standing fuel. The Colorado State Forest Service (CSFS) works with landowners to offer technical expertise, information and grant funding to help reduce wildfire risks in priority watersheds.

Best Management Practices to Protect Water Supplies

The CSFS also helps address the risk of nonpoint source pollution by providing Forestry Best Management Practices (BMPs) for Colorado. These are guidelines and other information that helps forest landowners, land management agencies, the timber industry and contractors to protect water supplies. Federal and state land management agencies subscribe to these practices, but they are voluntary on private lands in Colorado.

Biennially since 2008, the CSFS, in cooperation with other state and federal agencies, has monitored the application and effectiveness of forestry BMPs in the state through an audit steering committee. A field monitoring team also conducts sample site visits. The objectives of the monitoring are to determine if the BMPs are being implemented and evaluate their effectiveness in protecting water resources. A total of 79 forestry-related BMPs, which include minimizing the number of necessary access roads and retaining adequate post-harvest woody material on the



▲ John Twitchell, district forester for the CSFS Steamboat Springs District, shares how BMPs are used on forest management projects in the Colorado State Forest. Photo: Lisa Mason, CSFS

ground for ecological benefits, are considered and/or rated for each site.

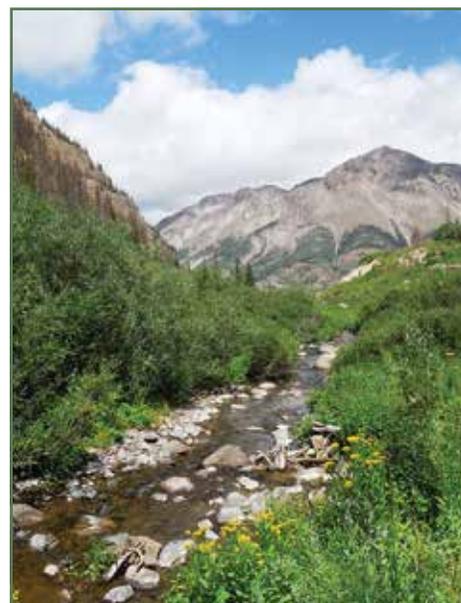
Since 2008, BMP audits have been completed at 18 field sites across 26 counties and five National Forests in Colorado. And in 2014, six field sites (two federal, three private and one state) were visited by the monitoring team. The data from those audits will be analyzed and the field monitoring report will be published and made publicly available in 2016. Any recommendations from the BMP monitoring reports are used

for educational and outreach purposes only, and all confidentiality of contractors and/or landowners is maintained.

“Forestry-related BMPs set the standard for water resources protection in natural resources management,” said John Stednick, a professor in the Watershed Science program at Colorado State University. “These CSFS audits show a high implementation rate of BMPs on forested lands, and their overall effectiveness demonstrates protection of water resources from nonpoint source pollution.”



▲ Rich Edwards, CSFS assistant staff forester, trains field staff in forestry BMPs to protect water resources. Photo: Lisa Mason, CSFS



▲ BMPs protect water from nonpoint source pollution. Photo: Lisa Mason, CSFS

Forestry on the Plains

The Great Plains of eastern Colorado offer unique ecosystems that sustain some of the most diverse wildlife populations in the state, and are home to many hunting and recreational opportunities. The plains also support a vital agricultural economy, sustaining local communities and producing food for the nation. Despite the largely non-forested setting – or because of it – every tree on the plains is that much more critical to providing human and ecosystem services.

Forests interspersed on the state's semi-arid plains include: riparian woodlands along river and stream corridors, piñon-juniper woodlands in canyon and bluff areas, windbreak and shelterbelt plantings on agricultural lands, wildlife plantings on the shortgrass prairie, and community forests in cities and towns. Except for the naturally occurring riparian and piñon-juniper forests, most of the trees on the plains have been planted to modify the harsh environment and make it more suitable for humans, livestock and crop production.

The Colorado State Forest Service (CSFS) helps rural landowners and plains communities with tree selection, planting and care advice; insect and disease concerns; management of invasive tree/shrub species; community forestry; wildfire mitigation; and outreach, service and education.

Conservation Plantings

Agroforestry, which is the deliberate integration of trees and shrubs into crop and animal farming systems, is vital for creating environmental, economic and social benefits in eastern Colorado. For more than 50 years, the CSFS Nursery has been a reliable source of tree and shrub seedlings for agroforestry and other plains conservation plantings. Once they mature, living windbreaks and snow fences – as well as other larger planting projects using CSFS seedling stock – can last for decades.

Some of the primary functions of planted trees on the Eastern Plains include:

- windbreaks and shelterbelts that protect livestock, crops and homesteads from wind and snow
- reduced soil erosion
- shade and energy savings
- living snow fences that keep roadways accessible
- riparian and upland buffers to protect water quality
- wildlife habitat

Managing Invasives

Many tree species have been introduced to Colorado's Eastern Plains. While most have been beneficial and survived only under irrigation, a few species escaped cultivation and thrived despite the harsh growing conditions. Two tree species in particular— Russian-olive and tamarisk – were introduced into Colorado in the late 1800s and are now considered invasives, displacing native vegetation.

Russian-olive is a medium-sized tree native to Europe and Asia with silvery green foliage and olive-like fruit. Tamarisk, or salt cedar, represents a group of shrub-like smaller trees native to southern Europe, North Africa and central Asia introduced as ornamentals or for use in shelterbelts and stream-bank stabilization. These tree species have invaded riparian areas and floodplains throughout the West, displacing native cottonwoods and willows. Tamarisk thickets, especially in the Arkansas River Basin, alter the hydrology of riparian areas, evaporating more water than native vegetation and reducing stream flows.

Community Forestry

Planted trees in plains communities add structure and beauty, provide places to gather

and recreate, reduce summer cooling costs and add to property values. The CSFS assists these communities by providing: technical assistance, information and workshops to address tree planting and care; development and support for local tree boards; community tree inventories; response to tree insect and disease concerns; and direction for the Tree City USA® program and Arbor Day events.

Wildfire Mitigation

Wildfire mitigation is another important function of Eastern Plains forestry. Prior to human settlement, wildfires played a frequent and important role in preserving plains ecosystems, but significant development and land-use changes have altered the once wild prairie landscapes. Now an increasing number of homes in these areas brings a heightened risk of accidental fire starts – and real risks to life and property. The CSFS works with residents of eastern Colorado to help them understand what measures they can take to help reduce local wildfire risks, and offers educational materials and programs to assist landowners and communities in taking risk-reducing actions.



▲ Children help plant trees at an Eads Arbor Day celebration. Photo: CSFS

Colorado Legislation Helps Shape Our Future Forests

This report focused on the current state of Colorado's forests, the benefits they provide, and forest concerns that impact ecosystems, the economy and human life and property. It also demonstrated how forest management is the most effective way to deal with these concerns. Good forest stewardship yields healthy forests that are more resilient to insects and disease, and reduces the risk of catastrophic wildfires. Forest management also helps preserve air quality, protects water supplies, supports recreation and tourism, and encourages a diverse wood products industry. Everyone benefits from having healthy forests.

The Colorado General Assembly understands that Colorado residents and visitors alike demand healthy, resilient forest landscapes. And they should – 90 percent of Coloradans participate in some form

of outdoor recreation each year, and 100 percent of Coloradans utilize the air and water coming from our forests. Since these annual reports were first published in the year 2001, state lawmakers have supported forest health efforts, promoting legislation that will help improve the health and vigor of Colorado's forests.

There has been more forestry-related legislation in Colorado over the past 15 years than in the previous half-century.

Multiple pieces of legislation have passed in recent years, which have supported forest management actions that demonstrate

community-based approaches to forest restoration and watershed health; reduced the threat of wildfire to communities and infrastructure; and helped facilitate the development and implementation of Community Wildfire Protection Plans. Legislation including HB 09-1199 has enhanced the technical assistance, service, education and outreach the Colorado State Forest Service (CSFS) provides every day.

Since 2007, more than \$8 million provided through Forest Restoration Grant Program legislation in Colorado, and leveraging more than \$14 million in matching funds, has allowed for the treatment of 18,000



▲ Columbines near Fern Falls in Rocky Mountain National Park. Photo: Nancy Dadisman, CSFS

acres of Colorado forestland. This financial assistance for landowners and communities continues to protect Colorado's forested watersheds and communities from threats such as wildfire and water-supply concerns.

Legislative actions in response to catastrophic events will always be vital to meeting the state's needs, but we need to take care of our forests before legislation is ever necessary. Forest management is a proactive effort, requiring vigilance and dedication – not just from professional foresters, but also landowners, educators, conservation organizations, elected officials, fire protection districts and other state and federal partners. The CSFS and other land management and forestry agencies in Colorado need everyone's support and interest to face large-scale forest challenges.

We look forward to continued legislative and public support as we all work together to promote more resilient, diverse forests. By working together, 15 years from now this annual report will describe many more positive impacts in Colorado forests.



▲ Boyd Lebeda, district forester for the CSFS Fort Collins District, shows Senator John Kefalas and former House Representative Randy Fischer mountain pine beetles underneath ponderosa pine bark. Photo: CSFS

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