

COLORADO STATE FOREST SERVICE
EST. 1955

Colorado Forest Action Plan

2020

The Colorado State Forest Service is a steward of the state's forestlands, committed to the challenge of creating and maintaining healthy, resilient forests for generations to come.



RED MOUNTAIN *peeks over the San Juan ridgetops along the Million Dollar Highway, a stretch of Hwy. 550 that connects Ouray and Silverton.*

ON THE COVER *The banks of Lost Lake, in Colorado's Grand Mesa National Forest, are flanked by forestland that helps filter sediment and nutrients to keep the water clean. Healthy forests play an integral role in providing drinking water for residents in Colorado, 18 other states and Mexico.*

Photos: Kamie Long, CSFS



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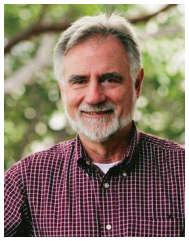
ONLINE APPENDICES AVAILABLE AT
csfs.colostate.edu/forest-action-plan

Colorado State Forest Service Creates Path to Guide Stewardship of Colorado's Forests



Michael B. Lester

In your hands, or on your screen, you are viewing the path forward for Colorado's forests – and in many ways the future of our way of life in Colorado. Our forests play a vital role in what makes Colorado special. Healthy forests provide habitat for Colorado's abundant wildlife; the basis for our world-renowned recreation opportunities; clean air; clean water for residents, 18 other states and Mexico; forest products that bolster local economies; and carbon sequestration that helps mitigate climate change.

To ensure our forests — and these critical resources — persevere, the Colorado State Forest Service's updated *2020 Colorado Forest Action Plan* provides an in-depth analysis of the trends affecting Colorado's forests and guidance on how to improve forest health and resiliency.

To conduct the analysis for the action plan, the CSFS assembled experts from across the state. The action plan is the result of the work of these dedicated professionals, including diverse stakeholders with expertise in forestry, hydrology, engineering, government and other natural resource disciplines. This action plan covers all forests in Colorado, across all ownerships.

Much of Colorado's forests are not healthy. When forests are in an unhealthy state, wildland fires can grow into catastrophic fires that threaten public safety. These threats include destruction of our communities in the wildland-urban interface, pollution of our air and damage to our limited, valuable water supplies. Uncharacteristic wildfires substantially reduce the ability of forests to sequester carbon.

Current and emerging conditions are threatening the health and resiliency of forests in Colorado. There is a solution, but it requires an investment in our forests that cannot be sporadic. Rather, that investment must be focused and strategic, cross-boundary and collaborative. With more than 24 million acres of forest, where should we focus our efforts? That is where this action plan comes in. Driven by science and organized by themes, this plan informs us where the areas of greatest need are in Colorado. It includes data that can assist Colorado's decision-makers in investing in our forests where these investments will make the most difference.

Our forests are essential to our way of life, and they provide us with priceless benefits. However, we cannot take them for granted. This proactive Forest Action Plan can lay the groundwork for critical investments that will enhance the health of Colorado's forests for current and future generations.



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

THE COLORADO STATE FOREST SERVICE *is a service and outreach agency of the Warner College of Natural Resources at Colorado State University and provides staffing for the Division of Forestry within the Colorado Department of Natural Resources.*

THE MISSION *of the CSFS — to achieve stewardship of Colorado's diverse forest environments for the benefit of present and future generations — permeates through 17 field offices, the state office and five divisions within the organization. Implementation of the* 2020 Colorado Forest Action Plan *builds on this mission and will require collaboration, communication and coordination with partners and stakeholders, both across Colorado and in neighboring states.*

Action Plan Maps Colorado's Priorities in Forest Stewardship

The *2020 Colorado Forest Action Plan* provides a strategic framework to address the benefits, conditions and trends in Colorado's forests, as well as the threats and challenges the state's forests face across political, jurisdictional and ecological boundaries. State forest action plans are mandated by the Cooperative Forestry Assistance Act of 1978, passed by Congress and amended by the 2008 and 2014 U.S. farm bills. This is an update to the *2010 Colorado Forest Action Plan*.

A Colorado State Forest Service team developed the *2020 Colorado Forest Action Plan* and solicited feedback from partners and stakeholders through a series of meetings across the state, using participatory geospatial analysis and iterative strategy development. While there are unique natural resource priorities for different regions of the state, the top priority identified statewide is reducing the risk of uncharacteristic wildfire.

THE FOREST ACTION PLAN RESOURCE ASSESSMENT is organized around six themes: forest conditions, living with wildfire, watershed protection, forest wildlife, urban and community forestry and forest products.

Each theme includes a map and associated goals, strategies and approaches that fall within one or more of the national priorities of states' forest action plans:



CONSERVE and manage working forest landscapes for multiple values and uses.



PROTECT forests from threats.



ENHANCE public benefits from trees and forests.

The action plan also includes a Forest Legacy Program Assessment of Need. A composite priority map in the Forest Action Plan Resource Assessment section highlights areas of the state where forest management and risk reduction activities are urgently needed and multiple goals can be met. Based on this map, about 10% of Colorado's 24 million acres of forest are in urgent need of treatment to address forest health, wildfire risk and watershed protection threats, at a cost of approximately $4.2 billion.

THE FOREST ACTION PLAN RESOURCE STRATEGIES sets the stage for how the CSFS will use this plan. Importantly, implementation of this action plan extends beyond the CSFS mission and operations, requiring collaboration, communication and coordination among partners and stakeholders in Colorado and neighboring states.

An overview of the gap between necessary and existing program opportunities is provided in the Resource Strategies. Coupled with the composite priority map, this can be used as a foundation to guide how federal, state and private program funds and other grant funding are applied. Additionally, it can be used to identify new potential funding opportunities in priority forests moving forward.

This Forest Action Plan will be reviewed in five years, and new data and information will be incorporated, as applicable, making this a living document. The CSFS encourages and welcomes feedback on this plan for future consideration.

ACCESS ACTION PLAN DATA ONLINE IN COLORADO FOREST ATLAS

The data and information contained within this plan are for public use. All analyses were conducted statewide, by aggregating data and information at a watershed scale.

Ancillary data and information should be incorporated at the local level to refine this statewide priority analysis.

The statewide priority assessment data can be accessed through a Forest Action Plan application in the CSFS Colorado Forest Atlas, coloradoforestatlas.org.

To begin developing the *2020 Colorado Forest Action Plan*, a Colorado State Forest Service team consulted with external partners and stakeholders to determine six themes and set goals for forest stewardship moving forward. These themes can be tracked throughout the plan using the following icons:



FOREST CONDITIONS

Colorado's diverse forests cover about 24 million acres across a broad elevation gradient. Forests provide many benefits including clean water for agriculture, municipal and industrial use, recreation, habitat, grazing opportunities, nutrient cycling and soil retention, improved air quality and carbon sequestration and storage. They also provide for resource use and cultural significance and offer a sense of place. Increasing pressures on forests are expected to continue as a changing climate challenges the forests' natural defenses against insects and disease. Longer fire seasons and more uncharacteristic wildfires also are expected. Adaptive forest management will be necessary to address the dynamic threats to forest health in Colorado.



LIVING WITH WILDFIRE

Wildfire plays a critical role in maintaining the health of many ecosystems in Colorado. Frequent, low-intensity fires burn in lower elevation montane forests to reduce understory vegetation, while high-intensity fire helps with regeneration in some high-elevation forest types, such as lodgepole pine. A long legacy of fire suppression has altered historic fire cycles and led to the dangerous buildup of fuels in some areas. Coupled with the effects of climate change, this makes living with wildfire a challenge in Colorado. Risk-reduction practices must be promoted as populations increase in the wildland-urban interface.



WATERSHED PROTECTION

Colorado's forested watersheds deliver clean water to residents, 18 other states and Mexico, and provide the biological diversity needed for a future that is balanced both socially and ecologically. Current and expected future conditions, including persistent droughts and uncharacteristic wildfires, have and will continue to negatively impact forest health and the source water and habitat these forests provide. Water is an increasingly limited resource in Western states. Therefore, practicing forest management to improve forest health is critical to protecting and enhancing this precious resource.

Photo: pixabay.com

ACTION PLAN ICONS

FOREST WILDLIFE

Colorado's forest habitats are home to diverse wildlife, including many of the 159 species that Colorado Parks and Wildlife identifies are in need of conservation. Habitat quality continues to be affected by widespread forest disturbances such as wildfire and insect and disease outbreaks, which can intensify with drought and climate change. These disturbances alter critical components of habitat, including native vegetation, water, food and cover. As urban development continues to threaten ecological connectivity, maintaining unfragmented forested habitat is essential.

URBAN AND COMMUNITY FORESTRY

Colorado's urban areas are their own varied ecosystems, comprised of green infrastructure such as trees, yards, open spaces, parks, greenways, rivers, ponds and habitat corridors. These provide residents with access to clean air and water, reduce energy consumption and noise pollution, increase property values and enhance mental and physical health. Urban forests regulate climate by providing shade, mitigating the heat island effect and reducing extreme weather impacts. To sustain these forests, planning will be required that considers expected population growth, climate resilience, invasive species and civic engagement.

FOREST PRODUCTS

Important Colorado timber species include lodgepole pine, spruce, ponderosa pine, Douglas-fir, true firs and aspen. In recent history, there has been a steep decline in the value of timber due to market conditions, widespread insect and disease infestations and large wildfires. Additionally, the loss of harvesting and processing capacity has contributed to a declining contractor workforce. To meet future timber harvesting and forest management program needs in Colorado, mill and workforce capacity must be addressed, and new and emerging markets such as biochar and pellets should be promoted.

National Action Plan Priorities

Theme sections address conditions, trends, challenges and threats to each respective theme. Goals and strategies outlined in the themes are connected to the national priorities of state forest action plans using these icons:

CONSERVE working forestland

PROTECT forests from harm

ENHANCE public benefits from trees and forests





The Colorado State Forest Service has documented forest conditions and monitored changes in forest health since the agency was established in 1955. Photo: CSFS

History and Challenges: Improving Forest Health Remains Crucial in Colorado

Colorado has about 24 million acres of forests that provide multiple environmental, social and economic benefits. A state's forest action plan provides the opportunity "to shape and influence forest land use on a scale and in a way that optimizes public benefits from trees and forests for both current and future generations" (State and Private Forestry Redesign Initiative; 2008 U.S. Farm Bill). The Colorado State Forest Service has designed this plan to provide a road map for improving forest health across Colorado in the coming decade.

Colorado's forests vary widely across a broad elevation gradient — from Arkansas River riparian habitat at 3,350 feet, dominated by plains cottonwoods, to spruce-fir forests growing up to approximately 12,000 feet. Above treeline, alpine habitat reaches up to 14,440 feet on Mount Elbert, the highest peak in Colorado.

Major forest types in Colorado can be categorized by the dominant overstory vegetation; these include conifer-hardwood, conifer, mixed conifer, hardwood (primarily aspen), lodgepole pine, oak shrubland, piñon-juniper, ponderosa pine,

FOREST HEALTH

"The perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance."

— The Society of American Foresters

COLORADO'S FORESTS: FOREST TYPES AND LOCATIONS

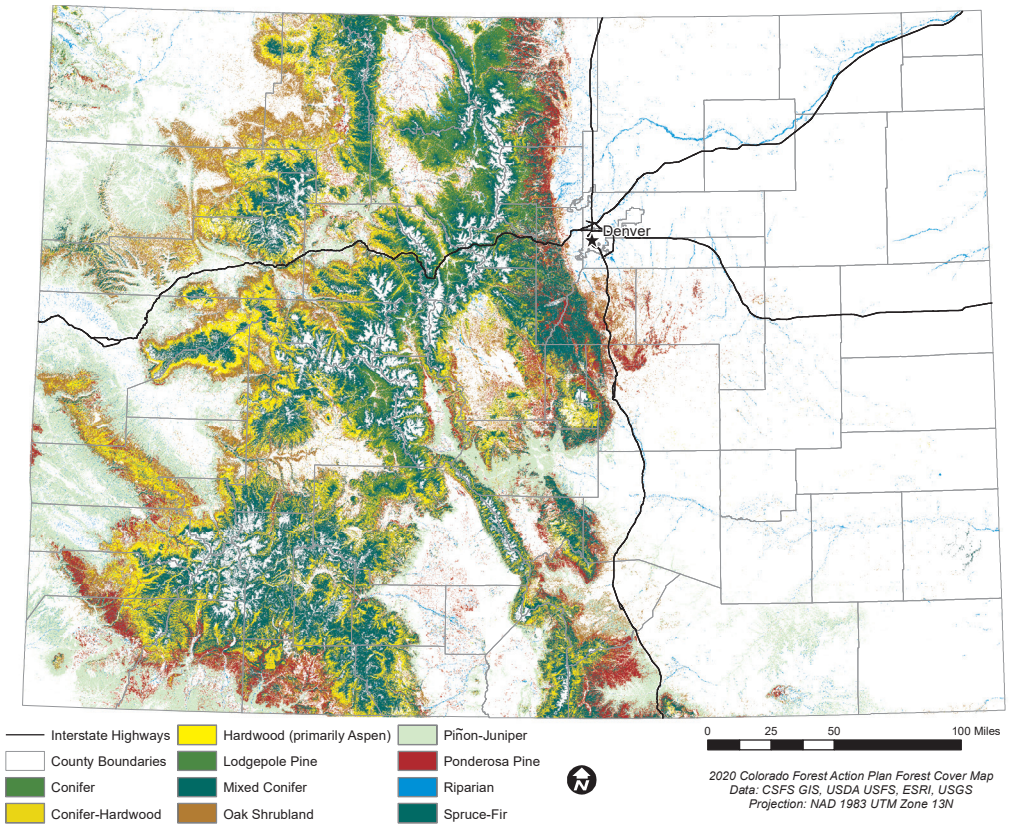
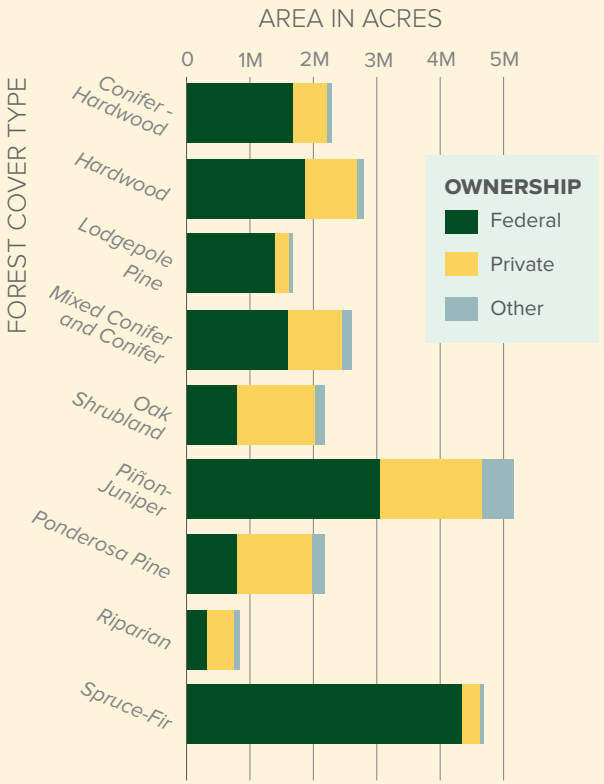


FIGURE A

Roughly 65% of Colorado's forests are managed by the federal government, 30% are in private ownership and 5% are managed by other entities (e.g., state, tribal, local, nongovernmental organizations and land trusts) [1]. The CSFS does not own land; it provides service and outreach as the leading state forestry organization and is a source of professional expertise across the state. The CSFS works with all forestland owners, through partnerships and collaborations. Map: CSFS

FIGURE B

FORESTED ACRES:
OWNERSHIP AND COVER TYPE [1,2]



riparian and spruce-fir *(Figure A)*.

Wildfires play an important role as a natural disturbance in some of these forest types; they can increase diversity and landscape heterogeneity. One example is high-elevation lodgepole pine forests, which rely on high-intensity heat to open their serotinous cones, releasing seeds to regenerate growth. Other disturbances including insect and disease infestations, grazing/herbivory, flooding, avalanches and windstorms can stimulate forest regeneration, promoting a variety of forest types, age classes and densities.

More information about forest cover types is on the CSFS website at *csfs.colostate.edu/colorado-forests/forest-types*.

Colorado's forested watersheds are the headwaters for four major rivers — the Colorado, Arkansas, Rio Grande and South Platte. These pass through many of Colorado's urban centers and contribute water to 18 other states and Mexico. Forests have various effects on the natural water cycle — they affect the quantity and quality of water — and forest health impacts watershed health. Water is stored in forest soils, used by trees to produce biomass and released into the air as oxygen and water vapor. This process impacts precipitation timing and quantity. Tree roots collect and filter rainfall and runoff, reducing the concentration of pollutants in water downstream and decreasing sedimentation and erosion.

Forests also play a major role in atmospheric cycles. Not only do trees absorb carbon dioxide and produce oxygen through photosynthesis, they can also absorb ozone, carbon monoxide, sulfur dioxide, nitrogen oxides and particulates. Fossil fuel use, an open system that does not have a mechanism to recapture emitted carbon dioxide, continuously adds carbon to the atmosphere. Private

TALK LIKE A FORESTER

WATERSHED
is a land area that channels rainfall and snowmelt to creeks, streams and rivers, and eventually to outflow points such as reservoirs, bays and the ocean [3].

WATERSHED HEALTH
is a measure of ecosystem structure and function [4].

STRUCTURE
is the three-dimensional spatial distribution of trees, plants and other nonliving elements, such as soils, slopes and hydrology. Measurements of structure can include tree shapes, heights, spacing, arrangement, diameter and age.

FUNCTION
refers to ecosystem processes such as the water cycle, nutrient cycling, energy flow and succession.

and public forests provide a critical avenue to help mitigate these additional atmospheric carbon dioxide concentrations. Forested lands in the United States offset approximately 11% of the total U.S. fossil fuel emissions [5] while representing over 90% of the land's carbon sequestration capacity [6].

Understanding the pathways between sequestration, storage (stock) and emissions provides insight into the forest carbon cycle *(Figure C)*.

Carbon Sequestration:
How Healthy Forests Help

Carbon sequestration refers to the carbon dioxide (CO_2) that is absorbed by trees during photosynthesis.

It is stored within various biomass pools that may eventually return to the atmosphere through respiration, decomposition or disturbance (i.e., fire or insect outbreak causing mortality) [6,7].

These biomass carbon pools have five components:

- Aboveground live biomass includes all living biomass above the soil, such as stems, stumps, branches, bark, seeds and foliage. This includes live understory vegetation.
- Belowground live biomass includes all living biomass of coarse, living roots thicker than 0.08 of an inch in diameter.
- Dead wood includes all nonliving woody biomass either standing, lying on the ground (but not including litter) or in the soil.
- Forest floor litter includes the leaves, needles and branches less than 3 inches in diameter that are lying on the ground.
- Soil organic carbon includes all organic material in soil to a depth of 1 meter, but excluding the coarse roots of the belowground pools.

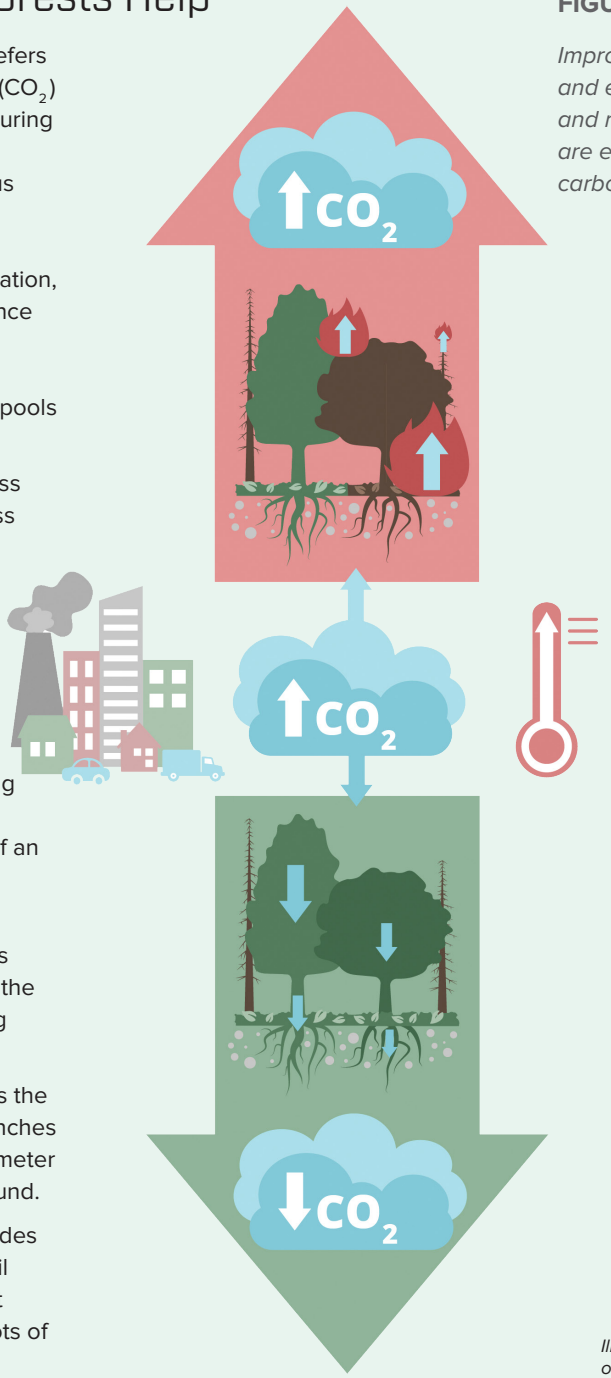


FIGURE C

Improving overall forest health, and ensuring forest restoration and regrowth in burned areas, are essential for increasing carbon sequestration.

1 *Higher average temperatures can lead to drought conditions in forests, which can increase fire frequency and severity. Fire releases carbon from forests into the atmosphere.*

2 *Increasing CO_2 concentrations in the atmosphere and higher average temperatures stimulate trees and vegetation to take in carbon (sequester).*

3 *When trees take in carbon, it lowers carbon concentrations in the atmosphere. Standing dead trees, litter and soil in forests store carbon. Decomposing trees emit some carbon.*

Illustration: Northern Institute of Applied Climate Science

WHAT HAPPENS WHEN COLORADO'S FOREST HEALTH DECLINES?

Potential effects could include:

- ***Negative impacts to water quality*** *and quantity that affect cities, communities, municipalities, industries and agriculture*
- ***Reduced air quality*** *and carbon storage and sequestration*
- ***Elevated risk of uncharacteristic wildfire*** *that negatively impacts habitat, forests, watersheds, economies and public health*
- ***Diminished scenic value*** *and decline in recreation opportunities and experiences*
- ***Decline in hunting and fishing*** *related to habitat loss*
- ***Heightened public safety concerns*** *related to standing dead and fallen trees and fire evacuations*
- ***Unstable forest products markets*** *and decline in local economies*



Whether hunting, biking, hiking or more, residents and visitors seek out Colorado's forests for a variety of recreational pursuits — generating $37 billion [14] in consumer spending annually. From 2018 to 2019, Colorado Parks and Wildlife reported more than $96 million dollars in revenue from the purchase of hunting and fishing licenses. Photo: CSFS

Forests are Central to Colorado's Economy, Culture, Lifestyle

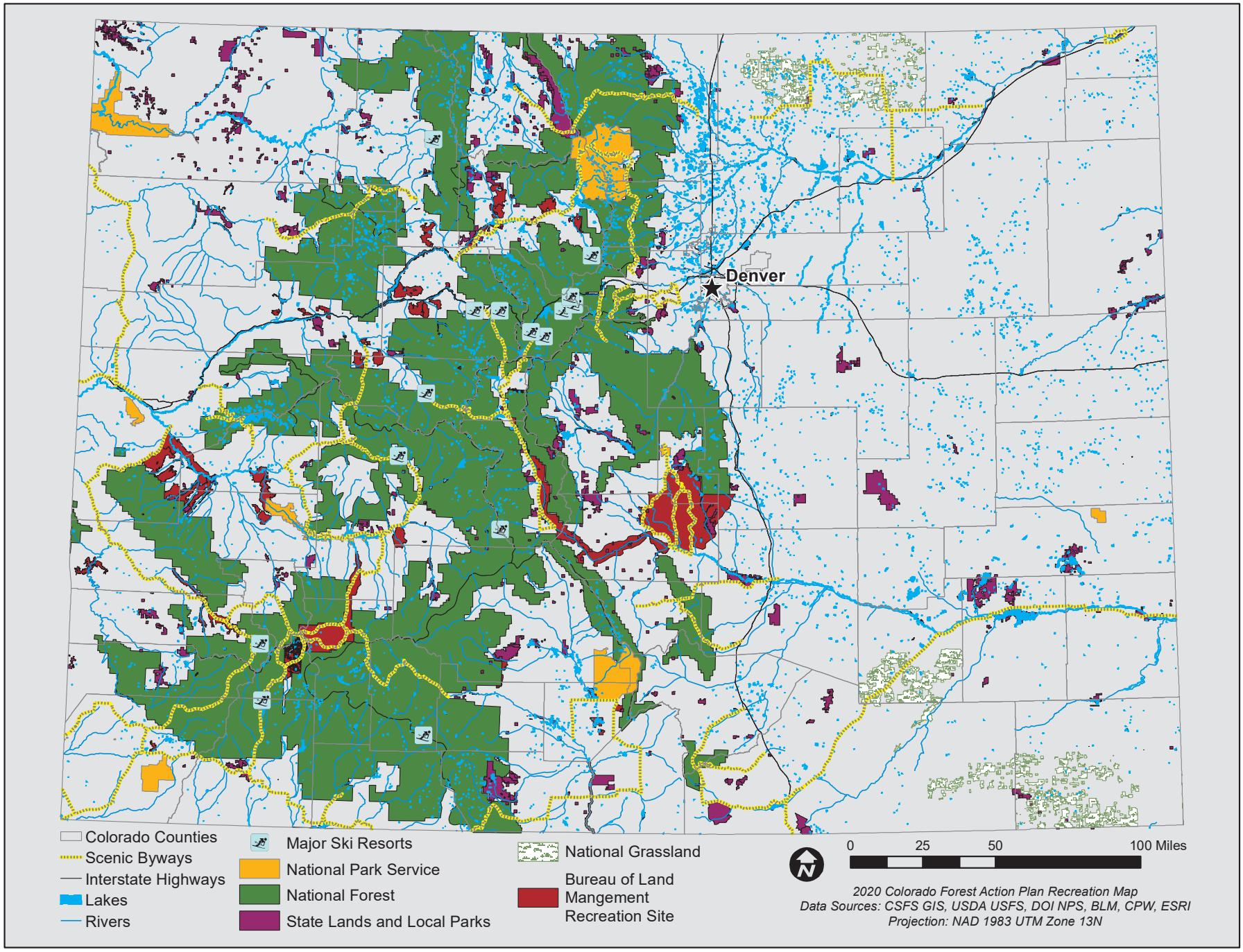
Colorado's forests shape the state's economic and social character, so investment in their future is imperative. To **CONSERVE**, **PROTECT** and **ENHANCE** the health of our forests will help ensure Colorado's legacy. Strategic planning such as this Forest Action Plan is necessary to address threats and challenges to ecosystem services in what is known as "Colorful Colorado."

Healthy forests provide a wide range of tangible goods and intangible benefits. These ecosystem services [8,9,10] — the direct and indirect benefits humans get from the environment — provide clean and ample water, clean air, carbon sequestration and storage, recreation opportunities, scenic views, habitat for plants and wildlife, wood products, renewable energy, nontimber market commodities, cultural history and a sense of place.

In 2015, 80% of Colorado residents relied on forested watersheds to deliver municipal water supplies [4]. These watersheds also provide critical water to rural agricultural lands. The Colorado Department of Agriculture reports agricultural activities contribute $41 billion annually in economic output, employ nearly 173,000 people and export goods to over 100 countries.

Recognizing the inseparable link between healthy forests and the ecosystem services they provide, more cross-boundary projects are being implemented in Colorado to support management and stewardship of these resources. One example is the From Forests to Faucets program, a collaboration among the U.S. Forest Service, Denver Water, the Colorado State Forest Service and the Natural Resources Conservation Service. This program was designed to improve forest conditions in watersheds that supply critical drinking water to the city of Denver.

Recreation Lands: Colorado's Designated Outdoor Spaces



TALK LIKE A FORESTER

FOREST HEALTH
is the perceived condition of a forest, derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance (*as defined by the Society of American Foresters*).

UNCHARACTERISTIC WILDLAND FIRE
is an increase in wildfire size, severity and resistance to control, as compared to that which occurred historically in the native system [16].

WILDLAND-URBAN INTERFACE (WUI)
is where structures and other human developments meet or intermingle with wildland vegetation.

WILDFIRE RISK
is the likelihood of a fire occurring (*likelihood*), the associated fire behavior when a fire occurs (*intensity*) and the effects of the fire (*susceptibility*) on highly valued resources and assets.



Introducing youth to the benefits of trees is critical to the CSFS mission of creating healthy forests for future generations. CSFS Supervisory Forester Adam Moore, right, explains how to plant the lilacs that participants in the PALS afterschool program will take home with them after an annual tree planting in Alamosa. PALS has been helping the CSFS with the planting project for 10 years. The conservation seedlings were grown and donated by the CSFS Nursery. Photo: PALS

By 2021, the program will have invested more than $64 million in forest management to protect Denver's water supply.

Based on U.S. Forest Service Forest Inventory and Analysis 2019 data, total carbon storage (C) on Colorado's forest approximates 1,386 million metric tons (MMT) [5]. This is equivalent to the amount of coal (made primarily of carbon) that can be carried in 1,000 incredibly long trains. Each train would take up the entire 280-mile distance from Fort Collins to Gillette, Wyo., the "Energy Capital of the Nation" [11].

In Colorado, 811,000 acres [12] of urban and community forests provide green infrastructure for clean water and air, energy conservation, stormwater attenuation, reduction in noise pollution, property value enhancement, connectivity of habitat corridors and improved mental and physical health [12,13]. These ecosystem services provide monetary benefit; for example, 556,000 urban trees catalogued in COTreeView equate to approximately $48 million annually.

Across urban and rural economies, outdoor recreation in Colorado generates $37 billion in consumer spending annually, and 511,000 direct jobs [14].

From 2018 to 2019, Colorado Parks and Wildlife reported over $96 million dollars in revenue from hunting and fishing license sales.

Resource use also is an important income source in both urban and rural communities; the primary wood products industry in Colorado had estimated sales of $98.1 million and employed 6,650 people in 2016 [15].

Colorado's forests also are central to the state's cultural identity. There are over 1,500 sites and buildings listed with National Register of Historic Places, eight national monuments and four national parks within the state.

Forest resources are stewarded by the indigenous Ute Mountain Ute and Southern Ute on tribal lands. Numerous museums and annual events reflect Colorado's pride in outdoor recreation, mining history, livestock trade, ski resorts, and brewing and film industries.

Colorado's Forests Face Persistent Challenges, Increasing Temperatures, More Uncharacteristic Wildfires

In the *2010 Colorado Forest Action Plan*, the major threats to Colorado's forests were climate change and drought, uncharacteristic wildfire and post-fire erosion, insects and disease and human development. These challenges persist in 2020 and are expected to continue in the next 10 years and beyond. These drivers of change in Colorado's forests also affect the ability of trees to sequester and store carbon.

Averaged across Colorado, mean annual temperatures have increased by 2 degrees Fahrenheit over the past 30 years [17]. All future climate models project a continued increase in mean annual temperatures, with the greatest warming expected in the summer months *(Figure E)* [18,19].

By the middle of this century, there could be as many as 40 fewer days when the temperature in high-elevation areas of the state drops below 32 degrees, and the entire Southwestern U.S. is expected to experience more prolonged droughts [20].

The challenge faced by the CSFS, and all forest stewards, is to manage forests to provide benefits now and into the future. The *2020 Colorado Forest Action Plan* is a tool to meet this challenge.

Warm, drought years in Colorado are increasingly common compared to decades past [17]. Colorado has already seen the cascading disturbance effects of extreme drought conditions, including increased fire and area burned and forest insect outbreaks, leading to widespread tree mortality. Tree mortality leads to soil erosion, which negatively impacts water quality and watershed health. The longer dead trees stand on the landscape, the less they are worth to the forest products industry. Tree mortality also affects aesthetics and property values.

Decades of fire suppression that began in the early 1900s in the Western U.S. altered historical wildfire regimes and led to a dangerous buildup of vegetative fuels in some areas [21]. Over time, this resulted in higher incidence of uncharacteristic wildfire, which is a particular concern for water quality since sedimentation may increase and water quality can decrease after such fires [22]. Between 2000 and 2019, there were 450 wildfires in Colorado greater than 100 acres in size, totaling approximately 1.8 million acres [23]. Every wildfire can have positive and negative impacts on natural systems and human life and property, almost always in some combination. Some recent fires had overall positive impacts on forest conditions (e.g., West Fork, Decker), some had negative impacts to watersheds including high rates of post-fire erosion (e.g., Hayman, High Park) and others had significant negative impacts to human life and property (e.g., Black Forest, Waldo Canyon). Ultimately, fire cannot be excluded from natural systems in Colorado; however, risk reduction is more important than ever, as the increasing trend of uncharacteristic



After a wildfire in mountainous terrain, steep slopes can direct runoff and sediment into streams, causing a decrease in water quality and an impact on stream health. Photo: CSFS

INSECTS AND DISEASE: ACRES AFFECTED BY MOUNTAIN PINE BEETLE AND SPRUCE BEETLE SINCE 1996

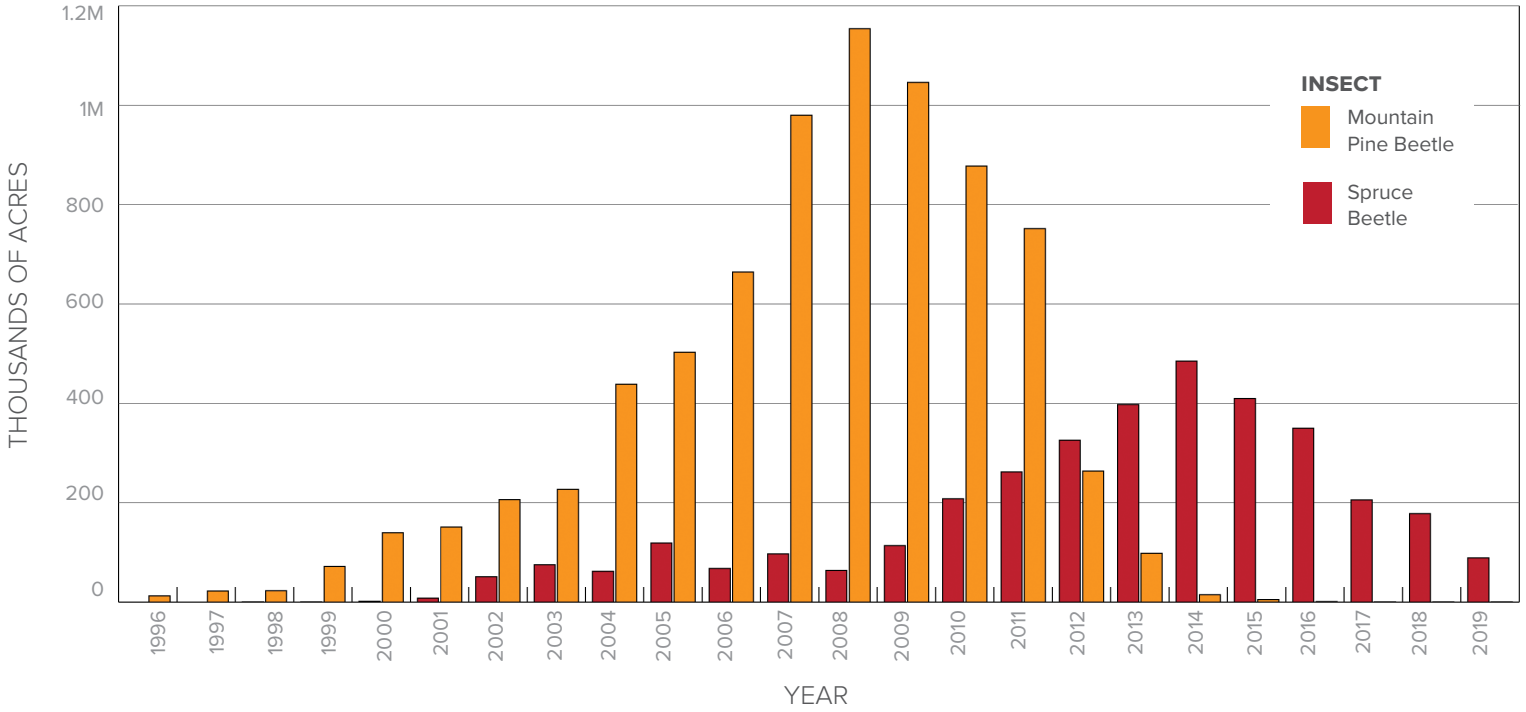


FIGURE D
Acres affected in Colorado by mountain pine beetle and spruce beetle, as determined by aerial detection surveys conducted by the U.S. Forest Service and the Colorado State Forest Service. Graphic: Dan West, Ph.D., CSFS

wildfires in Colorado is expected to continue based on drought and climate change projections [21,24,25].

Between 2010 and 2020, oscillations in the Palmer Drought Severity Index (PDSI) — a measure of dryness based on recent precipitation and temperature [26] — exacerbated tree susceptibility to bark beetle-caused mortality. Approximately 64% of pine forests were significantly affected by mountain pine beetle from 1996-2015 [27]. Although not every tree in every acre was affected, some acres saw more intense tree mortality than others.

On the heels of mountain pine beetle-caused mortality, approximately 40% of high elevation spruce-fir forests have been affected by spruce beetle, another native bark beetle, since the mid-2000s.

Lower in elevation, western spruce budworm has defoliated Douglas-fir trees, contributing to negative aesthetic effects and decreased tree vigor, which has subsequently increased Douglas-fir bark-beetle-caused mortality.

Combined, these disturbances have affected more than 20% of Colorado's forests since the turn of the century, and have resulted in millions of acres of standing dead wood *(Figure D)*.

Human development adds additional complexity to managing forests that are already under increased threat of disturbance from things like wildfire and insect outbreaks. The population of Colorado continues to increase; it grew 145% from 1970 to 2015 (2.2 million to 5.5 million) and is forecast to increase another 41%-70% by 2050 [28].

In 2017, the wildland-urban interface (WUI), where structures and other human developments meet or intermingle with wildland vegetation, encompassed an estimated 3.2 million acres and 2.9 million people [2].

In Colorado, grasslands, shrublands and forests all can be considered part of the WUI. Forests with dense canopies or heavy vegetative fuel loads in close proximity to development are the highest for WUI risk. Models project the WUI could encompass 9 million acres by 2040 [29].

In 2017, approximately 11% of Colorado's population lived in the highest WUI risk areas *(WUI risk categories 7-9; Figure F)*.

Wildfire risk is defined as the likelihood of a fire occurring (likelihood), the associated fire behavior when a fire occurs (intensity) and the effects of the fire (susceptibility) on highly valued resources and assets [30].

CLIMATE: OBSERVED / PROJECTED TEMPERATURE CHANGE

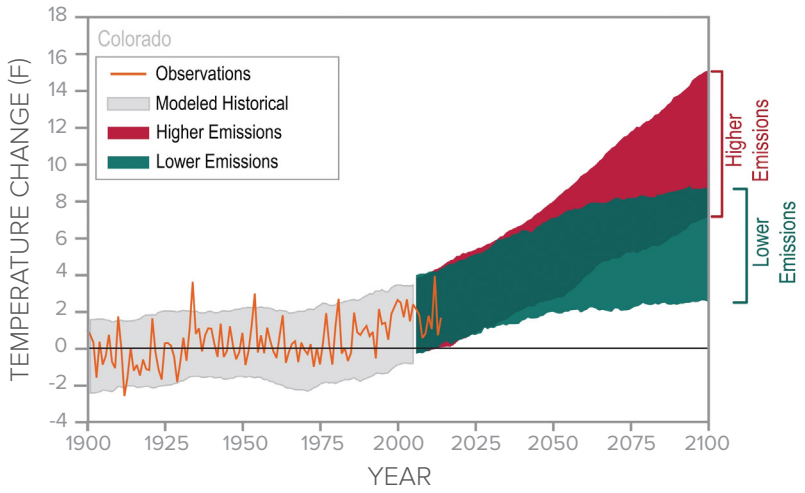


FIGURE E

Observed and projected changes are shown in near-surface air temperature for Colorado. Observed data are from the period 1900-2014. Projected changes for 2006-2100 are from global climate models for two possible futures: a higher greenhouse gases (GHG) emissions scenario and a lower GHG emissions scenario. Shading indicates the range of variation for the models. Graphic: Reproduced with permission from RMRS-GTR-376 [19]

WUI RISK: STATEWIDE WILDLAND-URBAN INTERFACE RISK POPULATION, 2017

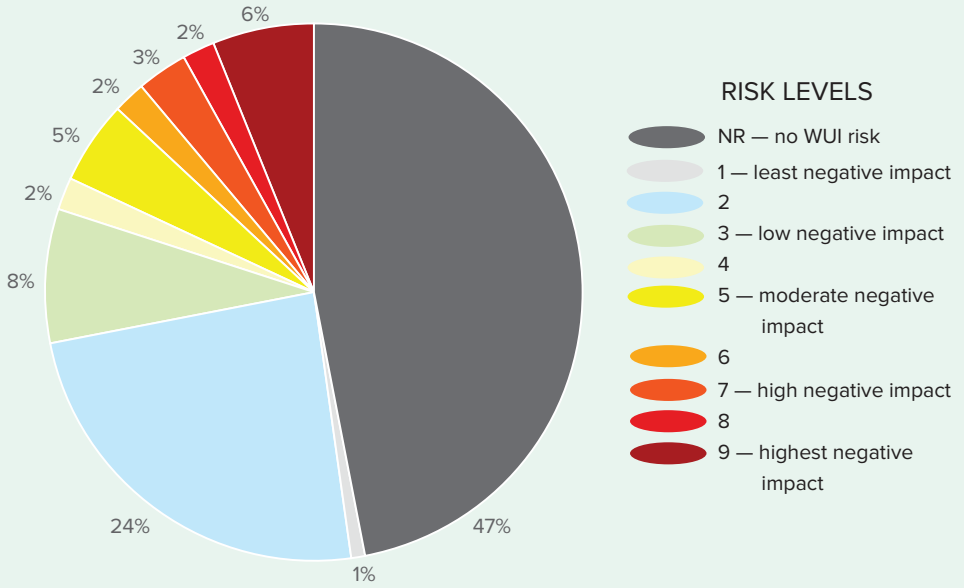


FIGURE F *The wildland-urban interface includes the portions of Colorado where human development meets wildland vegetation. The majority of Coloradans live in places with at least some increased risk of wildfire or heightened fire intensity. Graphic: Colorado Forest Atlas, CSFS*

Another layer of complexity in managing Colorado's forests under increased disturbance is understanding the impacts of these drivers of change to the carbon cycle. Decomposing dead wood releases some carbon into the atmosphere, and some is stored in the soil; these ratios are influenced by climate, wood type and soil type, among other variables.

Since 1990, Colorado's total forest ecosystem carbon stock has decreased by approximately 6% [5]. This 30-year decline was experienced across all biomass carbon pools except dead wood, which increased from 33 MMT C in 1990, to 113 MMT C in 2019 — a striking 342% increase. Since at least 1990, Colorado's forest ecosystems are estimated to be a net source of carbon rather than a net sink. In 2018, these forests emitted approximately 11.1 MMT CO_2 eq (does not include trees on nonforested land).

Within the contiguous 48 states, only Montana and Idaho experienced similar shifts in carbon stocks — but neither as severe as Colorado's.

These 30-year carbon flux trends also are magnified and compounded by socio-economic demands. Further expansion of the wildland-urban interface will continue to result in the loss of forestland. Forest conversion to other uses limits food and habitat for wildlife. Depressed timber markets and inadequate infrastructure limit the long-term carbon storage ability of wood products and building construction.

These trends are connected by ongoing ecological processes. Climatic changes in precipitation and temperature will continue to negatively impact forest health, alter carbon sequestration rates of forest ecosystems and increase the probability of uncharacteristic wildfire. Wildfires release additional carbon into the atmosphere while reducing the potential short-term carbon sequestration rate of forests.

Highly disturbed watersheds without restoration will continue to lose carbon as snowmelt and rain create flash-flood scenarios that remove carbon-rich mineral soils and forest floor litter. Continued widespread insect and disease outbreaks will also impact carbon fluxes as live trees become dead standing snags and downed dead wood. Inadequate natural and artificial regeneration following disturbances, and a lack of forest management efforts at the pace and scale necessary to address these drivers of change, will have long-term negative impacts on the ecosystem services provided by Colorado's forests.

State Goal of Reducing Greenhouse Gas Requires Adopting Strategic Carbon Plan

A cohesive, statewide strategic carbon plan for sequestration is needed to address many complex issues, including land-use planning and conversion; urban and community forestry; afforestation, reforestation and regeneration; forest age, structure and composition; timber and wood product markets; silvicultural practices; natural and uncharacteristic disturbance types and regimes; climate change; soil health; watershed off-site flows; carbon markets; and continued data collection, analysis and modeling.

Colorado is a member of the U.S. Climate Alliance, a bipartisan coalition of governors, state agencies and nonprofit organizations committed to reducing greenhouse gas emissions that align with the 2016 Paris Agreement [31].

To help meet these goals, lawmakers introduced House Bill 19-1261, which would require a statewide goal to "reduce 2025 greenhouse gas emissions by at least 26%, 2030 greenhouse gas emissions by at least 50%, and 2050 greenhouse gas emissions by at least 90% of the levels of statewide greenhouse gas emissions that existed in 2005" (HB 19-1261).

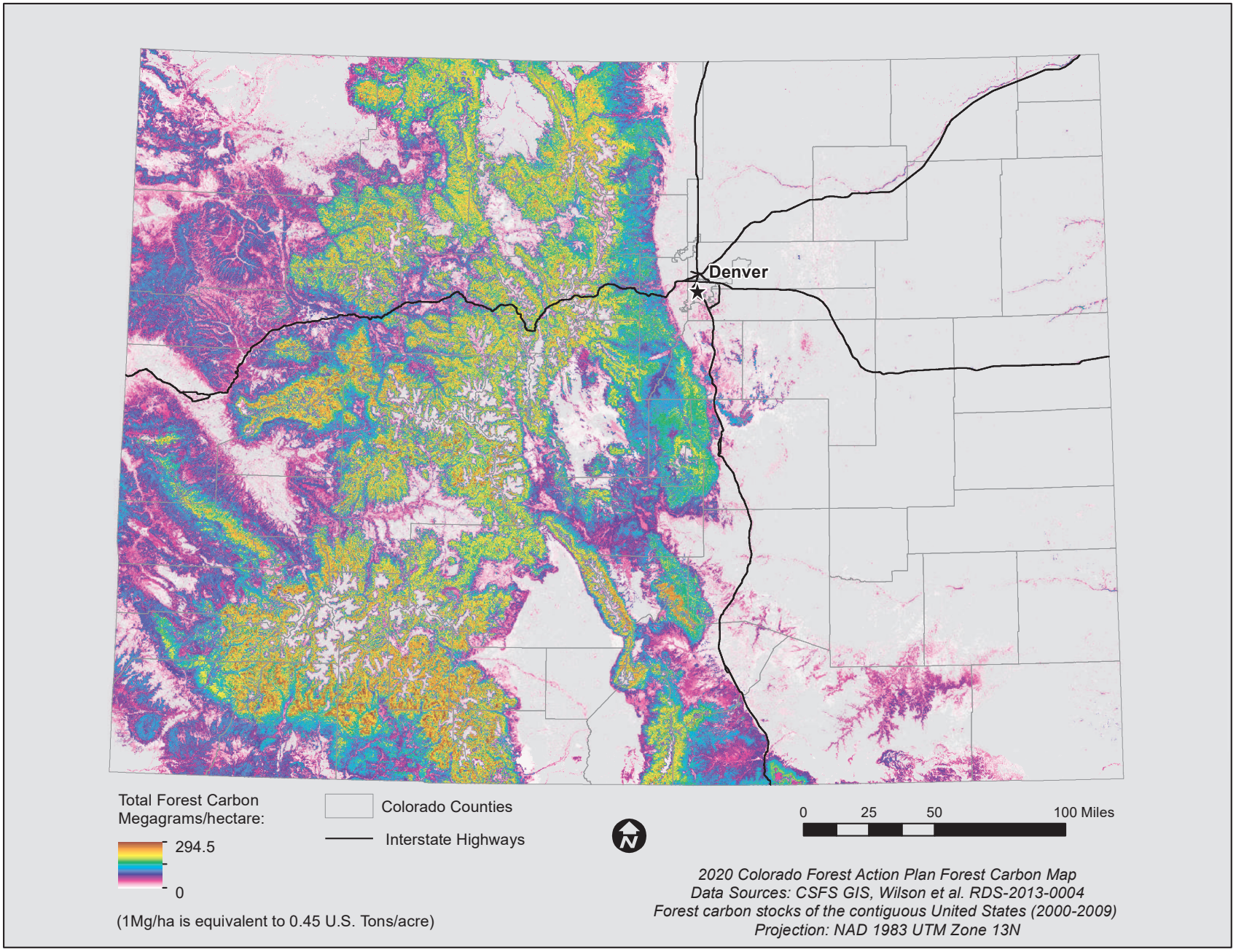
A major component of U.S. Climate Alliance goals is to manage natural and working lands (NWL) to become resilient and healthy landscapes that sequester and store carbon. Healthy forests provide significant and cost-effective opportunities to offset greenhouse gas emissions. The Colorado NWL Climate Task Force [32] — comprised of members from the Colorado State Forest Service, Colorado State University, Colorado Department of Agriculture and Colorado Department of Natural Resources — is developing recommendations for a series of management pathways and practices on the state's forests, farms, rangelands and wetlands that would help meet HB 19-1261 goals. These efforts, combined with the Northern Institute of Applied Climate Science forest carbon management menu of adaptation strategies and approaches that were used to develop the goals, strategies and approaches of this action plan [33], will be critical components in creating a statewide carbon strategic plan to support climate change adaptation to **CONSERVE**, **PROTECT** and **ENHANCE** resilient and healthy forest resources.

This Forest Action Plan is part of this process; HB 19-1261 and the Colorado NWL Climate Task Force also are critical to creating healthy and resilient forests in Colorado.



Establishing and maintaining healthy, resilient forests increases their ability to offset greenhouse gas emissions. Photo: CSFS

Carbon: Colorado's Aboveground Forestland Carbon Stocks 2000-2009



Data Source: Wilson, Barry Tyler; Woodall, Christopher W.; Griffith, Douglas M. 2013. Forest carbon stocks of the contiguous United States (2000-2009). Newtown Square, PA: U.S. Forest Service, Northern Research Station. https://doi.org/10.2737/RDS-2013-0004



IDENTIFYING PRIORITIES



A Douglas-fir seedling grows in the hollowed bowl of an old Douglas-fir stump on La Jara Reservoir State Trust Land. Developing healthy forests starts with forest management and identifying priority areas and projects. Photo: Adam Moore, CSFS

Action Plan Process: How the CSFS Involved Stakeholders in Shaping the Future

The Colorado State Forest Service action plan team consulted with external partners and stakeholders to determine six themes with forest stewardship goals that fall under the national priorities of **CONSERVE**, **PROTECT** and **ENHANCE**.

THE FIRST OVERARCHING GOAL of a state forest action plan is to identify areas of greatest need and opportunity for forests. Based on this, three of the six themes were selected to develop a priority composite map for Colorado: forest conditions, living with wildfire and watershed protection.

THE SECOND OVERARCHING GOAL of a state forest action plan is to develop a long-term strategy to address areas of greatest need and opportunity. The CSFS action plan team worked across the five CSFS divisions: Administration, Communications and Communities, Forest Planning and Implementation, Forestry Services, and Science and Data, as well as with partners across the state to achieve this goal (see Contributors, page 83).

The *2020 Colorado Forest Action Plan* highlights statewide, cross-theme resource strategies that will be implemented to address goals in priority subwatersheds, as well as the gap between existing and necessary programs needed to achieve these goals.

The Forest Legacy analysis of need overview is included after the theme sections, and the full analysis is attached as Appendix 1.

BUILDING THE PLAN BEGAN BY SELECTING THEMES

- *Forest Conditions*
- *Living with Wildfire*
- *Watershed Protection*
- *Forest Wildlife*
- *Urban and Community Forestry*
- *Forest Products*

THEME DEVELOPMENT

CLIMATE CHANGE WORKSHOP GUIDED ACTION PLAN THEMES

As forests respond to a changing climate, adaptive forest management uses the best available science to play a role in these responses with the overarching goal of sustaining ecosystem services [35]. To address climate change within the six themes, the CSFS action plan team attended a two-day forest action plan workshop hosted by the Northern Institute of Applied Climate Science and the Department of Forest and Rangeland Stewardship at Colorado State University. During the workshop, the team derived goals, strategies and approaches for each theme.

The workshop used the NIACS Climate Change Response Framework, a cross-boundary approach among land managers, scientists and landowners to incorporate climate change considerations into natural resource management [34].

It was the first workshop of this kind conducted in the development of a state forest action plan and covered regional and local effects of climate change on Colorado's forest ecosystems; adaptive and sustainable forest management; and identification of resources and tools to integrate climate adaption into on-the-ground management.

Through a variety of CSU and NIACS presentations, small-group work sessions and facilitated roundtable discussions, action plan theme leads identified unique climate change impacts; projected likelihood of impacts and severity; selected potential adaptation actions from NIACS menus of adaptation strategies and approaches as applicable; and summarized strategies and approaches for action and monitoring.

For each theme and the Forest Legacy Program content, a risk matrix was used to identify and prioritize projected climate change impacts and severity *(Appendix 2)*.

Adaptation actions derived from the workshop, the NIACS menus of adaptation strategies and approaches, and the Adaptive Silviculture for Climate Change framework were integrated into the strategies and approaches section of each Forest Action Plan theme.

ASCC Research Network Examines How Forest Management Can Adapt for Climate Change

Current forest management methods can integrate adaptive approaches to mitigate climate change effects [35,36].

The Adaptive Silviculture for Climate Change (ASCC) [37] is a long-term research network partnership that currently has one project in the San Juan National Forest of Colorado, and leaders are planning a new project in the Colorado State Forest near Walden in collaboration with the CSFS.

The ASCC conducts experiments across various forest ecosystem types in the U.S. and Canada, linking managers with scientists to produce operational tactics that can facilitate adaptive responses to uncertain future climate. Under the ASCC framework, silvicultural systems can be designed with the intent of resistance, resilience or transition *(Figure G)*.

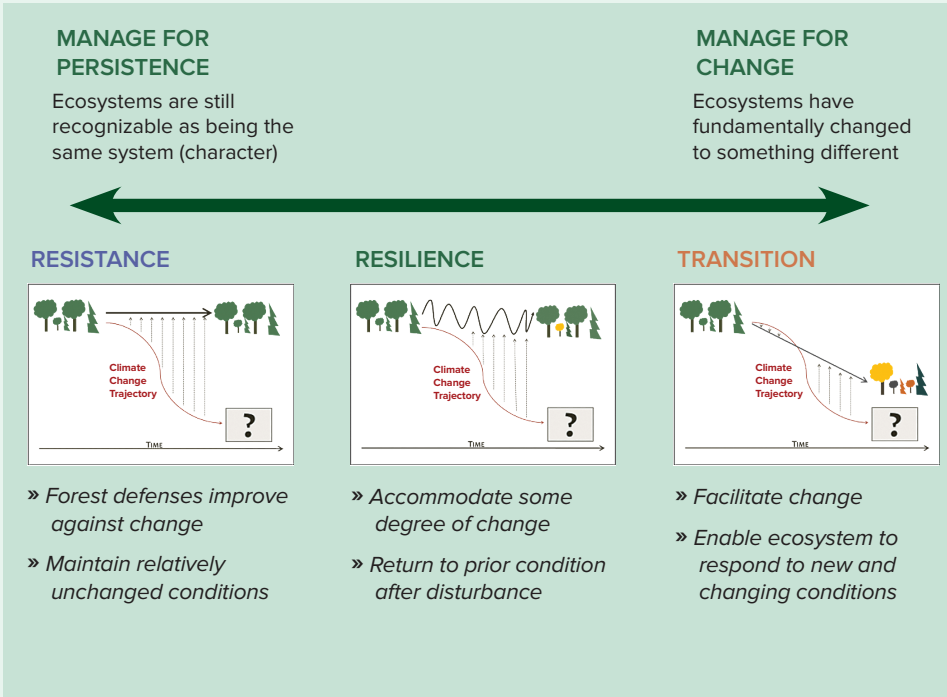


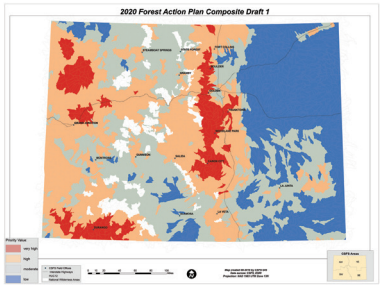
FIGURE G
The Adaptive Silviculture for Climate Change (ASCC) framework [34,37]. Resistance (to change in species composition and structure) will typically require the most investment and effort. Developing more flexible composition and structural goals designed for resilience is more likely to promote elasticity in regard to disturbances and climate shifts. Silvicultural systems designed for transition include alterations to species composition and structure and planning for alternate and adaptive actions over time.

PRIORITY COMPOSITE MAP: A PROGRESSIVE DEVELOPMENT

DRAFT 1

CSFS field office review

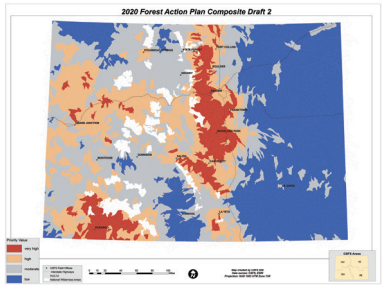
***RESULT:** Adjust statewide layer weights*



DRAFT 2

External review

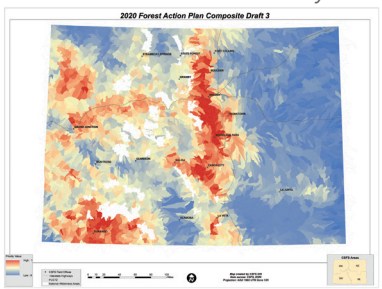
***RESULT:** Adjust statewide layer weights*



DRAFT 3

Forest Health Advisory Council review

***RESULT:** Add CDPHE source water layer*



FINAL MAP

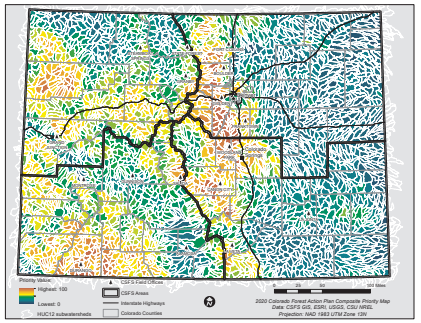


FIGURE H *The Forest Action Plan composite priority map was created through an iterative, participatory process to capture natural resource priorities statewide. Note: Weights for action plan themes are different for each version of the composite priority map. The purpose of this iterative process was to capture the majority of subwatersheds identified as a priority during internal and external meetings.*

Statewide Participation Helped Incorporate Priority Watersheds in Composite Map

The high-priority areas identified in the action plan composite map are subwatersheds where goals from the forest conditions, living with wildfire and watershed protection themes can be achieved on the same management footprint by a project or activity. The CSFS staff, partners and stakeholders joined in collaborative meetings held across the state to lend their knowledge and expertise to the priority mapping effort and strategy development.

Each of these three themes has unique geospatial layers, weighted based on progressive feedback from experts statewide, before being included in the final priority map (*Figure H and detailed GIS methods in Appendix 3*).

ITERATIVE, PARTICIPATORY MAPPING PROCESS

The first draft composite priority map was presented to CSFS staff in each of the four CSFS areas — Northeast, Northwest, Southeast and Southwest. Staff members provided feedback on the level of priority for groups of subwatersheds in their area, addressing the following questions:

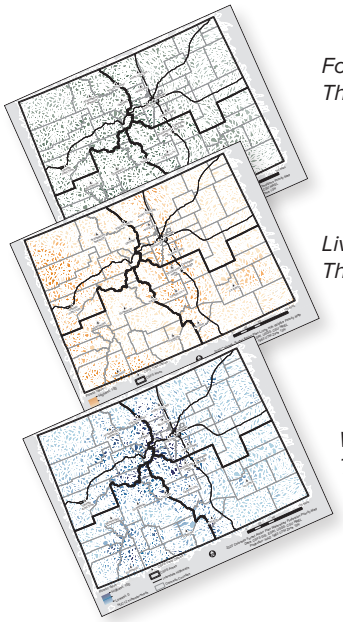
1. What are the goals in this area?
2. What type of work is planned or in progress in this area?
3. What is the scale of the planned or in-progress work?
4. Who are the existing and potential partners in this area?

Using this feedback, the layer weights were tested at a statewide scale and evaluated based on a layer that included all subwatersheds identified in the feedback. The resulting second draft map was based on the weighting scheme that captured the greatest proportion of high-priority subwatersheds.

During the fall of 2019, the CSFS held eight stakeholder outreach meetings across the state to gain feedback from subject

FIGURE I

PRIORITY MAP:
LAYER INCLUSIONS



Forest Conditions Theme Priority Map

+

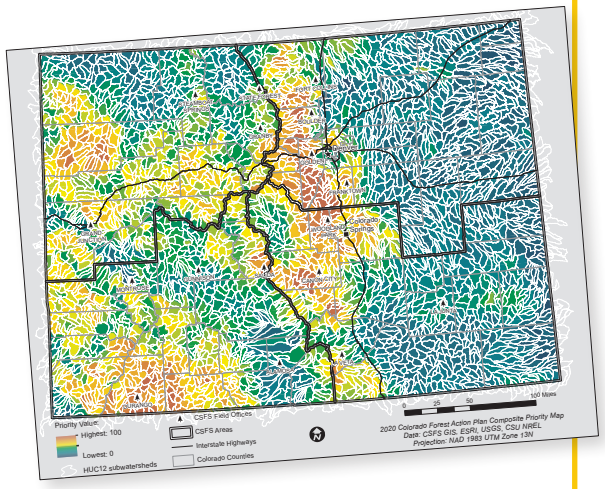
Living with Wildfire Theme Priority Map

+

Watershed Protection Theme Priority Map

=

Priority Composite Map



matter experts on the second draft composite priority map and layers (*Appendix 4*). About 90 partners and stakeholders participated, providing information regarding priority natural resource goals around the state, outlined in the Priority Resource Goals table on page 25.

The CSFS hired an independent contractor to serve as a nonbiased facilitator for these meetings.

"The team took their forest action plan development very sincerely. They took the time to design a process that elicited participants' best thinking and deep experience. ... They considered their experience from the previous forest action plan, learned from that experience and used it to develop this process and this plan. It's how adaptive management is supposed to work when it works well," the contractor said.

Each meeting was structured for participants to work in teams on large, laminate printouts of the second draft map, marking groups of subwatersheds and their level of priority. The teams addressed the same four questions asked of CSFS staff.

Each team presented its map at the meeting and gave the rationale for selecting groups of subwatersheds. The CSFS staff collected the maps and accompanying feedback sheets, then digitized subwatersheds for evaluation *(Appendix 5 map)*.

Feedback from the meetings helped the CSFS identify new statewide layers that could capture critical watershed protection issues (e.g., source water, diversions, conveyances), as well as ancillary geospatial layers to be compiled for use in local projects (e.g., infrastructure – *layer info in Appendix 6*).

After integrating the new watershed protection layers, all potential weighting scenarios were tested and evaluated. Then, the final composite priority map was selected based on the weighting scenario that captured the greatest proportion, 58% *(Appendix 5),* of the subwatersheds that were identified in the internal and external feedback.

All of the composite map layers were processed at the 12-digit hydrologic unit code (HUC) sixth-level scale [38], with continuous values from 0 to 100, where increasing values indicate increasing priority. The 12-digit HUC represents subwatersheds; most are 10,000 to 40,000 acres in size and there are 3,159 in Colorado.

The subwatershed unit was chosen because it represents the required scale to address forest stewardship goals across the state, while incorporating regional variability.

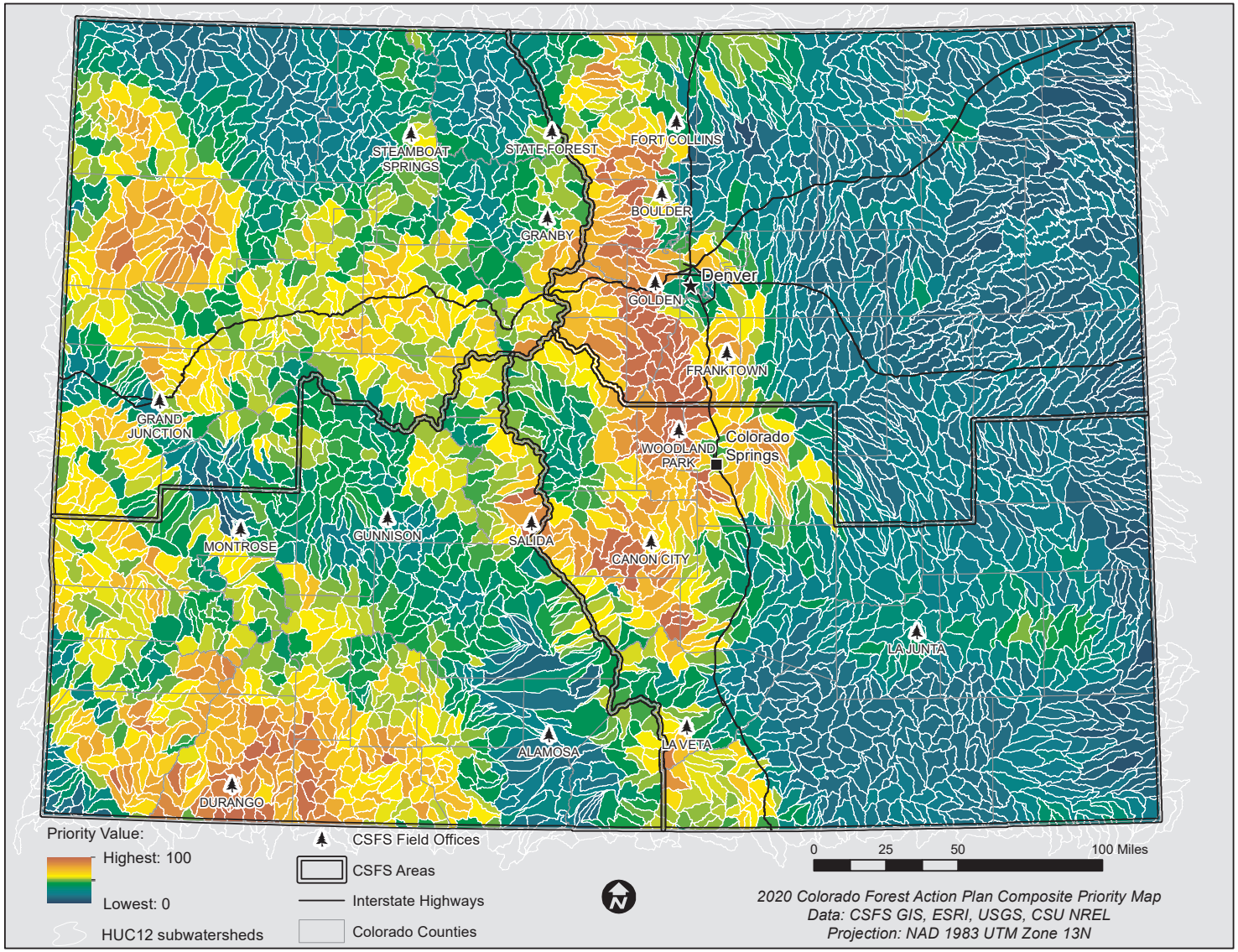


The Colorado Forest Action Plan working group met with regional experts around the state to form the priority composite map. Photo: CSFS

MORE ONLINE

View and download county reports from the composite priority map and theme priority maps in the Forest Action Plan application of the Colorado Forest Atlas, coloradoforestatlas.org

Subwatershed Priority Composite Map: About 10% of Colorado's forests are at the highest priority for action, with a cost of approximately $4.2 billion



Geospatial layers incorporated (Figure I):

» *Forest Conditions Theme Priority Map (weighted 2x)*

» *Living with Wildfire Theme Priority Map (weighted 1x)*

» *Watershed Protection Theme Priority Map (weighted 1x)*

For details concerning geospatial weighting and methodology, see individual theme sections and Appendix 3.

FACTORS AFFECTING TREATMENT COSTS PER ACRE:

- ***Acres —*** *size of project*
- ***Location —*** *travel distance to project site, cost to mobilize equipment*
- ***Handwork —*** *lop and scatter, specialty and involved amount of handwork*
- ***Accessibility —*** *slope/terrain*
- ***Harvesting and hauling*** *vs. mastication vs. lop and scatter vs. on-site whole tree chipping*
- ***Timber sale*** *vs. fuels reduction/forest health project*
- ***Product utilization requirements*** *— hauling timber, mulching, chipping*
- ***Complexity*** *of project*
- ***Equipment and crew*** *needed*
- ***Work around homes*** *(involving handwork/thinning and mastication). High-maintenance projects with frequent revisits, small lots, multiple landowners, structure types and values add complexity. All costs increase in wildland-urban interface.*

(For an analysis of average costs and harvesting case studies, see Appendix 7.)

Treatment Costs Vary Greatly, Depend on Commercial Value, Accessibility

Cost of treatment by acre is highly variable; some forest cover types have little commercial value (e.g., piñon-juniper) and will require high investment per acre. Large landscapes that are identified as high priority are sometimes largely inaccessible based on topography. Regional to local data and information should be incorporated in priority subwatersheds to identify additional considerations including operational capacity.

Total Acres of Colorado Forestland in priority watersheds, by cover type

All numbers are estimates. Treatment costs do not include overhead/administration, which averages 35% but can be up to 51%.

Forest Cover Type	Total acres in state	Acres in composite priority sub-watersheds	% of total acres in composite priority sub-watersheds*	Acres treated in composite priority subwatersheds 2008-2017**	% total acres in composite priority sub-watersheds treated 2008-2017**	Average cost per acre for treatment ***	Total cost for untreated acres
Piñon-Juniper	5,162,565	664,579	12.9	6,125	0.9	$1,733	$1,141,100,782
Mixed Conifer	2,490,326	667,949	26.8	65,235	9.8	$2,087	$1,257,864,118
Spruce-Fir	4,679,814	202,948	4.3	7,224	3.6	$1,925	$376,768,700
Ponderosa Pine	2,081,808	482,355	23.2	53,084	11.0	$1,581	$678,677,451
Conifer-Hardwood	2,290,536	203,429	8.9	12,554	6.2	$1,500	$286,312,500
Hardwood	2,807,121	111,255	4.0	6,730	6.0	$1,416	$148,007,400
Oak Shrubland	2,183,640	77,361	3.5	3,503	4.5	$1,050	$77,550,900
Lodgepole Pine	1,676,906	86,617	5.2	12,306	14.2	$1,700	$126,328,700
Riparian	833,745	67,029	8.0	4,869	7.3	$1,950	$121,212,000
Conifer	116,593	2,856	2.4	85	3.0	$2,087	$5,783,077
STATE TOTAL/AVG.	**24,323,054**	**2,566,378**	**10.6**	**171,715**	**6.7**	**$1,702.90**	**$4,219,605,628**

**Considered subwatersheds with priority value greater than 60. Values of 60 considered high priority based on natural breaks in the data.*

***Includes CSFS, USFS, BLM. Dissolved based on geometry — only physical vegetation management at stand and plan level, prescribed fire and wildfire; does not include planned projects*

****CSFS estimates; does not include cost offsets for timber sales*

Identifying Priorities: Where watersheds meet regional resource goals

Priority Resource Goals	Number of HUC 12 subwatersheds identified
Reduce risk of uncharacteristic wildfire	453
Enhance wildlife habitat	282
Protect drinking water infrastructure	254
Protect drinking water supply	238
Riparian habitat restoration	165
Improve resiliency to pests and pathogens	149
Protect irrigation water supply	81
Protect power infrastructure	80
Maintain transportation corridors	63
Mitigate bark beetle impacts	62
Enhance recreation and tourism opportunities	54
Watershed protection	53
Community protection	39
Policing dispersed recreation/transient population	39
Protect cultural resources	37
Maintain forest products industry	33
Protect communication infrastructure	24
Protect active mining operations	23
Protect important forest areas from development and fragmentation	21

Counting Subwatersheds Helps Prioritize

One of the outcomes of the statewide meetings was identifying priority resource goals based on regional knowledge. Calculating the number of HUC 12 subwatersheds that could be associated with each goal helped prioritize them. Reducing wildfire risk was the top priority statewide, with 453 subwatersheds identified based on this resource goal.

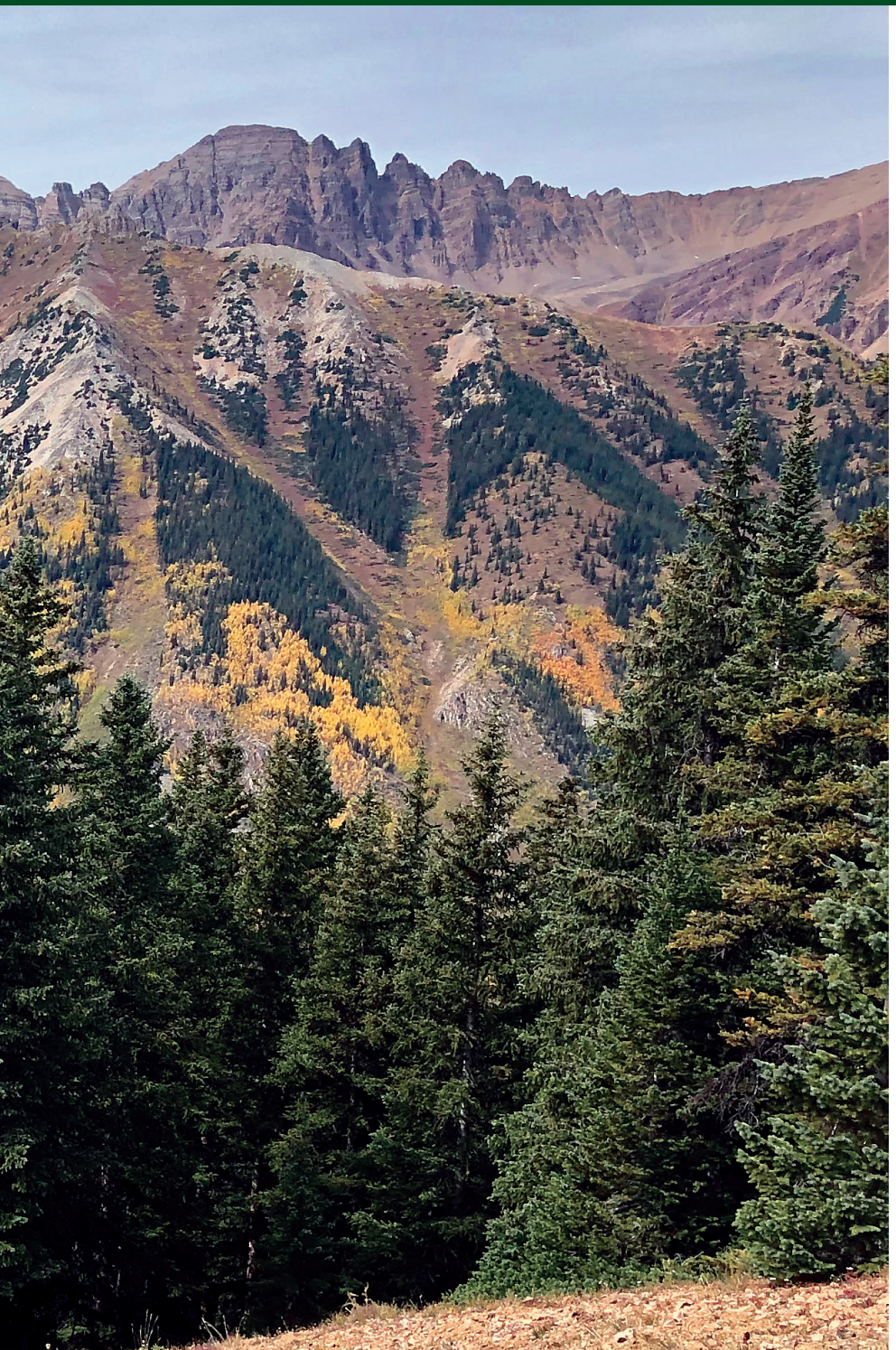
One unexpected outcome of this exercise was the prioritization of power and communication infrastructure protection. The CSFS compiled statewide data for these infrastructure types and developed a subwatershed prioritization map for each that can be used as ancillary data *(Appendix 6)*.

Priority Resource Goals	Number of HUC 12 subwatersheds identified
Protect national monuments	21
Protect train infrastructure	9
Prevent flooding, sediment delivery, erosion	8
Facilitate social community adjustments through a deeper understanding of living with fire	7
Erosion prevention	7
Mitigate recreation impacts	5
Preserve and protect biodiversity	5
Restore departed forest conditions	4
Protect gas infrastructure	3
Aspen enhancement	2
Restore native species	2
Prevent timber encroachment	2



The White River National Forest between Aspen and Crested Butte is one of the areas CSFS Forest Inventory and Analysis crews routinely survey. The CSFS crews are leaders in FIA certification training and data academy workshops within the Interior West. Photo: Wilfred Previant, for CSFS

FOREST THEMES AND GOALS



Action Plan Themes: Focus Areas for Improving Forest Health in Colorado

Each of the six action plan themes includes conditions and trends, challenges and threats, goals, strategies and approaches, as well as a theme map.

The goals of each theme align with the national priorities.

28 FOREST CONDITIONS

46 FOREST WILDLIFE

34 LIVING WITH WILDFIRE

52 URBAN AND COMMUNITY FORESTRY

40 WATERSHED PROTECTION

58 FOREST PRODUCTS

National Action Plan Priorities

CONSERVE working forestland

PROTECT forests from harm

ENHANCE public benefits from trees and forests

FOREST CONDITIONS

Background

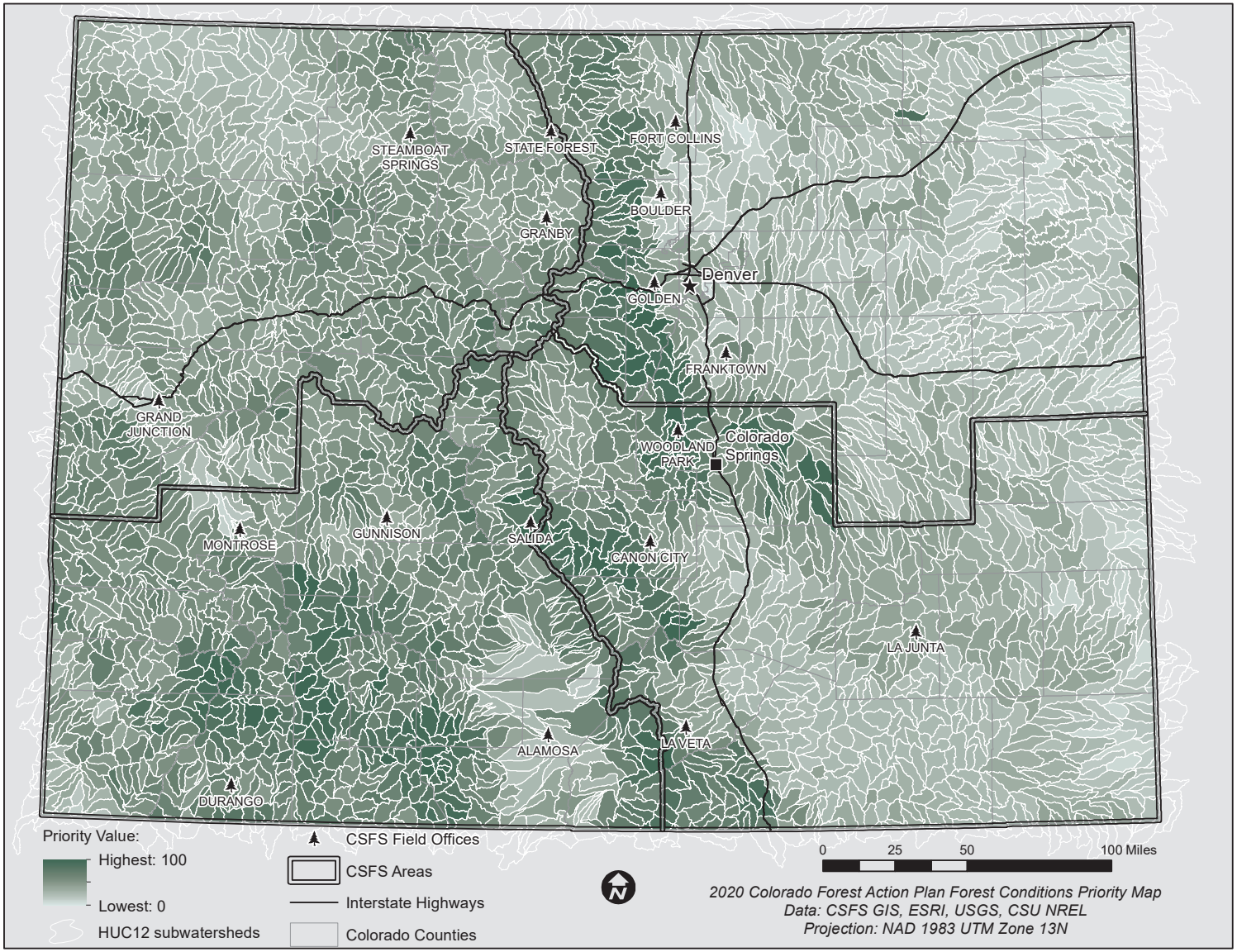
Colorado's approximately 24 million acres of forested lands [2] can be classified into general forest types based on primary canopy cover and environmental conditions including elevation, climate and soils. Major forest types in Colorado include conifer-hardwood, conifer, mixed conifer, hardwood (primarily aspen), lodgepole pine, oak shrubland, piñon-juniper, ponderosa pine, riparian and spruce-fir.

Approximately 65% of Colorado's forests are under federal management, primarily by the U.S. Forest Service and the Bureau of Land Management [1]. Private ownership accounts for approximately 30% of forestland. The remaining 5% spans various public entities including state, county and city, tribal and nongovernmental organizations *(Figure B)*.

Forests provide a wide range of social, economic and ecological benefits, including clean water for agriculture, municipal and industrial use, habitat, grazing, nutrient cycling and soil retention, improved air quality, carbon sequestration (uptake) and storage, recreational opportunities and resource use, as well as offer residents cultural significance and a sense of place.

CSFS Forester Ashley Garrison holds up a prism as part of a survey in a ponderosa pine plot for forest inventory data. Inventories help determine forest management needs based on current tree counts and conditions. Photo: CSFS

Subwatershed Priority Map for Implementing Forest Condition Goals



Geospatial layers incorporated:

These layers were selected to evaluate potential forest threats in the coming decades.

- *Basal area (density) loss projected based on potential insect and disease disturbance through 2027 (weighted 2x) [39]*
- *Potential for canopy fire in 2017 (weighted 2x) [2]*
- *Wildland-urban interface (WUI) projected to 2040 (proxy for land use conversion) (weighted 1x) [29]*

CONDITIONS AND TRENDS

» **Over 22% of the standing tree volume in Colorado's forests is dead wood**, with the leading causes of mortality being insects (65%), disease (23%) and fire (4%) [40,41]. Increasing pressures on forests will continue as temperature increases affect natural defenses from insects and disease.

» **Longer fire seasons are expected**, with larger and more intense wildfires. The three wildfires that have accounted for the largest loss of structures in Colorado have all occurred in the past decade — High Park, Waldo Canyon and Black Forest fires [42].

» **Colorado's population is predicted to increase** another 41%-70% from 2015 levels by 2050 [28], much of which will be in the wildland-urban interface and contribute to forest conversion. In addition, increasing population will increase demands on recreation and other forest uses.

» **Some forests are experiencing a negative net growth** (live tree volume increase relative to dead tree loss) when considering species (e.g., lodgepole, aspen, piñon-juniper, true fir) 5 inches or larger in diameter [40].

CHALLENGES AND THREATS

» **An increase in insect and disease activity** and its effects on forests

» **Lengthening wildfire seasons** with larger, higher intensity wildfires

» **Lack of seedling regeneration** after forest disturbance

» **Reduced soil moisture** in summer

» **Warmer temperatures**, both annual and seasonal

» **Conversion of forest** to nonforest through development and disturbance



Planting seedlings and reforesting areas impacted by large-scale disturbances, such as wildfire, is an important approach to address forest conditions. Photo: CSFS

GOALS AND STRATEGIES

GOAL #1



CONSERVE



PROTECT

KEEP FORESTS AS FORESTS

Conversion and fragmentation of forests comes in many forms including disturbances, land use conversion, climate stressors and air pollution. While these changes in forest cover may occur due to various drivers, maintaining and improving forestland provides valuable ecosystem services. Forest management challenges can increase substantially with fragmentation, which complicates planning and implementation across jurisdictional boundaries. Colorado's forests respond to disturbances in a variety of ways based on forest type, climate stress and usage.

STRATEGY 1: Maintain and, where practical, increase forest cover. Promote forest retention and creation.

Approaches

1. Enhance economic incentives, such as the Colorado Forest Agriculture incentive and Forest Legacy Program
2. Promote silvicultural practices that support forest regeneration
3. Encourage natural regeneration through forest management
4. Address afforestation and reforestation through planting and re-planting trees appropriate to current and expected future conditions (especially post-disturbance)
5. Use agroforestry such as wind breaks, living snow fences, tree farms and silvopasture practices in agricultural settings
6. Use native or new, future-adapted genetic variations of species as appropriate in restoration and adaptive management projects

STRATEGY 2: Reduce the impacts of biological stressors. Manage for more resilient forests that can better survive disturbances and changing climate.

Approaches

1. Use silvicultural practices that identify and promote biological and structural diversity, including thinning and regeneration techniques
2. Remove/prevent invasive and non-native species
3. Actively manage forests to improve resilience to insects and disease

STRATEGY 3: Plan for post-disturbance recovery and transition.

Approaches

1. Preserve forest systems that will maintain resilience to future disturbance
2. Monitor and manage for potential transitions in forest systems
3. Promote post-fire recovery through various means including planting and soil stabilization

---

GOAL #2



PROTECT



ENHANCE

IMPROVE FOREST PRODUCTIVITY

This requires expert interaction with local knowledge that addresses the challenges of maintaining current forest productivity, recognizes the difficulties of improving productivity and understands the effort and capacity required to renew forest productivity following disturbances.

A wide variety of silvicultural tools and techniques can be used to actively manage forest structure, composition and diversity to improve productivity and forest health. By sustainably improving productivity, Colorado's current and future forests will be more adaptable, have increased carbon sequestration rates, be more resistant and resilient to short- and long-term disturbances, provide for a more robust timber market and improve habitat, water and air quality.

STRATEGY 1: Maintain and enhance species and structural diversity and complexity. Diversify species and structure to provide myriad ecosystem services.

Approaches

1. Maintain and enhance existing and new forest productivity by managing for diversity in tree age and size classes and stocking/density
2. Address afforestation and reforestation using viable species with the potential to increase forest productivity over time
3. Retain dead trees, both standing and fallen, to maintain carbon storage stocks and provide high-quality habitat cover and food for wildlife
4. Support a wood products industry to harvest stored carbon and promote regeneration for future



Forester Nate Beckman, right, meets at a residence near Golden to discuss an ongoing fuels mitigation project to remove debris and dead trees and create migration corridors for wildlife in the populated foothills area. The family is working with the CSFS to ensure the needs of wildlife are met while also reducing wildfire risk on their property. Photo: Amy Bulger, CSFS

GOALS AND STRATEGIES (CONT.)

GOAL #2



PROTECT



ENHANCE

carbon storage and sequestration

STRATEGY 2: Promote the ability of forest systems to resist and rebound from disturbances.

Approaches

1. Manage fire-dependent forest systems to maintain and promote resistance to fire mortality
2. Protect regeneration and planting from mortality induced by environmental factors or human activity
3. Seed and replant post-disturbance to renew the forest system's carbon storage and sequestration capacity, especially in young stages of relatively rapid growth

TALK LIKE A FORESTER

ADAPTIVE MANAGEMENT
is a structured, iterative process for decision making to reduce uncertainty through structured hypothesis testing and monitoring of outcomes. This approach supports decision making that meets resource management objectives while simultaneously accruing information to improve future management (*as defined by the U.S. Forest Service*).

GOAL #3



CONSERVE



ENHANCE

PROMOTE ADAPTIVE MANAGEMENT

Use adaptive management to support current sustainable forests and plan for future disturbances and forest type change, acknowledging that environmental, social and economic changes require adaptation. This will require identifying forested areas and forest systems that are healthy and resilient to environmental and economic pressures. In addition, as environmental and economic conditions change, there is a need to identify forest types that will be more resilient to disturbance and environmental change.

In conjunction with adaptive management, developing monitoring protocols and social approval of forest management are critical to success.

STRATEGY 1: Reduce impacts of biological stressors. Manage for appropriate diversity and complexity in species, age and size.

Approaches

1. Manage for resistant and resilient forest composition, age, structure and function
2. Mitigate invasive plant species
3. Consider reforestation with species mixes better suited to expected future climate conditions

STRATEGY 2: Facilitate forest community adjustments through species retention and transitions. Promote continued ecosystem function by managing species and structure.

Approaches

1. Encourage native species that are expected to adapt to future conditions
2. Protect seedlings and saplings
3. Identify productive sites and best adapted species
4. Monitor natural regeneration response to changing environmental conditions

STRATEGY 3: Maintain and create refugia (areas of relative stability to climate change). Identify desired forested landscape compositions that are resilient.

Approaches

1. Inform management decisions regarding key desirable tree species and forest structure
2. Create species reserves both in forests and in nursery operations, including legacy trees
3. Monitor for forest response to treatments and harvesting, natural disturbance and climate change

LIVING WITH WILDFIRE

Background

Fire plays a critical role in maintaining the health of fire-dependent forest, shrubland and grassland ecosystems in Colorado. Some lower-elevation forests rely on frequent, low-intensity fires to control regeneration and reduce understory vegetation, while some high-elevation forest types, such as lodgepole pine, rely on high-intensity fire to regenerate the forest. However, a long history of fire suppression and lack of forest management have altered historical fire cycles and led to a dangerous buildup of fuels in some areas, leading to higher incidence of uncharacteristic wildfire.

Fire creates carbon emissions through direct burning followed by the decay of trees and other vegetation destroyed by the fire. Uncharacteristic wildfires can damage soils and impair future forest recovery, which leads to potential loss of future carbon sequestration from those acres impacted [33].

Population growth into the wildland-urban interface — the area where structures and other human developments meet or intermingle with wildland vegetation — presents additional challenges for public safety and community resiliency [43]. As more people choose to live in wildfire-prone areas, additional homes and lives are at increased risk of being affected by wildfires. Wildfire risk is calculated by three factors: the likelihood of a fire occurring (likelihood), the fire behavior when a fire occurs (intensity) and the effects of the fire on highly valued resources and assets (susceptibility) [30].

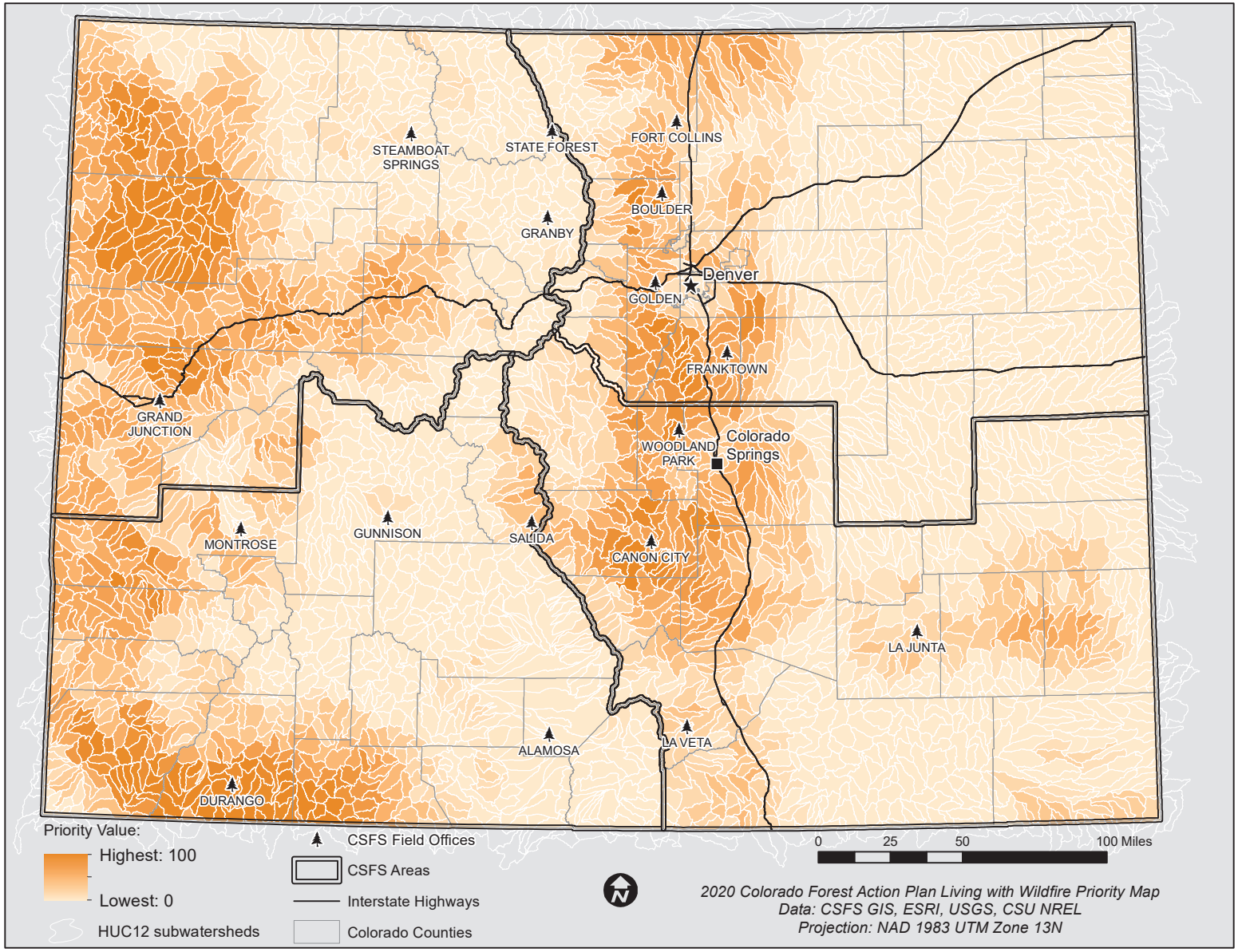
The National Cohesive Wildland Fire Management Strategy is the framework land management agencies and stakeholders use for addressing wildfire issues in Colorado. This strategy is a collaborative process that seeks all-lands solutions to wildland fire management issues, focusing on three goals: 1) restore and maintain resilient landscapes; 2) create fire-adapted communities; and 3) safe and effective fire response.

In Colorado, the first two goals are the primary responsibility of the CSFS, while goal three is the primary responsibility of the Division of Fire Prevention and Control. The Forest Action Plan focuses on addressing resilient landscapes and fire-adapted communities. Fire management goals and strategies are addressed in DFPC's August 2018 *Strategic Plan for Supporting Colorado's Fire Agencies*.



Over half of Colorado residents live in the wildland-urban interface, where wildfires can quickly threaten homes. Blackened, still-smoldering trees show where the 2018 Buffalo Mountain Fire neared houses in Silverthorne. Fuel breaks that buffer these neighborhoods helped firefighters halt the blaze, illustrating the necessity for wildfire risk reduction as the state's population continues to grow into WUI areas. Photo: U.S. Forest Service

Subwatershed Priority Map for Implementing Living with Wildfire Goals



Geospatial layers incorporated:

» *Wildfire risk 2017 — defined as the possibility of loss or harm occurring from a wildfire and includes four values at risk: current wildland-urban interface, drinking water assets, forest assets and riparian assets, which are combined with burn probability. Layer weights consistent with 2017 Colorado Wildfire Risk Assessment [2].*

CONDITIONS AND TRENDS

» **Of the 10 largest recorded wildfires** in Colorado history, seven have occurred since 2010 and have burned more than 897,000 acres combined [42].

» **The wildfire season has lengthened** due to a changing climate, resulting in wildfires that start earlier, last longer, cost more to suppress, cause more damage and threaten more lives than ever before. Climate impacts and vulnerabilities are influencing vegetation and fire occurrence through warmer temperatures (annual and seasonal), more days with extreme heat and more variable precipitation.

» As of 2017, more than 2.9 million people, **half of the state's population, live in Colorado's wildland-urban interface** [2]. The largest recent increases in population growth within the WUI are in areas where agricultural lands are becoming fallow or being developed. Currently, the WUI covers approximately 3.2 million acres in Colorado; models project it could encompass over 9 million acres by 2040 [29]. Colorado's population will increase another 41%-70% from 2015 levels by 2050 (7.7 million to 9.3 million) [28]. As Colorado's population increases in the WUI, human exposure to the negative impacts of wildfire, including post-fire erosion impacting water sources and reduction in air quality due to smoke, will become a significant public health issue.



BEFORE



AFTER

The same tree with a crooked trunk in the center of these photos shows how a CSFS forest management project near Evergreen cleared dense trees to reduce wildfire risk. Tree thinning is one forest management tool that can bolster forest health and protect property. Photo: Emma Brokl, CSFS

» **Communities have been proactively addressing wildfire hazards** through the development of Community Wildfire Protection Plans (CWPPs). These plans bring together diverse local interests to discuss mutual concerns for public safety, community sustainability and natural resources [44]. Currently there are 239 CWPPs in Colorado (50 county-level, 48 fire protection district-level and 141 local-level). CWPPs can quickly become outdated due to lack of capacity, changes in community structure, available information and technology. Over 85% of Community Wildfire Protection Plans are over five years old, and almost half are more than 10 years old.

» **Social dynamics in the WUI add complexity** to wildfire risk reduction strategies: longer-term residents with legacy community knowledge relocate [45], and differences are seen between urban and rural populations in shared values and perspectives, as well as in organizing as a community [46].

CHALLENGES AND THREATS

» **Community capacity for wildfire risk reduction planning** and implementation

» **Wildfire risk reduction activities** are often done at the scale of an individual parcel, rather than strategically linked across communities and landscapes

» **Limited understanding of living in a fire-dependent environment** including risk from wildfire and potential post-fire impacts (socio-economical, environmental)

» **Lack of understanding of fire-adapted community concepts** amongst stakeholders

» **Limited understanding of social dynamics** within WUI communities

» **Lack of consistent land use regulations and building codes** to address infrastructure in WUI areas

» **Uncertainty about climate** impacts and vulnerabilities

» **Limited wood products markets**, contractors and funding for fuels reduction activities

» **High potential for wildfire smoke** to impact more people due to an increase in the size and intensity of wildfires, paired with increased population in and near the WUI

» **Current level of planning and implementation** of wildfire risk reduction activities does not typically occur at the scale necessary to reduce wildfire risk

» **Social and environmental constraints** of using prescribed fire

GOALS AND STRATEGIES

GOAL #1

PROTECT

ENHANCE

PROMOTE COMMUNITY FIRE ADAPTATION

Fire-adapted communities take personal responsibility and implement actions to reduce wildfire risk. These communities consider people, developments, businesses, infrastructure, cultural resources and natural resources in planning efforts to prepare for the effects before, during and after a wildfire. Actions communities take not only reduce wildfire risk but also increase forest health through sound management practices.

The goal is to make communities and ecosystems more resilient to the negative impacts of wildfire and to create safer and healthier conditions for both people and the environment.

STRATEGY 1: Facilitate social community adjustments through a deeper understanding of living with wildfire.

Approaches

1. Collaborate with land management agencies, fire protection districts, place-based collaboratives and insurance organizations to promote fire-adapted concepts that lead to reduction of risk to communities
2. Utilize existing programs and networks (i.e., Firewise USA®, Ready-Set-Go, Fire Adapted Communities Learning Network)
3. Realign community expectations before, during and after a wildfire
4. Ensure wildfire risk reduction information is current and incorporates the latest science (socio-economical, environmental)
5. Work with communities to improve the understanding of living in a fire-dependent environment
6. Take advantage of current events (i.e., a local fire) to engage communities

STRATEGY 2: Enhance community wildfire risk reduction planning.

Approaches

1. Support the development, revision and implementation of Community Wildfire Protection

GOALS AND STRATEGIES (CONT.)

GOAL #1



PROTECT



ENHANCE

Plans. Integrate CWPP elements into the Federal Emergency Management Agency's Hazard Mitigation Plans

2. Maintain and enhance the Colorado Wildfire Risk Assessment to provide a consistent statewide risk assessment for risk reduction planning efforts
3. Promote placed-based efforts for wildfire risk reduction activities
4. Reduce structural ignitability; establish and enhance evacuation routes
5. Enhance land use planning through adoption of building codes that address home ignition zone concepts
6. Integrate post-fire recovery (social and environmental), smoke impacts, evacuation and at-risk population considerations into CWPPs

STRATEGY 3: Increase pace and scale of wildfire risk reduction efforts.

Approaches

1. Coordinate fuels treatments at a scale, and strategic value, that will significantly reduce wildfire risk
2. Support local funding solutions for wildfire risk reduction work (i.e., county ballot initiatives)
3. Collaborate with local, state and federal land management agencies, communities and private landowners to link fuel treatments to increase effectiveness on a landscape scale

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GOAL #2



CONSERVE



PROTECT



ENHANCE

REDUCE THE RISK OF UNCHARACTERISTIC WILDFIRE

Wildfire plays a critical role in fire-dependent ecosystems; however, current fuel and climate conditions are contributing to uncharacteristic wildfires that are having negative impacts on watersheds and communities. Focusing on reducing risk through vegetation management will help minimize the negative impacts of wildfires.

STRATEGY 1: Reduce the risk and long-term impacts of severe disturbances.

Approaches

1. Alter forest structure or composition to reduce risk or severity of wildfire
2. Collaborate with local, state and federal land management agencies, communities and private landowners to link fuel treatments to increase effectiveness on a landscape scale
3. Promptly revegetate sites after disturbance with appropriate plant material

STRATEGY 2: Maintain and enhance species and structural diversity.

Approaches

1. Promote diverse forest age classes where ecologically appropriate
2. Maintain and restore diversity of native species
3. Utilize fire as a tool, including prescribed fire and managed wildfire

STRATEGY 3: Facilitate community adjustments pre- and post-disturbance through species transitions.

Approaches

1. Favor or restore native species that are expected to be adapted to future conditions
2. Guide changes in species composition at early stages of stand development
3. Disfavor species that are distinctly maladapted
4. Manage for species and genotypes with wide moisture and temperature tolerances

GOAL #3

ENHANCE

PROMOTE THE ROLE OF FIRE IN ECOLOGICAL PROCESSES

Fire plays a critical role in Colorado's ecosystems and years of exclusion have negatively affected forest health and function. Integrating fire back onto the landscape through prescribed fire and managed wildfire will improve forest health and reduce the negative impacts of wildfire on human populations. Prescribed fire is an effective means to reduce hazardous fuels and to reintroduce fire into fire-dependent ecosystems. The amount of smoke produced from prescribed fires is significantly less compared to the amount generated during large wildfires, especially long-duration fires [47]. Prescribed fires can help mitigate adverse public health impacts of larger wildfires.



Prescribed burning is an effective tool in forest management, clearing understory vegetation that may otherwise make wildfires burn with greater intensity. Photo: CSFS

STRATEGY 1: Sustain fundamental ecological functions.

Approaches

1. Reduce impacts to soils and nutrient cycling
2. Reduce competition for moisture, nutrients and light
3. Restore or maintain fire in fire-dependent ecosystems by using it as a tool to achieve species and structural diversity

STRATEGY 2: Improve the understanding of the role fire plays in Colorado's ecosystems, including the need for using prescribed and managed wildfire as tools.

Approaches

1. Increase diversity of partners engaged in the Colorado Prescribed Fire Council
2. Increase outreach and education around fire's natural role in Colorado's ecosystems and the trade-offs of using prescribed fire versus wildfire smoke impacts

STRATEGY 3: Increase the use of prescribed and managed wildfire.

Approaches

1. Foster relationships among researchers, managers, practitioners and emergency responders to facilitate knowledge transfer and resource sharing
2. Integrate potential prescribed fire projects in planning efforts (e.g., forest management plans, CWPPs)
3. Identify areas to manage fire to reduce fuels and restore ecosystems. Coordinate with appropriate entities and integrate information into response plans and management actions

WATERSHED PROTECTION

Background

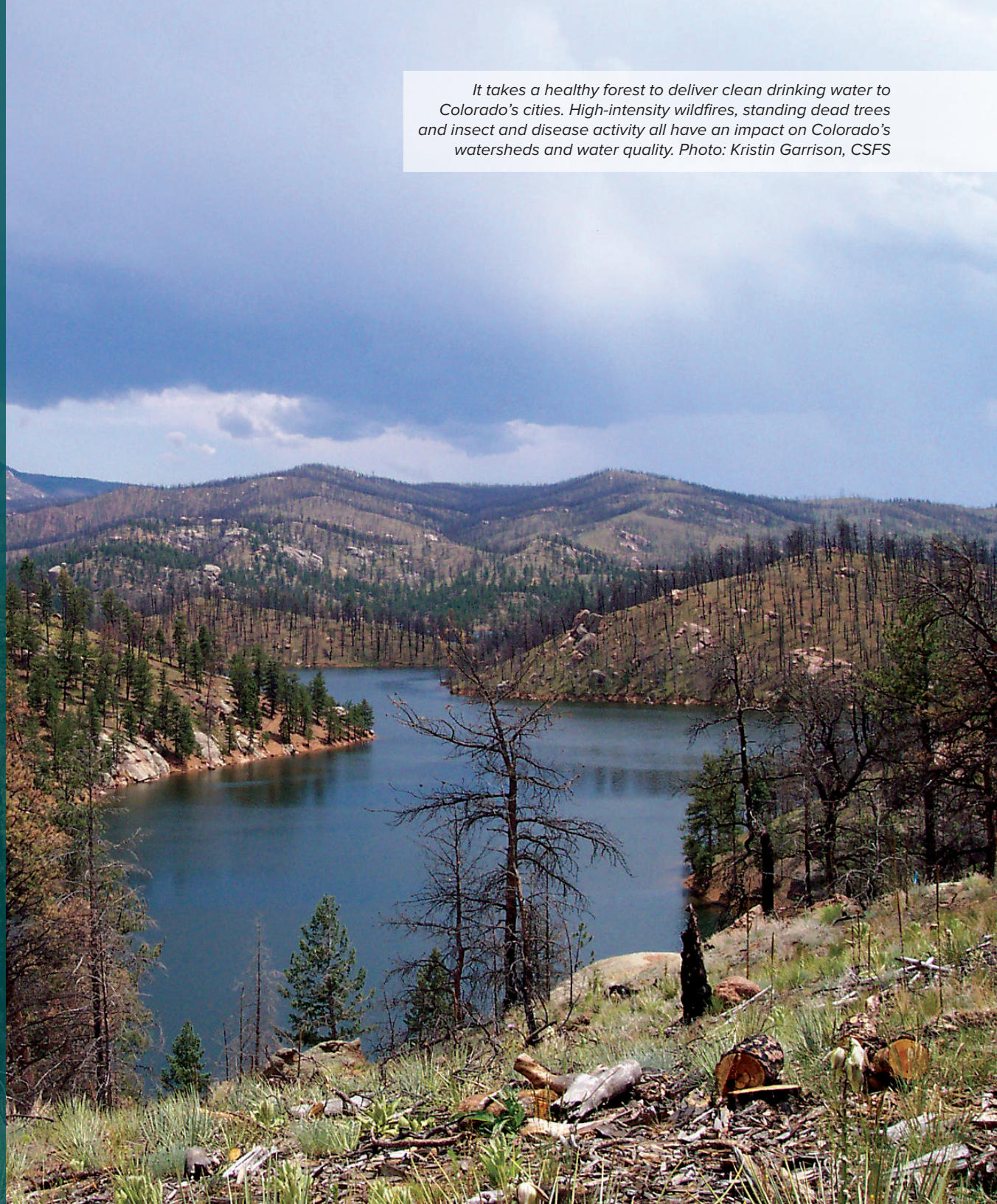
Sustainable water supplies are one of the most critical natural resources in the American West. There is an important connection between the health of forested watersheds and downstream water quality.

According to Colorado's Water Plan, developed by the Colorado Water Conservation Board and its partners, much of the West relies on Colorado for water, with 18 other states and Mexico receiving some supply from the state's watersheds [4]. Water sourced in Colorado has value for a broad range of uses that support economies, livelihoods and the environment, including agricultural production, municipal consumption, recreational activities and wildlife. Colorado's semi-arid climate, recurring droughts and competing demands for an increasingly limited resource make sound management of these water supplies critical.

Colorado's forested watersheds provide the supply of clean water and biological diversity needed for a future that is balanced economically, socially and ecologically. To **CONSERVE**, **PROTECT** and **ENHANCE** Colorado's headwaters requires adaptive forest management.

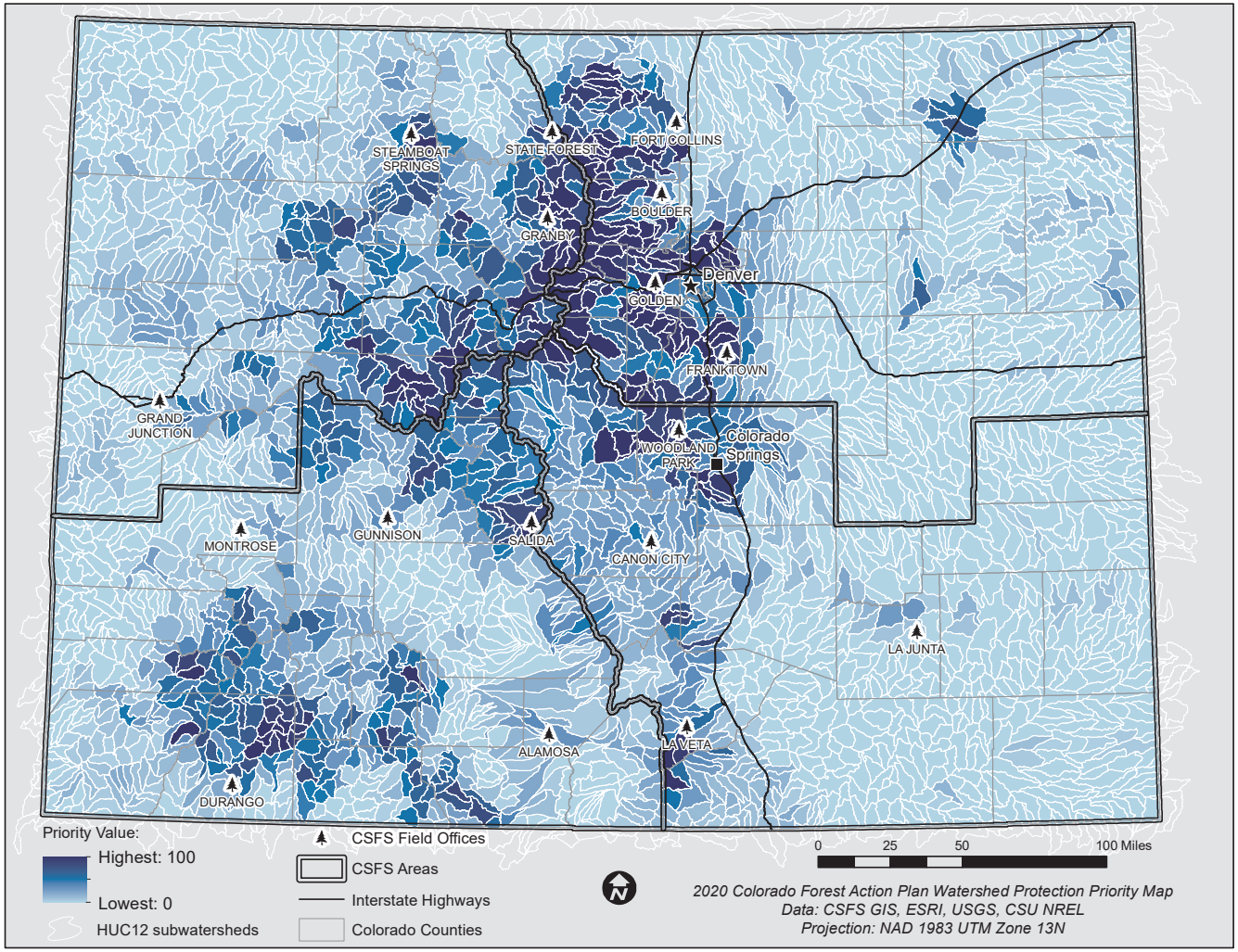
Although forest disturbances including wildfire and insect and disease outbreaks are a natural part of the environment, Colorado has experienced increasing numbers of large, high-intensity wildfires and unparalleled levels of bark-beetle-caused tree mortality [48]. These disturbances are creating concerns over the sustained delivery of clean water from forested watersheds. Effects of uncharacteristic wildland fire on watershed health include sedimentation of water supply infrastructure, undesirable changes in forest conditions and decreased water quality.

Continued integration of forest and watershed health is a critical action to address Colorado's water future. The alignment of management strategies that support the synergy between forests and water will be integrated within future iterations of the Colorado Water Plan. The Colorado Forest Action Plan will inform and mutually support the state's water supply planning efforts.



It takes a healthy forest to deliver clean drinking water to Colorado's cities. High-intensity wildfires, standing dead trees and insect and disease activity all have an impact on Colorado's watersheds and water quality. Photo: Kristin Garrison, CSFS

Subwatershed Priority Map for Implementing Watershed Protection Goals



Geospatial layers incorporated:
Two subthemes were incorporated. Data were integrated from the Colorado Department of Public Health and the Environment's Source Water Assessment and Protection (SWAP) Program to improve consistency with other statewide prioritization efforts.

Subtheme 1 — *Improve and maintain the quality of water (weighted 2x)*
- *Municipal drinking water intakes served by area [49]*
- *Surface water zones [49]*
- *Predicted post-fire erosion rates [50]*
- *Groundwater under the influence of surface water zones [49]*
- *Groundwater zones [49]*

Subtheme 2 — *Infrastructure (weighted 1x)*
- *Conveyances — open channels, ditches, open-channel tunnels [49]*
- *Surface water diversion intakes [49]*
- *Surface water source intakes [49]*
- *Groundwater under the influence of surface water intakes [49]*
- *Groundwater wells [49]*



Midway through thinning in the Pikes Peak Watershed South Slope project, cut logs wait to be decked and removed. Active forest management plays a critical role in maintaining sustainable sources of drinking water needed for Colorado's future. Without it, wildfire and insect-caused tree mortality can adversely affect the quality of water coming from forested watersheds such as this one. Photo: Andy Schlosberg, CSFS

CONDITIONS AND TRENDS

» **Climate change, drought and unhealthy forests** are increasing the occurrence of large wildfires and widespread insect and disease outbreaks. These disturbances negatively impact water quality.

» **Projections of increased disturbance frequency and severity** create concerns regarding the sustained delivery of clean water from headwater forests. According to Colorado's Water Plan, approximately 80% of Colorado's population relies on forested watersheds to deliver municipal water supplies [4]. In addition, Colorado residents, industry and agriculture will have an increasing demand for water as the population increases another 41%-70% from 2015 levels by 2050 [28].

» **A 50%-200% increase in area burned annually** is projected in Colorado by 2050 [24].

» **Over 6 million acres of forestland have been affected by insect outbreaks** in Colorado since the mid-1990s [51].

CHALLENGES AND THREATS

» **Conversion of forest cover**, including species type and deforestation

» **Increase in forest insects and disease**

» **Increase in uncharacteristic wildfire** (frequency, severity and duration)

» **Lack of seedling regeneration** post-disturbance

» **Seasonal changes in precipitation** — more frequent heavy precipitation events and prolonged drought

» **Reduced soil moisture**

» **Population growth** places an additional strain on a limited water supply

» **Maintaining a balance** between public access and protection, including the need for road construction (access vs. impacts)

GOALS AND STRATEGIES

GOAL #1



CONSERVE



PROTECT



ENHANCE

IMPROVE AND MAINTAIN WATER QUALITY AND QUANTITY

Sustained delivery of clean water is closely linked with the health of headwater forests. Water originating from well-managed forested watersheds typically has lower nutrient and sediment concentrations than water originating from forestland in an unhealthy condition.

STRATEGY 1: Maintain and enhance water quality.

Approaches

1. Moderate surface water temperature increases by establishing riparian areas to increase canopy coverage that shades surface water
2. Follow Forestry Best Management Practices to Protect Water Quality in Colorado [52] or other best management practice guidance when engaging in all forest management activities, including product harvests, fuels mitigation projects and forest health treatments
3. Manage headwater forests with efforts that will reduce the risk of post-fire erosion
4. Maintain mature riparian forests
5. Reduce loading of nutrients and other pollutants

STRATEGY 2: Accommodate altered hydrologic processes.

Approaches

1. Manage forests to be able to sustain during periods of decreased water availability
2. Enhance the ability to retain water as snowpack within forests
3. Prepare for frequent, heavy precipitation events and flooding

STRATEGY 3: Sustain fundamental hydrologic processes.

Approaches

1. Maintain or restore forest and vegetative cover in riparian areas
2. Leave coarse woody debris (dead and down) to enhance soil moisture
3. Maintain and restore stream channel form and function
4. Maintain and restore floodplain connectivity

GOAL #2



PROTECT



ENHANCE

IMPROVE RESILIENCY OF CRITICAL WATER INFRASTRUCTURE

Colorado has seen an increase in the severity of post-fire runoff, erosion and debris flows, due in part to fires that are larger and burn more intensely. For example, runoff from the Buffalo Creek (1996) and Hayman (2002) fires created large-scale ash and debris flows into Strontia Springs Reservoir. These burn scars continue to threaten Denver's water supply and have cost $27.7 million in rehabilitation to date.

STRATEGY 1: Prioritize forest management treatments in areas that will have the biggest impact on critical water supply infrastructure [53].

Approaches

1. Alter forest structure or composition to reduce the severity or extent of uncharacteristic wildfire
2. Establish strategic fuel breaks to slow the spread of uncharacteristic wildfire
3. Utilize input from and collaborate with strategic water partners to prioritize treatments around key reservoirs and infrastructure

STRATEGY 2: Promote and restore fire in fire-dependent ecosystems.

Approaches

1. Identify locations where pre-treatments, such as thinning, support the use of prescribed or managed fire
2. Increase outreach and education around fire's natural role in the environment
3. Utilize prescribed fire and manage wildfires as tools to help maintain previous treatments

STRATEGY 3: Collaborate across organizations and land ownerships for landscape-scale treatments.

Approaches

1. Establish relationships with agencies to jointly assess current conditions and identify treatment needs and priorities that will improve critical water infrastructure



Hermits Rest Trail overlooks the Gunnison River and Morrow Point Dam. The CSFS Forest Inventory and Analysis crews work in this and other piñon-juniper woodland forests around the state to monitor forest health biometrics such as fuel loading, growth, productivity and more. Photo: Wilfred Previant, CSFS

GOALS AND STRATEGIES (CONT.)

GOAL #2

PROTECT

ENHANCE

2. Develop treatment plans and prescriptions at appropriate landscape scales
3. Develop maintenance plans to retain treatment effectiveness in the future
4. Monitor for treatment effectiveness

STRATEGY 4: Assist in post-disturbance recovery.

Approaches

1. Enhance site-appropriate tree age and species diversity for overall forest resilience
2. Expedite post-disturbance reforestation and recovery
3. Facilitate forest ecosystem adjustments through species transition
4. Restore disturbed sites with a diversity of species that are adapted to future conditions
5. Control invasive species establishment
6. Repair infrastructure (roads, trails, etc.)

GOAL #3

PROTECT

ENHANCE

SUSTAIN OR RESTORE FUNDAMENTAL ECOLOGICAL FUNCTIONS FOR WATERSHED HEALTH

Healthy watersheds not only provide clean and consistent water supplies, they also help sustain habitat, recreational opportunities, carbon storage, air purification and many other functions.

STRATEGY 1: Support ecological functions that forests provide, including air and water purification, habitat, carbon sequestration and nutrient cycling.

Approaches

1. Maintain resilient forests adapted to a changing climate
2. Support a diversity of approaches in carbon exchange and markets
3. Evaluate carbon sequestration and cycling at landscape scales over long time frames
4. Base forest management and policy decisions on the best available science

STRATEGY 2: Prevent conversion of forested land to nonforested uses.

Approaches

1. Practice reforestation on disturbed or converted land with species expected to adapt to changing conditions, with focus on areas deficient in natural regeneration
2. Prevent forest fragmentation by utilizing easement opportunities such as those offered through the Forest Legacy Program
3. Prioritize remediation of remaining trees following disturbance or conversion

STRATEGY 3: Promote ecosystem services.

Approaches

1. Promote mitigation and adaptation to climate change
2. Recognize that healthy watersheds enhance cultural benefits such as recreation and an increased quality of life
3. Promote sustainable livestock grazing to reduce heavy fuel loads with best management practices

FOREST WILDLIFE

Background

All forest types in Colorado provide important habitat for wildlife, and all forestry activities affect wildlife habitat. Thus, incorporating information and data concerning current conditions and threats to wildlife is critical to forestry planning, implementation and monitoring.

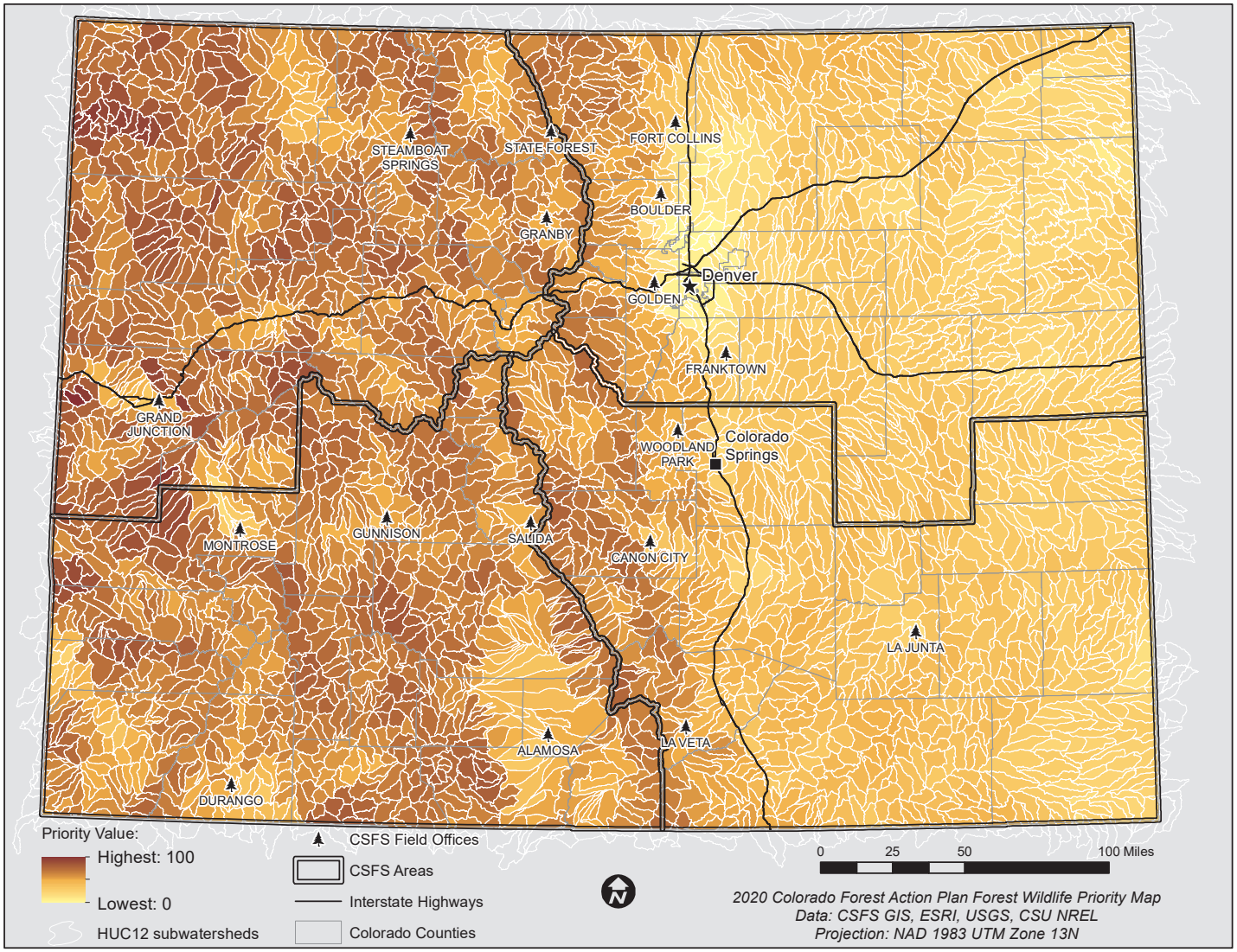
Colorado's *State Wildlife Action Plan*, created by Colorado Parks and Wildlife, identifies best management practices for forest habitat and restoration of natural processes as two of the best ways to help wildlife conservation across the state.

Additionally, consideration of climate-adaptive strategies and approaches is essential to ensuring forest management activities are sustainable. Engaging the public to increase understanding of the connection between forestry and wildlife is a strategy that is underutilized and can promote positive outcomes for both wildlife and habitat.



Effective forest management includes consideration for wildlife habitat. Restoration of natural processes is considered one of the best ways to help wildlife conservation across Colorado. Photo: Amy Bulger, CSFS

Subwatershed Priority Map for Implementing Forest Wildlife Goals



Geospatial layers incorporated: *Two subthemes were incorporated. Data were integrated from Colorado Parks and Wildlife's 2015 State Wildlife Action Plan (SWAP) to improve consistency with other statewide prioritization efforts.*

Subtheme 1 — *Habitat quality and connectivity (weighted 2x)*
- » *Ecological connectivity [54]*
- » *Landscape disturbance index [55]*

Subtheme 2 — *Wildlife distribution (weighted 1x)*
- » *Large mammal ranges [56]*
- » *Critical habitat for species of greatest conservation need (Tier 1 Terrestrial) [56]*
- » *Priority watersheds for Aquatic Tier 1 species [56]*

CONDITIONS AND TRENDS

» **Colorado's 159 "Species of Greatest Conservation Need" are negatively impacted** by a lack of knowledge (including understanding species' needs and responses to management) and natural systems modifications (including natural hydrologic and fire regimes). These were top issues identified in the most recent *State Wildlife Action Plan* by Colorado Parks and Wildlife. The 2015 plan identified the issues, as well as the 159 vertebrate animals and mollusks considered "Species of Greatest Conservation Need" [56].

» **The quantity and quality of habitat** continue to be affected by disturbances such as insect and disease outbreaks and uncharacteristic wildfire across Colorado.

» **Disturbances are amplified** by increasing drought occurrence, climate change (e.g., shifting seasonality of fire and vegetation) and altered native vegetation (e.g., riparian area deforestation, woody encroachment and non-native invasive species).

» **Drought and climate change are depleting available resources** for wildlife including water, food and cover. Available habitat is shifting across the landscape in response. These conditions and trends require implementation of adaptive forestry management techniques that are compatible with habitat structure and function.

» As urban, suburban and exurban **development continues to threaten ecological connectivity**, the need for conservation easements in critical watersheds cannot be overstated.



Moose rely on a variety of forest habitats, from willows for foraging, to thick pines and firs for shade on hot days. Maintaining healthy, varied forests is imperative to sustain the state's wildlife, both large and small.
Photo: Amy Bulger, CSFS

CHALLENGES AND THREATS

- **Changing seasonality**, including early spring thaws and late frosts, less snow and shorter winters, altered timing of precipitation and longer fire seasons
- **Declining health** of streams, riparian areas and wetland ecosystems
- **Altered stream flows**
- **Increases in insect pests**, forest pathogens and non-native invasive species
- **Lack of seedling regeneration** after a disturbance
- **Loss of critical species habitat** and increasing fragmentation with land conversion



As Colorado's wildland-urban interface gains human population, wildlife that live in proximity — such as the iconic bighorn sheep that dwell on cliffsides along the Interstate 70 corridor — face increasing connectivity issues. Proactive forest management can increase habitat paths for animals to seek shelter and migration routes. Photo: Amy Bulger, CSFS

GOALS AND STRATEGIES

GOAL #1

CONSERVE

PROTECT

ENHANCE

CONSERVE, ENHANCE AND PROTECT CRITICAL HABITAT

Addressing the challenges and threats to habitat, forestry activities can help prioritize conserving existing areas of high biodiversity, enhancing and connecting habitat corridors and protecting ecosystem structure and function.

STRATEGY 1: Facilitate shifts in the geographic and elevation ranges of species, in anticipation of future conditions.

Approaches

1. Establish corridors and minimize barriers to allow for wildlife movement to new suitable habitats
2. Prepare suitable habitat in anticipation of future introduction, reintroduction or natural range shift of a species
3. Conserve leading-edge populations (high altitude, northern, etc.)

STRATEGY 2: Sustain positive and reduce negative interspecific and biotic interactions.

Approaches

1. Increase or protect existing native biodiversity
2. Protect functional groups of wildlife or keystone species that help sustain ecosystem functions
3. Detect, monitor and mitigate exotic and invasive forest species

STRATEGY 3: Establish and enhance protected areas and habitat reserves.

Approaches

1. Create and connect existing large, intact and protected habitat
2. Protect areas at high risk of change due to climate effects or land use
3. Conserve sites expected to provide future suitable habitat and create climate refugia
4. Protect habitat connectivity such as adjacent reserves and migration corridors

GOALS AND STRATEGIES (CONT.)

GOAL #2

PROTECT

ENHANCE

INTEGRATE HABITAT CONSIDERATIONS INTO FORESTRY ACTIVITIES

Minimizing human disturbance and replicating natural disturbance, restoring diversity to degraded landscapes and maintaining healthy forests across jurisdictional boundaries will enhance and protect habitat.

STRATEGY 1: Plan for and reduce human disturbance and human-wildlife conflict.

Approaches

1. Reduce or remove human disturbance stress such as forestry activities during sensitive time periods
2. Evaluate where forest management can impact critical habitat for species of greatest conservation need
3. Avoid, minimize or mitigate land conversion that is incompatible with habitat preservation

STRATEGY 2: Protect, restore and maintain sources of food, water and cover as components of habitat.

Approaches

1. Increase plant species diversity and complexity
2. Prioritize native vegetation in habitat improvement projects
3. Create and protect a diversity of microhabitats and microclimates
4. Enhance primary food sources for species that are specialists and/or climate-sensitive
5. Create and maintain replicated sources of food, water and cover in a variety of locations across the landscape
6. Maintain or mimic natural disturbance regimes to enhance habitat
7. Promote livestock grazing where appropriate

STRATEGY 3: Adjust management of food, water and cover that forests provide to align with expected future conditions.

Approaches

1. Use novel, future-adapted genotypes in forest restoration
2. Consider and promote sources of food, water and cover across the annual cycle and different life stages in response to changing phenology

STRATEGY 4: Promote habitat conservation on lands outside of protected areas.

Approaches

1. Identify and restore degraded landscapes with high potential habitat suitability
2. Reduce or limit barriers to wildlife movement across the landscape
3. Maintain healthy forests on private lands near and between public lands
4. Enhance green infrastructure in urban or developed landscapes

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GOAL #3

ENHANCE

INCREASE PUBLIC UNDERSTANDING OF THE CONNECTIONS BETWEEN FORESTRY AND HABITAT

Forestry activities and habitat protection can be incompatible or complementary; however, this is not always well understood. Public engagement and improved coordination with partners and stakeholders are essential to increasing understanding of these connections.

STRATEGY 1: Engage communities in forest wildlife conservation.

Approaches

1. Develop public outreach and technical assistance programs to describe how healthy forests impact wildlife
2. Respect and incorporate landscape values of indigenous communities in activities and decisions
3. Coordinate across agencies and scales to ensure programs are complementary
4. Collaborate with research partners at universities on social science projects to better understand human-wildlife interactions



This dusky grouse in the Flat Tops Wilderness depends on a healthy forest ecosystem. These mountain-dwelling grouse travel the forest floor in search of food and mates, flying short distances into the canopy of large trees to escape danger and find shelter. Photo: Amy Bulger, CSFS

URBAN AND COMMUNITY FORESTRY

Background

Colorado's cities and towns offer dynamic ecosystems with interconnected social, economic and ecological components. These urban and community forests are comprised of trees in yards, streetscapes, open spaces, parks, greenways, rivers, ponds and habitat corridors. This natural and constructed green infrastructure [57] provides ecosystem services, which are the direct and indirect benefits humans get from a healthy ecosystem. Those include: clean air and water, energy conservation, stormwater mitigation, reduction in noise pollution, improvements in air quality, property value enhancement, connectivity of habitat corridors, carbon sequestration and the betterment of mental and physical health [8].

The sustainable vibrancy of Colorado's urban and community forests will require strategic and adaptive planning that addresses: rapid population growth, wildland-urban interface (WUI) risk, climate resilience, invasive species, sustainable funding, a changing labor force, public awareness, stewardship, education and civic engagement [58].

Colorado's urban and community forests provide the equivalent of millions of dollars in annual ecosystem service benefits. For example, trees on Fort Collins' municipal streets and in parks provide ecosystem services with a net benefit of $1.17 million per year [59]. A similar study of Metro Denver found that the urban forest contributed $551 million in "property value increases, energy savings, carbon storage, stormwater runoff reduction, and air quality benefits" [60].

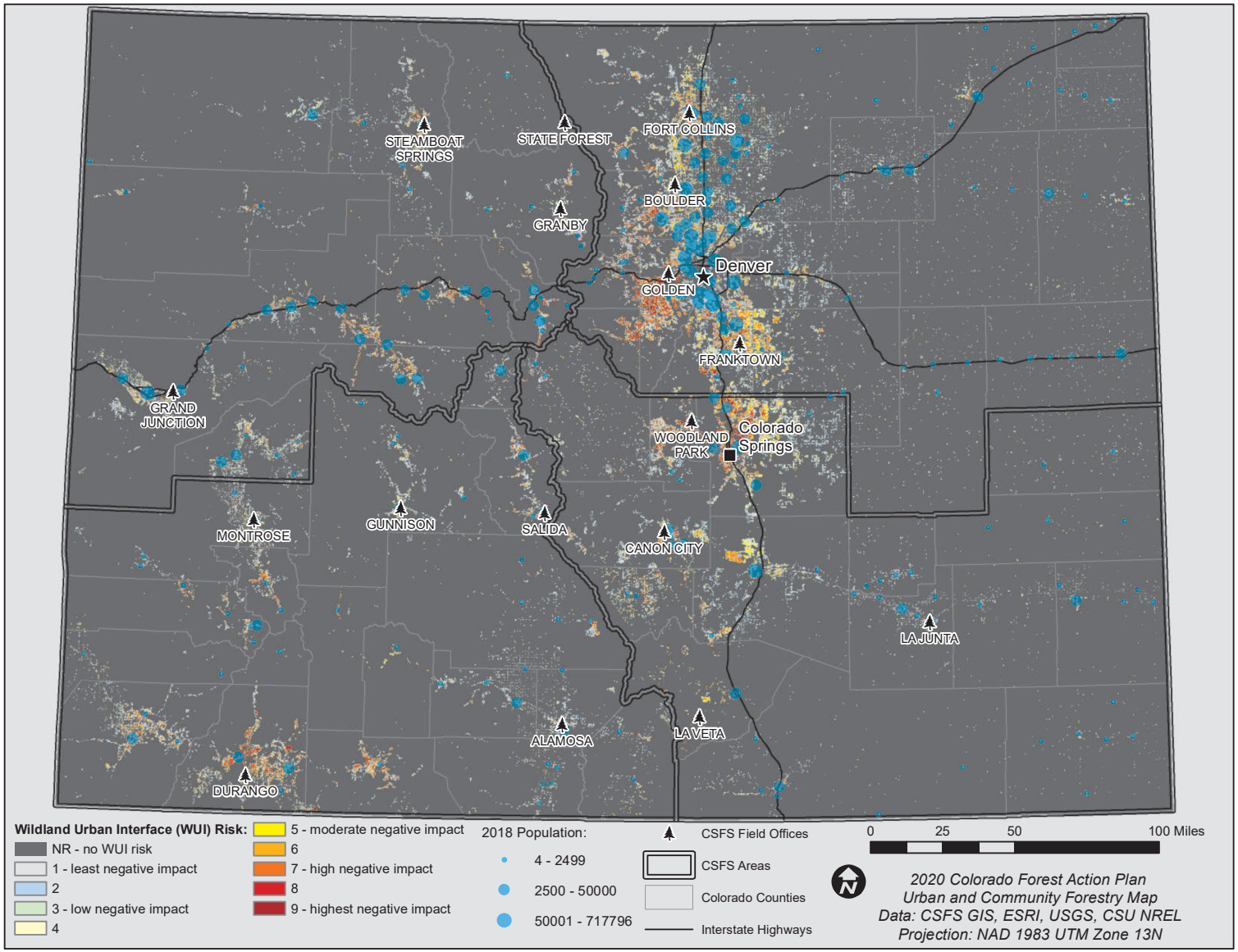
Tree canopy cover is critical to offsetting the impacts of a warmer climate, extreme storm events, energy consumption and the air pollution associated with an increasing population. Increasing the overall canopy cover can be the easiest way to maintain a city's vibrancy, improve social health and contribute to the economy.

Every tree planted creates a twofold, or more, return on that investment [61]. To **CONSERVE**, **PROTECT** and **ENHANCE** urban tree canopies, there are numerous funding, planning, education and inventory resources available. These include Tree Campus USA and Tree City USA programs, the Colorado Tree Coalition and Project Learning Tree. Collectively, these efforts expand awareness about the benefits provided by urban and community forests.



Colorado's urban forests, like this Fort Collins neighborhood near Horsetooth Reservoir, provide the equivalent of millions of dollars in annual ecosystem service benefits. Photo: marekuliasz, iStock

Priority Map: Areas of Opportunity for Urban and Community Forestry



Geospatial layers incorporated:

Data are from 2010 U.S. Census [62] and 2017 Colorado Wildfire Risk Assessment [2]

- *Urban Areas (UAs) > 50,000 people*
- *Urban clusters (UCs) 2,500 – 50,000 people*
- *Rural encompasses all population, housing and territory not included within an urban area, and communities are areas that may contain some, all or none of urban areas (UA/UC) and are recognized by geopolitical boundaries*
- *Wildland-Urban Interface: any area where man-made improvements are built close to, or within, natural terrain and flammable vegetation. WUI risk is a measure of the potential impact on people and their homes from wildfire [2].*

CONDITIONS AND TRENDS

By 2018 estimates, over 5.5 million people live in Colorado. By 2050, this is projected to increase by as much as 4 million people [28].

In 2010, Colorado's urban areas represented 1.5% (977,000 acres) of the state's land, an area expected to double to 3% in 2040 [12,62]. This will result in a projected urban footprint of 1.9 million acres that will require conversion of forest and agricultural lands into urban areas, impacting the quality and availability of clean air, safe water, healthy soil, habitat and green infrastructure.

More challenging, the wildland-urban interface (WUI), the area where structures and other human developments meet or intermingle with wildland vegetation, currently encompasses an estimated 3.2 million acres and 2.9 million people, based on the CSFS 2017 Wildfire Risk Analysis [2]. Models project the WUI could encompass over 9 million acres by 2040 [29]. Strategic planning for green infrastructure across city, regional and state scales to improve human health, wellness and safety is necessary given projected urban and WUI expansion.



Many Colorado classrooms and communities participate in annual Arbor Day celebrations around the state, with the Colorado State Forest Service frequently helping teach children the benefits of trees. Photo: CSFS

Across Colorado, the urban and community tree canopy ranges from 17.6%-21.6%, while impervious surfaces may represent 30%-50% or higher of the land cover [12,60,63].

By 2040, Denver could be 70% paved or built over, further contributing to the urban heat island effect [64]. Denver averages 8.9 acres of park space per 1,000 people, less than the national average of 13.1 acres [64]. In terms of carbon sequestration rates, the lack of green infrastructure ranks Colorado 45th out of 48 states [65].

CHALLENGES AND THREATS

- **Rapid population growth** requiring additional and appropriate levels of supporting green infrastructure
- **Land-use conversion** and fragmentation impacting habitat quality and quantity
- **Population expansion into the wildland-urban interface**, combined with an increased probability of uncharacteristic wildfires
- **Decline of climate resiliency and adaptability** in urban and community forests
- **Human health and wellness** requiring adequate food access, water quality, air quality, hazard tree removal and moderation of the urban heat island effect
- **Impact of invasive pests** on existing community forests
- **Limited funding** to assist with strategic planning and adaptive management
- **Limited financial resources** for inventory, monitoring, outreach and civic engagement

GOALS AND STRATEGIES

GOAL #1



CONSERVE



PROTECT



ENHANCE

PROMOTE THE ROLE AND INFRASTRUCTURE DEVELOPMENT OF URBAN AND COMMUNITY FORESTS TO ADVANCE PUBLIC HEALTH, WELLNESS AND SAFETY

Improving and enhancing urban living environments through healthy and resilient community forests is a cost-effective tool that contributes to positive health outcomes. Strategic planning related to population density and growth, green and gray infrastructure, expansion of the wildland-urban interface and the enhancement of public spaces will maximize community and ecosystem sustainability.

STRATEGY 1: Master planning efforts that include urban and community trees and forests need to occur at city, regional and state scales.

Approaches

1. Increase overall urban canopy to reduce impacts of urban heat sinks and stormwater flow while improving air quality
2. Engage in community planning efforts including public and private tree inventories, monitoring, planting to increase urban canopy, selection of climate-adapted species, proper maintenance schedules and continuous hazard tree removal
3. Reduce landscape fragmentation by creating green infrastructure corridors
4. Alter forest structure and composition to reduce risk or severity of wildfire, focusing on the wildland-urban interface

STRATEGY 2: Develop resources and tools to improve and highlight the positive and synergistic relationships among green infrastructure, forest, trees, and public health and wellness.

Approaches

1. Inventory private and public urban and community forests to monitor ecosystem services with the U.S. Forest Service Urban Forest Inventory and Analysis (UFIA), CO-Tree View and/or i-Tree
2. Utilize USFS Urban Forest Project Reporting Protocol

STRATEGY 3: Expand opportunities for collaboration among residents, collaboratives, agencies and other sectors.

Approaches

1. Create redundancy of habitat types, riparian areas and refugia on the landscape
2. Connect existing tree-affiliated groups and organizations through electronic resources

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GOAL #2



ENHANCE

PROMOTE AND INCREASE PUBLIC AWARENESS, LEADERSHIP DIVERSITY AND EQUITY WITHIN THE URBAN FORESTRY COMMUNITY

Current and projected changes in Colorado's demographics require understanding and engaging different perspectives, cultures, genders and ages. This broadens economic and social opportunities while building and strengthening communities. Understanding the critical importance of community, economics and ecosystem benefits protects, conserves and enhances the urban and community forests of today and tomorrow.

STRATEGY 1: Create, maintain and enhance educational programs that focus on urban and community forests.

Approaches

1. Identify current urban forestry education programs and organizations responsible for the programs (e.g., Project Learning Tree)
2. Enhance educational outreach of urban-forestry-focused organizations (e.g., Colorado Tree Coalition)
3. Coordinate with state agencies that provide education and outreach programs to ensure the largest impact on students and communities

STRATEGY 2: Increase engagement of underserved and minority communities within urban and community forestry.

Approaches

1. Identify underserved and minority communities within Colorado that would benefit from urban and community forestry programs

GOALS AND STRATEGIES (CONT.)

GOAL #2

ENHANCE

2. Determine existing programs to increase engagement (e.g., Project Learning Tree) and assess the need for additional programs
3. Translate existing English publications into Spanish and other languages as needed
4. Partner with professional groups like the International Society of Arboriculture and the Society of American Foresters to host training events in Spanish

STRATEGY 3: Increase workforce development opportunities and green jobs.

Approaches

1. Inventory private and public urban forests to monitor ecosystem services with the U.S. Forest Service Urban Forest Inventory and Analysis (UFIA), CO-Tree View and/or i-Tree
2. Research and develop alternative renewable biomass energy markets and resources
3. Provide education about forestry careers through Project Learning Tree's Green Jobs curriculum



GOAL #3

CONSERVE

PROTECT

ENHANCE

IMPROVE AND ENHANCE ECOSYSTEM HEALTH AND BIODIVERSITY FOR LONG-TERM RESILIENCE BY INTEGRATING URBAN AND COMMUNITY FOREST MANAGEMENT, MAINTENANCE AND STEWARDSHIP INTO ALL SCALES OF PLANNING

A dynamic green infrastructure provides residents, cities, towns and municipalities with a sustainable job market, stormwater management, improved habitat, quality drinking water, energy conservation, and enhanced public health, wellness and safety.

STRATEGY 1: Sustain or restore fundamental ecological functions.

Approaches

1. Increase forest species biodiversity, structure variability, and tree health and resilience to disturbance and climate change
2. Maintain and restore hydrological functions and riparian areas
3. Monitor the introduction of invasive species and mitigate existing invasive species
4. Reduce landscape fragmentation by creating green infrastructure corridors

STRATEGY 2: Enhance carbon storage to mitigate greenhouse gas emissions and support climate change resilience, restoration and sustainability within urban and community forests.

Approaches

1. Increase overall urban canopy to help offset greenhouse gas emissions and lower energy demands for heating and cooling buildings
2. Revegetate sites after natural and land-use conversion disturbances
3. Increase species biodiversity, structure variability and individual tree health
4. Select species that match projected climate and site conditions
5. Realign significantly disrupted ecosystems to meet expected future conditions



More and more residential neighborhoods continue to flank the Denver skyline, commonly stretching into the wildland-urban interface of the foothills, as this view from Morrison shows. Photo: iStock

IN METRO DENVER

» By 2040, Denver could be 70% paved or built over, further contributing to the urban heat island effect [64].

» Denver averages 8.9 acres of park space per 1,000 people, less than the national average of 13.1 acres [64].

ACROSS COLORADO

» In terms of carbon sequestration rates, the lack of green infrastructure ranks Colorado 45th out of 48 states [65].

In 2010, Colorado's urban areas represented 1.5% (977,000 acres) of the state's land, an area expected to double to 3% in 2040 [12,62].

FOREST PRODUCTS

Background

Important Colorado timber species for the forest products industry include lodgepole pine, Engelmann and blue spruce, ponderosa pine, Douglas-fir, true firs (white and subalpine) and aspen. Colorado had 10.52 million acres of nonreserved timberland in 2016 – this is productive forestland that can grow commercial-grade timber and is not permanently reserved from utilization through statute or administrative designation (such as a National Park). Ownership of nonreserved timberland in Colorado is approximately 80% public and 20% private [41]. The private timberland was classified as nonindustrial forestland. Sawtimber volume on timberland was estimated to be 14.5 billion cubic feet [41].

The timber industry in Colorado can be subdivided into two broad groups, though there is much crossover. Harvesting contractors engage in logging and mitigation services that involve removing timber from the landscape, while wood processors have the capability to produce and sell wood products. Many harvesting contractors are willing to sell wood products and some own processing facilities. The interests of these groups are represented by the Colorado Timber Industry Association (CTIA), *coloradotimber.org*.

The most recent in-depth survey of harvesting contractors operating in Colorado was conducted in 2014 [66]. A more limited survey of some harvesting contractors and wood processors was conducted in 2019 by CTIA (unpublished). The 2014 survey identified a sample size of 236 contractors, down from 373 in a similar survey conducted in 2002. Most of these companies were small businesses, and 91% had fewer than 10 employees. The average time in business was 17.8 years, and only about 33% were capable of fully mechanized harvesting operations. In the 2014 survey, 50.6% of respondents were willing to bid on projects over 100 acres in size, though most also reported they preferred small projects on private land ranging from 10 to 100 acres.

Timber harvested for all public, private and tribal landowners was 116,656 thousand board feet (MBF) in 2016 [15]. The preferred species harvested were 55% lodgepole pine and 22.6% Engelmann and blue spruce. Almost 80% of the logs harvested were sawlogs for lumber; the remaining 20% were used for other wood products.

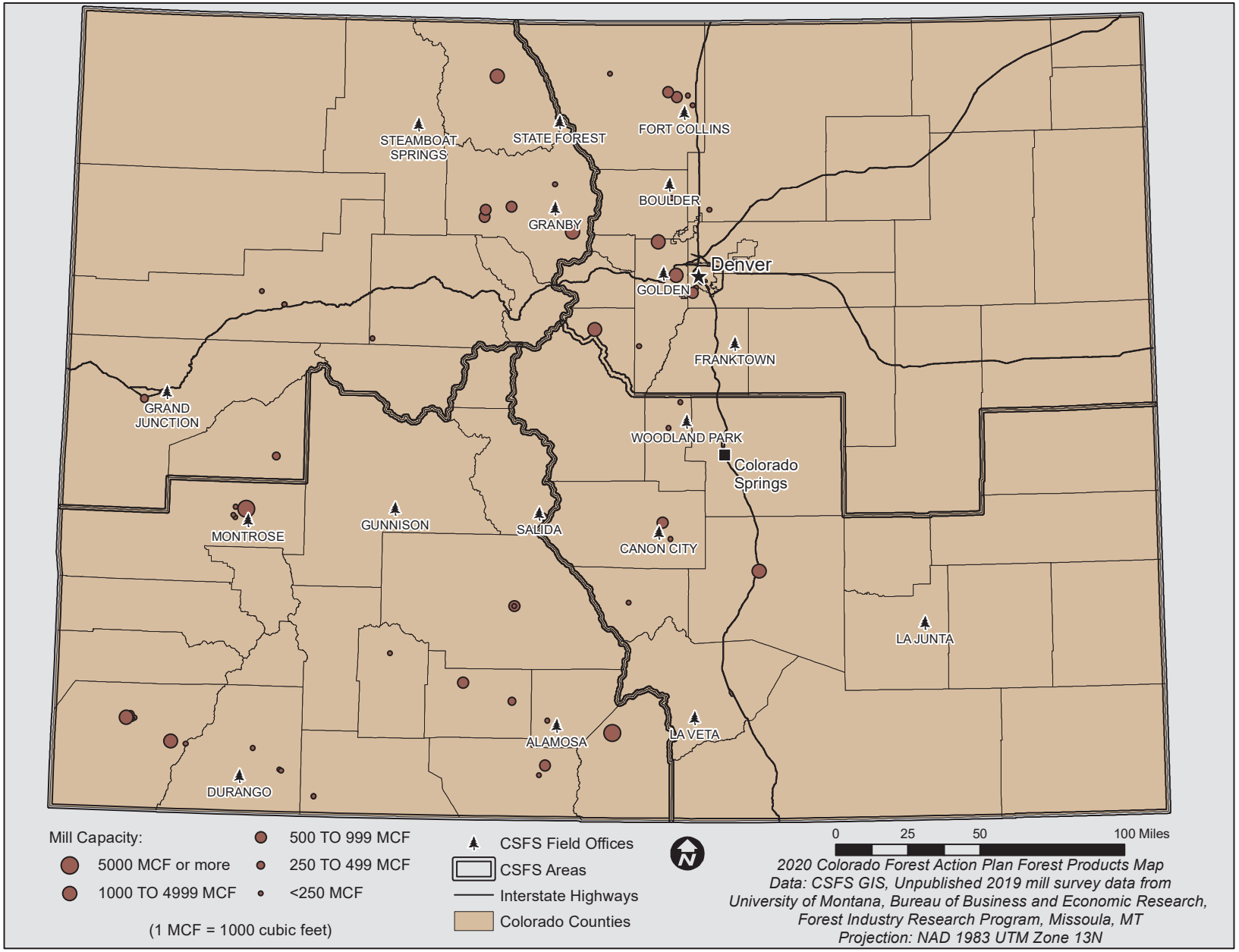
In 2016, there were 55 primary wood processing facilities in the state, down from 133 in 2002 [15]. Thirty of these facilities produced primarily lumber, 10 produced house logs and log homes, and 15 produced other products such as excelsior, fuel pellets, post, poles, log furniture and biomass/energy.

Most Colorado lumber mills are small — out of the 30 lumber production facilities operating in 2016, 22 mills produced less than 2 million board feet (MMBF) annually and the other eight produced 92% of the state's lumber. The total timber-processing capacity for the state is estimated to be 46,531 MCF (thousand cubic feet) [67]. However, in 2016, only 29,466 MCF were processed, about 63% of capacity. Not all of the logs harvested in Colorado are processed in-state; mills outside of the state also utilize logs from Colorado forests. Nonetheless, Colorado relies heavily on imports from out-of-state to satisfy demand for wood products. Increasing processing capacity and competition by growing the number of businesses that utilize logs for value-added forest products is the best opportunity to offset harvesting costs in the state.



Photo: freeimages.com

Priority Map: Locations and Capacities of Mills in Colorado



Geospatial layers incorporated:

Unpublished mill location and size class data are from the Bureau of Business and Economic Research at the University of Montana (2016) supplemented by CSFS data.

CONDITIONS AND TRENDS

» **The harvesting contractor workforce has declined** significantly since 2002. The existing workforce is expected to be inadequate to meet future timber harvesting and forest mitigation programs in Colorado. Additional capacity will need to be developed and more workers trained.

» **Harvesting costs have escalated** considerably in Colorado over the past decade. Explanations for the escalation include reduced price competition resulting from a diminished contractor base, emphasis on treating densely stocked stands that have a high percentage of small diameter trees and a lack of markets for this woody biomass.

» **The wood processing industry in Colorado declined** considerably from 2002 to 2016, but recently there has been some significant expansion including added sawmill capacity in the San Luis Valley and a cogeneration biomass facility built in Gypsum.

» Although **wood markets** were dramatically impacted by the 2008 housing collapse, they have recovered over the past decade.

» **Strong markets will be necessary** to fully utilize existing capacity and to support future capacity increases. The Colorado State Forest Service's Colorado Wood Utilization and Marketing Program (CoWood, *csfs.colostate.edu/cowood*) promotes wood use in Colorado by providing loans for infrastructure development, offering technical assistance and conducting applied product research.



CHALLENGES AND THREATS

» **Decline in the value** of timber and resulting products generated from the forest due to insect and disease activity and wildfires

» **Loss of processing capacity** for timber harvesting and forest products

» **High cost of forest management treatments** relative to product value

» **Increasing competition** with forest products from out of state

Some of the timber harvested from the Chicken Creek Forest Project near Evergreen was turned into chips, posts and poles, firewood and sawtimber. The 50-acre Forest Restoration and Wildfire Risk Mitigation project, done with the Jefferson County Conservation District, helps reduce active-crown fire potential. The CSFS will monitor the area and evaluate which treatments have the greatest impact on potential fire behavior in various forest types and how long those remain effective. Photo: Wilfred Previant, for CSFS

GOALS AND STRATEGIES

GOAL #1

ENHANCE

MAINTAIN AND DEVELOP MORE RESILIENT INDUSTRY CAPACITY REQUIRED TO MEET FOREST MANAGEMENT NEEDS

Maintaining a sufficient forest products industry is often required to achieve forest management objectives. It will likely be necessary to develop additional capacity to align with future treatment goals.

STRATEGY 1: Maintain the capacity of the forest products industry to align with management needs.

Approaches

1. Determine industry capacity requirements based on projected forest management activities
2. Assess the sufficiency of the existing timber harvesting and forest products industry
3. Support workforce development (recruitment and training), focusing on engagement of younger generations to balance an aging wood utilization workforce
4. Promote increased use of existing capacity
5. Build additional capacity as required through development and support of innovative, sustainable financing mechanisms for local industry
6. Provide a sufficient, consistent supply of timber and/or biomass feedstock to the wood processing industry
7. Explore and adopt public and private partnerships for investing in new biomass processing facilities and markets

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GOAL #2

PROTECT

ENHANCE

INCREASE THE NUMBER OF FORESTED ACRES TREATED ANNUALLY THROUGH COST OFFSETS OF INCREASED UTILIZATION

Costs of forest management activities have been increasing which, in the absence of cost offsets, limits the number of high-priority acres that can be treated. Increased utilization of timber resources provides opportunity for cost offsets. Development of a diverse forest products industry is crucial for success.

STRATEGY 1: Improve the alignment of industry operating areas with forest management needs in high-priority watersheds and wildland-urban interface areas.

Approaches

1. Highlight where industry operating areas overlap high-priority watersheds
2. Design and implement management projects to take advantage of overlap
3. Develop industry capacity in areas where it is lacking
4. Improve the efficiency of agency processes to increase the pace and scale of forest management activities

STRATEGY 2: Diversify industry products and operations to better utilize timber resources (species composition and size class) and increase industry viability.

Approaches

1. Identify all possible uses for available timber resources
2. Align uses with existing industry product mix
3. Identify opportunities for diversification, including potential industry clusters and facility co-location prospects
4. Conduct research to help identify viable markets and marketing strategies for Colorado wood products businesses
5. Focus on development of value-added niche products
6. Partner with industry to build capacity with a more diverse, profitable product mix

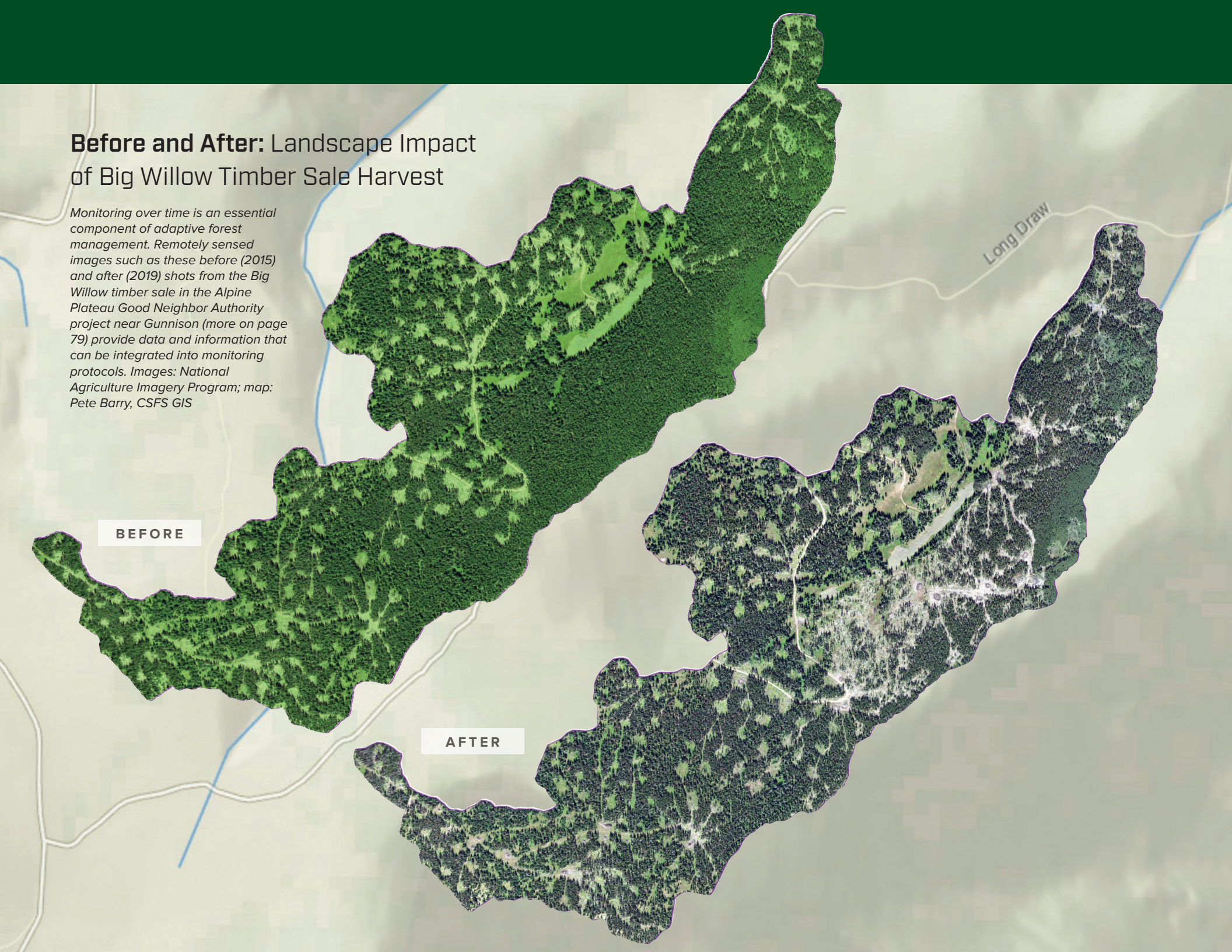
STRATEGY 3: Increase carbon storage by utilizing timber resources.

Approaches

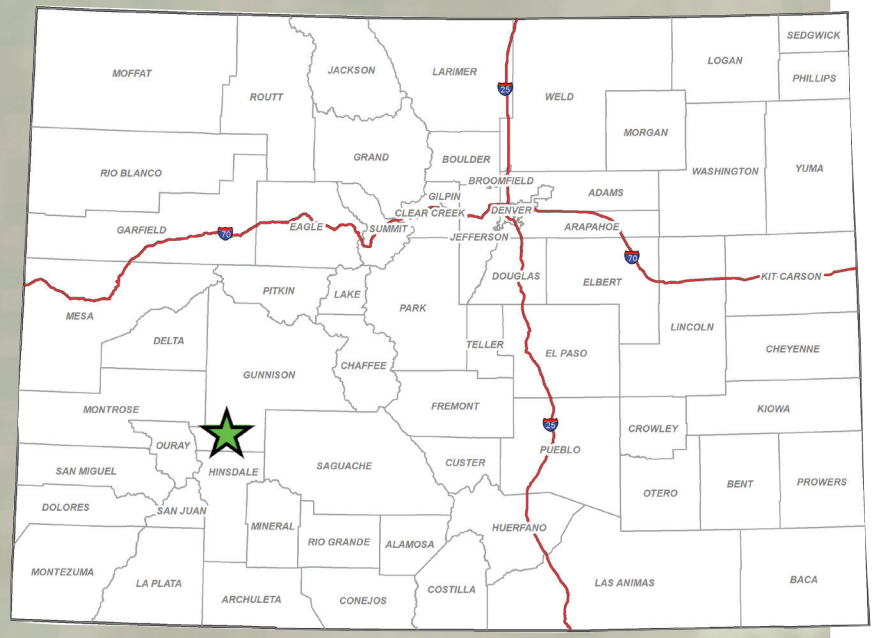
1. Match timber resources to options that maximize utilization and net carbon storage
2. Work with industry to reduce wood residue generation through improved processing efficiency
3. Find product opportunities for underutilized timber resources and processing residues

Before and After: Landscape Impact of Big Willow Timber Sale Harvest

Monitoring over time is an essential component of adaptive forest management. Remotely sensed images such as these before (2015) and after (2019) shots from the Big Willow timber sale in the Alpine Plateau Good Neighbor Authority project near Gunnison (more on page 79) provide data and information that can be integrated into monitoring protocols. Images: National Agriculture Imagery Program; map: Pete Barry, CSFS GIS



PROJECT LOCATOR:
ALPINE PLATEAU GOOD NEIGHBOR AUTHORITY



Identifying Needs and Using the Plan: A Framework for Coordinated Management

Stakeholders and collaborative groups can utilize the *2020 Colorado Forest Action Plan* as a framework toward a coordinated approach to forest management in Colorado, regardless of land ownership.

The CSFS will use the Forest Action Plan to engage stakeholders and collaborators, with an overarching goal to align resources where they will have the most significant and long-term impacts on the landscape. Other national, regional, state and local planning efforts can be used to complement the Forest Action Plan.

To **CONSERVE**, **PROTECT** and **ENHANCE** high-priority subwatersheds identified in the Forest Action Plan composite map, the primary strategy is to plan and implement activities and projects that are most likely to achieve multiple goals in the same project area.

Planning can follow two methods:

» **The first** begins with the composite priority map to identify areas for new activities and supplements the map with other action plan theme data and/or local data and information.

» **The second** begins with local priorities and includes reviewing the action plan composite priority map and other theme data to evaluate areas where activity boundary expansion and/or cross-boundary collaboration can increase efficiency and impact.

The Forest Action Plan sets direction for CSFS staff and programs, and the CSFS will engage stakeholders and collaborators in planning, implementation and monitoring.

Start Using the Action Plan Based on the Priority Map or Targeted Local Need

State forest action plans are mandated by the Cooperative Forestry Assistance Act of 1978 (as amended by the 2008 and 2014 farm bills) in order to receive federal State and Private Forestry funds.

Several competitive funding opportunities require applicants to address priorities identified in the Forest Action Plan.

The Colorado State Forest Service will focus the majority of core services in high-priority subwatersheds in order to:

» **Concentrate resources** where activities can have the greatest impact.

» **Guide program and grant funding** to where it should be applied, to ensure consistency of management activities with top state forest resource issues, management goals and individual program requirements.

» **Work with stakeholders** to develop projects that address mutual priorities in high-priority subwatersheds.

STRATEGY SCOPE

» **Ownership —** Priority and resource strategy recommendations are applicable to all land ownerships.

» **Organization —** Priority and resource strategy recommendations are applicable to all land management organizations that plan and implement forest stewardship activities in Colorado.

» **Scale —** These Resource Strategies are intended to direct project-level planning efforts to priority subwatersheds (sixth level, 12-digit HUCs) and introduce broad strategies and approaches that can be incorporated into more site-specific project-planning efforts.

Tactical and prescriptive planning should occur at the local level by managers and stakeholders who are experts on local conditions.

METHOD 1: THE MAP

Start with the Forest Action Plan composite priority map to identify strategic locations of projects in priority subwatersheds. Individual subwatershed values for the composite priority map can be found in the Forest Action Plan application of the Colorado Forest Atlas, at *coloradoforestatlas.org*.

This map can be supplemented with other action plan data and ancillary local data, as applicable.

To **CONSERVE**, **PROTECT** and/or **ENHANCE** these subwatersheds, activities most likely to achieve multiple priority goals in the same project area should be pursued. Based on project goals, managers should refer to the applicable theme(s) section(s) of this action plan to evaluate potential strategies and approaches.

For example, managers could plan fuels reduction treatments designed to protect high-risk wildland-urban interface areas and critical sourcewater infrastructure. The same project also could incorporate strategies and approaches intended to lower risk of severe insect and disease outbreaks and improve or maintain habitat for target wildlife species.

Projects incorporating these goals as a foundation can then be expanded — where financially, socially, ecologically and operationally feasible — to create a mosaic of diversity and complexity in watersheds, which enhances forest resiliency to disturbance at a larger scale.

Implementation of this resource strategy will improve the efficiency of forest stewardship activities in Colorado by focusing limited resources in the highest priority subwatersheds and improving coordination of efforts across property ownerships and administrative boundaries. Implementation also will produce the greatest benefit to residents by emphasizing areas where the greatest number of key activity goals can be achieved on the same acre or within the same project areas.

Method 1 example:

Cooperative agreements between the CSFS and its partners will benefit from using the *2020 Colorado Forest Action Plan* composite priority map to select project areas that achieve multiple objectives in forest conditions, living with wildfire and watershed protection.

One example of a cooperative agreement is a new Good Neighbor Authority (GNA) project.

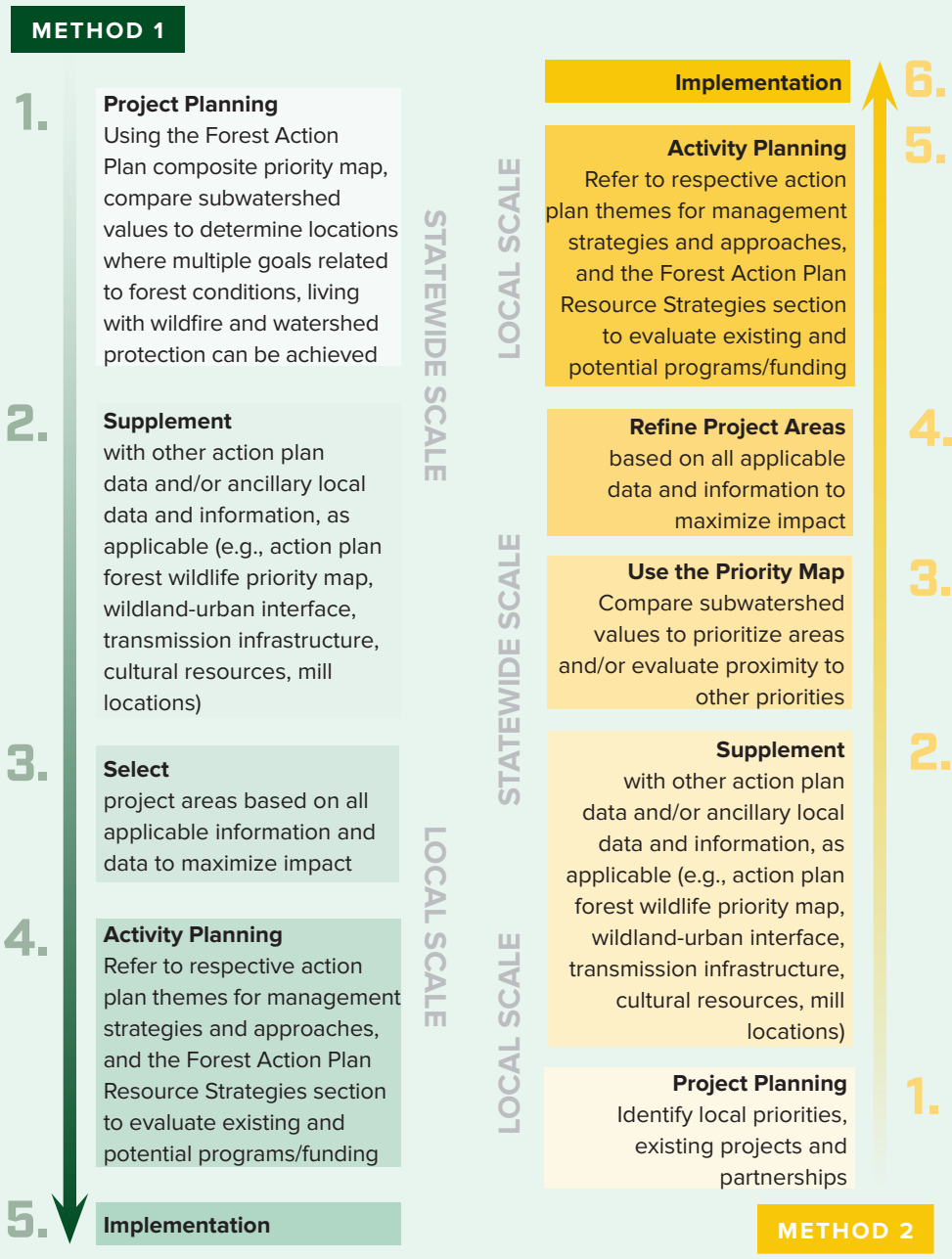
In a GNA Supplemental Project Agreement, the U.S. Forest Service and the CSFS identify a project or multiple projects that are of mutual interest, meet the intent of the GNA and meet the objectives of each agency (for an ongoing GNA example, see page 79 of this report). The action plan composite priority map provides a good starting point to select HUC 12 subwatersheds for a new GNA supplemental agreement, and project area(s) can be further refined using local ancillary data, such as proximity to mill locations, from the forest products theme map in the action plan and/or U.S. Forest Service priority areas data.

METHOD 2: LOCAL NEED

Start with local priorities and existing projects that are not necessarily captured in the *2020 Colorado Forest Action Plan* composite priority map. Examples include implementation of activities in Community Wildfire Protection Plans (CWPPs), update of an existing CWPP if it is more than 5 years old, protection of critical infrastructure such as transmission lines or transportation corridors, urban and community forestry and improvement of forest wildlife habitat.

First, using local data and information, select project areas. Next, compare subwatershed values from the action plan composite priority map in the action plan Resource Assessment (page 23) to identify strategic placement of activities in or adjacent to priority subwatersheds. Refine project areas, as applicable, based on the

PROJECT PLANNING: AN ILLUSTRATION OF TWO METHODS



potential for greater impact. Examples include expansion of project boundary to include a neighboring subwatershed where high wildfire risk threatens drinking water, or cross-boundary collaboration to expand the overall footprint of an activity.

Method 2 example:

The Colorado State Forest near Walden was established by the State Land Board in 1938 to promote grazing, recreation and forestry on 70,980 acres of contiguous land. It became a state park in 1970 and the CSFS began leading forest management there in 1986.

The pine beetle epidemic of the past few decades has increased harvesting of mature, dead stands of lodgepole pine, and the CSFS has worked closely with the State Land Board and Colorado Parks and Wildlife to address potential benefits and conflicts between timber sales and wildlife habitat.

Based on spatial data from the forest wildlife theme in this *2020 Colorado Forest Action Plan*, there are specific areas in the Colorado State Forest that encompass bighorn sheep, elk, mule deer and moose winter range, as well as summer and fall concentrations of black bears. There also are areas with low disturbance and high ecological connectivity. These action plan data layers can be used to identify and prioritize forest management areas with high lodgepole pine mortality that overlaps important wildlife habitat.

Moving forward, as harvest within the State Forest transitions from dead to green trees, action plan data can be used to investigate where mixed stand thinning and regeneration harvests can achieve forest health goals while maintaining important wildlife habitat.

If there are multiple watersheds where work should occur to achieve forest health goals, the composite priority map in the *2020 Colorado Forest Action Plan* can be used to refine project areas to maximize impact.

STATEWIDE CROSS-THEME RESOURCE STRATEGIES, MONITORING, METRICS

» The CSFS will support **cross-disciplinary partnerships** and collaborative work among federal, state and local agencies, nongovernmental organizations, communities and public volunteers to implement the Forest Action Plan. Funding mechanisms will be expanded through these partnerships and innovative grant opportunities. The CSFS will establish, maintain and update a statewide list of partnerships and potential funding mechanisms.

» To address cross-boundary, broad-scale challenges and threats to Colorado's forests and improve the effectiveness of forest stewardship using limited resources, the majority of new CSFS projects will be in **high-priority subwatersheds** identified in this action plan. The CSFS also will strive to expand work in multistate priority landscapes.

» **A Forest Action Plan application** in the Colorado Forest Atlas will allow the CSFS and partners to put action plan data to use in strategic planning efforts, including Shared Stewardship planning with the U.S. Forest Service. Project and activity planning in the Colorado Forest Atlas will be cross-checked with the action plan composite and theme maps to determine level of priority, making the number and acreage of new activities and projects within high-priority subwatersheds quantifiable and reportable. The CSFS will maintain and update the Colorado Forest Atlas to improve data and information sharing statewide.

» The CSFS will **enhance forest resistance and resilience** to climate change, or move toward transitions, and improve carbon storage and sequestration using the adaptive strategies and approaches developed in the Forest Action Plan. This will be achieved through developing new training for CSFS staff, identifying candidates with related education and experience in the hiring process, maintaining and expanding interagency partnerships for integrative project planning and collaborating with research partners at local universities.

» To monitor and quantify change in forest cover, vigor and carbon storage over time, CSFS **archival data and information** will be integrated with current interagency forest management data and Forest Inventory and Analysis data in the Colorado Forest Atlas. Project and activity monitoring protocols will be developed to quantify success at 1- to 10-year increments.

» The CSFS will **expand public understanding** of forest stewardship and its connection to sustaining ecologic, economic and social function in natural and urban systems by maintaining and developing outreach and education programs.

CSFS Programs Contribute to Plan Goals

Appendix 8 illustrates the programs the CSFS administers that will contribute to the implementation of the theme goals and strategies. This exercise highlighted the gap in resources available to implement some goals and strategies *(Figure J)*.

Program areas include state and private forestry, other federal programs, competitive grants, state programs and watershed programs.

There are additional funding mechanisms not listed in the table that could provide resources for CSFS to leverage (e.g., American Forest Foundation and National Wild Turkey Federation).

Given the number of local, state, federal and nongovernmental organizations that are engaged in natural resource management in Colorado, it is challenging to capture all available resources to implement the resource strategies.

A comprehensive list of resources available across organizations needs to be developed and is identified in the Resources Necessary section.

COVERAGE: CSFS PROGRAMS RELATED TO THE ACTION PLAN

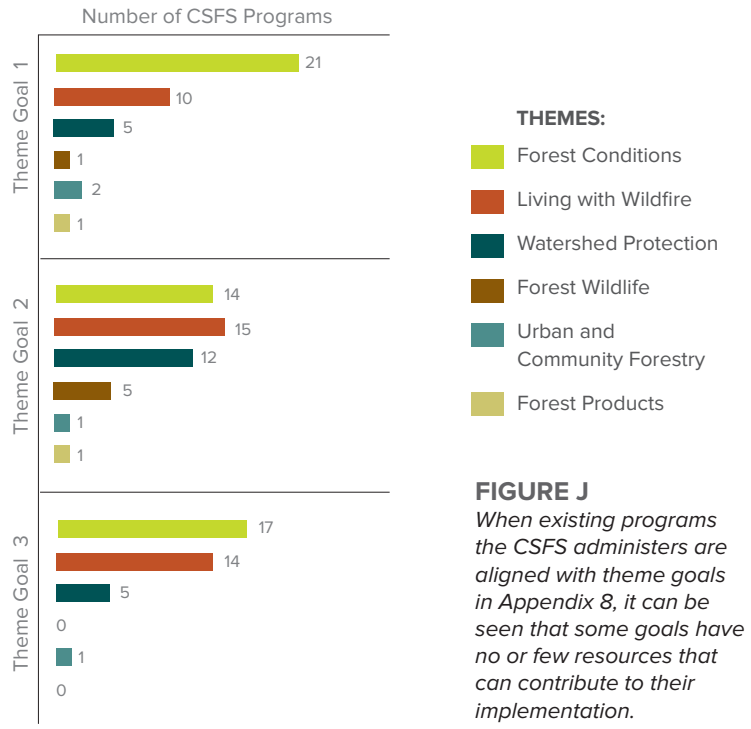


FIGURE J
When existing programs the CSFS administers are aligned with theme goals in Appendix 8, it can be seen that some goals have no or few resources that can contribute to their implementation.



Forests are a critical component of healthy watersheds. The Colorado State Forest Service is committed to protecting Colorado's source water for residents. Photo: David Mark, Pixabay

CSFS Helps Protect Colorado's Drinking Water

The 1996 Amendments to the Safe Drinking Water Act (SDWA), 42 U.S.C. 300f et seq., directed that each state develop a Source Water Assessment and Protection (SWAP) program.

The Colorado Department of Public Health and Environment's SWAP program has supported and facilitated community-based protection and preventative management strategies, through development of source water protection plans, to minimize adverse contamination to public drinking water sources.

Local source water protection implementation is the primary mechanism to protect and preserve our drinking water resources. Federal, state and local interagency coordination also is a necessary component to effectively manage the lands and minimize potential contaminant threats to drinking water supplies.

Forested watersheds in Colorado supply approximately 80% of the state's population with drinking water. Therefore, wildfire mitigation and forest stewardship are essential to protecting drinking water supplies. The CDPHE and the CSFS are committed to working collaboratively in the following ways on drinking water protection strategies:

» **Share source water delineation** and source water protection planning areas (e.g., GIS shapefiles, priority hydrologic unit codes (HUCs)) to define priority landscapes for drinking water protection under data sharing agreements.

» **Maintain and monitor healthy watersheds** and restore degraded forested areas by mutually implementing best management practices, riparian buffers, headwater protections and other forest management strategies identified in source water protection plans and this Forest Action Plan.

» **Establish partnerships**, leverage available funding sources and coordinate with other federal, state and local governments, municipal water providers, communities, landowners, watershed groups and other nongovernmental organizations to mitigate wildfire risk to drinking water supplies.

Working Toward Action Plan Goals Requires Investments in Staff, Funding, Programs

To increase the impact of the CSFS and partner work in priority subwatersheds, all funding must be diversified, leveraged, increased and sustained.

As indicated by the CSFS Funding Trends section on page 70 in this action plan, the CSFS budget is derived from a wide variety of sources that are generally stagnant or declining. Budget increases relative to the scale of the challenges and threats outlined in the Resource Assessment are necessary.

The resources necessary to address the scale of threats and challenges identified in the *2020 Colorado Forest Action Plan* do not end with funding. Increased capacity for planning, implementation and collaboration is critical to achieving the goals, strategies and approaches outlined in the themes of this action plan.

ANALYSIS OF THE 2020 COLORADO FOREST ACTION PLAN

» **Conduct** a funding gap/economic analysis of the cost to achieve the goals of the *2020 Colorado Forest Action Plan*, beyond treatment costs (e.g., staffing, administration)

» **Identify** additional resources available to implement the action plan from local, state, federal and nongovernmental organizations

» **Evaluate** productivity and economic viability of forest management within high-priority subwatersheds

» **Develop** quantifiable metrics with benchmarks for implementing action plan strategies

» **Establish** cross-organization working groups to leverage resources and evaluate geographic areas of agreement between the action plan priority composite map and other priority efforts in the state

» **Create** a centralized database of forest stewardship partners and collaboratives

CAPACITY BUILDING AT CSFS

» **Train** existing staff and increase staffing capacity to address Forest Action Plan goals

» **Increase** staffing at the CSFS for planning, implementation, community collaboration, monitoring and developing an adaptive management program that is responsive to unforeseen major forest disturbances

» **Identify** funding sources to further develop and maintain the Colorado Forest Atlas as a one-stop shop for geospatial data in Colorado, and provide training for CSFS staff and collaborators. *coloradoforestatlas.org*

» **Increase** resources for outreach and education programs including integrating social science into messaging

» **Develop** cross-disciplinary working groups among communication professionals to share common messages about the benefits of forests to the environment, the economy and society

» **Identify** resources to support systems (e.g., i-Tree, CO-Tree View) that help quantify and manage Colorado's urban forest resources

» **Continue** to survey Forest Inventory and Analysis plots that were established by the U.S. Forest Service across the Front Range to monitor the ecological health of urban forests (see *fia.fs.fed.us/program-features/urban/* and *csfs.colostate.edu/forest-management/forest-inventory-analysis/urban-fia/*)

» **Develop** monitoring protocols and identify data analysis needs (e.g., Forest Atlas, FIA data, remote sensing)

COMMUNITY CAPACITY BUILDING

» **Provide** more support to community leaders

Increased capacity for planning, implementation and collaboration is critical to achieving the goals, strategies and approaches outlined in the themes of the *2020 Colorado Forest Action Plan*.

» **Increase** local government involvement with forest health issues

» **Increase** involvement in cross-boundary landscape planning efforts in the state

WILDFIRE RISK REDUCTION AND POST-FIRE RECOVERY RESOURCES

» **Promote** new wildfire councils capable of supporting local needs for information, resources and coordination

» **Identify** funding to maintain, update and enhance the Colorado Wildfire Risk Assessment

» **Encourage** retrofitting homes to reduce structural ignitability

» **Improve** infrastructure debris removal post-fire

» **Increase** hazard tree removal

» **Improve** flood mitigation efforts

» **Identify** additional funding sources for post-fire recovery efforts and resources, including re-vegetation of the appropriate species for the area

» **Align** the timber industry with post-fire recovery

» **Develop** a statewide plan for coordinating post-fire recovery efforts on nonfederal lands, identifying roles and responsibilities, resources, etc.

FOREST PRODUCTS INDUSTRY IMPROVEMENT

» **Fairly** and equitably support increased forest industry capacity to sustainably address forest health issues, and offset the cost of treatments

» **Develop** low-interest loans for the forest products industry

» **Launch** grants to incentivize use of low-value wood

» **Promote** state tax incentives, including extension of exemption for blue stain wood products (beetle-kill)

» **Stimulate** infrastructure and markets for handling small diameter material

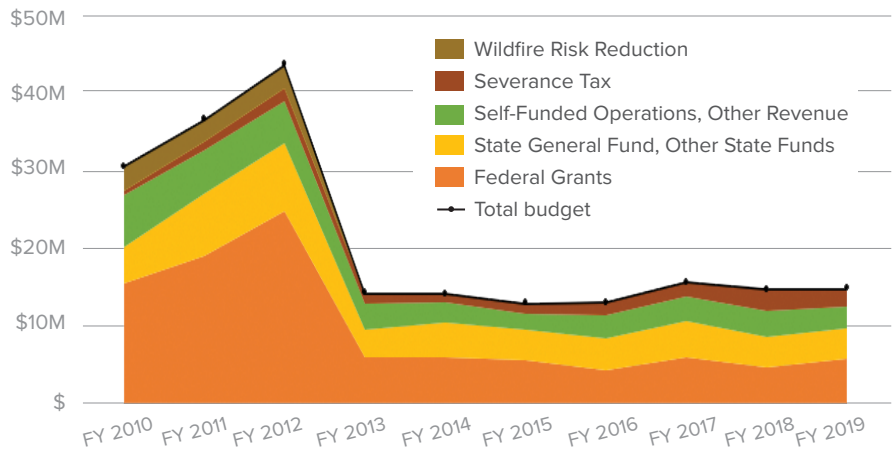


Forester and CSFS Program Delivery Manager Diana Selby helps clear small trees and branches during a forest management thinning project to bolster forest health. Increasing staffing to help develop an adaptive management program is one of the recommended resources necessary to achieve the goals set forth in the 2020 Colorado Forest Action Plan. *Photo: CSFS*

How the Colorado State Forest Service Is Funded

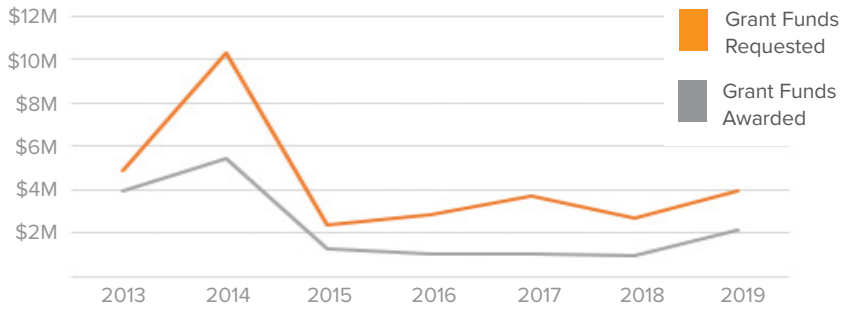
The Colorado State Forest Service derives its budget from federal grants, state general fund and other state funds, self-funded operations and other revenues, severance tax and wildfire risk reduction funding.

CSFS BUDGET TRENDS: FISCAL YEARS 2010-2019



CSFS GRANT PROGRAM: FOREST RESTORATION AND WILDFIRE RISK MITIGATION GRANT

(formerly DNR Wildfire Risk Reduction Grant)



1 FEDERAL GRANTS

FEDERAL FISCAL YEAR: OCTOBER 1-SEPTEMBER 30

Federal funds are subject to annual appropriations, which vary year to year.

Federal grant funding includes consolidated payment grants, domestic grants, supplemental project agreements, cooperative agreements, challenge cost share agreements, sub-grant agreements, research grants and cost reimbursable agreements.

Federal funding at the CSFS declined after fiscal year 2012 for various reasons, including fire management responsibilities being transferred to the Division of Fire Prevention and Control in July 2012, decreasing U.S. Forest Service regional funds available to states and unsuccessful applications for some competitive federal grants.

Transferring fire management responsibilities, including programmatic funding and staffing, to DFPC contributed to a decrease in related federal and state funding beginning in July 2012.

The CSFS further focused its efforts on forest management, wildfire mitigation, risk reduction planning and forestry outreach objectives in place of fire management responsibilities. As of FY 2019, federal funds account for 33% of CSFS funding sources.

2 STATE GENERAL FUND AND OTHER FUNDS (NON-SEVERANCE TAX)

STATE FISCAL YEAR: JULY 1-JUNE 30

State general fund contributions are subject to annual appropriation by the Colorado Legislature and vary each year.

Other state funds come from agreements with state agencies for specific projects. General fund dollars are used for the CSFS operating expenses, including wages, vehicles, facility leases, safety supplies, operating supplies and services.

Over the past 10 years, there has been a steady increase in state general funding appropriations; in FY 2016, this funding comprised 31% of the CSFS funding sources.

In FY 2020, state general fund appropriations and other state funds (non-severance tax) accounted for 24% of the CSFS funding sources.

3 SEVERANCE TAX

FUNDING FROM 2010-2019

Healthy Forests and Vibrant Communities, House Bill 09-1199, provides $1.3 million in annual funding from the Colorado severance tax revenue fund. It enhances CSFS' capacity to address growing forest management and wildfire mitigation needs and improves technical capacity to:

- **Implement** forest management and fuels reduction projects
- **Reduce** wildfire risk to life, property and watersheds
- **Assist** communities and others to develop Community Wildfire Protection Plans
- **Support** utilization and marketing of wood products
- **Provide** loans to forest products businesses

In 2017, Senate Bill 17-050 reauthorized HB 1199 for seven years. The bill combined the Wildfire Risk Reduction Grant Program (administered by the Colorado Department of Natural Resources) and the Colorado Forest Restoration Grant Program (administered by the CSFS) into one program administered solely by the CSFS through the Healthy Forests and Vibrant Communities Program and called the Forest Restoration and Wildfire Risk Mitigation Grant Program.

Although $1 million was allocated to each program prior to the passage of SB 17-050, the combined programs have an allocation of $1.05 million, which resulted in a reduction of funding for the program.

4 SELF-FUNDED OPERATIONS AND OTHER REVENUE

THE CSFS IS A STATE-ASSISTED AGENCY, mandated by the Colorado Legislature to supplement appropriated general fund monies with revenue generated through fees charged for goods and services.

All residents benefit indirectly from tax-supported funding of CSFS programs and services that ensure long-term management and care of Colorado's nonfederal forest resources. Landowners who more directly accrue the benefits of these programs and services share in the costs of CSFS operations through service fees.

Examples of self-funded activities include professional forestry services for specific projects and programs of work, fees for services and the CSFS Nursery operations.

Self-funded revenue is more variable than other funding sources due to the opportunistic nature of the services. The CSFS is a nonregulatory agency and services are dependent on landowner interest. Over the past 10 years, dramatic fluctuations in needs for services has resulted in self-funded revenue contributing to 12% of the CSFS funding sources in FY 2012, 24% in FY 2013 and 22% in FY 2020.

Self-funded operations fill the gaps in federal and state funding that the CSFS needs on an annual basis.

5 WILDFIRE RISK REDUCTION

THE CSFS ADMINISTERS GRANTS TO FUND PROJECTS that reduce the risk of damage to property, infrastructure and water supplies, as well as those that limit the likelihood of wildfires spreading to populated areas.

From the start of the DNR's Wildfire Risk Reduction grant program in 2013 to the current CSFS-administered program, applications requesting approximately $30.77 million have been submitted, with $15.8 million available to allocate to projects. From 2013-2019, the CSFS was able to fund only 199 of the 378 submitted grant applications, awarding just 51% of the amount requested by Colorado landowners.

Since the funding program was combined and administered by the CSFS, over the last three funding cycles there have been requests for approximately $10.4 million and only $4.2 million available to fund projects, representing 40% of the project funding requested.

> **The uncertainty of available funding makes it challenging to have consistency within the Forest Restoration and Wildfire Risk Mitigation Grant Program and program support through Healthy Forests and Vibrant Communities.**

Outlook for Severance Tax, Wildfire Risk Reduction

Funding for the Forest Restoration and Wildfire Risk Mitigation Grant Program and CSFS program support from Healthy Forests and Vibrant Communities is derived from Tier 2 of the Colorado severance tax revenue fund.

Funding availability through the severance tax fund is completely dependent on revenue received from oil and gas development. In recent years, the volume of oil and gas development that has occurred in Colorado has been highly volatile, and generally trending downward.

Over the past 10 years, there has been a steady increase in severance tax funds contributing to the CSFS funding sources, with the highest point at 21% of the funding sources in FY 2020. However, the current projections from the state of Colorado point to a sharp decrease in funds for the next three years.

The uncertainty of available funding makes it challenging to have consistency within the Forest Restoration and Wildfire Risk Mitigation Grant Program and program support through Healthy Forests and Vibrant Communities. The Colorado General Assembly passed bills to allocate additional funding to the Tier 2 programs from general funds to backfill the gaps during the 2018 and 2019 legislative sessions.



Former CSFS forester Kathryn Hardgrave and Comet the golden retriever enjoy a fall day helping establish seedlings. Working with landowners, partner agencies and neighboring states helps the CSFS complete as many projects as possible on a limited budget. Photo: CSFS

WORKING WITH NEIGHBORS



Ahead of the Curve: As the Population Grows, CSFS Focuses on Greatest Impact

It is more important than ever to **CONSERVE**, **PROTECT** and **ENHANCE** Colorado's forestlands for future generations.

As the state's population continues to grow rapidly, forest and water resources are pressured from competing interests, and forestland is at risk of conversion to other uses.

Colorado is a desirable state to call home, in part because of the ability to live close to recreational opportunities. However, more housing and community developments are encroaching on public and private forestlands, threatening to fragment the very landscape that is one of Colorado's signature traits.

It is essential to work across political, jurisdictional and ecological boundaries to achieve the goals of the *2020 Colorado Forest Action Plan*.

In this section, we highlight the Forest Legacy Program, Shared Stewardship and case studies of the CSFS working with neighbors to **CONSERVE**, **PROTECT** and **ENHANCE** Colorado's forestlands. A National Priorities Report can be found in Appendix 9.

> **"Without natural resources life itself is impossible. From birth to death, natural resources, transformed for human use, feed, clothe, shelter, and transport us. Upon them we depend for every material necessity, comfort, convenience, and protection in our lives. Without abundant resources prosperity is out of reach."**
>
> — *Gifford Pinchot,* Breaking New Ground

Preventing Fragmentation: Forest Legacy Program Offers Support for Landowners While Protecting Forestland



FOREST LEGACY PROGRAM

Since 2007, Forest Legacy projects have protected 21,000 acres in Colorado through eight conservation easements in seven counties. These "working forests" provide benefits including water quality, wildlife habitat, forest products, opportunities for recreation and more.

LEARN MORE

The full 2020 Forest Legacy Program Assessment of Need is in Appendix 1 of this plan.

The Forest Legacy Program is a conservation program administered by the U.S. Forest Service in partnership with the Colorado State Forest Service. It identifies environmentally important, privately owned forests and uses conservation easements or fee-acquisition land purchases to ensure these lands are not converted to nonforest uses. The program gives private landowners the opportunity to retain ownership and management of their land while receiving compensation for unrealized development rights.

Colorado landowners who want to protect private forest areas (that currently or could someday be threatened by development or conversion) have the opportunity to work with the CSFS and apply for funding from the Forest Legacy Program.

The CSFS releases an annual request for proposals for Forest Legacy Program applications. From the submissions, projects are selected through a competitive review process — first at the state level and then at the national level. Federal Forest Legacy funds come from the Land and Water Conservation Fund, which receives money from a small portion of offshore oil and gas royalties (not taxpayer dollars).

APPLICATION TIMELINE

The process of applying, being selected, receiving funding and conducting due diligence on a project can take several years. It requires a high degree of commitment from landowners and partners. If awarded Forest Legacy funding, the funds will not be available to use for two years after the date the application is submitted.

UPDATED ASSESSMENT OF NEED AVAILABLE

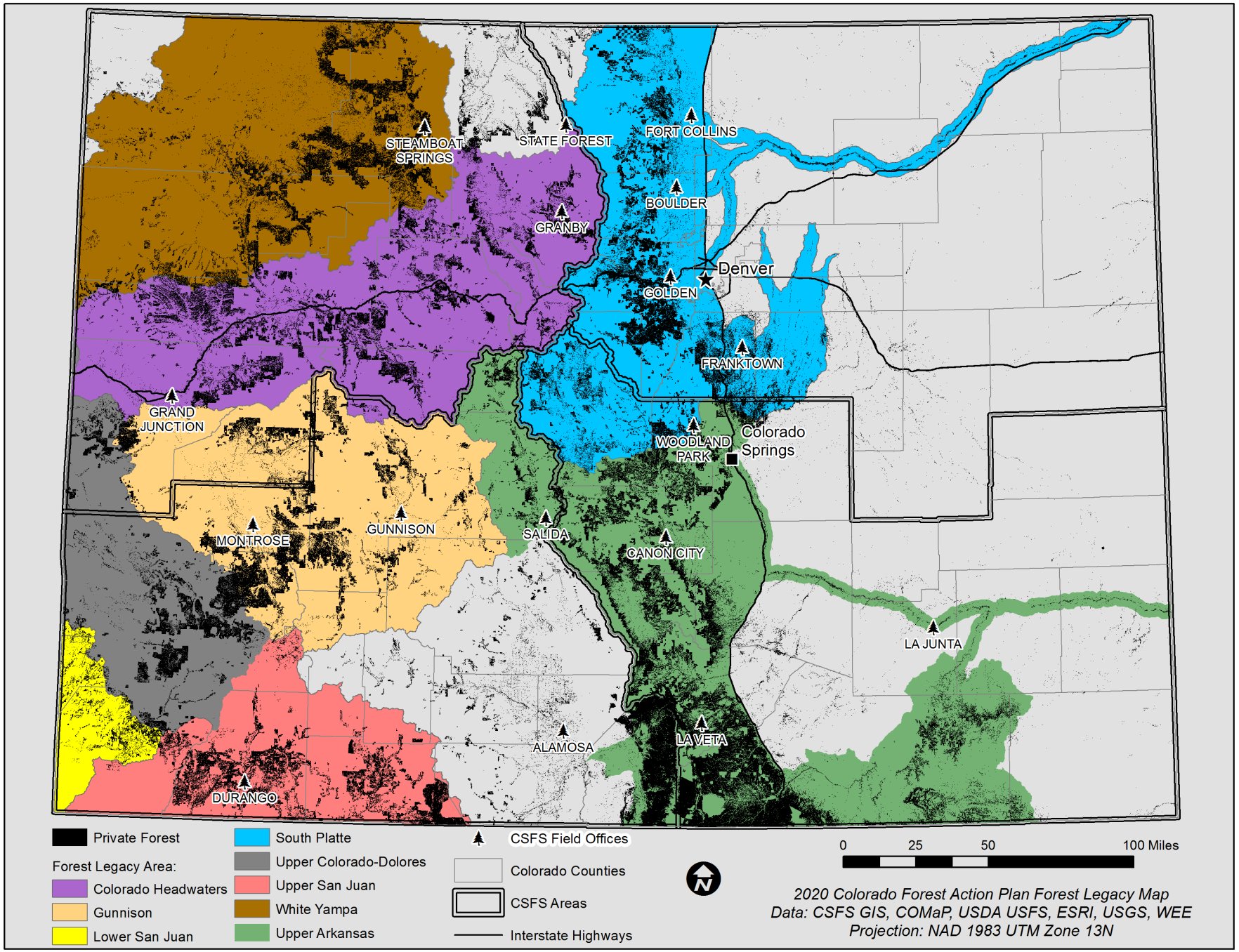
Only landowners in the areas of the state identified as Forest Legacy Areas in the current Colorado Forest Legacy Program Assessment of Need are eligible to apply for Forest Legacy Program funding.

The assessment presents a revised map showing areas eligible for Forest Legacy funding, along with a detailed description of the specific conservation values for each Forest Legacy Area.

The updated assessment reflects areas of eligibility utilizing current land and population data and trends.

The CSFS reached out to a number of prominent land trusts and natural resource conservation organizations in Colorado to get feedback on which criteria identified by the Forest Legacy Program for project selection are most critical. Participants ranked 10 criteria for project selection based on their land conservation goals and criteria, and current/planned conservation work. Their rankings were incorporated into the updated Forest Legacy map.

Forest Legacy Map: Areas Eligible to Apply to the Program



CASE STUDY

TOLLAND RANCH

Forest Legacy Conservation Easement Protects Iconic Ranch, Water Resource

Owned by the Toll family for 120 years and four generations, this beautiful Front Range landscape had long been a priority for conservation, in part because it is central to the history of the area. The Tolland Ranch sits east of the Moffat Tunnel's east portal and west of Rollinsville.

In 1904, the switchback railway known as the Giant's Ladder was built over Rollins Pass.

Thousands of Denver socialites rode the rail line, which stopped at the historic town of Tolland for lunch. Today, Amtrak's California Zephyr still carries passengers through the Toll property on their way from Chicago to San Francisco.

In 1994, brothers Henry Toll, Jr. and Giles Toll conveyed 1,320 acres to the U.S. Forest Service, clearing the way to establish the James Peak Wilderness in 2002. By 2013, the property was the Forest Legacy Program's top national priority.

By 2015, the landowners placed the historic 3,334-acre property in a conservation easement. The Conservation Fund and the Colorado State Forest Service worked with the Toll family, with the support of Boulder and Gilpin counties, to secure federal funding from the Forest Legacy Program, state funding from Great Outdoors Colorado and local funding from Boulder County.

The CSFS holds the easement for this property, one of the largest intact private holdings along the Front Range.

Now protected forever, the property remains in the Toll family's private ownership and the conservation easement protects critical drinking water sources for Boulder and Denver. A 4-mile stretch of upper South Boulder Creek runs through the property, which Denver Water relies upon to help deliver safe drinking water to 1.5 million people.

"The conservation easement provides us with a structure and some resources to continue the preservation ethic of our great-grandparents Katharine and Charles Toll, our grandparents Henry and Cyrena Toll, and our parents Hank and Lydia Toll," said landowner Wolky Toll. "Preservation of land and historic structures is an involved process in the face of a booming Colorado population and all the climatic variables in the high valleys."



A Forest Legacy conservation easement, supported by the Colorado State Forest Service and federal funding, helped forever protect part of the Tolland Ranch that holds a 4-mile stretch of South Boulder Creek, a critical watershed that contributes part of the drinking water for nearly 1.5 million people. Photo: Toll family, for CSFS

The Toll property creates an expansive buffer between the 14,000-acre James Peak Wilderness and rural subdivisions and urban areas to the east.

Through the decades, the Tolls have maintained a deep commitment to practicing sustainable forestry and working with the CSFS to manage forests on the property. A CSFS Forest Stewardship Plan, prepared in cooperation with the landowners, helps guide forest management and meets a requirement of the Forest Legacy Program. Most recently, the landowners have been establishing relationships with the Cheyenne and Comanche tribes to utilize forest products from the conservation easement.

CSFS Assists Tribal Ranches with Wildfire Risk Reduction Projects in Southwest Colorado

The Colorado State Forest Service has a longstanding history of working alongside the Ute Mountain Ute tribe in the southwest corner of Colorado, assisting with forest planning and implementation projects since the 1980s.

Staff members from the CSFS Gunnison and Durango field offices provide assistance by completing forest management plans on tribal ranches (non-reservation lands), such as the Pine Crest Ranch in Gunnison County. This recent Douglas-fir beetle sanitation and thinning project was completed in 2019 to promote wildfire risk reduction, and the non-saw log material that was left was salvaged for the Ute Mountain Ute tribe to use as firewood. This project was funded through the CSFS-administered Forest Restoration and Wildfire Risk Mitigation Grant Program, and a U.S. Department of Agriculture Western Bark Beetle grant.

Two other ongoing collaborations include work on the Adams and Cherry Creek ranches. At Adams Ranch, basal area reduction is being used to promote fuels reduction and reduce the risk of catastrophic wildfire.

The Cherry Creek Ranch narrowly escaped the impact of the East Canyon Fire that burned 2,905 acres directly to the west of the property in June 2020. Prior to that, the ranch and surrounding drainage were impacted by bark beetle outbreaks over the last seven years that have led to significant ponderosa pine mortality. The roundheaded pine beetle, mountain pine beetle and, likely, the western pine beetle all have infested these stands of trees simultaneously, giving this project a multifaceted purpose. The project goals are to reduce the infestation of bark beetles on the forested ranch lands, improve stand vigor of residual ponderosa pines, salvage wood products and reduce fire hazard by reducing fuel loads.

The U.S. Department of Interior Bureau of Indian Affairs Reserve Treaty Rights Lands funding program supports both the Adams Ranch and Cherry Creek Ranch projects.



In 2019, staff from the Colorado State Forest Service's Gunnison Field Office worked with Ute Mountain Ute tribal members to complete a 21.3-acre Douglas-fir beetle sanitation and thinning project on the Pine Crest Ranch in Gunnison County. The CSFS Durango Field Office staff is currently bidding on several projects across multiple Ute Mountain Ute ranches, encompassing more than 150 acres in the Four Corners area. Photo: Sam Pankratz, CSFS



The Colorado State Forest Service provided critical information during the 2019 Decker Fire near Salida that helped firefighters protect residential properties. Photo: Joy Jackson, for CSFS

CASE STUDY

SANGRE DE CRISTO MOUNTAINS

CSFS Key in Assessing Properties During Decker Fire

Lightning started the Decker Fire in the upper elevations of the northern Sangre de Cristo Mountains on Sept. 8, 2019.

Initial wildfire response blended suppression and management for ecological benefits. The rare, late-season, high-altitude wildfire brought with it the possibility that (under certain environmental conditions) it could burn into populated areas, including Salida and other towns along the Highway 50 corridor.

The CSFS played a key role in providing the Incident Management Team with private property wildfire risk assessments that were completed since 2015. The CSFS also helped actively assess properties during the fire.

The CSFS forest management history in Chaffee County, including property assessment efforts since 2015 and the Decker Fire assistance, illustrate direct contributions and influences on the Envision Chaffee County initiative and the depth of knowledge and experience contributing to the revised Community Wildfire Protection Plan.

CASE STUDY

CHAFFEE COUNTY

Community Wildfire Protection Plan Revision Provides Residents with 'Fire-Ready Future'

Chaffee County is home to 20,000 residents, and 80% of the county is on public lands.

The county serves as the headwaters watershed for the Arkansas River, which serves as a major agricultural water source, providing an estimated 1 million downstream residents with their domestic water supply. It also hosts 102 miles of Gold Medal trout fishing waters and is the most visited river for recreational rafting in the U.S.

In 2017 over 1,500 residents and more than 70 organizations created a "vision" of how to preserve and enhance the myriad natural and social resources in Chaffee County, to create a fire-ready future. They named the effort Envision Chaffee County, and in 2018 voters approved the vision and funding for taking action — a large part of which was revising the county Community Wildfire Protection Plan using new ideas and approaches to create "the next generation Community Wildfire Protection Plan."

The CSFS was integral in this effort based on a decades-long history of forest management in the area and a program established in 2015 to provide no-cost wildfire risk assessments for interested communities in the county.

> **"This innovative community-driven wildfire plan delivers a disciplined approach to treat the right acres for the greatest community benefit."**
>
> *— Damon Lange, CSFS Southwest Area Manager's comment in the Chaffee County CWPP*

The assessment program is funded by Chaffee County Title 3 funds and uses advanced spatial prioritization tools that have been supported by the Colorado Forest Restoration Institute to prioritize fuel treatments.

In particular, the CSFS is closely involved in facilitating future boots-on-the-ground forest management activities in support of the Envision Forest Health Council's goals.

CASE STUDY

ALPINE PLATEAU

Good Neighbor Authority Project Clears Dead Trees for Southwestern Community

Authorized in 2000 through the Interior Appropriations Act and limited to partnerships between the Colorado State Forest Service and U.S. Forest Service for the first five years, the Good Neighbor Authority (GNA) was expanded nationally in the 2014 U.S. Farm Bill.

Now, this program provides a mechanism for state forestry agencies to enter cooperative agreements with the U.S. Forest Service and the Bureau of Land Management to accomplish shared objectives across jurisdictional boundaries.

Cross-boundary GNA activities can include fuels management, habitat improvement, insect and disease control and commercial timber removal, among others. The GNA is a prime example of shared stewardship in Colorado; it includes cross-boundary activities achieving multiple goals and objectives across a broad landscape, and it promotes ongoing engagement with local, state and federal agencies and legislators.

As of April 2020, there were 16 GNA supplemental project agreements completed or in progress in Colorado *(Appendix 9)*.

The Good Neighbor Authority allows the CSFS to enter cooperative agreements with federal agencies to accomplish forest management goals across boundaries.



Good Neighbor Authority projects allow state forestry agencies to make cooperative agreements with federal agencies to accomplish shared objectives, such as clearing and utilizing dead trees on the Alpine Plateau near Blue Mesa Reservoir. In early 2020, there were 16 GNA projects completed or in progress across Colorado. Photo: CSFS

The Alpine Plateau GNA project was initiated by the CSFS and USFS on lands in the Gunnison Ranger District, with the primary goals of dead tree utilization and community wildfire protection. Engelmann spruce trees, stressed by years of above-normal temperatures and below-normal precipitation, have succumbed to spruce beetles across hundreds of thousands of Colorado acres, including the area of this GNA project. The Arrowhead and Blue Mesa subdivisions, with over 300 homes, are in the wildland-urban interface just a few miles to the north.

Secondary objectives of this project include facilitating forest recovery and resiliency, reduction of hazardous trees that pose threats to recreationists, increasing public safety and supporting the local forest products economy.

The project is designed to utilize standing dead trees by removing them from the forest while they retain value and before they increase fuel loading on the ground.

This project includes the 2,155-acre Big Willow Salvage timber sale. At 11,000 feet in elevation, it is the largest timber sale administered to date by the CSFS through GNA.

Another planned sale is Ridge Stock Salvage, covering about 1,386 acres, and discussions have begun with partners for new potential GNA projects in the surrounding area.

CSFS Practices Shared Stewardship to Work with Partners Across Landscapes

The U.S. Forest Service conceptualized Shared Stewardship in 2018 as an outcome-based investment strategy to work with partners and stakeholders across landscapes to co-manage risk, use new tools to better target investments, focus on outcomes at the right scale and recalibrate the wildland fire environment for the benefit of people, both now and for generations to come.

This concept aligns well with the Colorado State Forest Service mission. The *2020 Colorado Forest Action Plan* themes also align well with Shared Stewardship, and will be used to plan and evaluate cross-boundary priority landscapes, identify data and information to supplement decision-making, maximize the number of goals achieved by one activity or project, and evaluate resources including programs, partners and potential funding.

In Colorado, a Shared Stewardship memorandum of understanding was signed by Gov. Jared Polis and USDA Undersecretary for Natural Resources and Environment Jim Hubbard on Oct. 23, 2019.

> **"Shared Stewardship is about working together in an integrated way to make decisions and take actions on the land."**
>
> *— Vicki Christiansen, U.S. Forest Service Chief*

It outlines applicable state and federal programs and authorities to carry out shared stewardship, which include state-delivered landowner technical assistance, forest health assistance, wildland fire suppression, prescribed fire, state-delivered U.S. Forest Service State and Private Forestry Programs, Good Neighbor Authority and other farm bill authorities, the Landscape Scale Restoration program, and State Trails and Great Outdoors Colorado grants.

Shared Stewardship: Three Core Elements

1. **Determining management needs on a state level.** The U.S. Forest Service will prioritize stewardship decisions directly with the states, setting priorities together and combining mutual skills and assets to achieve cross-boundary outcomes desired by all.
2. **Doing the right work in the right places at the right scale.** The U.S. Forest Service will use new mapping and decision tools to locate treatments where they can do the most good, thereby protecting communities, watersheds and economies where the risks are greatest.
3. **Using all available tools for active management.** The U.S. Forest Service will use every authority and tool to do more work on the ground, including timber sales, mechanical treatments and carefully managed fire, working with partners and stakeholders to choose the right tools.

— From U.S. Forest Service publication FS-118 August 2018

CASE STUDY

2-3-2 PARTNERSHIP

Colorado's Multistate, Regional Forestry Priorities Align with 2020 Action Plan Map and Shared 2-3-2 Goals for New Mexico

During the development of the *2020 Colorado Forest Action Plan*, the Colorado State Forest Service was involved in discussions with forestry experts in Wyoming, New Mexico, Utah and Kansas regarding their processes and priority mapping efforts.

The forests that extend between Colorado and New Mexico are of particular interest to both states, primarily for reasons related to watershed protection. One example of this is the Two Watersheds – Three Rivers – Two States Cohesive Strategy Partnership, better known as the "2-3-2," launched in 2016. It brings together a diverse "team of teams" comprised of members from 12 nongovernmental organizations and nine federal, state and local agencies, including the CSFS *(Figure K)*.

The 2-3-2 was created by cross-boundary stakeholders who recognized the connection between river headwaters in Colorado and over a million people who rely on the water sourced in the San Juan Mountains. Threats to this connection were starkly realized after the 2013 West Fork Complex, a series of wildfires that threatened these vital headwaters, communities and infrastructure for four months across 109,615 acres that held large tracts of beetle-killed spruce-fir forest.

The 2-3-2 brings together 12 NGOs and nine federal, state and local agencies, including the CSFS. The partnership challenges the notion of administrative boundaries and has secured more than $5 million since 2016 for watershed improvement.

The 2-3-2 has secured more than $5 million and accomplished many goals, including facilitating the use of prescribed fire with resources from multiple forests; leveraging funding to secure Rural Conservation Partnership Program work on private lands; building an online spatial data portal for planning treatments; working with partners to identify future projects; promoting collaborative development of fire management decision support tools; monitoring forest treatments; and facilitating dialogue between forest and wildlife groups.

In 2019, the 2-3-2 completed a three-year strategic plan outlining the following objectives: watershed protection; cross-boundary collaborative planning; the application and management of fire across boundaries; advancement of industry opportunities; elevation and enhancement of local effort successes; encouragement for a holistic approach to forest management; and utilization and promotion of relevant science.

Partners in the 2-3-2 challenge the notion of administrative boundaries and work together to realize a collective impact on a watershed scale.



The Wolf Creek Pass area — within both the San Juan and Rio Grande national forests — has been affected by beetle activity and wildfire damage. The 2-3-2 focuses on coordinating management efforts here for the greatest benefit to forest health and area communities. Photo: 232partnership.org

MORE *information on the 2-3-2 Partnership can be found at 232partnership.org*

CSFS Helping Build Pace and Scale of Forest Management

The Rocky Mountain Restoration Initiative (RMRI) is a stakeholder-driven collaborative process launched in 2019 that aims to increase the resilience of Colorado's forests, wildlife habitats, communities, recreation and water resources across all lands in the Rocky Mountains. The U.S. Forest Service and National Wild Turkey Federation bring representatives from other groups and agencies together for this effort, to increase the pace and scale of restoration under the principles of shared stewardship.

Colorado was chosen as a pilot for the RMRI, due to the large number of headwaters in the state and Colorado's history of collaborative forest and watershed management.

The RMRI recognizes that the U.S. Forest Service, the Colorado State Forest Service and their partners invest significant funding in forest treatments; however, vulnerabilities persist and work must be focused in high-priority landscapes to maximize impact and mitigate risk.

A large portion of southwestern Colorado was selected for the RMRI pilot *(Figure K)*.

When overlaid with the *2020 Colorado Forest Action Plan* priority map, much of the pilot area matches the high-priority subwatersheds identified in the action plan analysis. In fact, individual data layers in the 2020 action plan will likely be very useful in RMRI planning efforts.

In addition to the Southwest Colorado project selected as RMRI's first focus area, the group agreed to explore ways to engage and support the Upper South Platte and Upper Arkansas projects.

The CSFS is looking forward to working with new collaboratives and stakeholder-driven efforts such as RMRI in priority subwatersheds, to appropriately address annual forest threats posed by wildfire, insects and disease across nearly 400,000 acres of the state.

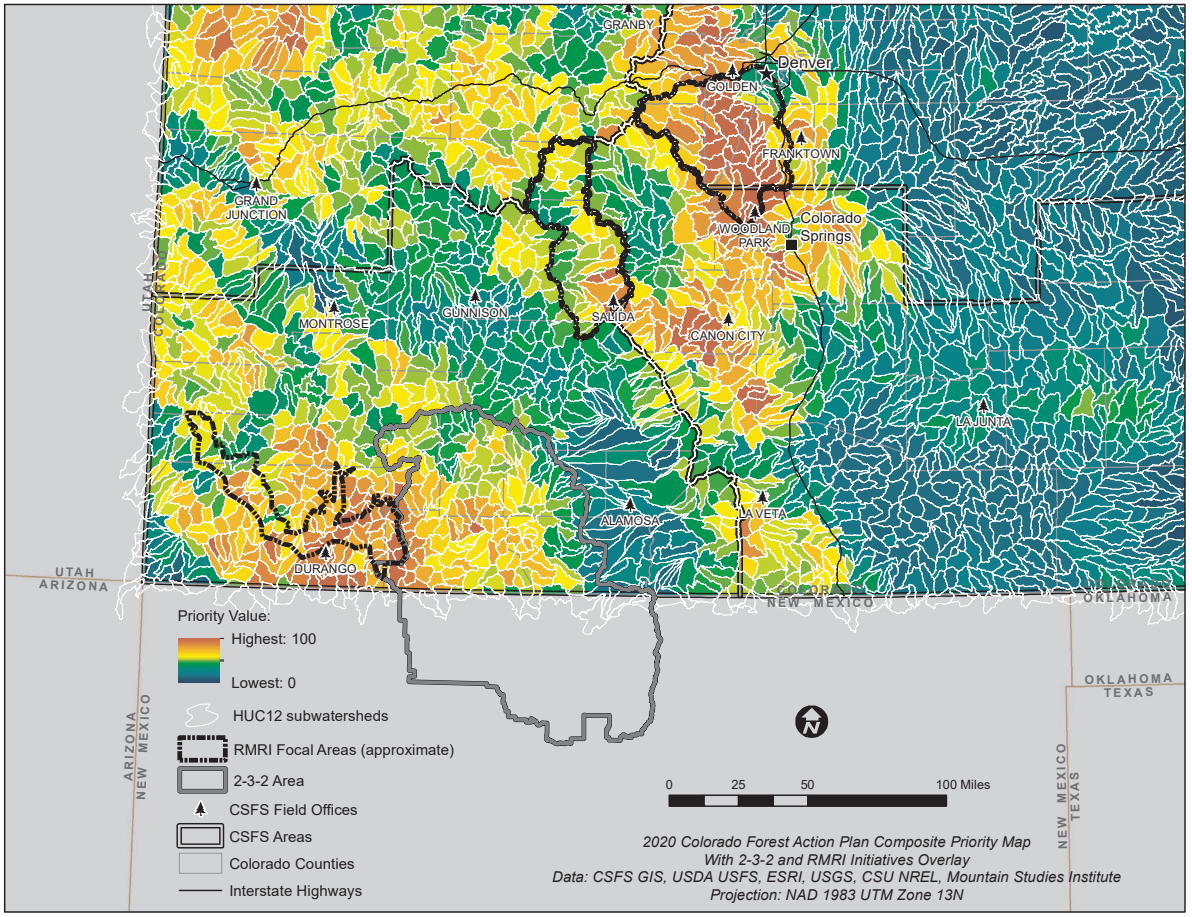


FIGURE K *The* 2020 Colorado Forest Action Plan *composite priority map shows highest priority areas for CSFS work in orange and red, with an outline of the overlapping 2-3-2 (Two Watersheds – Three Rivers – Two States) Cohesive Strategy Partnership focus area and the Rocky Mountain Restoration Initiative focus area. Map: CSFS*

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The Colorado State Forest Service relies on partners and volunteers, such as this group of residents, to assist with forest management efforts on the ground. Photo: CSFS

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FOREST MANAGEMENT IS FOREST HEALTH

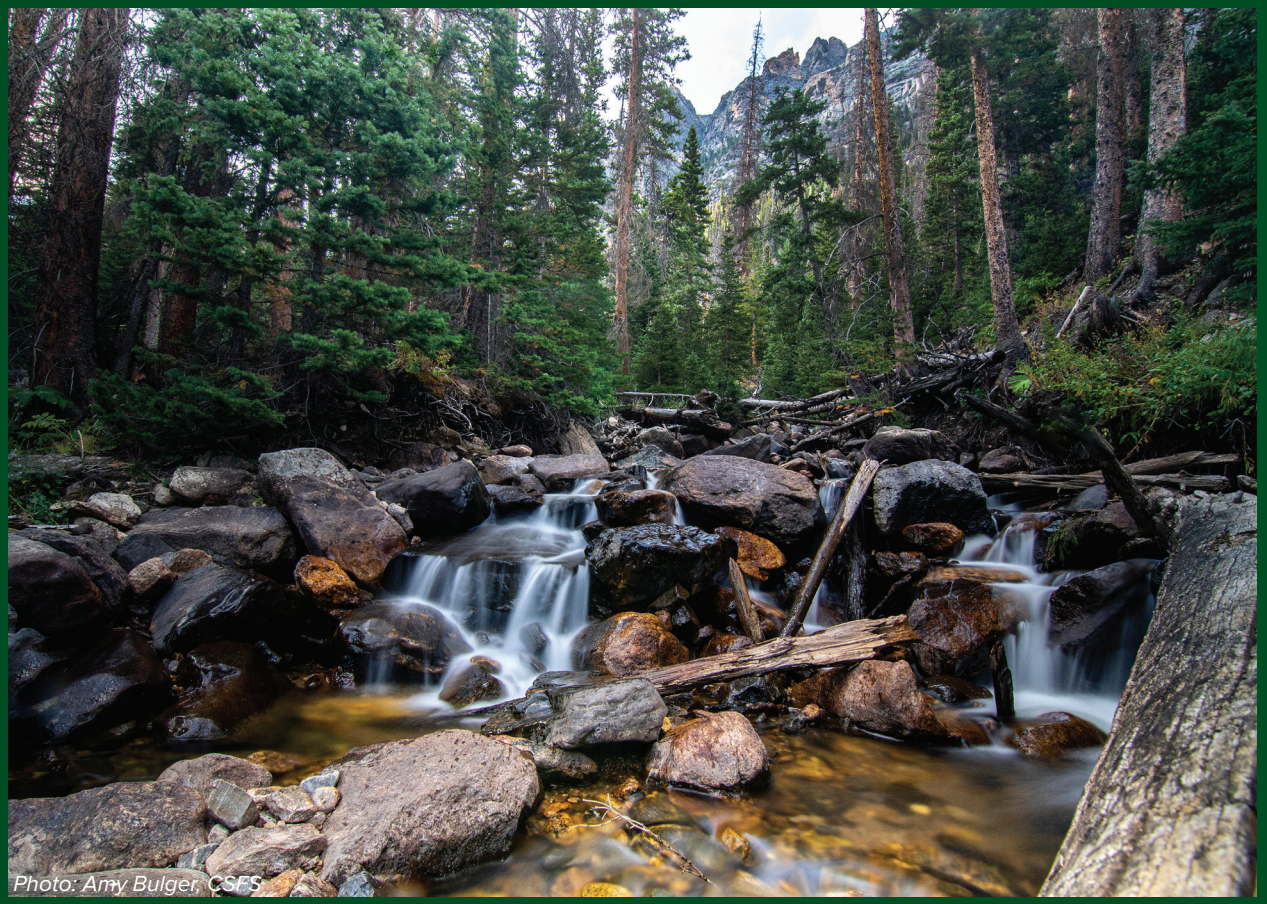

Photo: Amy Bulger, CSFS

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