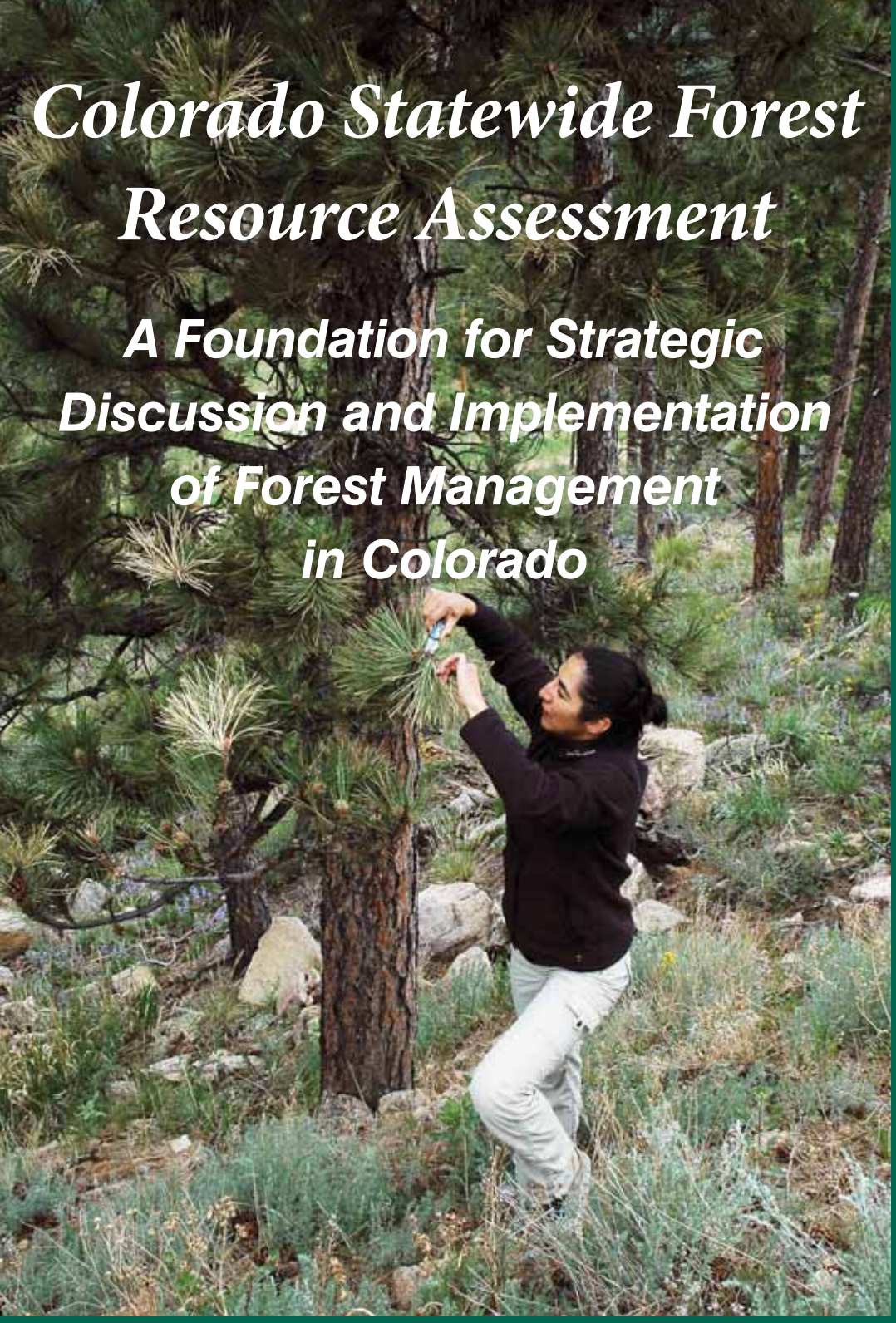
Colorado Statewide Forest Resource Assessment

A Foundation for Strategic Discussion and Implementation of Forest Management in Colorado



Colorado State Forest Service

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The Colorado Statewide Resource Assessment and all appendices are available online on the Colorado State Forest Service website at http://csfs.colostate.edu/pages/statewide-forest-assessment.html. Appendices B — I are not included in this document.

I. Executive Summary

The Statewide Forest Resource Assessment is the first geospatial assessment completed by the Colorado State Forest Service. This report contains the complete set of data used to inform the assessment, as well as the process we followed and a list of the people we engaged. It also contains information about Colorado's forest types and ownership, a brief history of forest uses in Colorado and actions we can take to address priority needs. The objective of the assessment is to provide a spatial overview of Colorado's forests and display areas in the state where resources are best focused to achieve desired future conditions.

Early in the assessment process we established an interagency, interdisciplinary steering team to identify the best available data layers. We then combined the individual data layers according to three national themes identified in the Forestry Title of the 2008 Farm Bill (Conserve Working Forest Landscapes, Protect Forests from Harm, and Enhance Public Benefits from Trees and Forests). The data then was combined to provide a comprehensive overview of the important forest resource areas across Colorado. Through the development of the assessment and this document, we discovered topics/themes/areas for which significant data were available and other topics/themes/areas for which a pressing need to develop additional data exists. To equitably identify important forest areas across Colorado, we used only data that best represented specific resources and values at the statewide level.

This report contains data sets that were combined to address the three national themes and represents the best available data at the time this report was published. Additional data included in this report provides resource information, but was not included in the thematic combinations. The structure of some of the additional data sets was not conducive to integration into a combined data set. It is important to note that the data included in this report can be combined in numerous ways. As noted earlier, we selected the combination of data sets that best address the three national themes. This assessment is designed to be a living document and is structured to allow incorporation of new data as it becomes available. The assessment will be reviewed and updated at a minimum of every 5 years.

All data in this report is available for public use, and we look forward to hearing your thoughts on the assessment. We also invite you to help us further identify gaps so that we can develop additional data sets that better describe our forest resources. This assessment will frame discussions regarding our forested areas and will help determine appropriate distribution of limited resources to areas where they will be most effective. During our discussions across the state, we also will examine the importance of our forest resources and how to effectively conserve them so they continue to serve society's needs without compromising future productivity.

II. Background

The Colorado Statewide Forest Resource Assessment was initiated in response to a mandate from the U.S. Forest Service (USFS) and contained in the Forestry Title of the 2008 Farm Bill (P.L. 110-234).[1] The assessment was developed under the leadership of the Colorado State Forest Service (CSFS) and in accordance with national direction issued jointly by the USFS and the National Association of State Foresters (NASF).

Statewide assessments are a key component of the USFS State and Private Forestry (S&PF) Redesign Initiative that was launched in 2008. These assessments will provide a science-based foundation to assist state forestry agencies and their partners in: 1) identifying the areas of greatest need and opportunity for forests across their states, and 2) developing a subsequent long-term strategy to address them.

By encouraging states to work collaboratively with their partners to identify and address priorities, the U.S. Congress and the USFS hope to ensure that S&PF funds are invested in those areas where they will make the most significant difference for both the state and the nation.

In Colorado, the CSFS also will use the state assessment as a tool to identify where opportunities exist to facilitate forest management across jurisdictional boundaries and help all partners quantify the full scale of actions and resources needed to address Colorado's forest health challenges.

State and Private Forestry Redesign Initiative

The S&PF branch of the USFS provides technical assistance and cost-share funding to every state in the nation in support of issues related to wildland fire, insects and disease, private forest stewardship and community forestry on non-federal land. In Colorado, this funding is received and distributed primarily by the CSFS.

The S&PF Redesign Initiative was conceived by state and federal partners in response to increasing pressures on our nation's forests and decreasing availability of resources and funds. In the face of these challenges, the USFS and state foresters determined that more progressive, large-scale strategies were needed to sustain our nation's forest resources.

The purpose of the redesign initiative is "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."[2] In designing the initiative, state foresters worked closely with the USFS to:

- Examine current conditions and trends affecting forest lands.
- Review existing S&PF programs to determine how best to address threats to forests on a meaningful scale.
- Develop a strategy to deliver a relevant and focused set of S&PF programs and opportunities.

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[1] Forestry is addressed in Title VIII of the 2008 Farm Bill. The first section of this title amends the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2103c), which provides the authorization for many S&PF programs.

[2] More information on the USFS S&PF Redesign Initiative is available at http://www.fs.fed.us/spf/redesign/index.shtml.

The new redesign approach focuses on three consensus-based national themes with accompanying strategic objectives:

Conserve working forest landscapes.

- Identify and conserve high-priority forest ecosystems and landscapes.
- Actively and sustainably manage forests.

Protect forests from harm.

- Restore fire-adapted lands and reduce risk of wildfire impacts.
- Identify, manage and reduce threats to forest and ecosystem health.

Enhance public benefits from trees and forests.

- Protect and enhance water quality and quantity.
- Improve air quality and conserve energy.
- Assist communities in planning for and reducing wildfire risks.
- Maintain and enhance the economic benefits and values of trees and forests.
- Protect, conserve and enhance wildlife and fish habitat.
- Connect people to trees and forests.
- Manage and restore trees and forests to mitigate and adapt to global climate change.

Since 2008, a portion of S&PF funding has been and will continue to be allocated through a competitive process guided by these national themes. To ensure that proposals for this funding are being focused on high-priority areas with the greatest opportunity to achieve meaningful outcomes, each state or territory that wants to receive S&PF funding must work collaboratively with the USFS and other key partners to develop the following documents:

Statewide Forest Resource Assessment – Provides an analysis of forest conditions and trends in the state and delineates priority rural and urban forest landscape areas.

Statewide Forest Resource Strategy – Provides long-term strategies for investing state, federal and other resources to manage priority landscapes identified in the assessment, focusing on areas in which federal investment can most effectively stimulate or leverage desired actions and engage multiple partners.

States that receive S&PF funds also will be asked to submit an annual report that describes how such funds were used to address the opportunities identified in the assessment and strategy, including the leveraging of funding and resources through partnerships.

According to the 2008 Farm Bill, each state is required to complete both the assessment and strategy by June 2010 in order to qualify for most S&PF funds.

This document represents Colorado's completion of the assessment component of this requirement.

National Guidance for Statewide Forest Resource Assessments[3]

The development of a comprehensive statewide assessment of forest resources provides a valuable and unique opportunity to highlight the full scale of work needed to address priorities in the forests of each state and potentially across multiple states.

At a minimum, each statewide assessment must:

- Describe forest conditions and threats on all ownerships in the state.
- Identify forest-related benefits and services consistent with the national themes.
- Delineate priority forest landscapes or otherwise identify issues and opportunities that will emphasize and address the Statewide Forest Resource Strategy.
- Identify any multi-state areas that are a regional priority.
- Incorporate existing statewide plans as appropriate.

The national guidance recommends that states base their assessments on publicly available geospatial data, but it allows states to use a combination of qualitative, quantitative and geospatial sources to provide information relevant to key state issues and national themes. In addition, non-geospatial information can be used in combination with geospatial data to identify priorities. States may identify separate priority areas for different programs and issues.

In developing a statewide assessment, each state forestry agency is directed to coordinate with the State Forest Stewardship Coordinating Committee, State Technical Committee, State Urban Forestry Council, state wildlife agency and applicable federal land management agencies to ensure that the assessment addresses the rural-to-urban landscape continuum and identifies opportunities for program coordination and integration. State forestry agencies also are asked to involve other key land management and natural resource partners as appropriate to ensure the state's assessment integrates, builds upon and complements other natural resource plans.

Process for Development of Colorado's Statewide Assessment

Colorado's Statewide Forest Resource Assessment was developed under the leadership and guidance of the CSFS and through a contract with the Colorado Chapter of The Nature Conservancy (TNC). The Nature Conservancy worked closely with CSFS personnel to establish and implement an assessment process to accomplish the following:

- Ensure that geospatial data and other information used in the assessment are scientifically valid and meet both state and national guidelines.
- Facilitate meaningful involvement and input from key land management agencies, research entities and other partners.
- Integrate existing state level natural resource plans as appropriate.
- Allow the CSFS to use the accumulated data to work with partners in identifying emphasis areas throughout the state.

[3] See Appendix A for a complete version of the National Guidance for State Assessments and Resource Strategies jointly issued by the NASF and the USFS on October 20, 2008.

To assist in the identification of the best available data layers, an interagency and interdisciplinary steering team was established.[4] Steering Team members worked to:

- Recommend parameters for the data and scope of the assessment
- Identify the best available geospatial data layers that met the data parameters and national guidance.
- Work with subject area experts as needed to identify and apply data layers.
- Ensure that data were analyzed, applied and described both credibly and effectively.
- Engage and communicate with colleagues and partners.

At the recommendation of the steering team, data gathered for the assessment were limited to existing sources that were available for all ownerships at the state level. The steering team also recommended that the assessment consider a full range of forest types – including piñon-juniper, oak shrublands and riparian forests – and that the analyses encompass the rural-to-urban landscape continuum.

In addition to the steering team and diverse subject-matter experts, other agencies and partners were engaged through a variety of presentations and workshops.[5] Included in this outreach were the Colorado State Forest Stewardship Coordinating Committee, Colorado State Technical Committee, leadership of the USFS Rocky Mountain Region, governments of the Ute Mountain Ute and Southern Ute tribes, and others. The Colorado Division of Wildlife (CDOW) was consulted extensively on components of the assessment related to wildlife and wildlife habitat. Emphasis was placed on ensuring that the assessment furthers the priorities for species and habitat conservation established in the Colorado State Wildlife Action Plan.[6]

A particular effort also was made to ensure that the Governor's Forest Health Advisory Council was informed about the assessment development process and had several opportunities to provide input.

According to Congressional direction, each state's assessment and strategy must be reviewed and updated at least every 5 years, or as determined by the Secretary of Agriculture.

The CSFS made all final decisions about data layers and analysis methodologies.

[4] See Section VII for a full listing of steering team members and other subject-matter experts and partners that assisted in the development of the statewide assessment.

[5] See Section VIII for a full list of presentations, workshops and related outreach efforts associated with the development of the statewide assessment.

[6] Colorado and other states developed comprehensive State Wildlife Action Plans in response to Congressional direction in Title IX, Public Law 106-553 and Title I, Public Law 107-63 (State Wildlife Grants Program). The national guidance for Statewide Forest Resource Assessments specifically directs state foresters to coordinate with state wildlife agencies to promote coordination and synergy between these two documents. The Colorado Wildlife Action Plan was finalized on November 2, 2006, and is available at http://wildlife.state.co.us/WildlifeSpecies/ColoradoWildlifeActionPlan/.

III. Overview of Colorado's Forests[7]

With its diverse mix of coniferous and deciduous species, Colorado's forested landscape is, perhaps, one of the most complex of any in the Intermountain West. The basis for this vegetation mosaic is a physical landscape that ranges from plains and high plateaus to steep mountains, deep canyons and sloping foothills. A wide range of topographic, soil and growing conditions further influences this variety and contributes to the state's multi-faceted forest resources.

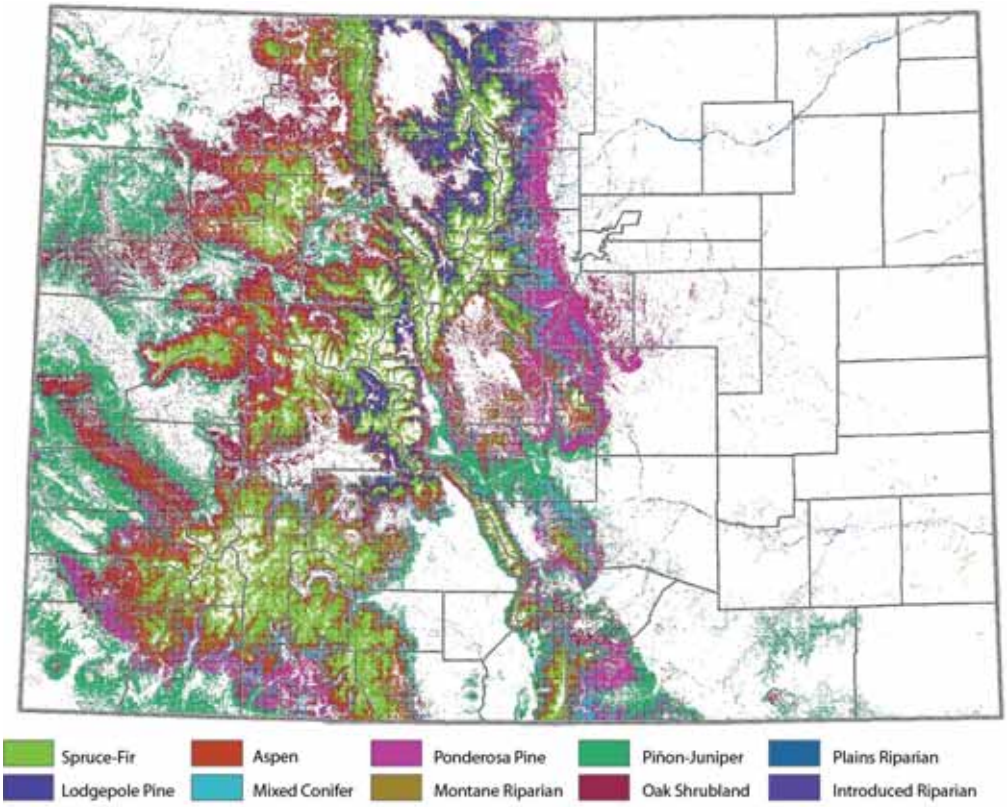
Responsibility for the stewardship of approximately two-thirds of Colorado's forests lies primarily with federal land management agencies. Private and other non-federal landowners control one-third of the state's forests. Historically, human use of the forest has been constant, ranging from subsistence gathering to harvesting for mining and railroad industries, and management for wildlife habitat, drinking water and recreation. Growing populations, urban development and climate change pose new and demanding challenges for today's forest managers.

Colorado's Forest Types

Forests and woodlands cover 24.4 million acres in Colorado.[8] Within these forested landscapes are several different tree species, the majority of which are coniferous or cone-bearing trees rather than deciduous trees that seasonally shed their leaves. For the purposes of this report, Colorado's primary forest species have been grouped into nine forest types described on the following pages, which are based on the dominant overstory vegetation (Helm 1998). The distribution of these forest types across the landscape is determined by factors such as climate, soil, elevation, aspect and disturbance history (Rogers et al. 2000). In terms of overall acreage across the state, the largest forest types in Colorado are aspen (21 percent), piñon-juniper (21 percent) and spruce-fir (19 percent). The mixed-conifer and oak shrubland types account for 10 percent each, followed by ponderosa pine (8 percent) and lodgepole pine (7 percent). Montane riparian (4 percent) and plains riparian (1 percent) represent the smallest forested acreages.

[7] Much of the information contained in this section is adapted from the annual forest health reports produced by the Colorado State Forest Service, particularly the *2001 Report on the Condition of Colorado's Forests*. The 2001-2008 reports are available online at http://csfs.colostate.edu/pages/pub-csfs2.html.

[8] This number and the statistics that follow are based on the definition of forest vegetation that was established for this report, which includes piñon-juniper, oak shrublands and riparian forests, in addition to more traditional forest types. All analyses regarding these vegetation types are based on LANDFIRE vegetation data as described in Appendix B – Data Methods and Sources available at http://csfs.colostate.edu/pages/statewide-forest-assessment.html



Map 1 – Forest Types in Colorado

Forest Type	Acres
Spruce-Fir	4,571,066
Lodgepole	1,662,750
Aspen	5,065,277
Mixed Conifer	1,783,740
Ponderosa Pine	2,527,660
Montane Riparian	934,666
Piñon-Juniper	5,177,926
Oak Shrubland	2,365,998
Plains Riparian	246,493
Introduced Riparian Vegetation	116,899
Total	***24,452,476***

Table 1 – Forest Acreage by Type

Spruce-Fir[9]

Spruce-fir is among the most extensive forest types in Colorado, covering approximately 4.6 million acres or 19 percent of the state's forested lands.[10] Engelmann spruce and subalpine-fir are the primary species in this forest type, but aspen and other conifers also may occur. The USFS manages the majority of spruce-fir forests (88 percent), which generally grow at elevations from 9,000 to 12,000 feet. Unlike many other Colorado forest types, spruce-fir forests are not adapted to fire. In the case of a stand-replacing fire, it may take as long as 300-400 years for a spruce-fir forest to regenerate. Threats to spruce-fir include fire and native insects such as spruce beetle and western spruce budworm, particularly in times of drought or when trees are otherwise stressed.

Spruce-fir forests are highly valued for their contributions to water supply, recreation and wood products. The soft wood and uniform color makes spruce ideal for boards, mine props, plywood and musical instruments. Although there are fewer uses for subalpine fir, it can be made into lumber, produces fine Christmas trees and its aromatic resin serves as a basis for "pine-scented" products and adhesives (CSFS 2008). Spruce-fir forests also provide important habitat to a number of subalpine wildlife species, including the red squirrel, snowshoe hare, pine marten, boreal owl, Clark's nutcracker and three-toed woodpecker. Spruce-fir forests are essential to the habitat matrix required by the endangered Canada lynx, and one of Colorado's most at-risk amphibians – the boreal toad – inhabits open and mesic areas within spruce-fir forests, including subalpine lakes with marshes and beaver ponds. Seventeen of Colorado's Species of Greatest Conservation Need, as identified by the Colorado Division of Wildlife (CDOW), rely on spruce-fir forests for their primary habitat. The CDOW identifies habitat shifting and alteration due to climate change as a significant threat to wildlife that rely on spruce-fir habitats.[11]

Aspen

Aspen is another of Colorado's extensive forest types, covering 5 million acres or 21 percent of the state's forested land.[12] The aspen is Colorado's only widespread, native deciduous tree and can be found from 6,900 to 10,500 feet in elevation, particularly on the West Slope. The USFS manages the majority of Colorado's aspen forests (62 percent), but a significant portion (27 percent) is in private ownership. While aspen's thin, living bark makes it prone to a host of insect pests and diseases, the primary threats to Colorado's aspen forests are fire suppression and chronic animal browsing (especially by elk) of young aspen shoots (CSFS 2005). A recent wave of aspen die-off (referred to as "sudden aspen decline") has caused additional concern in some parts of the state. Scientists suspect drought, warmer temperatures, aspect and elevation are strong factors in this decline, although tree age also is a factor. Research on this issue is ongoing.

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[9] Colorado's forest types are listed in this section according to the elevation at which they generally occur, beginning with the highest elevation and proceeding to the lowest.

[10] For more information on spruce-fir and other high-elevation forests in Colorado, see the *CSFS 2008 Report: The Health of Colorado's Forests* available online at http://csfs.colostate.edu/pages/pub-csfs2.html.

[11] The Species of Greatest Conservation Need referred to throughout this assessment were identified by the Colorado Division of Wildlife as part of Colorado's State Wildlife Action Plan available online at http://wildlife.state.co.us/WildlifeSpecies/ColoradoWildlifeActionPlan/.

[12] For more information on Colorado's aspen forests, see the *CSFS 2005 Report on the Health of Colorado's Forests* and *2008 Report: The Health of Colorado's Forests* available online at http://csfs.colostate.edu/pages/pub-csfs2.html.

Human uses of aspen forests include cattle and sheep grazing, recreation, hunting and harvesting of wood products. Aspen is a preferred species for paneling, veneer products such as matchsticks and chopsticks, fiberboard, excelsior, animal bedding and decorative gifts (Mackes and Lynch 2001). Colorado's aspen forests also provide essential wildlife habitat and are second only to riparian areas in terms of biodiversity richness. Along with their keystone wildlife species, the beaver, aspen forests are particularly important to cavity-nesting woodpeckers and songbirds, birds of prey and gamebirds. Aspen forests in the southern Rocky Mountains are one of the only remaining places where purple martins use natural nesting habitat rather than nest boxes for breeding. Seventeen of Colorado's Species of Greatest Conservation Need rely on aspen forests as their primary habitat (CDOW 2006). The CDOW identifies habitat degradation due to altered fire regimes as a threat to wildlife that rely on aspen.

Lodgepole Pine

Lodgepole pine forests cover slightly more than 1.5 million acres in Colorado or approximately 7 percent of the state's forested lands. The USFS manages more than three-quarters of Colorado's lodgepole pine; only 13 percent is in private ownership. The lodgepole pine type is widespread between 8,000 and 10,000 feet in elevation and generally occurs on gentle to steep slopes in Colorado's northern and central mountains.[13] Lodgepole pine forests grow and die uniformly. Most of Colorado's lodgepole pine forests developed following hot, stand-replacing crown fires (CSFS 2008). The prolific regeneration that naturally occurs in the open, sunny areas left in the fire's wake often results in dense stands of 20,000 or more trees per acre. These forests often are referred to as *dog-hair* stands.

Lodgepole pine forests blanket many landscapes tied to Colorado's water supply and provide the back-drop for popular recreational activities such as skiing, hiking and biking. In the late 19th century, much of Colorado's demand for railroad ties was supplied by lodgepole pine forests, which still provide a range of wood products, including house logs, structural lumber, log furniture, decking, telephone poles and structural plywood (CSFS 2006). Plant and animal diversity tends to be relatively low in lodgepole pine forests, but they do provide important cover for mule deer, elk, black bear and a variety of birds and small mammals. Sixteen of the state's Species of Greatest Conservation Need, including Canada lynx, significantly rely on lodgepole pine forests (CDOW 2006).

In Colorado and throughout much of the Rockies, lodgepole pine forests are experiencing a severe and widespread epidemic of mountain pine beetle. Tree mortality from the beetle currently covers nearly 2 million acres, which includes virtually all of the state's mature lodgepole pine in addition to other forest types. Although the mountain pine beetle is a native insect that is always present at endemic levels, the size and severity of this outbreak may be unprecedented and has caused tremendous concern relative to public safety and essential infrastructure. It is unknown whether a large-scale bark beetle epidemic such as this current epidemic previously occurred in Colorado.

[13] For more information on Colorado's lodgepole pine forests, see the *CSFS 2006 Report on the Health of Colorado's Forests* and *2008 Report: The Health of Colorado's Forests* available online at http://csfs.colostate.edu/pages/pub-csfs2.html. See the References section for complete citations.

Mixed Conifer[14]

The mixed conifer forest type occurs at approximately 6,900 to 10,500 feet in elevation, nestled between lower-elevation forests such as ponderosa pine and higher-elevation subalpine forests such as spruce-fir. Colorado has 1.8 million acres of mixed-conifer forest, which is primarily managed by the USFS (873,280 acres) and private landowners (602,356 acres). As its name suggests, the mixed-conifer type includes a diverse range of species. The distribution and structure of mixed-conifer forests are strongly influenced by temperature and moisture gradients, in addition to soil types and fire. White fir often dominates as the climax species on moist sites and in the southern part of the state, while ponderosa pine, Douglas-fir or Rocky Mountain juniper tend to be the climax species on warmer and drier sites. Engelmann spruce, blue spruce, subalpine fir, bristlecone pine and limber pine also may be present in the mix.

Fire regimes in mixed-conifer forests vary by site, but generally are of low frequency and mixed severity, ranging from 20-year cycles to 150 years or more depending on moisture and elevation.[15] As a result of fire suppression, many mixed-conifer forests currently are denser and contain more dead fuel than they did historically. These heavy accumulations greatly increase the chances for high-intensity, stand-replacing crown fires. Prior to human settlement, these stand-replacing fires would only occur every 200 to 500 years. Mixed-conifer forests are important for watershed protection and recreational and scenic opportunities. Mixed-conifer forests provide many wood products manufactured by local Colorado businesses. Compared to other forest types, the value of mixed-conifer forests for wildlife is not well understood. However, many neotropical migratory songbirds breed in mixed-conifer forests and elk use them extensively during calving season and in summer. Flammulated owls and northern goshawks are among the sensitive species that use mixed-conifer stands, especially those that include blue spruce. Twenty Species of Greatest Conservation Need use mixed-conifer forests as a primary habitat (CDOW 2006).

Ponderosa Pine

Ponderosa pine forests, woodlands and savannas occupy approximately 2 million acres in Colorado or 8 percent of the state's forested land. Although ponderosa pine is most common between 6,000 and 9,000 feet, it begins to appear on the landscape around 5,000 feet where prairies and shrublands transition into open ponderosa pine forests.[16] Private landowners control 49 percent of this forest type, while the USFS manages 34 percent. Because it is more accessible than other species, and largely in private ownership, ponderosa pine has been an important source of lumber and other wood products throughout Colorado's history. These forests currently are a significant resource for recreation and water supply. They also are the backdrop for the majority of the state's wildland-urban interface communities.

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[14] This section is adapted from information available from LANDFIRE (www.landfire.gov) and NatureServe (www.nature-serve.org/explorer).

[15] For more specific information about this variation in fire regimes, please see the LANDFIRE biophysical setting descriptions for mixed-conifer at www.landfire.gov or the USFS fire effects information system at www.fs.fed.us/database/feis/.

[16] For more information on Colorado's ponderosa pine forests, see the *CSFS 2004 Report on the Health of Colorado's Forests* at http://csfs.colostate.edu/pages/pub-csfs2.html.

Ponderosa pine forests are the only forest type designated as a high-priority habitat in Colorado's State Wildlife Action Plan. Twenty-eight of Colorado's Species of Greatest Conservation Need rely on ponderosa pine forests as their primary habitat (CDOW 2006). One of the most significant of these species is the Pawnee montane skipper. This butterfly is federally listed as Threatened and is restricted to the Upper South Platte watershed in Colorado where it inhabits ponderosa pine forests in which blue grama grass and prairie gayfeather are found in the understory. Other species include the Mexican spotted owl, northern goshawk, Townsend's big-eared bat and the American three-toed woodpecker. Primary threats to ponderosa pine forests include urban development, noxious weeds and the long-term impacts of fire exclusion. Ponderosa pine forests evolved with natural cycles of frequent, low-intensity fire that allowed mature pine trees to survive, but killed competing conifer seedlings. Several decades of near total fire exclusion have resulted in significantly increased tree density in many of these forests, as well as encroachment from Douglas-fir. Such conditions increase the risk of large, high-intensity crown fires in ponderosa pine forests and have increased their susceptibility to native insects and diseases. The Colorado Biodiversity Scorecard ranks ponderosa pine forests as one of the state's *weakly conserved* forest types (CNHP and TNC 2008).

Piñon-Juniper

Piñon-juniper woodlands are widespread in the lower elevations ranging from 4,900 to 8,000 feet on Colorado's West Slope and exist in limited distribution in south-central Colorado and on the Eastern Plains. The most common species within this type are Colorado piñon pine and Utah and one-seed juniper, although Rocky Mountain juniper may codominate or replace one-seed at higher elevations. Piñon-juniper woodlands account for just over 5 million acres or approximately 21 percent of the state's forested lands. Fully half of Colorado's piñon-juniper landscapes are managed by the Bureau of Land Management (BLM) with another 32 percent in private ownership. Piñon-juniper stands vary considerably in appearance and composition, depending on soil depth, elevation and geographic locations. While piñon and juniper may co-occur in some landscapes, either species may be dominant on its own in others. Some believe that the ecological dynamics of these woodlands have changed since European settlement, resulting in increased density and encroachment on grasslands, but limited research is available to verify these concerns (Romme and others 2008). The research that does exist suggests that piñon-juniper forests likely were diverse historically, as they are today.

Although not a traditional timber species, piñon-juniper forests have long been important to local communities for such products as fuelwood, fence posts, pine nuts, forage for livestock and watershed protection. More recently, communities and businesses have begun to turn to piñon-juniper forests as a source of biomass for fuel and energy. Piñon-juniper forests also provide habitat for many of Colorado's rarest plants along with the gray vireo, one of the state's rare birds. Piñon-juniper forests are significant habitat for reptiles, in general, and for lizards in particular. They are extensively used as wintering grounds by elk on the Western Slope and as year-round cover by elk on the Eastern Plains (e.g., Purgatoire Canyon). A notable 32 of the state's Species of Greatest Conservation Need rely on piñon-juniper forests as a primary habitat (CDOW 2006).

Oak Shrublands

Oak shrublands cover approximately 2 million acres in Colorado between elevations of approximately 6,000 and 9,000 feet. These shrublands account for 10 percent of the forested lands in Colorado and are found throughout most of western Colorado, along the southern Front Range and in the central part of the state. Their appearance can range from dense thickets with little understory to relatively moist sites with a rich understory of shrubs, grasses and wildflowers. Fifty-seven percent of Colorado's oak shrublands are in private ownership; the USFS and BLM are responsible for approximately 19 percent and 18 percent, respectively.

Fire usually plays an important role in maintaining oak shrublands; it promotes regeneration, controls the invasion of trees, and increases the density and cover of Gambel oak and serviceberry (CNHP 2009). Many of these landscapes currently suffer from altered fire regimes due to extensive fire suppression, especially in the wildland-urban interface. Wildlife species associated with oak shrublands include sharp-tailed grouse, mule deer, elk, Abert's squirrels, black bears, blue grouse and Merriam's turkey. Populations of some shrubland birds have been in sharp decline for quite some time. Among these species is the green-tailed towhee – a typical inhabitant of oak shrublands. Oak shrublands is a primary habitat for 17 Species of Greatest Conservation Need (CDOW 2006).

Montane Riparian

Montane riparian forests occur along rivers and streams in Colorado's foothill and mountain regions, beginning around 6,000 to 7,500 feet in elevation. Montane riparian forests occupy roughly 1 million acres in Colorado and account for 4 percent of the state's forested lands. These forests tend to be dominated by alder and blue spruce, but may be imbedded within several other forest types, including ponderosa pine, aspen and spruce-fir. The USFS manages the majority of Colorado's montane riparian (40 percent) and private landowners (36 percent). Riparian forests may be found within the flood zone of rivers, on islands, sand or cobble bars, and immediately adjacent to streambanks. The health and sustainability of these systems depends on a natural hydrologic regime, especially annual to episodic flooding.

In a semi-arid state such as Colorado, the benefit of riparian areas to wildlife often is disproportionate relative to their size. The vast majority of species that occupy montane habitats rely on riparian forests at some point in their life cycle. This is especially true of many amphibian species, as well as such water-dependent species as beaver and river otter. Elk, mule deer and moose also favor montane riparian habitats. Boreal toads and northern leopard frogs are closely associated with montane riparian forests and adjacent wetlands – these habitats are especially important as breeding sites. Colorado's most important fisheries are mountain streams surrounded by riparian forests. More than 50 percent of the state's native fish are Species of Greatest Conservation Need and nearly all rely on riparian forests to maintain healthy populations. Riparian forests, including both montane and plains types, also are important for a number of migratory and tree-roosting bats, including the red bat, silver-haired bat and hoary bat.

Plains Riparian

Low-elevation plains riparian systems are found along rivers and streams throughout the western Great Plains. At 250,000 acres, these forests represent just 1 percent of the state's forested lands, but they support a tremendous

amount of biodiversity. Ownership of these forests is dominated by private landowners (190,358 acres) but the state (23,584 acres) and BLM (11,146 acres) also control notable portions. Where plains riparian systems support forests, those forests typically are dominated by plains cottonwood in association with several species of willow and a variety of shrubs, grasses and forbs. Like montane riparian forests, plains riparian areas have a disproportionate benefit to wildlife species relative to their size. Native prairie fishes and amphibians (especially leopard frogs) are typical indicators of healthy plains riparian systems. Bald eagles occur here year-round and neotropical songbirds are common inhabitants during migration and breeding season. Other typical species include deer (white-tail and mule), Merriam's turkey and a variety of owls.

Low-elevation riparian systems often are subjected to heavy grazing and/or other agricultural use, and can be significantly degraded. This degradation leaves them vulnerable to invasion by non-native grasses, forbs and shrubs. Tamarisk and Russian olive are particularly prominent. Riparian forests also may be seriously impacted by pollution, surface water diversions and groundwater depletions. Overall, prairie riparian and wetland ecological systems (along with shortgrass prairie) are the most altered of Colorado's ecosystems. Not surprisingly, rivers and streams of the Eastern Plains are identified as high-priority habitats of concern in Colorado's State Wildlife Action Plan (CDOW 2006).

Plains Working Forests (Agroforestry)

Scattered across the plains of Colorado are small acreages of forest that have been planted for a variety of conservation purposes. Though designed and planted for specific purposes, these areas can be defined as working forest lands that provide the same environmental services as the naturally occurring working forests. Their small size and wide distribution make it difficult to include them in a statewide assessment, but their establishment has been a high priority since the plains were settled. These forests provide a disproportionate benefit to those that have chosen to live and/or make their living through agriculture on the plains.

Since the Dust Bowl days of the 1930s, several state and federal programs have supported conservation tree and shrub plantings on both private and publicly owned lands. Through a cooperative interagency program, more than 200 living snow fences were planted along county, state and federal roads in Colorado to keep snow from drifting onto roadways. These were purposely designed to provide multiple benefits such as livestock protection, erosion control and wildlife habitat enhancement. Several are located on the Pawnee National Grasslands. Colorado Division of Wildlife and local Pheasants Forever chapters worked together to establish more than 1,350 windbreak/shrub thicket combination plantings to benefit the economically important ring-necked pheasant population. A significant proportion of the early Stewardship Incentives Program, Agricultural Conservation Program and Great Plains Conservation Program funding provided cost-share to private landowners to establish windbreaks, shelterbelts and habitat plantings on the plains.

Presently, the Continuous Conservation Reserve Program provides incentives for establishing livestock and farmstead shelterbelts, field windbreaks and living snow fences on crop land, in addition to riparian forest buffers on crop land and pasture land adjacent to water courses and water bodies.

Windbreaks, shelterbelts and their renovation are identified as priority resource concerns by several local work groups that help determine distribution of Environmental Quality Incentives Program funds on the plains.

Most of the trees and shrubs planted for conservation purposes on the Colorado plains have come from the Colorado State Forest Service Nursery in Fort Collins. The CSFS Nursery was established in 1957 to meet the tree/shrub seedling needs of the Soil Bank Program. While distributing approximately 2 million seedlings each year, this nursery has capacity to produce 4.5 million seedlings annually. Roughly 5,000 landowners who own two or more acres purchase these seedlings on an annual basis. Private nurseries also provide seedlings for conservation purposes.

Threats to these small forests include the very weather extremes from which many were designed to provide protection. High winds, heavy snows and extreme temperature shifts often damage the trees. Invasive pests such as the gypsy moth and emerald ash borer have the potential to impact these plantings just as they do in community forests. Wildfire often burns conservation plantings. Sustaining these forests requires constant vigilance, maintenance and renovation so that they will continue to provide the environmental services needed by plains dwellers.

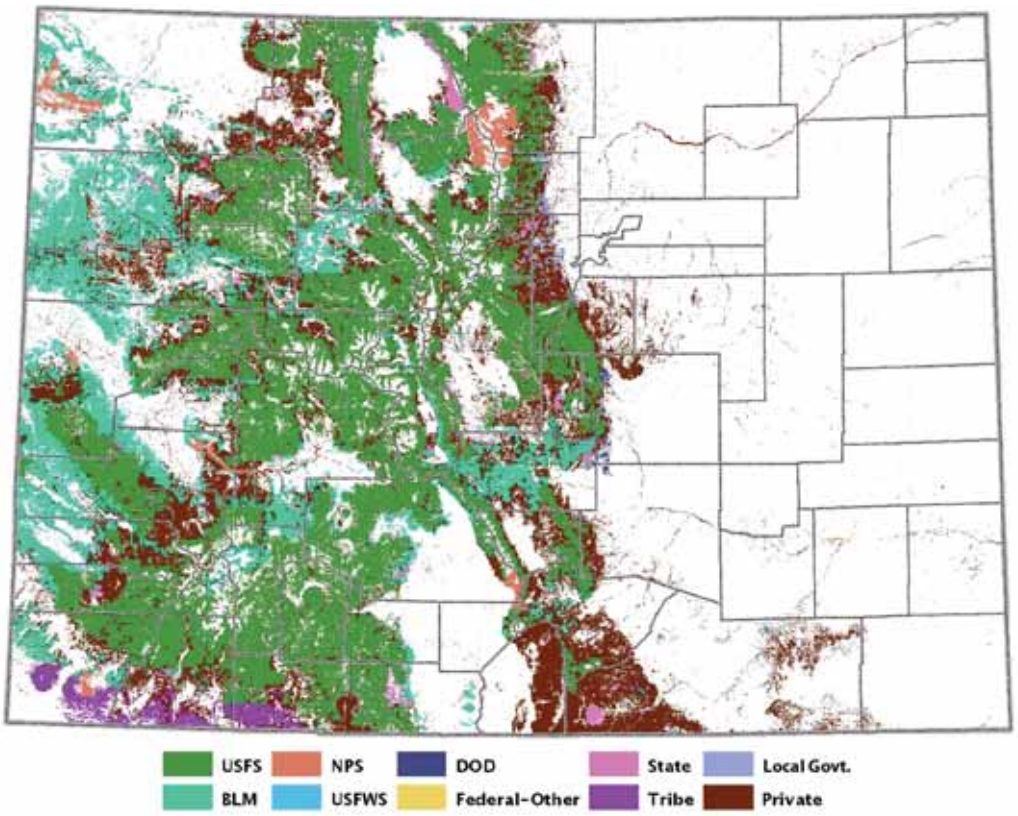
Data is needed to: assess opportunities for conservation tree and shrub planting; determine where aging conservation plantings require renovation; develop an inventory of existing plantings at a scale finer than the statewide level.

Ownership of Colorado's Forests

Decisions regarding the management, use and condition of Colorado's forests are complicated by a mosaic of public and private ownerships ranging in size from a single acre to several million acres. Each entity brings with it a unique set of philosophies, directives and regulations that further influence the decisions made about their particular part of the forest, as well as the options available to surrounding landowners.

Nearly 68 percent of Colorado's forests are in federal ownership; the primary land manager is the USFS with 47 percent or 11.3 million acres. Nearly three-quarters of the state's high-elevation species such as spruce-fir, lodgepole pine and aspen are located on USFS lands. The BLM oversees an additional 17 percent or 4.2 million acres, primarily in the state's lower elevation piñon-juniper and oak shrubland forests. The National Park Service has responsibility for 380,925 acres or 2 percent of Colorado's forests; the majority of these lands are within the borders of Rocky Mountain National Park.

Despite this significant federal presence, private landowners also play an important role in the stewardship of Colorado's forest resources. Approximately 186,000 private landowners control 30 percent or 7.1 million acres of the state's forested landscapes. Although the majority of these lands are in lower elevations, private landowners are represented in all of Colorado's forest types, including a notable portion of aspen and mixed-conifer forests.



Map 2 – Forest Ownership/Management in Colorado

The remainder of Colorado's forests is held by a combination of tribal governments, municipalities, state agencies and other non-federal entities. The Colorado State Land Board, for example, owns approximately 370,000 acres of forest land throughout the state; the largest parcel is the Colorado State Forest near Walden. Two resident tribes, the Ute Mountain Utes and Southern Utes, make their home in southwest Colorado where they own a total of 402,303 acres of forestland. The vast majority of these acres are in ponderosa pine and piñon-juniper forests. These tribes also retain specific hunting rights and other aboriginal rights on national forests throughout their traditional territory, which includes portions of Utah, New Mexico and Colorado. More than a dozen other tribes located outside Colorado also maintain tribal interests and inherent aboriginal rights in Colorado's national forests (USFS 2008).

Table 2 – Ownership/Management by Forest Type

Owner	Spruce-Fir	Lodgepole	Aspen	Mixed Conifer	Ponderosa Pine	Montane Riparian	Piñon-Juniper	Oak Shrubland	Plains Riparian	Introduced Riparian Vegetation	Total
USFS	4,003,327	1,266,761	3,148,695	873,280	884,472	369,816	302,693	443,255	455	2,954	**11,295,708**
BLM	139,454	75,057	348,156	197,062	272,987	169,116	2,583,784	431,329	11,146	23,650	**4,251,739**
NPS	92,116	45,972	38,361	20,782	20,854	16,905	128,579	23,042	335	1,478	**388,424**
USFWS	1,241	1,037	1,312	1,109	528	915	1,699	1,677	3,399	120	**13,039**
DOD	-	-	38	-	7,871	3,469	32,061	3,718	1,516	702	**49,377**
Fed-Other	53	16	1,721	228	759	279	792	3,271	1,240	1,509	**9,868**
State	28,867	42,436	110,172	57,217	83,632	22,693	135,515	81,786	23,584	3,464	**589,367**
Tribal	70	45	11,806	17,101	45,328	8,840	307,459	10,484	-	1,170	**402,303**
Local Govt.	4,731	7,334	15,229	13,225	73,099	6,665	10,159	14,237	14,271	436	**159,386**
Private	300,037	222,910	1,387,185	602,356	1,137,086	335,236	1,669,543	1,352,293	190,358	81,348	**7,278,351**
Total	**4,569,896**	**1,661,570**	**5,062,674**	**1,782,359**	**2,526,617**	**933,934**	**5,172,283**	**2,365,093**	**246,306**	**116,831**	**24,437,562**

Management History

Human interaction with Colorado's forests most likely began with early Native American inhabitants who gathered firewood for domestic use and may have set periodic fires to drive game (Shinneman and others 2000). Beginning in the 1800s, European and American settlers began harvesting forests for mine timbers, railroad ties and the construction of homes and other structures (CSFS 2001). As a result of this extensive use, many of Colorado's current forests represent second- or even third-growth stands.

The advent of federal forestland in Colorado came in 1893 when President Benjamin Harrison established five forest reserves in the state: the White River Plateau, Pikes Peak, Plum Creek, South Platte and Battlement Mesa. These, and future reserves, were managed according to principles of *sustained yield* for maximum long-term timber production. Following the disastrous wildfires of 1910, management directives also included aggressive suppression of all fire starts, a policy that has dramatically impacted the current condition of many forests in the state.

Although Colorado's steep topography, xeric climate and slow-growing forests generally have prevented wood production from becoming a major state industry, the sale of timber from federal land experienced a rapid increase during and after World War II, a trend that continued through the "baby boom" years of unprecedented economic growth and housing development. In 1960, the federal government added the concept of *multiple use* to the mandate of sustained yield on federal forest land. This new directive required that management address the values of outdoor recreation, grazing, watersheds and wildlife, in addition to traditional timber use.

Throughout the 1960s and 1970s, a variety of environmental laws were passed that still guide management of public forests today: the Wilderness Act, Wild and Scenic Rivers Act, Endangered Species Act, National Environmental Policy Act and National Forest Management Act. Beginning in the 1980s, the concept of ecosystem management became increasingly prominent in forest management, with emphasis on biological diversity, adaptive management and the integration of natural and human values.

During the early years of the 21st century, new challenges such as climate change, renewable energy, intense recreational use, billion dollar fire suppression costs and the growing disconnect between urban youth and the natural environment have begun to demand greater attention from public land managers.

While traditional timber management still occurs on both public and private forests in the state, the level of activity has been significantly reduced in the past decades. Timber sale acres in Colorado's national forests decreased from 26,125 in 1990 to 7,389 in 2008 (Reader 2009). As a result, the infrastructure that allowed forest managers to implement management on an effective scale in Colorado's forests also has been significantly reduced. Loggers and wood processing businesses in Colorado have become more dependent on sales that are designed for forest health salvage or wildfire risk reduction, rather than commercial timber values.

This reduction in the amount of acres harvested every year has resulted in a significant loss of forest products businesses. When forest products businesses close, forest landowners have fewer outlets for wood from forest management projects. Longer haul distances to wood-using facilities means reduced revenues for landowners. Without markets to offset the expense,

forest management costs per acre have increased significantly during the last 20 years. Maintaining viable markets for wood products is a key component of continuing forest management. We currently are investing significant public resources to treat forest lands at a net cost to the landowner. Balancing the revitalization of uses for forest products with the need for management can provide a cost-effective method to conserve Colorado's forest lands.

The state's private landowners are diverse; however, their management objectives tend to emphasize wildlife, recreation and scenic benefits, rather than traditional wood products. Because they compose one-third of Colorado's forests, these private landscapes are an important source of forest-related benefits and services. The CSFS administers a number of programs that provide technical and financial assistance in support of private forest landowners, including the Forest Stewardship, Forest Legacy, Tree Farm and Forest Agriculture Tax benefit programs.[17] Unfortunately, only a small portion of private landowners take advantage of these resources. As of 2009, only 1,100 private forest owners (less than 1 percent) had active forest stewardship plans for their properties, while only 600 were participating in the state's agriculture tax program. More than 280 Colorado forest landowners also participate in the American Tree Farm System.

Both the Southern Ute and Ute Mountain Ute tribes also actively manage the forest resources on their lands. Activities supported by the tribal governments include timber and woodland management, wildfire rehabilitation, prescribed burning, cottonwood propagation and greenhouse development, and community wildfire protection planning and services.

Managing forests on non-federal lands also is strongly influenced by rapid urban growth, which has had a significant impact in terms of fragmenting formerly large parcels of forest into smaller parcels with multiple owners and managers. As urban development expands into forests, options for forest management become more limited and complex, while the need to suppress fires to protect human safety and essential infrastructure increases dramatically.

The need to understand and mitigate or adapt to the impacts of climate change is a new challenge facing all of Colorado's forest owners and managers. Scientists expect that a continuation of warming temperatures would exacerbate existing stresses, which suggests that Colorado may see more and larger fires, continued insect and disease epidemics, and changes in species dynamics and range.

[17] For more information on CSFS landowner assistance programs, please see http://csfs.colostate.edu/pages/programs-home-land-owners.html.

IV. Opportunities for Positive Action

The purpose of Colorado's Statewide Forest Resource Assessment is to assist the Colorado State Forest Service and its partners in identifying landscapes across the state where the opportunity exists for a focused and collaborative investment of resources.

The core of the assessment lies in the sections that follow, each of which contains background, context and analysis for the spatial data layers that were selected for this project. These sections are organized according to the S&PF Redesign National Themes and Strategic Objectives so that the reader can clearly see how the information gathered for Colorado fulfills the national guidance and intent.

The data layers that follow served as the foundation for a subsequent review process conducted by the CSFS with interested partners and stakeholders to determine the final emphasis areas for Colorado (see Section V). These data are only appropriate for use at the macro scale to identify landscape-level trends and opportunities; they are not appropriate for use at a scale finer than the county level. Decisions about site-specific management strategies will require finer-scale data, involvement from land managers and other key stakeholders, and a clear understanding of the desired outcome for any proposed action.

Core Data Layers[18]

The minimum standards for Statewide Forest Resource Assessments, as described by both the USFS and Congress, specify that each assessment must identify benefits and services provided by forests; analyze the conditions, threats and trends that influence the ability of forests to continue providing these benefits and services; and then identify priority landscapes or other emphasis areas where the investment of forest management resources will produce the most meaningful result.[19]

In response to this direction, the team working on Colorado's assessment used the national themes as a guide to review existing geospatial data and determine the most relevant information sources to incorporate into the assessment. As previously noted, the team focused on data available at the state level for all ownerships.

LANDFIRE vegetation data was used to identify forestlands for Colorado and serves as the foundation of the entire assessment.[20] This dataset was reclassified into 10 forest types: spruce-fir, lodgepole pine, aspen, mixed conifer, ponderosa pine, montane riparian, piñon-juniper, oak shrubland, plains riparian and introduced riparian.[21] Additional foundation layers

[18] See Appendiix B at http://csfs.colostate.edu/pages/statewide-forest-assessment.html for complete descriptions of the Data Methods and Sources used to develop this assessment.

[19] For the purposes of this assessment, forest management is assumed to include the full range of management options, including the decision to avoid and/or curtail ground-disturbing actions.

[20] LANDFIRE is a national, interagency project, involving both the USFS and the U.S. Department of the Interior aimed at producing consistent, comprehensive maps and data that describe vegetation, wildland fuel and fire regimes across the United States. For more information on LANDFIRE, please see www.landfire.gov.

[21] See Appendix B at http://csfs.colostate.edu/pages/statewide-forest-assessment.html for more information on the individual biophysical settings that were grouped into these 10 forest types.

include standard ownership data and a data mask that identify lands on all ownerships that are available to be managed for wood products.[22]

After establishing the base vegetation data, the assessment team identified the following datasets as core layers that are of a quality and scale that can be overlaid with one another in response to assessment questions:

- Watersheds of importance for drinking water
- Habitat for imperiled wildlife species
- Habitat for economically important wildlife species
- Density of recreation opportunity
- Wildland-urban interface
- Wildfire susceptibility index
- Wildfire intensity index
- Post-fire erosion risk
- Insect and disease mitigation potential
- Projected change in human modification (fragmentation)

The team also identified or developed a select number of other geospatial layers that, due to differences in the nature and scale of the data, are not appropriate to be combined with the core layers, but that nevertheless provide valuable information. These layers are:

- Community forestry opportunity areas
- Forest Legacy opportunity areas
- Invasive species associated with forests
- Areas of concern for air quality
- Ecological departure
- Lands available for forest product management
- Urban layers
- Biomass potential

With the help of subject-matter experts, the core data layers were combined and analyzed to identify opportunities related to the objectives described in the national themes. These opportunities are presented in greater detail below. Non-spatial information is included in these sections to provide context for, and add value to, the spatial presentation.

Data Gaps

- In a surprising number of cases, the data that could most effectively answer the questions being posed by this assessment were either entirely unavailable or unavailable at the state level for all ownerships. In these instances, the Assessment Steering Team documented data gaps that would be beneficial to address prior to the next iteration of this document. These data gaps are summarized in Appendix C and highlighted in the relevant sections below.

[22] Lands available to manage for wood products are those forested lands with a slope of less than 50 percent that are located outside of national park or monument boundaries, or are federally designated as wilderness or roadless.

NATIONAL THEME: Conserve Working Forest Lands

Working forest lands conservation refers to the many ways landowners might use and manage their land to serve economic, environmental and social goals. All forests "work" by providing wildlife habitat, clean air, clean water, beautiful surroundings, etc., but a "working forest" is one that is actively managed using a forest stewardship/management plan as the roadmap or guide to provide sustainable outputs of forest products and revenue to the forest owner, while securing the health and integrity of wildlife habitat, water resources, recreation opportunities, aesthetic and other intrinsic values across the landscape. Working forest lands provide benefits to the public and the environment with a sustainable supply of forest products and jobs for rural communities, while conserving and enhancing other values.

One-third of Colorado's forests are owned and managed by private citizens. Although they are not part of the public domain, these forests provide tremendous benefits to people and the environment alike. Despite their recognized value, private forests in Colorado and across the nation are under tremendous pressure from housing development and conversion to non-forest uses. The USFS estimates that 1 million acres of private forestland are converted to developed uses every year (Stein 2005). That means by 2030, an estimated 22 million acres of the nation's productive forestland could be lost. This increased development in forested landscapes not only reduces the environmental and public benefits they provide; it also increases the number of communities at risk from wildfire and the related public cost of wildfire protection.

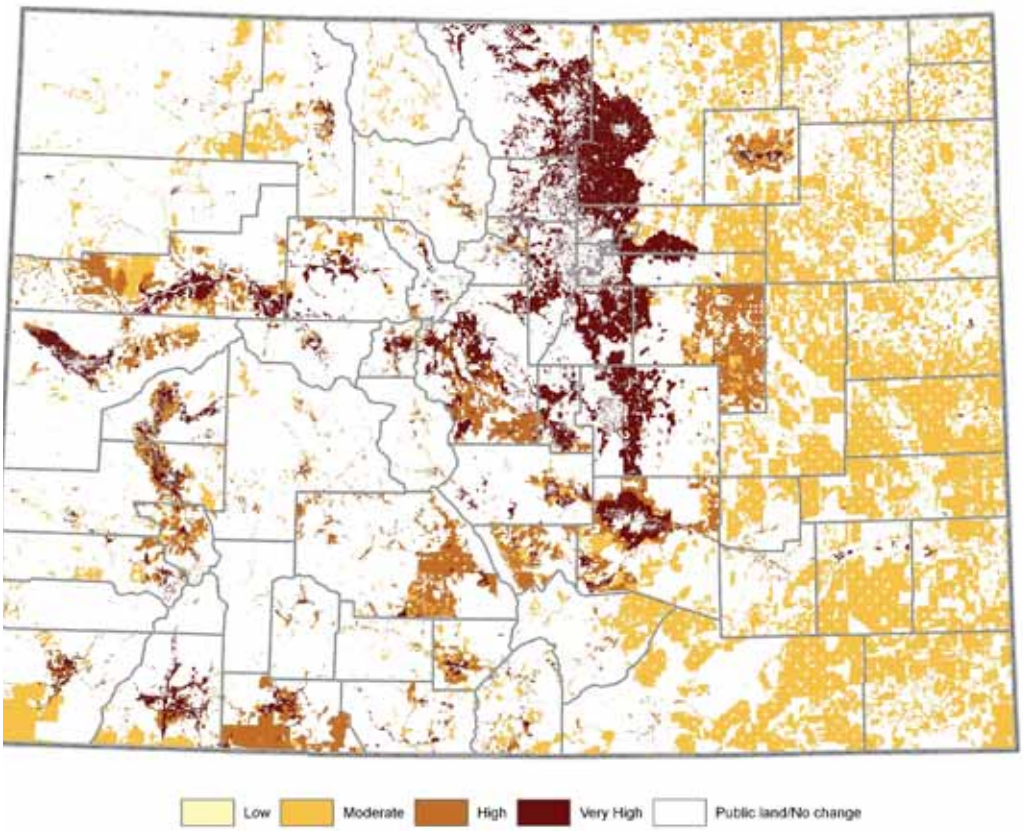
Colorado has an estimated 186,000 private forest landowners, all of whom are considered non-industrial. Although some landowners manage their forest lands to produce timber and other wood products, the majority of private forest owners emphasize recreation, wildlife and scenery in their management plans. The CSFS offers a number of technical and financial assistance programs, including conservation easements and management incentives, to encourage these landowners to retain and sustainably manage their lands as working forests. Public policymakers likely will need to continue seeking innovative ways, such as markets for ecosystem services and increased availability of federal conservation incentive programs, to make it both economically viable and attractive for private landowners to retain their land as forests.

Change in Degree of Human Modification 2000 – 2030

To conduct the overlay analysis, we converted the estimated housing density at each location into two measures of impact on wildlife habitat that capture the estimated amount of human modification of habitat by human development. The first is the amount of land cover that is modified by humans, or human modification of cover (HMc). This is an estimate of the visible "footprint" or spatial impact of development that causes modification to land-cover types, including the areas in and around structures and roads. This measure quantifies modifications associated with the housing unit and the general transportation and utility infrastructure necessary for residential development. As such, it provides a general estimate of the effects of housing density and roads (and utility corridors, etc.).

The second metric is an estimate of both the direct (HMc), and effective or functional aspects that are due to visible modifications to cover, as well as proximal effects associated with human activities such as lights, noise, sound, pets, etc. These effects typically decline as a function of distance away from housing units, roads and other associated infrastructure. This effect is referred to as the human modification function (HMf). We used a distance of 100m radius from each housing unit structure, which others have concluded to be representative of general ecological effects.

Estimates of HMc and HMf were developed from the interpretation of high-resolution aerial photography from more than 300 randomly located plots or “chips” throughout the public-private land interface in the southern Rockies ecoregion. Although some regional variation in effects of land use on habitat exists, these estimates provide useful measures of effects and are fairly robust given common development patterns. Future research, however, could pursue development of regionally specific estimates.



Map 3 – Projected Change in Human Modification from 2000 - 2030

Forest Type	Low	Moderate	High	Very High	Total
Spruce-Fir	1,900	36,231	52,976	26,718	**117,825**
Lodgepole	1,287	16,060	24,952	57,340	**99,639**
Aspen	5,547	186,892	246,873	154,599	**593,912**
Mixed Conifer	1,278	56,584	107,365	102,176	**267,403**
Ponderosa Pine	2,144	76,639	190,373	327,226	**596,382**
Montane Riparian	1,334	44,216	47,781	60,277	**153,609**
Piñon-Juniper	4,134	452,938	246,498	133,170	**836,740**
Oak Shrubland	2,917	252,199	203,475	149,137	**607,727**
Plains Riparian	232	37,291	14,711	44,499	**96,734**
Introduced Riparian	248	17,421	9,252	16,709	**43,631**
Total	**21,020**	**1,176,471**	**1,144,258**	**1,071,852**	**3,413,602**

Table 3a – Projected Change in Human Modification from 2000 - 2030 by Forest Type (acres)

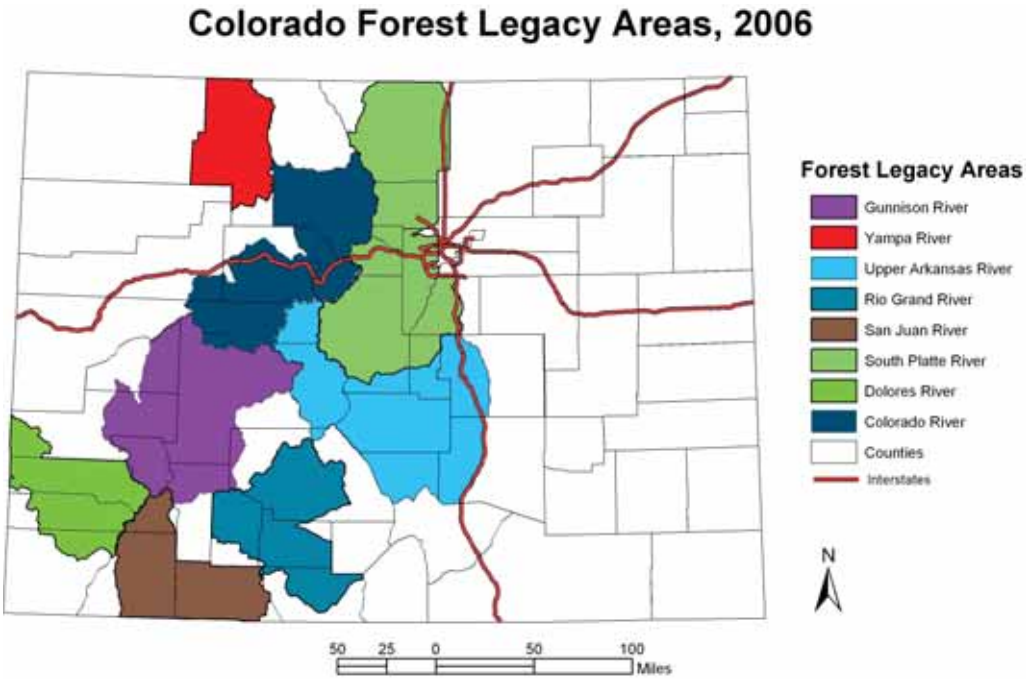
Owner	Low	Moderate	High	Very High	Total
USFS	234	3,265	7,811	10,399	**21,709**
BLM	164	5,836	7,122	4,121	**17,242**
NPS	2	107	70	126	**304**
USFWS	-	2	10	22	**34**
DOD	-	12	0	20	**33**
Federal-Other	-	18	42	30	**90**
State	16	2,327	652	1,677	**4,671**
Tribal	166	152,465	116,087	2,231	**270,949**
Local Govt.	7	107	258	2,792	**3,164**
Private	20,432	1,009,626	1,012,005	1,050,396	**3,092,460**
Total	**21,020**	**1,173,765**	**1,144,056**	**1,071,814**	**3,410,656**

Table 3b – Projected Change in Human Modification from 2000 - 2030 by Forest Ownership/Management (acres)

Identify and Conserve High-Priority Forest Ecosystems and Landscapes

- Forest Legacy Analysis – Focus on opportunities to conserve private working forests, particularly in areas where it can complement existing protected areas.[23]

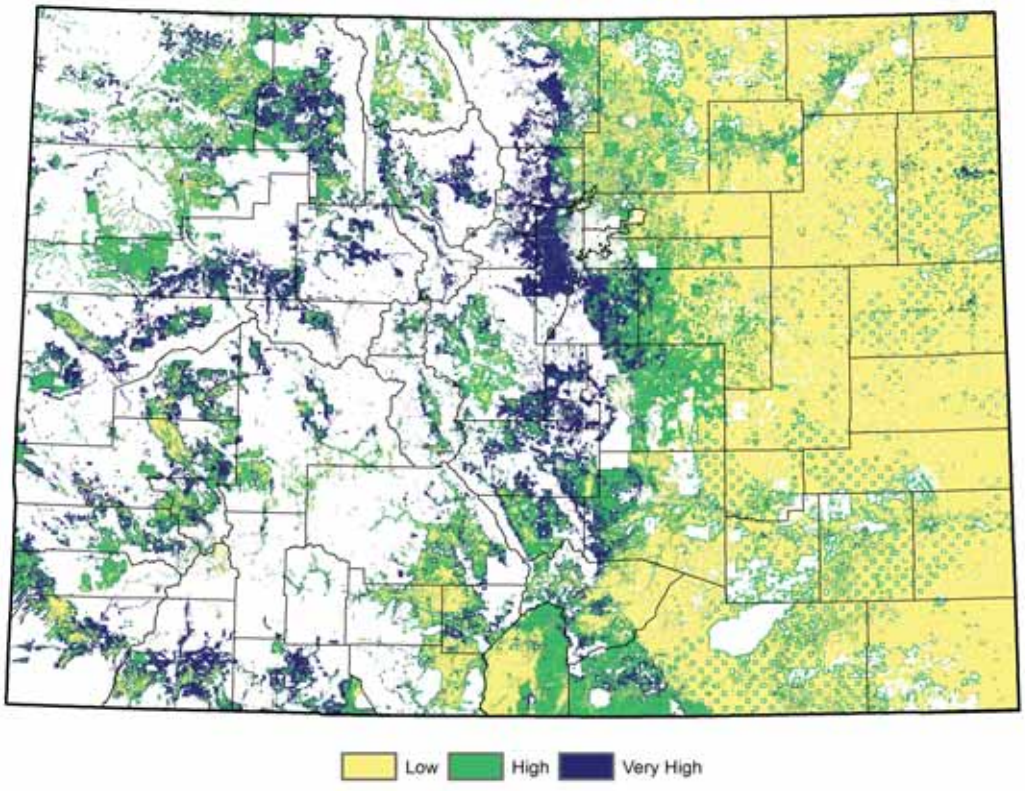
[23] See Appendix E: Colorado State-wide Forest Legacy Assessment of Need, Five Year, July 2006 at http://csfs.colostate.edu/pages/statewide-forest-assessment.html



Map 4 – Colorado Forest Legacy Areas

Actively and Sustainably Manage Forests

- Spatial Analysis – Identify opportunities to focus management assistance programs for private forest landowners.[24]

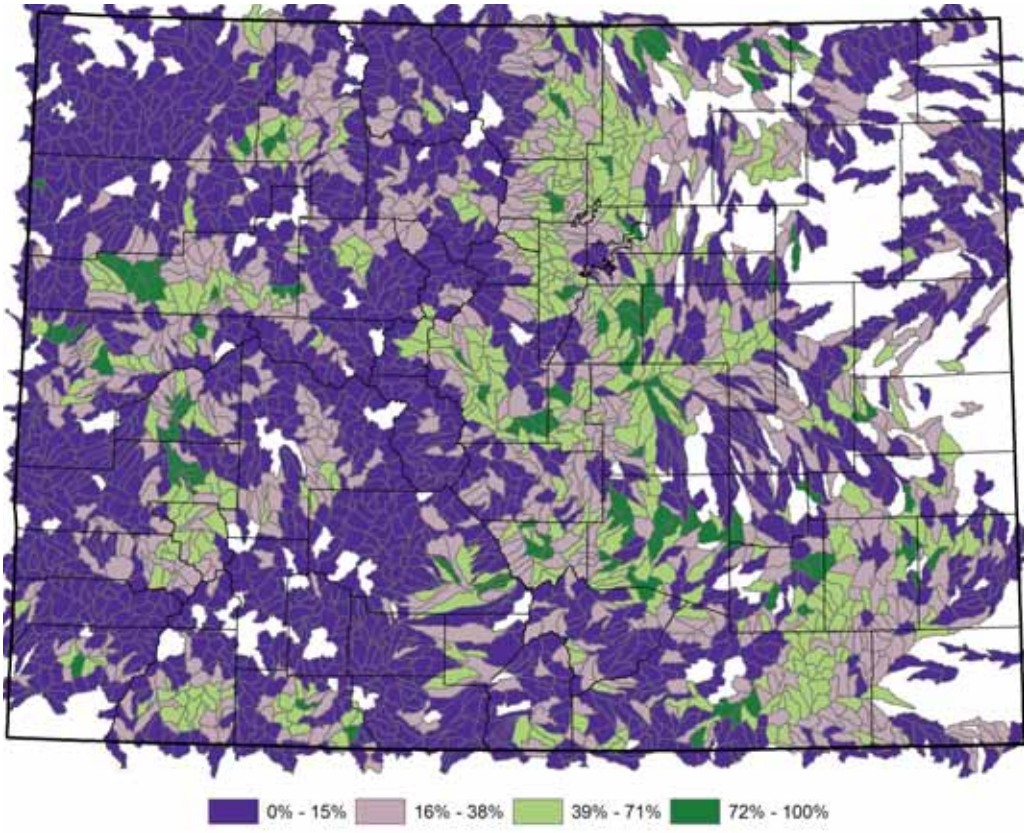


Map 5 – Colorado Spatial Analysis Project

[24] See Appendix D: Forest Stewardship Spatial Analysis Methodology Report for Colorado, December 2005 at http://csfs.colostate.edu/pages/statewide-forest-assessment.html

Conserve Working Forest Lands: Combined Theme Map

The three data sets displayed in the previous map, including change in degree of human modification, Forest Legacy and Colorado spatial analysis were combined and weighted to produce the final map.



Map 6 – Conserve Working Forest Lands: Combined Theme Map

Data Set Layer	Layer Weight Percent
Forest Legacy priority areas	44%
Colorado spatial analysis (includes change in housing density)	34%
Change in degree of human modification	22%

Table 6 – Conserve Working Forest Lands: Combined Theme

NATIONAL THEME: Protect Forests from Harm

Forest condition or health can be assessed by examining the interactions between three components: a forest's resilience to disturbance; its ability to sustain a natural range of biological diversity; and its ability to meet the current and future needs of people in terms of values, products and services (CSFS 2002). The majority of Colorado's forested landscapes are considered disturbance driven, meaning their condition is integrally linked with natural cycles of wildfire and insect and disease infestations, as well as periodic flooding, avalanches or windstorms. Without this regular rejuvenation, forests can become overcrowded and less diverse than they were in the past. The stress of competing for sunlight, water and other essential resources under these conditions renders trees vulnerable to insect and disease activity, fire or drought, and sets the stage for much faster and more devastating events to move across the landscape (CSFS 2002).

In Colorado, the lack of regular disturbance is the culprit behind many of the state's forest health challenges. More than a century of virtual fire exclusion, along with changes in land management priorities and practices, have left many of the state's forests highly susceptible to wildfire, insects and disease. Recent cycles of drought and the emerging impacts of climate change further exacerbate this situation.

Restore Fire-Adapted Lands and Reduce Risk of Wildfire Impacts

Overview: Although fire is only one of many processes that operate within a forest, it often is such a dominant process that to a great degree it can determine the composition, structure and dynamics of the entire ecosystem (Pyne 1996). Over thousands of years, forests and associated vegetation have adapted to a certain cycle and intensity of fire. These adaptations, such as thick bark or serotinous cones, enable vegetation to respond favorably to these naturally recurring events. When fire does not occur according to these cycles, forest resilience can decrease and fire events that do occur can cause long-term damage to soil, vegetation, wildlife and other ecosystem components (Pyne 1996).

In an effort to better classify the role fire plays in various ecosystems, scientists have identified five primary *fire regimes* that describe the frequency and characteristics of historic (pre-settlement) fires. In Fire Regime I, for example, fires return every 1 to 35 years, are of low to mixed severity, and generally replace less than 25 percent of the dominant overstory vegetation. In Fire Regime V, fires occur every 200 years or more and usually are stand replacing. In recent years, scientists and land managers have developed an additional system to classify and assess the role of fire using *fire regime condition class* (FRCC). This classification ranks ecosystems from 1 to 3 based on their level of departure from a set of reference conditions that reflect the vegetation and structure that would have existed on the landscape prior to European settlement (FRCC Guidebook 2008).

In Colorado, LANDFIRE data indicate that the forest types on 6.8 million acres have significantly departed from expected reference conditions. The primary cause of this departure is a management philosophy that virtually excluded fire from the landscape for over a century. This exclusion has been particularly damaging to forests in Colorado, including ponderosa pine, mixed conifer and piñon-juniper, which evolved with frequent, low- to moderate-intensity fires.

Analysis: Forest management, such as mechanical thinning of overly dense stands and use of prescribed fire, can reduce unwanted wildfire impacts by increasing forest resilience and restoring fire to a more natural role on the landscape. As part of this assessment, two data layers were analyzed to identify areas where forest management could play a beneficial role in restoring fire-adapted lands and reducing the risk of negative fire impacts to both the environment and human values. These layers are focused on: 1) wildfire susceptibility, and 2) potential for wildfire intensity. While these layers are useful on their own, they also can provide valuable information when combined with other data related to water supply, wildlife habitat, recreation and the wildland-urban interface.

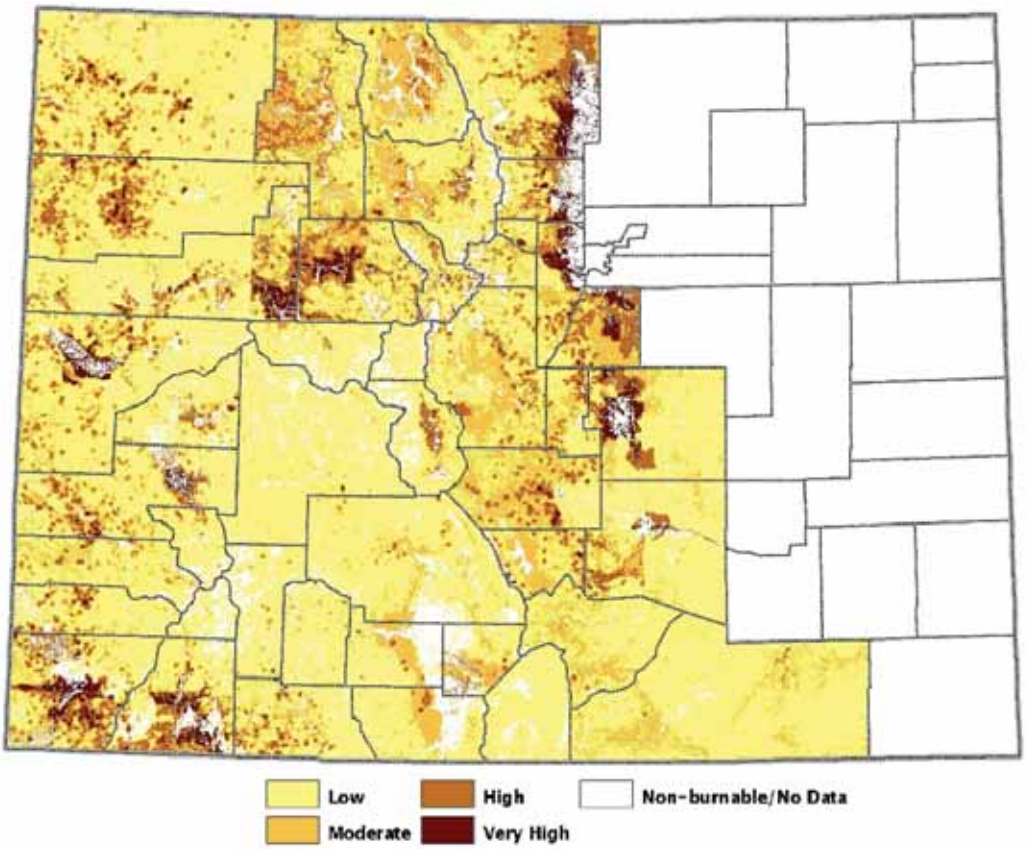
Wildfire Susceptibility

The first wildfire-related layer is the product of a 2008 analysis done by the Sanborn Map Company for the CSFS in order to identify forested areas across the state with a high susceptibility to fire starts.[25] To produce this layer, Sanborn developed a Wildfire Susceptibility Index (WFSI) for the forested areas of Colorado based on the probability of fire occurrence and predicted rate of spread once a fire started. Key inputs to this analysis included weather, historic fire occurrences, topography, surface fuels and canopy closure.[26] Sanborn worked with local fire behavior specialists to update the underlying dataset to account for changes in vegetative condition and structure due to large wildland fires and mountain pine beetle, and other insect and disease epidemics that have occurred since the LANDFIRE data were collected. The Eastern Plains were not included in the assessment because LANDFIRE data was not available at the time of the assessment.

This layer shows more than 2 million acres with a high to very high WFSI in Colorado. While all of the state's forest types contain some acreage in these categories, the majority of the high rankings fall in piñon-juniper forests, followed by ponderosa pine forests and oak shrublands. Notably, private landowners control nearly 800,000 acres in the high to very high categories, followed by the BLM and then the USFS. Forest management in landscapes ranked high to very high could be beneficial for mitigating hazardous conditions in areas where fire starts and rapid fire spread are likely.

[25] For more information on the Sanborn Map Company, Inc., please see their website at www.sanmap.com.

[26] It is important to note that the output of this analysis is limited by the lack of consistent and complete fire reporting data across all jurisdictions in the state.



Map 7 – Wildland Fire Susceptibility Index

Forest Type	Low	Moderate	High	Very High	Total
	10,826,486	3,223,808	1,220,280	371,253	**15,641,827**
Spruce-Fir	3,947,339	404,212	69,552	3,471	**4,424,574**
Lodgepole	1,490,230	110,341	20,632	1,323	**1,622,526**
Aspen	4,306,108	377,440	110,462	18,325	**4,812,336**
Mixed Conifer	1,342,069	292,514	119,179	12,166	**1,765,928**
Ponderosa Pine	1,571,027	515,061	292,794	88,044	**2,466,925**
Montane Riparian	672,115	138,241	62,868	17,815	**891,039**
Piñon-Juniper	2,959,102	1,266,594	641,579	185,939	**5,053,213**
Oak Shrubland	1,542,920	448,536	244,788	69,239	**2,305,483**
Plains Riparian	38,816	12,756	10,230	22,635	**84,436**
Introduced Riparian	44,352	24,803	16,476	5,867	**91,498**
Total	**17,914,077**	**3,590,498**	**1,588,560**	**424,822**	**23,517,958**

Table 7a – Wildland Fire Susceptibility by Forest Types (acres)

Owner	Low	Moderate	High	Very High	Total
USFS	9,438,679	1,074,468	366,019	36,161	**10,915,326**
BLM	2,782,922	877,741	440,937	79,562	**4,181,162**
NPS	281,026	50,725	31,342	12,451	**375,545**
USFWS	6,853	1,901	911	741	**10,407**
DOD	29,053	17,399	1,484	921	**48,857**
Federal-Other	5,481	492	310	434	**6,718**
State	393,680	117,706	37,435	9,993	**558,814**
Tribal	143,077	122,965	108,669	23,906	**398,618**
Local Govt.	51,493	35,974	28,979	34,658	**151,105**
Private	4,780,832	1,290,992	572,410	225,973	**6,870,207**
Total	**17,913,098**	**3,590,364**	**1,588,496**	**424,802**	**23,516,760**

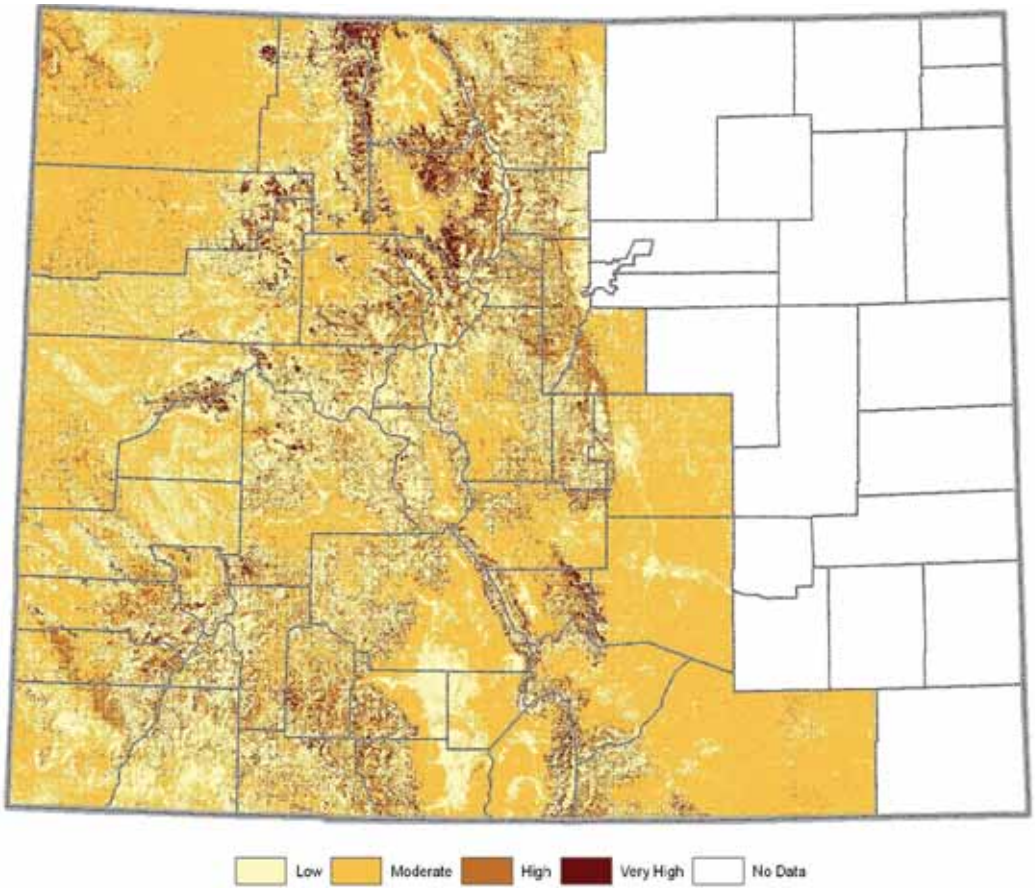
Table 7b – Wildland Fire Susceptibility by Ownership/Management (acres)

Potential for Wildfire Intensity

For the second layer, the USFS assisted the assessment team with use of a fire behavior mapping and analysis program known as FlamMap[27] to identify forested areas in Colorado with a significant potential for high-intensity fire as exhibited by long flame lengths and crown fire. The FlamMap analysis was conducted using the same weather, fuels and canopy data as the Sanborn WFSI.

In comparison to the wildfire susceptibility layer, this data layer reveals nearly 5.7 million acres with a high to very high wildfire intensity ranking. Spruce-fir forests, which naturally burn in infrequent stand-replacing fires, account for more than 2 million of these acres, followed by mixed conifer and ponderosa pine forests. The USFS manages the majority of these forests in which 3.7 million acres are in the high and very high categories. Private lands account for another 1.2 million acres in these categories; the BLM oversees just under 500,000 acres that also are ranked in these categories. Management in landscapes ranked high to very high could help reduce the potential for high-intensity crown fire where such fire is unwanted, or ensure that values at risk are proactively protected in areas where such fire may be desired for natural resource benefit.

[27] For more information on FlamMap, please see www.firemodels.org.



Map 8 – Wildland Fire Intensity Index

Forest Type	Low	Moderate	High	Very High	Total
Spruce-Fir	1,317,933	1,062,273	1,364,345	819,414	**4,563,965**
Lodgepole	726,643	321,380	276,050	337,355	**1,661,428**
Aspen	3,801,168	626,182	259,609	374,924	**5,061,883**
Mixed Conifer	560,061	285,167	645,953	290,082	**1,781,263**
Ponderosa Pine	1,169,115	522,714	568,113	237,489	**2,497,432**
Montane Riparian	568,617	193,653	124,962	38,745	**925,977**
Piñon-Juniper	1,404,444	3,480,014	127,010	125,883	**5,137,351**
Oak Shrubland	274,095	1,990,347	21,341	50,620	**2,336,403**
Plains Riparian	31,606	25,846	7,407	26,331	**91,190**
Introduced Riparian	17,526	82,904	2,216	286	**102,932**
Total	**9,871,208**	**8,590,478**	**3,397,006**	**2,301,130**	**24,159,822**

Table 8a – Wildland Fire Intensity by Forest Type (acres)

Owner	Low	Moderate	High	Very High	Total
USFS	5,280,057	2,307,319	2,250,772	1,452,260	**11,290,408**
BLM	1,253,727	2,497,214	292,158	207,293	**4,250,392**
NPS	121,213	155,075	67,342	44,516	**388,146**
USFWS	4,514	4,818	812	1,868	**12,012**
DOD	6,337	40,652	1,572	530	**49,090**
Federal-Other	2,906	3,588	242	251	**6,988**
State	205,547	246,158	68,199	46,441	**566,346**
Tribal	216,527	155,285	14,965	15,483	**402,259**
Local Govt.	61,329	36,987	33,231	22,757	**154,304**
Private	2,718,381	3,142,656	667,532	509,589	**7,038,158**
Total	**9,870,538**	**8,589,752**	**3,396,824**	**2,300,988**	**24,158,103**

Table 8b – Wildfire Intensity by Forest Ownership/Management (acres)

Data Gaps

- Need consistent fire reporting data for all jurisdictions across the state.
- Need updated LANDFIRE data on the current condition of Colorado's lodgepole pine forests.
- Need a fuel model to help predict fire behavior in the canopy of dead lodgepole pine forests.
- Need a fire susceptibility analysis for the Eastern Plains.

Identify, Manage and Reduce Threats to Forest and Ecosystem Health

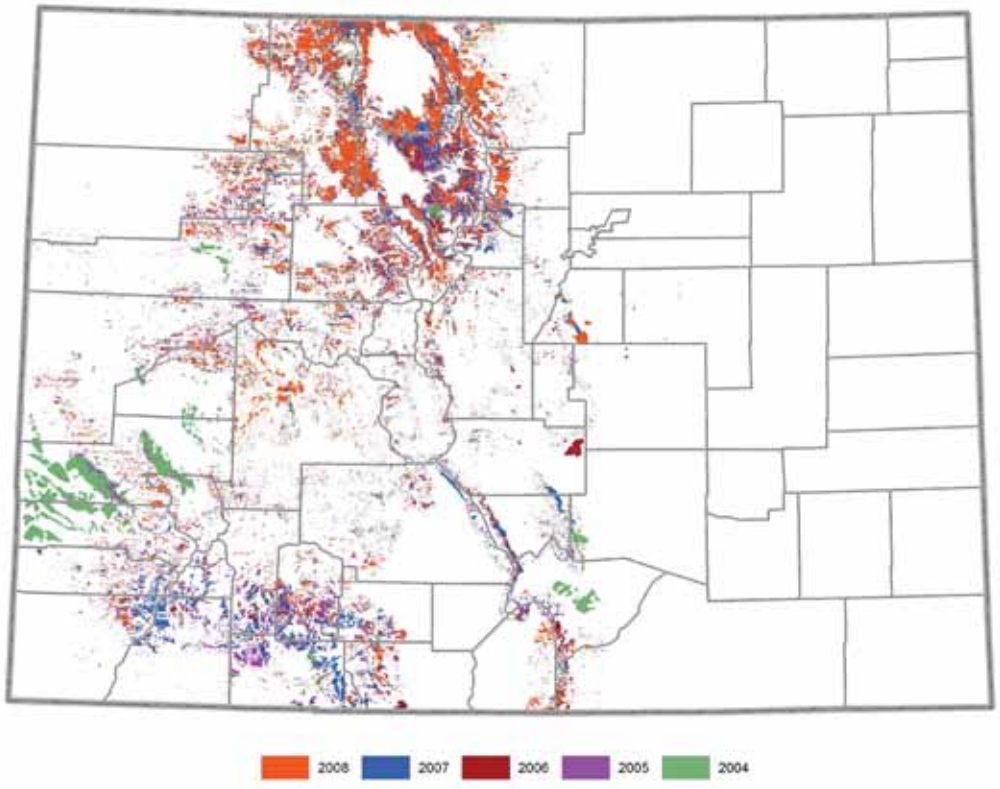
In addition to fire, insects and disease, invasive species and climate change also can cause unwanted impacts in Colorado's forests. Although many insects and diseases are native to the state, underlying forest conditions combined with climatic factors can cause them to operate at an intensity or scale that causes concern. Noxious weeds, such as tamarisk, cheat grass or meadow knapweed, however, are not native to Colorado's forests and their presence serves to displace native species, alter hydrologic regimes, increase wildfire risk and cause other damage within the ecosystem. Although the extent of future climate change impacts is unknown, current trends indicate the possibility for increased susceptibility to fire, insects and disease, decreased forest cover at lower elevations and loss of habitat for some forest-dependent species.

Insect and Disease Overview: A number of insects and diseases regularly impact the condition of Colorado's forests. Some are exotic, or introduced, but most are native and always present at endemic levels.

Natural cycles of insect and disease activity are an important component of a functioning forest ecosystem because they contribute to the diversity of sizes, age classes and species types across the forest landscape. Forest insects also provide food for wildlife and their activities can result in nesting, roosting and hunting sites for birds and other animals. They also can create occasional small openings that increase growth of understory grasses and forbs. Insects of primary concern in Colorado include the mountain pine beetle, spruce beetle, piñon ips beetle, western spruce budworm and balsam bark beetle. Diseases of concern include dwarf mistletoe and armillaria root

rot (CSFS 2001 and 2002). Some insects, such as bark beetles, regularly rise to epidemic levels in Colorado, causing widespread mortality. The result of these epidemics often is the stimulation of new forest growth, whether of the same tree species or of different species that are more responsive to the new, more open conditions.

Colorado currently is experiencing a mountain pine beetle epidemic that has impacted nearly 2 million acres, including virtually all of the state's 1.5 million acres of lodgepole pine, as well as additional acres in mixed conifer and ponderosa pine forests (CSFS 2008). The scale of this epidemic, which extends across much of the Rocky Mountains and into Canada, is larger and more intense than any known past epidemic. The mortality resulting from this event has raised concerns for public safety and the integrity of essential water and utility infrastructure, particularly in relation to the potential for falling dead trees and wildfire. Research is underway in Colorado to improve understanding regarding the dynamics of this epidemic to help determine whether it is likely to expand to ponderosa pine forests on the Front Range, and what it may suggest for future forest management.[28] The wide extent and loss of age-class diversity occurring in a relatively short time period throughout a significant portion of the range of lodgepole pine has potential ecological and social impacts that currently are poorly understood. More research is needed to help address the issue and provide forest resource managers with information to make decisions.[29]



Map 9 – Combined Aerial Survey Data

[28] Additional information on the potential for the current epidemic to spread into ponderosa pine forests can be found in an informal report produced by Jeff Witcosky, USFS forest health specialist for the Joint Ecology Working Group. The report is available at: http://www.frftp.org/docs_frpb/issue_1_mpb_pp_final_24mar2009.pdf

[29] For a summary of the current scientific understanding regarding lodgepole pine and the ongoing mountain pine beetle epidemic, please see Kaufmann, et al 2008 at:http://csfs.colostate.edu/pdfs/LPP_scientific-LS-www_000.pdf.

Recently, foresters, the public and the media also have focused significant attention on a condition dubbed sudden aspen decline (SAD).[30] Early this century, older aspen stands in many areas of Colorado began dying rather quickly. In 2008, aerial surveys conducted by the USFS and CSFS found at least 500,000 acres of aspen with some level of mortality.[31] Ungulate grazing, fire exclusion and perhaps drought are factors in the lack of regeneration that is evident around the edge of many established groves. Stands of vigorous young trees that regenerated, both naturally and through forest management, prior to the drought in the early years of this century may have remained healthy because the root systems were able to sustain a lower volume of woody biomass. Many insects and fungi have been associated with SAD, but to date, they appear to be indicators rather than direct causal agents.

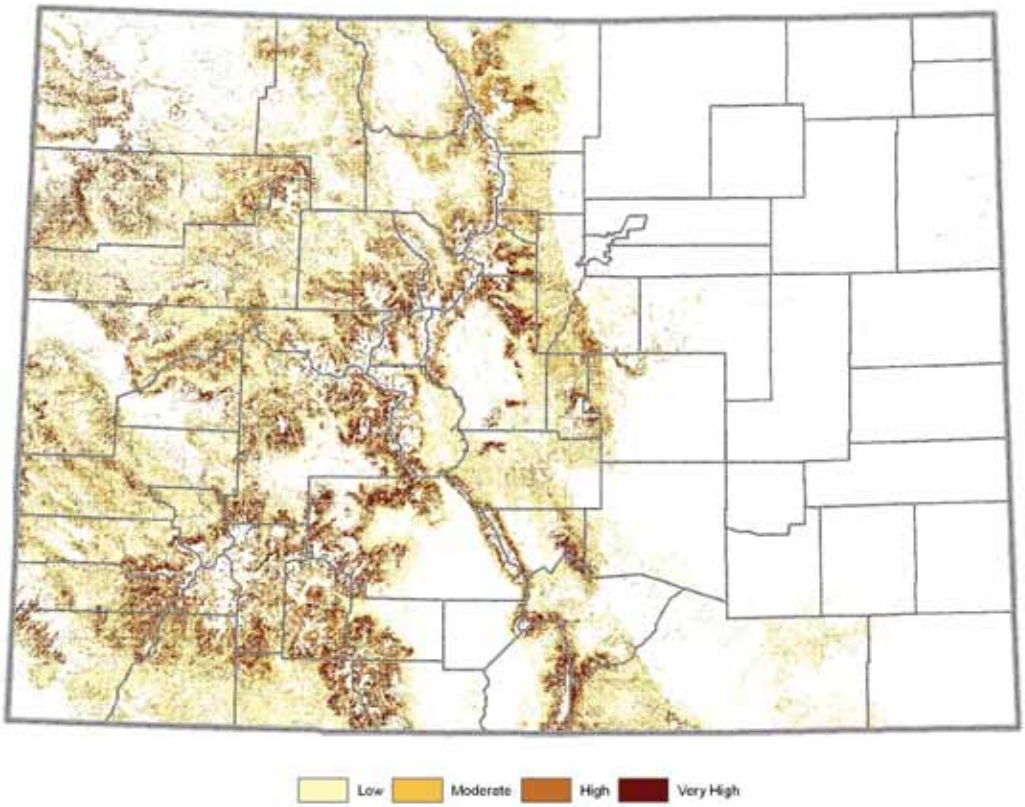
Insect and Disease Analysis: The most effective actions to reduce insect and disease damage involve alleviating stress or competition and restoring a forest's resilience prior to attack. Once infestation has begun, management options to mitigate intensity and spread are limited. The assessment team worked with the USFS Forest Health Technology Enterprise Team (FHTET) and the CSFS to develop a data layer showing areas across Colorado where pro-active forest management could reduce the potential for unwanted impacts from insects and disease. The key components of this analysis are past insect and disease activity and future risk of infestation based on basal area.

For the first component of the analysis, the FHTET used 6 years of aerial survey data to identify where insect and disease activity has occurred, as well as where it has occurred repeatedly in the same location. The second component was developed using current basal area to identify forests that are susceptible to insect and disease infestation. These two components were combined to reveal landscapes that are at high risk for insect and disease outbreaks in the future, but have not been so significantly impacted by past activity levels that mitigation efforts would be ineffective. Areas with extremely high insect and disease activity over the past 6 years were excluded from this final layer because they were deemed to be too significantly damaged for forest management to be helpful.

The final layer showing potential for mitigation of unwanted insect and disease impacts reveals that 5.5 million acres of forest land in Colorado have high to very high potential for the proactive use of forest management. These opportunities exist in all forest types but are greatest in spruce-fir, piñon-juniper and aspen forests. The USFS manages the majority of these lands, followed by the BLM and private landowners. It is important to note that some forest types, such as spruce-fir, have a naturally high basal area. Managers will need to examine conditions on the ground in these forests to determine whether management to reduce basal area or address insect and disease risks is warranted.

[30] This paragraph is adapted from the *CSFS 2008 Report: The Health of Colorado's Forests*.

[31] For more information, please see the 2008 Aerial Survey Highlights at http://www.fs.fed.us/r2/news/press-kits/2009/colo-aerial-survey/colo-survey-higlights.pdf.



Map 10 – Insect and Disease Mitigation Potential

Forest Type	Low	Moderate	High	Very High	Total
Spruce-Fir	1,388,394	415,205	859,231	1,155,215	**3,818,044**
Lodgepole	611,794	243,727	289,780	229,443	**1,374,744**
Aspen	2,708,667	575,842	576,574	578,410	**4,439,494**
Mixed Conifer	1,031,057	241,691	195,188	175,215	**1,643,151**
Ponderosa Pine	1,695,524	230,167	144,630	131,089	**2,201,410**
Montane Riparian	487,892	74,506	73,987	79,067	**715,453**
Piñon-Juniper	3,074,615	419,382	370,886	612,772	**4,477,655**
Oak Shrubland	1,187,166	26,217	15,938	14,407	**1,243,729**
Plains Riparian	17,192	1,086	745	2,243	**21,266**
Introduced Riparian	31,820	1,418	1,095	1,638	**35,971**
Total	**12,234,122**	**2,229,241**	**2,528,054**	**2,979,500**	**19,970,917**

Table 10a – Insect and Disease Mitigation Potential by Forest Type (acres)

Owner	Low	Moderate	High	Very High	Total
USFS	5,018,750	1,280,214	1,669,719	1,862,398	**9,831,081**
BLM	2,356,340	354,645	336,323	557,934	**3,605,242**
NPS	184,814	39,770	50,367	48,399	**323,351**
USFWS	1,464	391	691	830	**3,376**
DOD	31,073	2,416	2,309	1,388	**37,186**
Federal-Other	3,332	262	194	137	**3,925**
State	312,388	40,001	35,561	33,081	**421,031**
Tribal	284,263	27,218	16,190	10,149	**337,821**
Local Govt.	80,138	12,260	9,855	8,658	**110,910**
Private	3,960,880	471,950	406,725	456,325	**5,295,880**
Total	**12,233,441**	**2,229,127**	**2,527,936**	**2,979,301**	**19,969,804**

Table 10b – Insect and Disease Mitigation Potential by Forest Ownership/ Management (acres)

Data Gaps

- Need more consistent stand-level data for forest conditions on state and private land so that a more meaningful analysis of forest health across ownerships can be conducted.
- Need repeatable annual data on insect and disease activity that is consistent across the state. Because the current aerial survey is conducted by different individuals and on different portions of the state each year, its results are subjective and sometimes difficult to interpret regarding the nature and extent of identified activity.

Noxious Weeds Overview: Non-native, invasive plant species pose a threat to virtually all of the nation's natural systems, including forests and woodlands.[32] They have been characterized as a "catastrophic wildfire in slow motion" (USFS 2004). Global trade and transportation have increased opportunities for non-native plants to cross geographic boundaries as never before. Once present in the landscape, non-native species often are able to out-compete native species because no natural controls exist to keep them in check. This is especially true when ecosystem health already is stressed by such factors as drought, fire, pollution, resource overutilization or other disturbances. In addition to causing massive ecological disruption and reducing native biodiversity, invasive plants also can negatively impact human health, food production, recreational opportunities and economic sustainability. Invasive species, including plants, already have cost the U.S. economy $97 billion and have contributed to the decline of 42 percent of the nation's threatened and endangered species (Stein and Flack 1996).

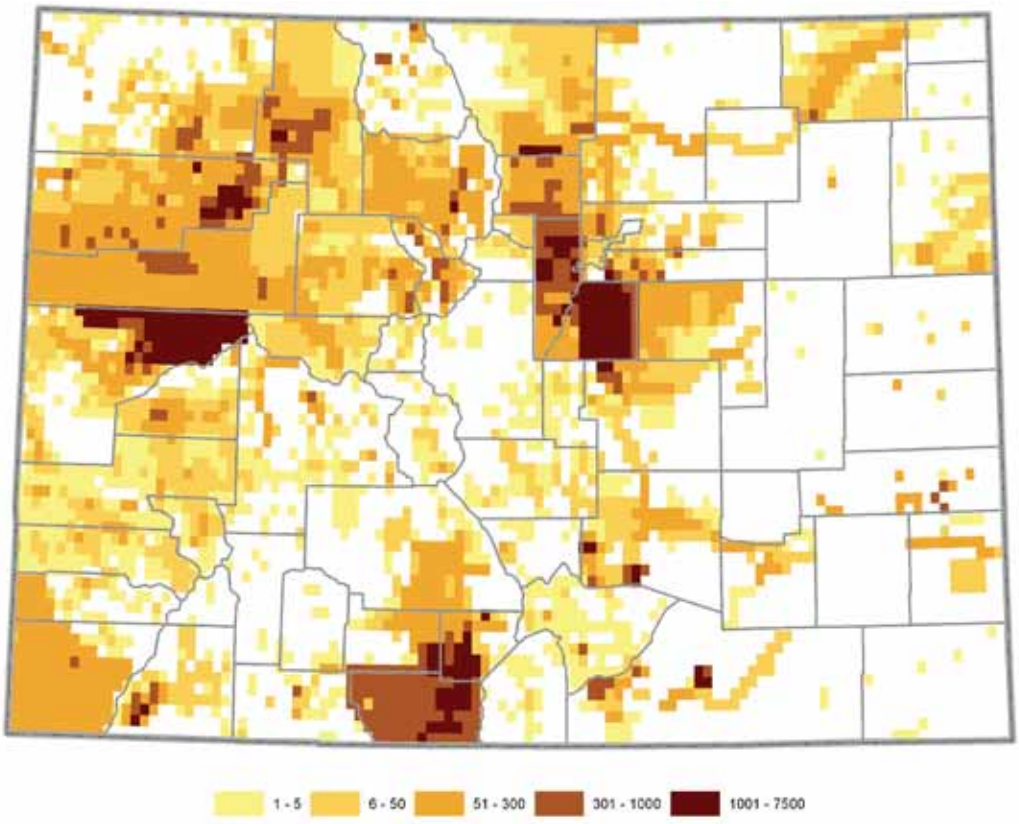
Although Colorado is relatively weed-free compared to some other western states, several non-native plant species designated as *noxious weeds*[33] are associated with the state's forests and woodlands. Among these species are meadow knapweed, myrtle spurge and yellow starthistle, for which eradication

[32] A species is considered invasive if it is non-native to the ecosystem under consideration, and if its introduction causes or is likely to cause economic or environmental harm and/or harm to human health (USFS 2004).

[33] "Noxious weed" is a legally defined term that refers to a specific plant species that has been designated for mandatory control by branches of local, state or federal government due to the harm, actual or potential, that the species is capable of inflicting upon the resources and values of society (Uhing 2009).

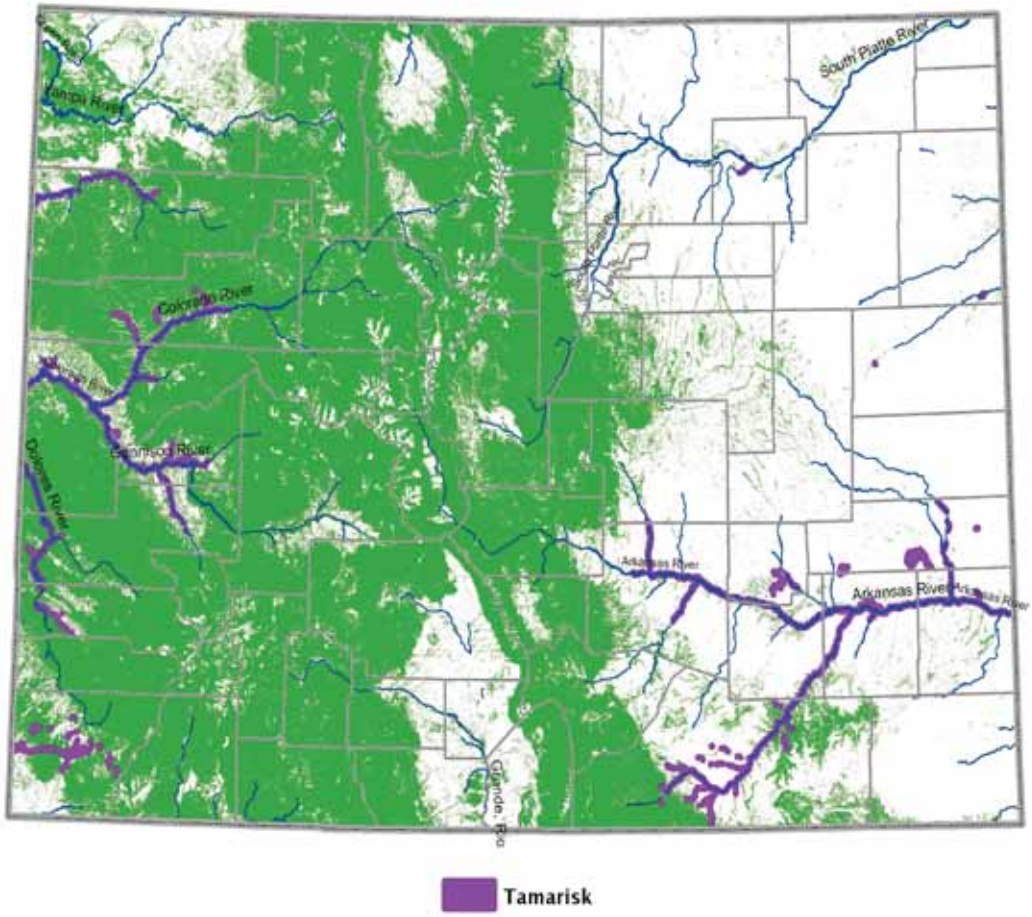
is legally mandated, as well as dalmation toadflax, oxeye daisy, leafy spurge, Russian olive and tamarisk (or salt cedar), which are designated for control in areas where they already occur and for prevention and control where they do not yet occur. Noxious weeds have displaced at least 10 percent of Colorado's native plant species, including the rare orange mountain dandelion and Ute ladies' tresses, which are under constant threat of extirpation from such aggressive species as leafy spurge and yellow toadflax. Each year, several Colorado children are hospitalized due to severe allergic reactions to myrtle spurge sap. The state's horse owners also lose an undetermined number of horses to the debilitating and irreversible brain damage caused by Russian knapweed (Uhing 2009). Tamarisk poses a particular threat to Colorado's riparian forests and associated aquatic ecosystems because it crowds out native plant species, changes natural stream morphology important to native fish species, reduces water availability and increases wildland fire risks.

Noxious Weeds Analysis: While prevention is the best approach for noxious weeds, a number of management techniques can help mitigate or control invasive plants. The Colorado Department of Agriculture (CDA), USFS, counties and others administer programs focused on prevention, eradication and control of noxious weeds and other invasive plants.[34] These programs also emphasize rehabilitation and restoration to help heal, minimize or reverse the harmful effects from invasive species (USFS 2004). Rehabilitation actions are particularly important following wildfire to prevent the establishment of aggressive noxious weeds.



Map 11 – Invasive Species

[34] For more information on the CDA Noxious Weed Management Program, please see http://www.colorado.gov/cs/Satellite/Agriculture-Main/CDAG/1167928159176.



Map 12 – Tamarisk and Forests

Data Gaps:

- Need more fine-scale data, preferably 30-meter data, on the location of noxious weeds in Colorado so that a determination can be made about how those species intersect with forests and where management could be most effectively applied.

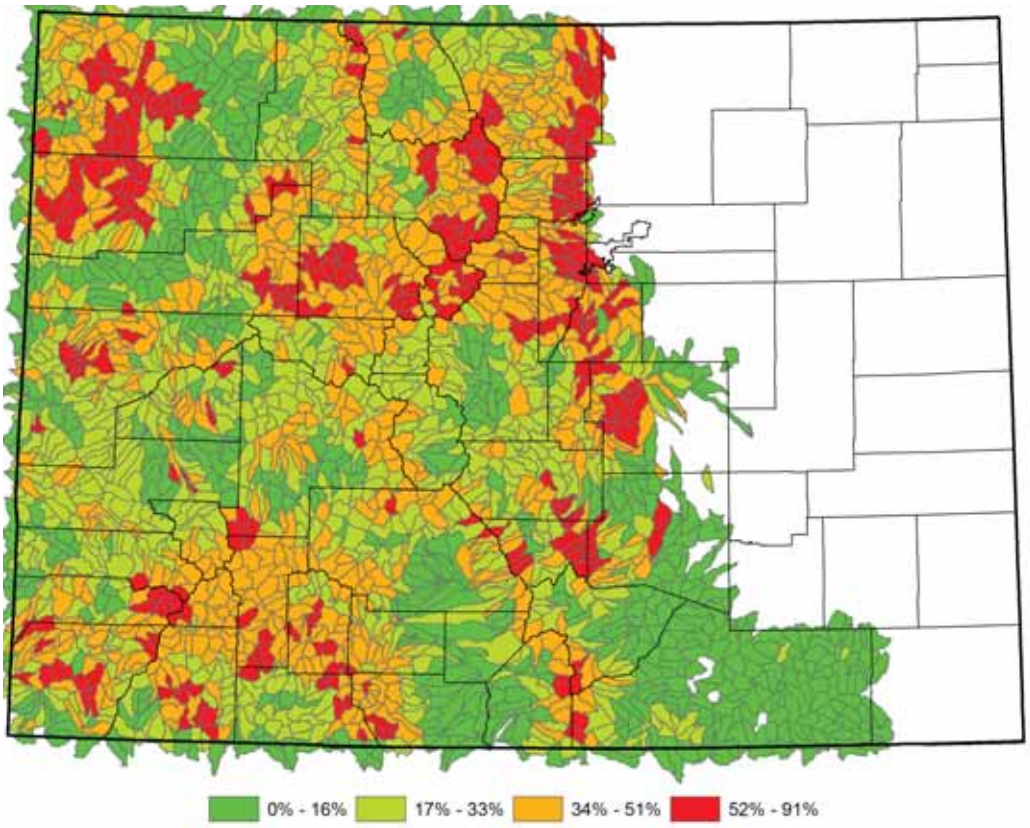
Climate Change Overview: Recent studies suggest that climate change is affecting Colorado and other western states more than any other part of the United States, except Alaska. When compared to the 20th century average, the West has experienced an average temperature increase during the last 5 years that is 70-percent greater than the world as a whole (Saunders and others 2008). Scientists already are seeing the effects of changing weather patterns and extreme events on the region's forests. Many of the most urgent forest management problems of the past 20 years, including increased wildfire severity and scale, extensive insect and disease infestations and changing water regimes have, in part, been driven by climate change (USFS 2008). In Colorado, scientists have attributed such events as the record-setting 2002 wildfire season, the current mountain pine beetle epidemic and sudden aspen decline to the impacts of a changing climate. The Colorado Division of Wildlife identified climate change as a threat to high-elevation habitats, including spruce-fir forests, and bristlecone and limber pine (CDOW 2006).

While some forest ecosystems and species may adapt rapidly enough to maintain viability and productivity, many are expected to experience change that will exceed their capacity to migrate or adapt. The Intergovernmental Panel on Climate Change recently stated that "mountainous ecosystems are virtually certain to experience the most severe ecological impacts from climate

change, including species extinctions and major biome shifts" (Parry and others 2007). Climate change poses a unique and critical challenge to land managers who will need to consider how to facilitate ecological resilience and adaptation while strategically managing forests to store carbon and otherwise mitigate climate change impacts. Past strategies that focused on maintaining vegetation within an historic range of conditions likely will cease to be an option in many areas and may need to be adjusted or replaced with approaches that support adaptation to the changing conditions of the future (USFS 2008).

Protect Forests from Harm: Combined Theme Map

Three data sets in this section, including wildfire susceptibility index (Sanborn), wildfire intensity index (USFS) and insect and disease mitigation potential were combined and weighted to produce the final map.



Map 13 – Protect Forests from Harm: Combined Theme Map

Data Set Layer	Layer Weight Percent
Wildfire susceptibility index (Sanborn)	33%
Wildfire intensity index (USFS)	40%
Insect and disease mitigation potential	27%

NATIONAL THEME: Enhance Public Benefits from Trees and Forests[35]

In Colorado and around the globe, trees and forests provide a number of public benefits that contribute significantly to our quality of life. These benefits often are referred to as ecosystem services and can be defined as "the life-support and life-enhancing services of natural ecosystems" (Watson 2008). Primary among these services are clean and abundant drinking water, habitat to support native biodiversity, wood products and renewable energy, carbon sequestration, and diverse recreational and scenic opportunities. In urban and community settings, trees and forests also serve as a kind of green infrastructure that improves air and water quality, reduces energy needs, buffers noise pollution, provides food and cover for wildlife, and offers opportunities for relaxation and respite.

The ecosystem services provided by forests often are viewed as free benefits to society. Consequently, their critical contributions often can be overlooked in public, corporate and individual decision-making.[36] When forests are undervalued, they also can be susceptible to development pressures, conversion or simple benign neglect. Recognizing forests as natural assets with economic and social value can help promote more responsible decision-making and improve the chances that land managers will receive the resources they need to sustain these critical assets over the long-term. This recognition provides the opportunity for the public to help finance management of these resources on both public and private land.

Protect and Enhance Water Quality and Quantity

Overview: The headwaters of four major U.S. rivers – the Arkansas, Colorado, Platte and Rio Grande – are located in Colorado's forests (CSFS 2007 and 2008). These rivers drain one-third of the lands within the lower 48 states and provide essential water supplies to 18 states including Kentucky, Tennessee, Utah and California. Water from Colorado's forests supports a variety of uses including public drinking water, agriculture, industrial uses (including mining), recreation and habitat for aquatic life (USFS 2008). Forests exert a strong influence on the quantity and quality of water within watersheds by protecting soil and preventing erosion, enhancing soil moisture storage and groundwater recharge, reducing flooding, filtering contaminants and maintaining the plant communities that also contribute to this process.

Land managers and water providers alike are concerned about the threat of high-severity wildfire in forested watersheds. High-severity fires impact forest soils by removing the protective layer of leaves, twigs, branches and needles, exposing mineral soil and sometimes facilitating the formation of a waxy, water-repellent layer that dramatically amplifies the rate of runoff. If significant precipitation occurs following a high-severity fire, resulting impacts on water systems can include rapid surface runoff and peak flows; flash floods that mobilize large amounts of suspended sediments, ash and debris; increased

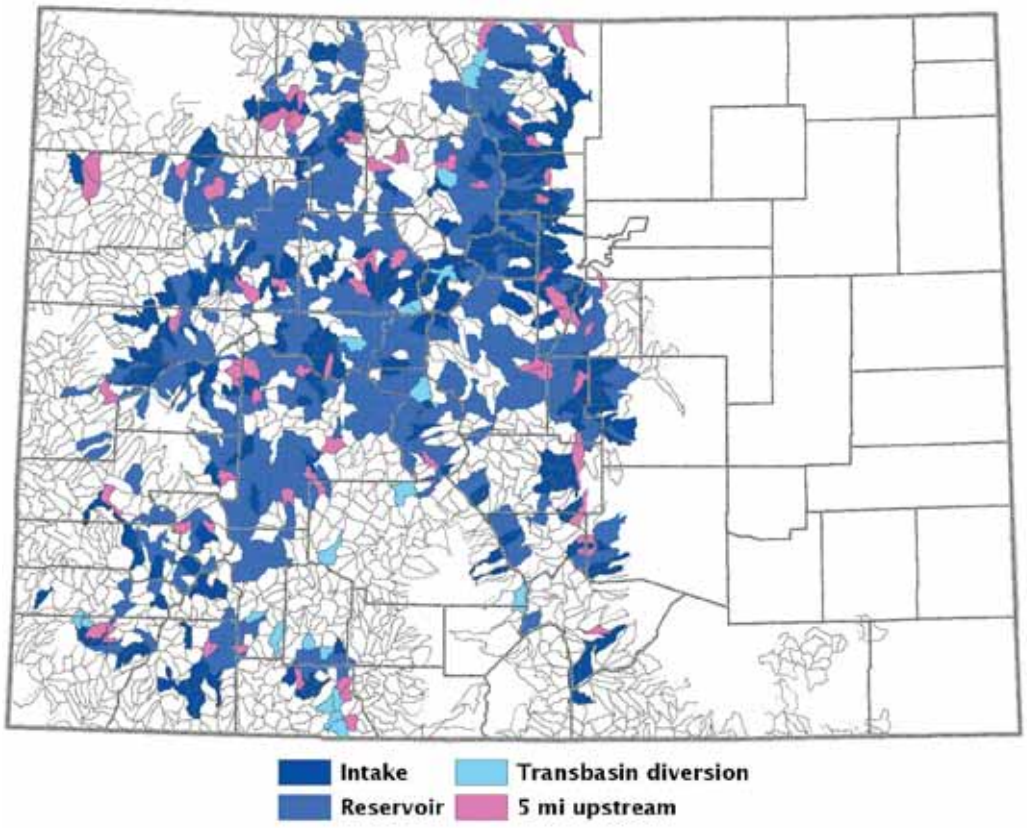
[35] The categories below have been slightly modified as follows from the strategic objectives that are specified for this theme in the National Guidance (see Appendix A): A new category has been added for "Protect and enhance forest-based recreation opportunities;" "Connect people to trees and forests, and engage them in environmental stewardship activities" has been modified to read "Connect people to trees and forests through engagement in community-based environmental stewardship;" and "Improve air quality and conserve energy" has been incorporated into this modified theme. In addition, the discussion on climate change has been incorporated into the theme on Protect Forests from Harm, rather than as a stand-alone item under Enhance Public Benefits from Trees and Forests.

[36] For more information, please see the Ecosystem Services website of the U.S. Forest Service at http://www.fs.fed.us/ecosystemservices/.

transport of materials that can adversely affect water quality for human use; and serious alteration or destruction of aquatic habitat (CSFS 2002). The 1996 Buffalo Creek Fire and 2002 Hayman Fire subjected Denver's municipal water supply to just this kind of damage and cost the Denver Water Board millions of dollars for repairs and rehabilitation.

Analysis: Forest management can reduce the risk of damaging wildfire in high-priority watersheds by reducing competition, and enhancing appropriate age and species diversity, as well as overall forest resilience. In an effort to identify the areas where this type of management could be most meaningfully applied, the CSFS chose to focus this analysis on forested watersheds of importance for drinking water supply. The assessment team worked with the Colorado Department of Public Health and Environment (CDPHE) to identify 642 sixth-level forested watersheds (typically 10,000 to 40,000 acres) with a direct link to critical infrastructure for municipal drinking water, such as intakes, reservoirs and trans-basin diversions. The forested portions of these watersheds cover 9.4 million acres and the primary forest types are spruce-fir, aspen and ponderosa pine.

These watersheds then were combined with a modeled geospatial analysis showing areas of susceptibility to post-fire erosion across the state. Key factors in this susceptibility analysis include vegetation, climate, soil type, topography and predicted fire behavior. Approximately 5.6 million forested acres in Colorado are at high to very high risk for negative impacts from post-fire erosion. The validity of this analysis was partially assessed by plotting previously documented incidents of post-fire erosion over the modeled output. Nearly all of these incidents occurred in the very high category identified by the model, with a small percentage falling in the moderate and high designations.



Map 14 – Important Watersheds for Drinking Water

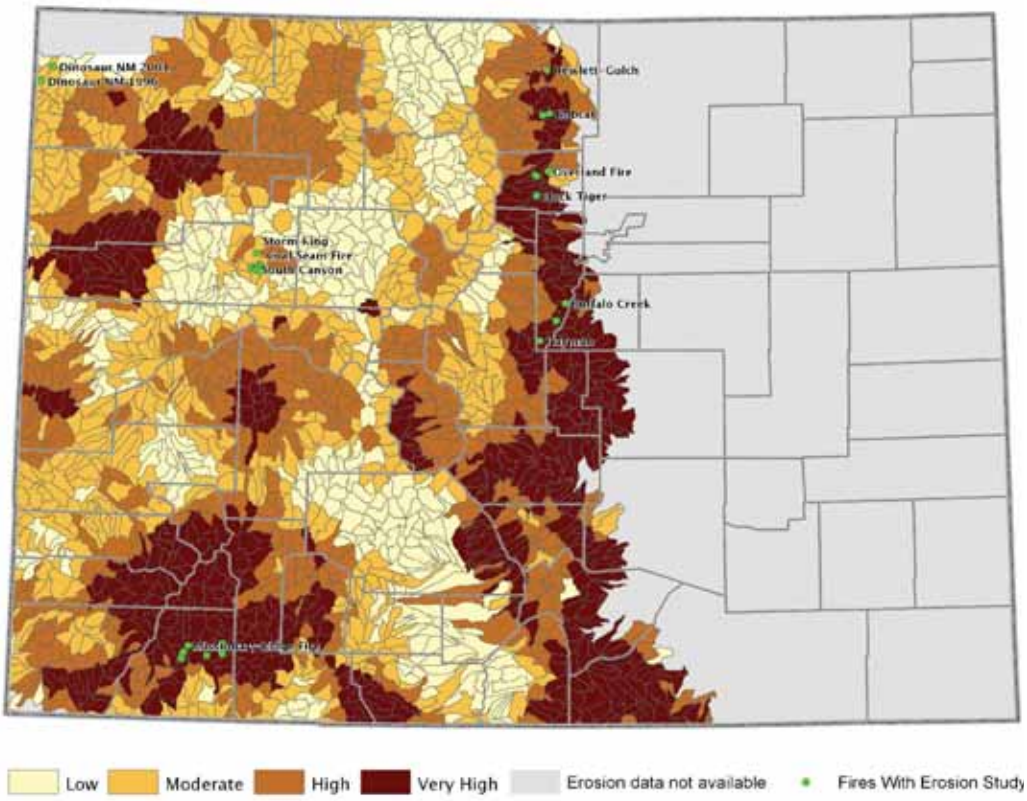
Forest type	Acres
Spruce-Fir	2,352,954
Lodgepole	947,846
Aspen	2,119,707
Mixed Conifer	685,669
Ponderosa Pine	1,169,920
Montane Riparian	360,321
Piñon-Juniper	823,763
Oak Shrubland	888,784
Plains Riparian	16,536
Introduced Riparian	15,620
Not Forested	4,357,960
Total	***13,739,080***

Table 14a – Important Watersheds for Drinking Water by Forest Type

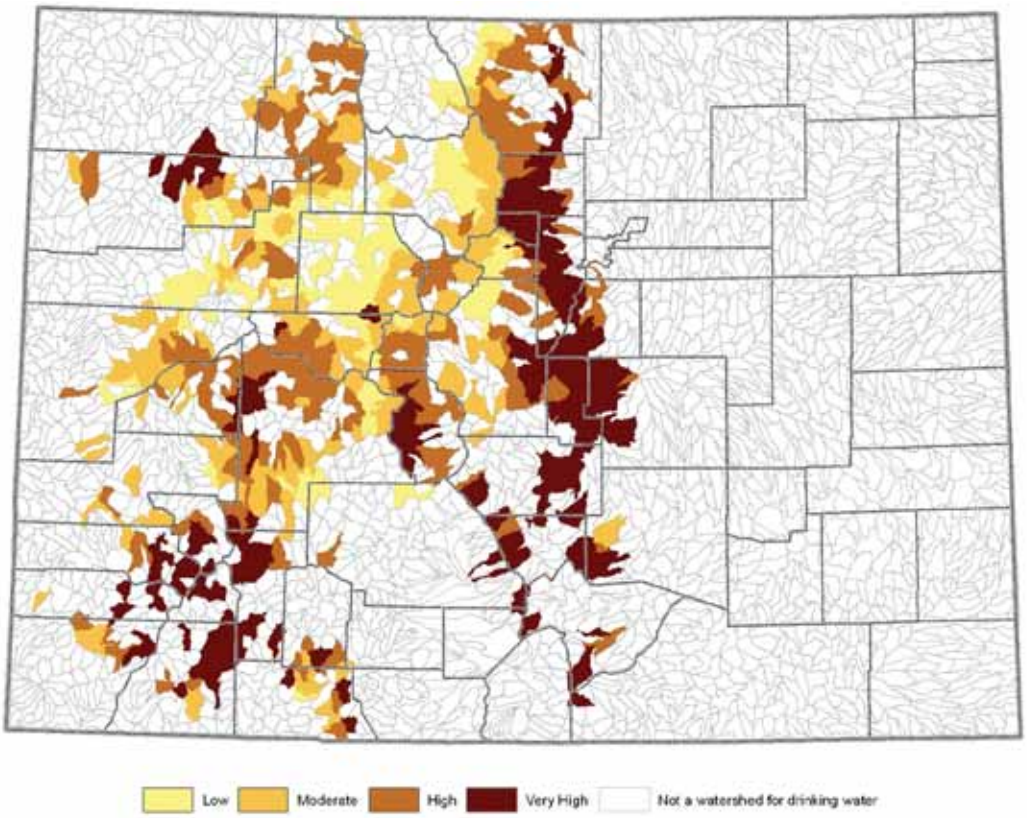
Owner	Acres
USFS	5,319,282
BLM	877,885
NPS	214,028
USFWS	2,680
DOD	13,782
Federal-Other	63,153
State	137,310
Tribal	1,952
Local Govt.	120,092
Private	2,630,777
Total	**9,380,940**

Table 14b – Important Watersheds for Drinking Water by Ownership/ Management

When combined, these two layers reveal 371 forested watersheds covering 5.6 million acres where drinking water supply infrastructure is at high to very high risk from post-fire erosion. Ponderosa pine forests have the highest number of acres (707,721) in the very high risk category, but when very high and high are combined, spruce-fir and aspen dominate with roughly 1.27 million acres each. The majority of the high and very high risk watersheds are in USFS (3.8 million acres) and private (2.72 million acres) ownership.



Map 15 – Post-Fire Erosion Risk



Map 15 – Risk of Post-Fire Erosion in Watersheds that are Important Sources of Drinking Water

Forest Type	Low	Moderate	High	Very High	Total Acres
Spruce-Fir	382,925	691,341	736,396	542,292	**2,352,954**
Lodgepole	329,664	261,924	233,911	122,347	**947,846**
Aspen	379,787	463,222	696,001	580,697	**2,119,707**
Mixed Conifer	52,182	75,206	211,994	346,287	**685,669**
Ponderosa Pine	53,322	119,931	288,942	707,721	**1,169,918**
Montane Riparian	51,234	88,173	108,025	112,888	**360,321**
Piñon-Juniper	148,817	236,159	207,801	230,984	**823,762**
Oak Shrubland	143,939	272,355	279,922	192,568	**888,784**
Plains Riparian	493	60	8,737	7,244	**16,534**
Introduced Riparian	3,580	7,766	2,060	2,214	**15,620**
Total Acres	**1,545,943**	**2,216,138**	**2,773,789**	**2,845,242**	**9,381,113**

Table 15a – Erosion in Watersheds that are Important Sources of Drinking Water by Forest Type (acres)

Owner	Low	Moderate	High	Very High	Total Acres
USFS	899,293	1,296,082	1,639,897	1,484,010	**5,319,282**
BLM	233,733	217,457	178,440	248,256	**877,885**
NPS	1,114	80,174	108,060	24,680	**214,028**
USFWS	-	-	2,522	158	**2,680**
DOD	-	-	185	13,597	**13,782**
Federal-Other	133	943	243	833	**2,151**
State	50,965	39,555	51,766	56,026	**198,312**
Tribal	11	1,488	-	453	**1,952**
Local Govt.	2,973	3,162	17,380	96,577	**120,092**
Private	357,684	577,279	775,154	920,654	**2,630,771**
Total Acres	**1,545,906**	**2,216,138**	**2,773,647**	**2,845,242**	**9,380,934**

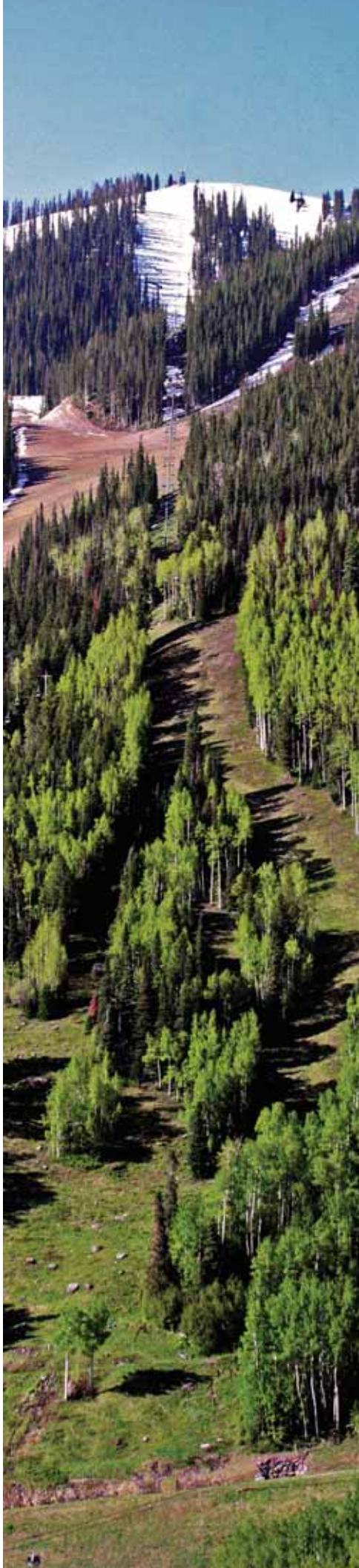
Table 15b – Erosion in Watersheds that are Important Sources of Drinking Water by Forest Ownership/Management (acres)

Data Gaps

- Need data on watersheds and associated components of water supply infrastructure to assess public use, including populations supported by those watersheds.
- Need data on watersheds of importance for agriculture.
- Need consistent state-level data on the locations of transbasin diversions.

Assist Communities in Planning for and Reducing Wildfire Risks

Overview: As Colorado's population continues to grow, more and more people choose to live within or adjacent to the state's forests and woodlands. While these wildland-urban interface (WUI) zones provide a scenic backdrop and some measure of seclusion, the proliferation of people and structures in wildland areas raises concern about wildfire risk. In a publication titled *Living with Fire: A Guide for the Homeowner*, the CSFS and its partners describe the WUI equation this way: While fire is a natural part of Colorado's forested



environment, many homes and other structures are built and/or maintained in this environment without regard to wildfire. With more people living in and using the wildlands, a greater chance of fire starts exists. The current condition of many forests in Colorado often means that once started, wildfires will burn intensely and be difficult to control. As a result of this equation, land managers see potential for greater loss of life and property, more significant damage to natural resources and increased demand for public fire suppression funding.[37]

More than 1 million people currently live in Colorado's WUI where forests and other vegetation are at high risk to wildfire. The WUI also includes essential components of community infrastructure, such as power and communications lines that may be of concern relative to fire. The size of the WUI is projected to nearly double by 2030, with the majority of this expansion occurring on private land. Fortunately, individuals and communities can take a number of steps to reduce their risk from wildfire which, in turn, increases firefighters' ability to safely do their jobs and decreases the amount of public resources that must be spent on wildfire suppression.

At least 144 Colorado communities have developed Community Wildfire Protection Plans (CWPPs) that identify and prioritize fuels treatments and other measures that will reduce the community's exposure to damaging effects from wildfire.[38] Many individual homeowners also have implemented defensible space, such as clearing trees and brush around homes, cleaning roofs and gutters of pine needles and leaves, stacking firewood away from structures and replacing such flammable building materials as cedar shake shingles with more fire-resistant options. These and other proactive steps must continue and dramatically increase if Colorado is to address its growing WUI challenge.

Analysis: Strategic fuels reduction combined with the implementation of defensible space around homes and structures can significantly reduce wildfire risk to people and communities. To assist the CSFS in identifying areas that could benefit from forest management to protect communities and essential infrastructure, the assessment team combined data on the current and projected extent of the wildland-urban interface with two measures of wildfire risk, one focused on susceptibility to fire and the other on the potential for wildfire intensity.[39] The initial layer on the extent of the wildland-urban interface includes a community buffer zone of two miles, which identifies communities associated with forest vegetation at risk from wildfire; more than 1.6 million acres in Colorado are included in this layer. Forty-one percent (674,742 acres) of this land is within one mile of a community boundary. These numbers are projected to jump to nearly 4 million acres by 2030; 67 percent (2.6 million acres) are located within one mile of a community boundary. The majority of these acres are in private ownership with USFS-managed lands close behind. The predominant forest type is ponderosa pine, followed by aspen, mixed conifer and lodgepole.

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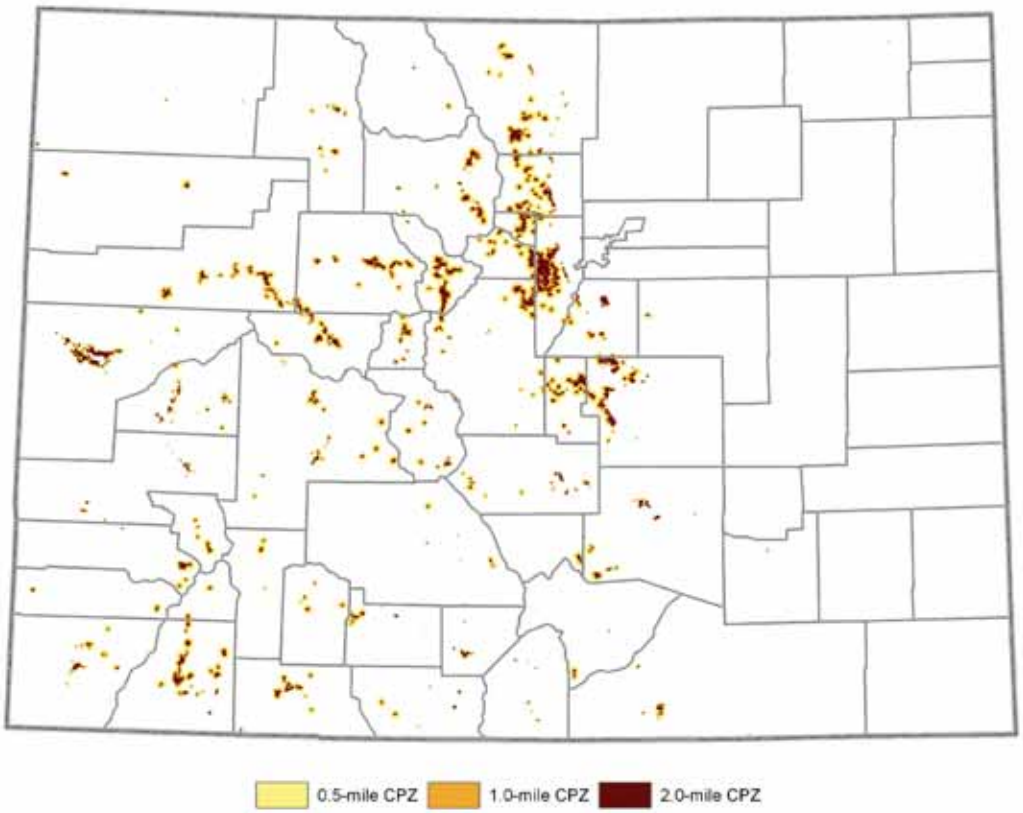
[37] *Living With Fire: A Guide for the Homeowner* can be found at http://csfs.colostate.edu/pdfs/LWF51303.pdf.

[38] For more information on Community Wildfire Protection Plans, including the CSFS *CWPP: Guide to Implementation*, please see http://csfs.colostate.edu/pages/community-wf-protection-planning.html and a list of approved CWPPs can be accessed on this webpage.

[39] For more information on wildfire risk layers, please see the section titled "Restore fire-adapted lands and reduce risk of wildfire impacts" beginning on page 26.



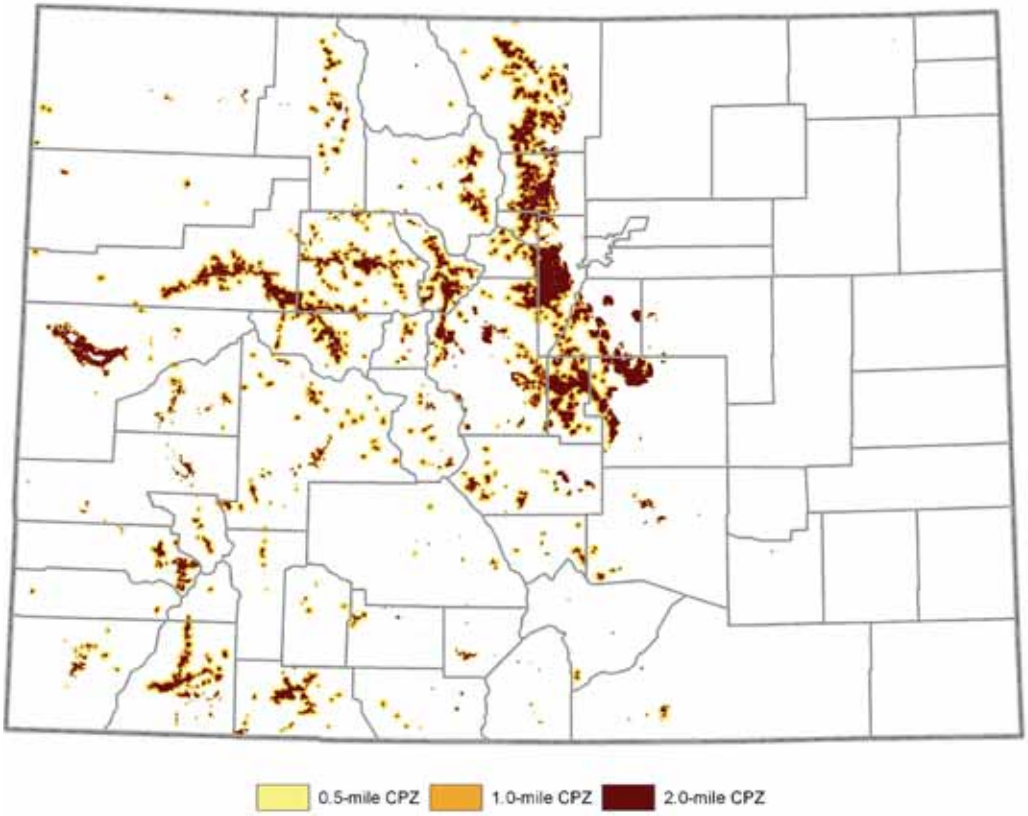
Map 16 – Wildland-Urban Interface (2000)

Forest Type	0.5 mile	1 mile	2 mile	Total
Spruce-Fir	10,779	24,529	103,725	**139,033**
Lodgepole	39,736	53,658	132,461	**225,854**
Aspen	42,468	64,480	176,508	**283,456**
Mixed Conifer	49,282	59,654	127,007	**235,944**
Ponderosa Pine	96,644	99,778	213,943	**410,365**
Montane Riparian	16,172	16,540	37,380	**70,091**
Piñon-Juniper	24,528	35,927	94,979	**155,434**
Oak Shrubland	14,392	18,873	49,905	**83,169**
Plains Riparian	560	367	574	**1,500**
Introduced Riparian	2,702	2,675	4,728	**10,105**
Total	**297,262**	**376,480**	**941,209**	**1,614,952**

Table 16a – 2000 Wildland-Urban Interface by Forest Type (acres)

Owner	0.5 mile	1 mile	2 mile	Total
USFS	47,096	126,404	436,082	**609,582**
BLM	6,064	20,390	61,508	**87,962**
NPS	2,062	6,184	20,455	**28,701**
USFWS	-	3	5	**8**
DOD	199	564	1,393	**2,157**
Federal-Other	66	172	164	**403**
State	2,848	5,653	20,402	**28,903**
Tribal	37	381	2,609	**3,028**
Local Govt.	12,434	16,212	32,311	**60,958**
Private	226,455	200,499	365,989	**792,944**
Total	**297,262**	**376,462**	**940,919**	**1,614,644**

Table 16b – 2000 Wildland-Urban Interface by Forest Ownership/ Management (acres)



Map 17 – Wildland-Urban Interface (2030)

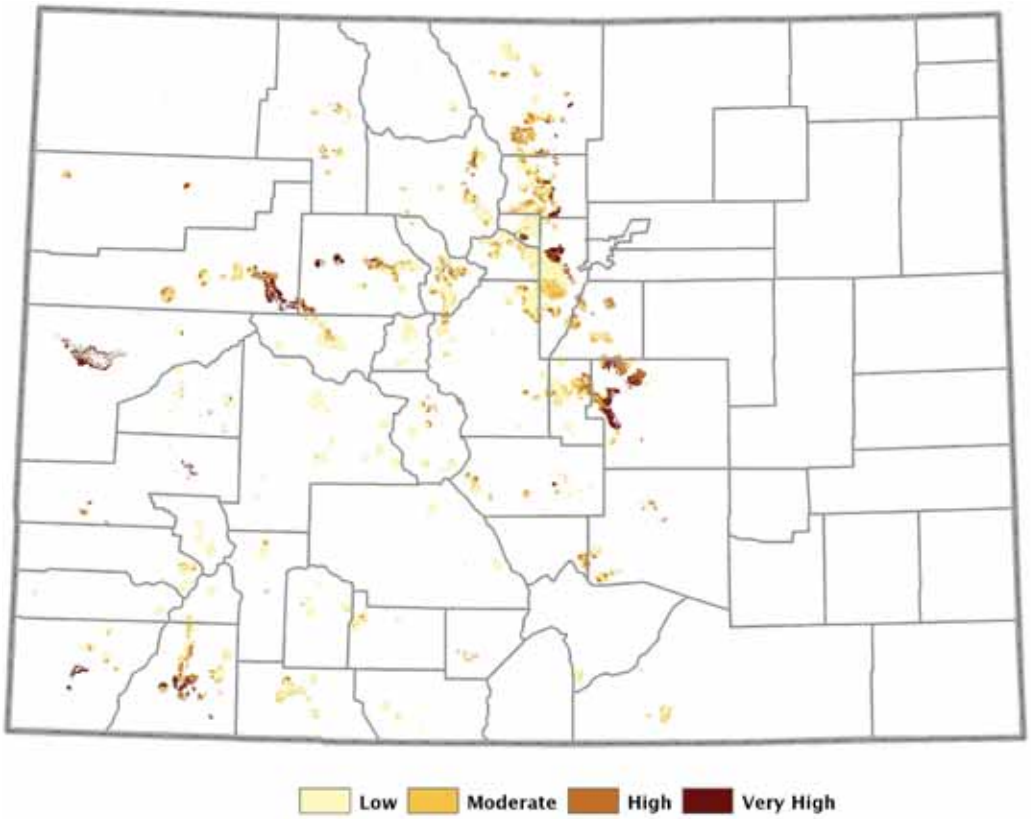
Forest Type	0.5 mile	1 mile	2 mile	Total
Spruce-Fir	55,744	75,146	243,543	**374,433**
Lodgepole	131,082	116,213	228,212	**475,507**
Aspen	218,294	178,929	377,709	**774,932**
Mixed Conifer	167,709	105,185	184,749	**457,643**
Ponderosa Pine	422,054	218,697	332,798	**973,550**
Montane Riparian	62,839	34,732	63,342	**160,914**
Piñon-Juniper	113,969	96,053	213,951	**423,973**
Oak Shrubland	87,311	58,783	121,983	**268,077**
Plains Riparian	1,277	361	345	**1,983**
Introduced Riparian	10,250	3,698	5,308	**19,255**
Total	**1,270,530**	**887,796**	**1,771,941**	**3,930,267**

Table 17a – 2030 Wildland-Urban Interface by Forest Type (acres)

Owner	0.5 mile	1 mile	2 mile	Total
USFS	298,807	465,822	985,474	**1,750,103**
BLM	53,233	83,866	184,413	**321,512**
NPS	7,059	12,285	27,610	**46,953**
USFWS	2	9	44	**55**
DOD	410	1,303	3,061	**4,773**
Federal-Other	169	121	310	**600**
State	13,658	20,892	41,460	**76,010**
Tribal	1,289	3,313	12,154	**16,756**
Local Govt.	38,195	29,981	30,611	**98,788**
Private	857,591	269,812	486,163	**1,613,566**
Total	**1,270,413**	**887,404**	**1,771,300**	**3,929,117**

Table 17b – 2030 Wildland-Urban Interface by Forest Ownership/ Management (acres)

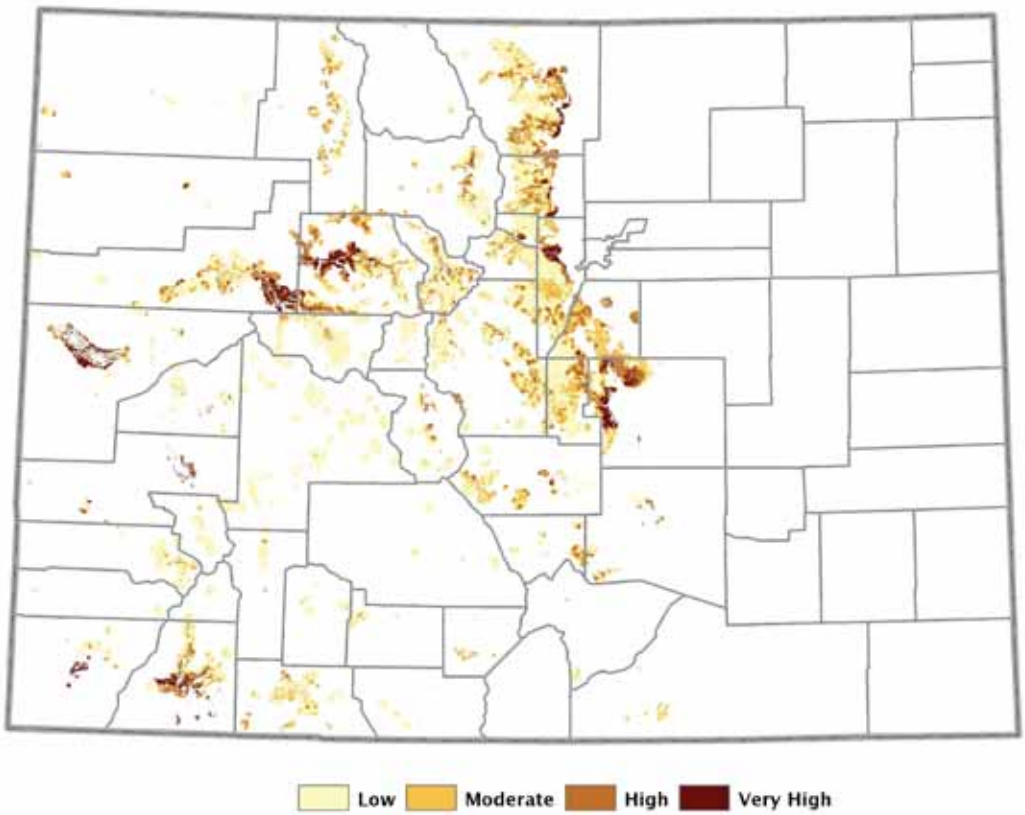
When the WUI data are combined with the wildfire susceptibility analysis, the outcome shows that more than 307,000 acres are associated with communities of high to very high susceptibility to fire. When the WUI data are combined with the potential for wildfire intensity, the outcome reveals that almost 490,000 acres have the potential to experience intense fire behavior in areas associated with communities.



Map 18 – Wildland-Urban Interface with Wildfire Susceptibility (2000)

2000 WUI/CPZ Buffer Distance	Low	Moderate	High	Very High	Total
0.5 mile	159,704	53,648	45,362	27,451	**286,166**
1 mile	213,437	76,896	51,622	26,105	**368,059**
2 mile	589,698	176,208	107,812	49,022	**922,741**
Total	**962,839**	**306,753**	**204,796**	**102,578**	**1,576,966**

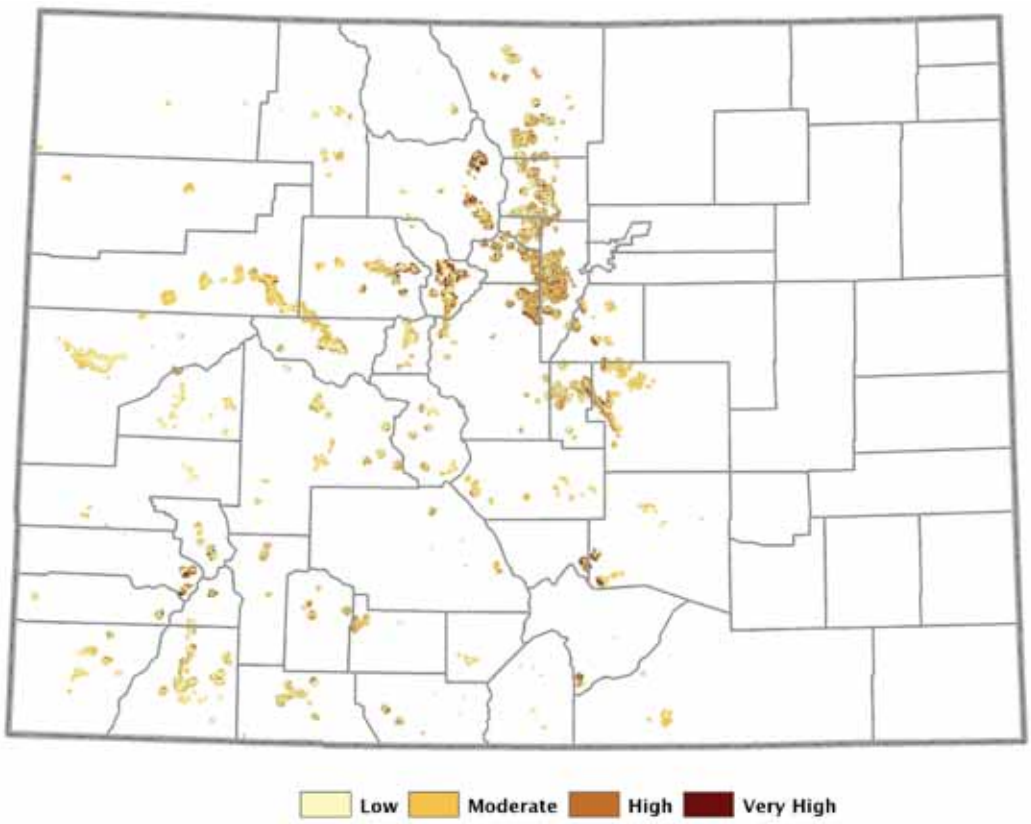
Table 18 – 2000 WUI Areas with Wildfire Susceptibility (acres)



Map 19 – Wildland-Urban Interface with Wildfire Susceptibility (2030)

2030 WUI/CPZ Buffer Distance	Low	Moderate	High	Very High	Total
0.5 mile	666,617	283,087	205,071	84,807	**1,239,583**
1 mile	537,605	182,475	112,284	38,664	**871,029**
2 mile	1,180,107	327,680	178,170	51,143	**1,737,100**
Total	**2,384,329**	**793,242**	**495,526**	**174,614**	**3,847,711**

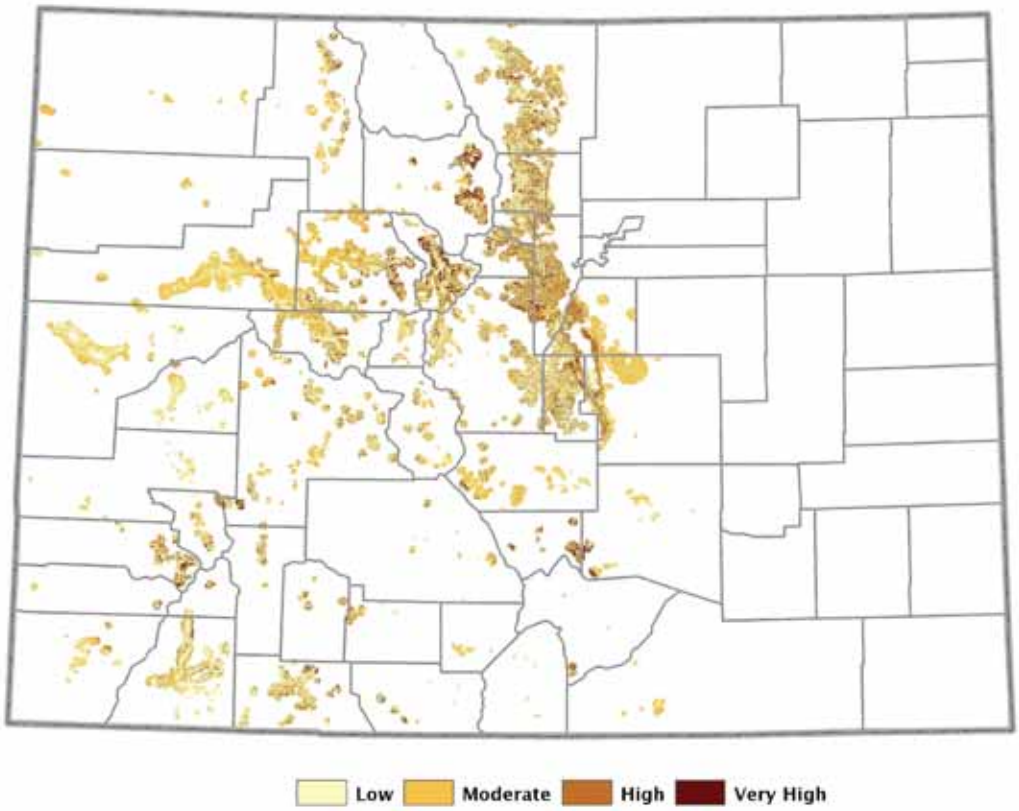
Table 19 – 2030 WUI Areas with Wildfire Susceptibility



Map 20 – Wildland-Urban Interface with Wildfire Intensity (2000)

2000 WUI/CPZ Buffer Distance	Low	Moderate	High	Very High	Total
0.5 mile	144,692	63,061	62,150	26,897	**296,800**
1 mile	174,040	84,518	78,330	39,138	**376,025**
2 miles	435,695	221,298	186,842	96,411	**940,246**
Total	**754,427**	**368,876**	**327,322**	**162,446**	**1,613,071**

Table 20 – 2000 WUI Areas with Wildfire Intensity (acres)



Map 21 – Wildland-Urban Interface with Wildfire Intensity (2030)

2030 WUI/CPZ Buffer Distance	Low	Moderate	High	Very High	Total
0.5 mile	604,993	312,610	244,572	106,940	**1,269,115**
1 mile	413,345	224,342	161,275	87,735	**886,697**
2 mile	802,413	474,991	318,158	174,486	**1,770,048**
Total	**1,820,751**	**1,011,943**	**724,005**	**369,161**	**3,925,860**

Table 21 – 2030 WUI Areas with Wildfire Intensity (acres)

Data Gaps

- Need a clear definition and data layer with spatial locations and boundaries for "communities" in Colorado. This should include polygon data showing the extent of each designated community.
- Need a consistent, state-level layer with the spatial locations and boundaries of approved Community Wildfire Protection Plans.
- Need a more consistent wildland-urban interface risk analysis for the Eastern Plains.

Maintain and Enhance the Economic Benefits and Values of Trees and Forests

Overview: Wood products derived from Colorado's forests include sawtimber, firewood, posts and poles, Christmas trees, log homes and furniture, paneling, flooring, animal bedding and a variety of landscaping materials. They also include chips, pellets and other materials associated with woody biomass for renewable heating and energy. Locally based forest products businesses provide valuable jobs and economic opportunities for Colorado communities.

They also are important partners in facilitating forest management. Without this harvesting and processing infrastructure to add value to woody materials removed from the forest, it may not be cost-effective to conduct some forest treatments needed to improve forest ecosystem health, protect homes and infrastructure, and maintain the aesthetic and recreational resources of the forest.

Although millions of acres of forest exist in Colorado, only a small portion is harvested each year. As a result, the state's forest industry comprises only a minor portion of Colorado's gross domestic product, and existing infrastructure for processing wood products has been reduced by close to half since 1980 (CSFS 2007). A 2001 study by Colorado State University and the USFS found that Colorado uses more than $4 billion in wood products each year, yet only 8 percent of these products are from Colorado's forests (Lynch and Mackes 2001).[40] The remaining 92 percent is imported from other states, Canada and Mexico. New ways to use harvested wood, especially small-diameter trees, are needed. According to the CSFS, much of the state's demand for wood products could be met by small-diameter timber and other woody material produced by forest restoration projects. This could include: $62 million in roundwood for fencing, utility poles, etc.; $32 million in wood energy such as firewood and wood pellets; $14 million in mulch, chips and sawdust; and $1.6 million in Christmas trees.[41]

Colorado uses extensive amounts of wood products annually, but it depends on imports from other states and countries to meet its needs. As a result, significant amounts of money from Colorado's economy are transferred elsewhere to purchase and transport wood. Despite the presence of abundant forests capable of providing many types of wood products and serious concerns about forest health and catastrophic fires, Colorado continues to import more than 90 percent of the wood it uses. In many cases, the wood being used is transported great distances from forests that are similar in composition to Colorado's forests and even less capable of producing wood fiber. Thus excellent opportunities exist for using trees from Colorado forests. In particular, small-diameter trees removed to improve forest health and reduce fire hazard could be utilized for some products. Additionally, policy and management questions related to Colorado's use of imported wood should be addressed (Lynch/Mackes 2001[42]).

Analysis: Forest management can contribute to a sustainable wood products industry by providing local contractors and businesses with job opportunities and materials for processing. The wood products industry, in turn, can facilitate the accomplishment of forest management objectives by supplying human resources to do the work and, often, by reducing the cost of needed treatments. To identify those forested lands most suited to management for timber, biomass and other wood products, the CSFS recommended highlighting available acres by developing an analysis screen that removes designated wilderness areas, designated roadless areas, national parks and monuments and lands with a slope greater than 50 percent.

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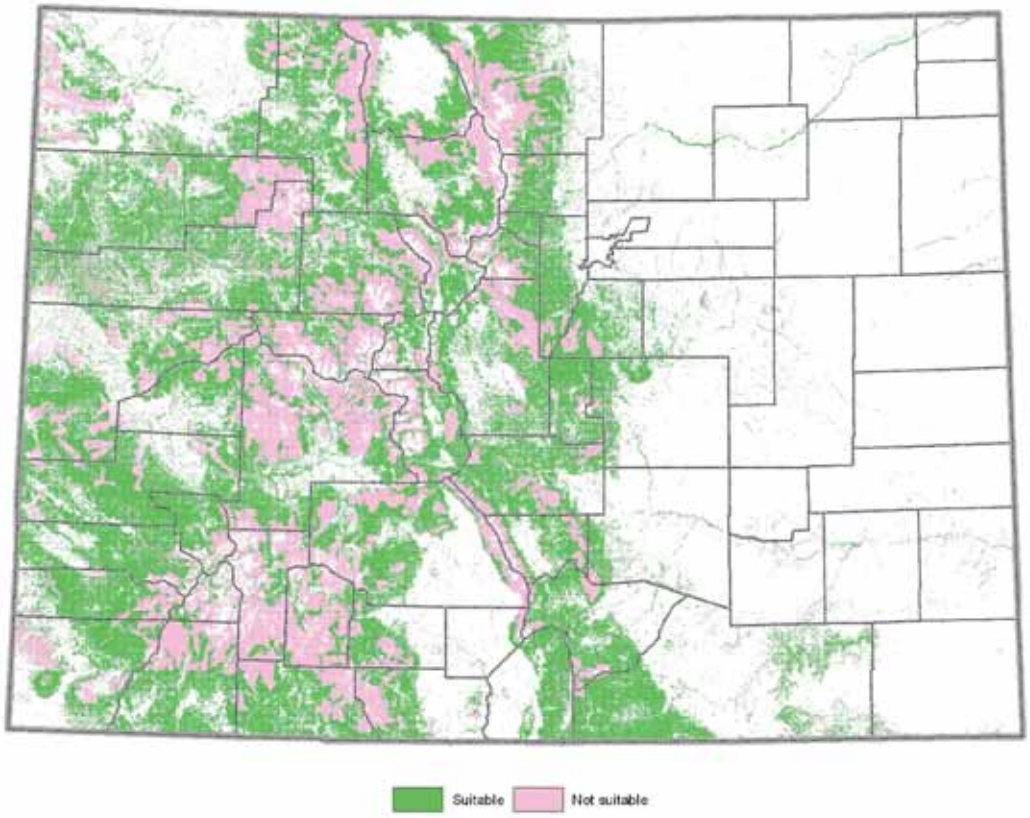
[40] This study did not include woody biomass used for bioheating and renewable energy.

[41] Please see the Colorado Forest Products website at http://csfs.colostate.edu/cowood/cfp.html.

[42] *Wood Use at the Turn of the Twenty-First Century, Lynch and Mackes, 2001 is available at* http://www.fs.fed.us/rm/pubs/rmrs_rp32.pdf.

The application of this screen reveals that 15.9 million acres are available for management of wood products, including biomass. The majority of these acres are in piñon-juniper, aspen and ponderosa pine. Private landowners control the majority of these acres (6.7 million), followed by the USFS (4.8 million) and the BLM (3.2 million).

This map data is coarse and represents a broad view of acres available for management. The CSFS is working to complete a refined biomass availability map that will show the ranking of the relative potential of lands to produce biomass for uses ranging from sources of heat to solid wood products. The map should be available by July 2010.



Map 22 – Acres Available for Management of Wood Products and Biomass

Forest Type	Acres for Wood Products / Biomass	
	Available	Not Available
Non-forest	39,441,421.45	2,730,957.08
Spruce-Fir	1,521,925.97	3,049,239.68
Lodgepole	928,660.82	734,125.38
Aspen	3,080,156.35	1,985,231.37
Mixed Conifer	1,127,144.66	656,634.12
Ponderosa Pine	2,004,500.77	523,214.11
Montane Riparian	671,674.90	263,011.48
Piñon-Juniper	4,170,849.82	1,007,188.88
Oak Shrubland	2,012,238.33	353,811.51
Plains Riparian	245,462.97	1,035.47
Introduced Riparian	108,232.68	8,669.17
Total	**15,870,847.27**	**8,582,161.18**

Table 22a – Forested Areas Available for Management by Forest Type (acres)

Owner	Acres Suitable for Wood Products/ Biomass
USFS	4,841,279
BLM	3,164,335
NPS	14,982
USFWS	12,958
DOD	47,682
Federal-Other	8,705
State	536,691
Tribal	365,908
Local Govt.	135,076
Private	6,728,994
Total	**15,856,610**

Table 22b – Forested Areas Available for Management by Owner (acres)

Data Gaps

- Need a state-level assessment of biomass supply for both wood products and renewable energy.
- Need completed stand-level vegetation data for state and private lands statewide.
- The CSFS is completing a map that ranks the relative availability of lands capable of producing biomass.

Protect, Conserve and Enhance Wildlife and Fish Habitat

Overview: Colorado's forests support a rich variety of wildlife species, including birds, mammals, fish, reptiles, amphibians, insects and plants. Wildlife find essential food, water and cover in the state's forests and, in turn, play a key role in shaping and rejuvenating the forest ecosystem. The abundance and diversity of wildlife species in any given forest changes and shifts as the forest moves through its natural successional stages. Presence of specific wildlife depends on forest age, structure, size and species composition. Tree density, canopy height, percent of canopy closure and the number of standing and fallen dead trees are among the structural features that affect habitat quality. When managing forests for wildlife, it is important to begin by identifying the specific habitat requirements and management sensitivities of any target species.

In Colorado, forests provide primary habitat for 65 of the CDOW's Species of Greatest Conservation Need, as well as 20 of the state's rarest plants (CDOW 2006 and CNHP & TNC 2008). Among these species are the Mexican spotted owl, Pawnee montane skipper, Canada lynx and several other species that have been federally designated as Threatened or Endangered.[43] Forested habitats also are important for a number of more common species of economic significance to the state for hunting and fishing, including elk, moose, mule deer and trout. In assessing Colorado's forested habitats, the CDOW identified ponderosa pine as a high priority and indicated that among forested habitats, piñon-juniper and ponderosa pine forests are in poorest condition due to habitat degradation and altered fire regimes. The CDOW also identified habitat loss due to climate change as a threat to the state's high-elevation forests, and altered fire regimes and excessive browsing as threats in Colorado's aspen forests.

Perhaps the greatest threat to all of the state's forest-dependent wildlife is habitat loss due to fragmentation and development (CDOW 2006). Forest fragmentation occurs when large, intact forest patches are divided into increasingly smaller tracts. Fragmentation results from many causes, including housing and other development or oil and gas extraction. Increasing land values, coupled with reduced income that landowners can derive from their property triggers much of this fragmentation. Such fragmentation of forested habitats can result in species loss due to predation and parasitism, and can reduce the genetic diversity of isolated populations. Birds that dwell in the interior of forests and wide-ranging carnivores such as lynx, wolverine and black bear are particularly affected.

Conservation of large forest patches will become increasingly important as managers anticipate the impacts of climate change. When fragmentation of forests is unavoidable, it is important to maintain connectivity and corridors between the remaining patches.

Analysis: Careful management of forest habitats, including avoidance of disturbance when warranted, can improve overall conditions for target wildlife species. To identify forested habitats of importance for wildlife, CSFS worked with TNC, the Colorado Natural Heritage Program (CNHP) and the CDOW to develop priority habitat data layers for species of concern and economically important species. Both layers then were combined with data on future risk

[43] A complete listing of Colorado's federally listed Threatened and Endangered species is available from the U.S. Fish and Wildlife Service (USFWS) at http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=CO.

of fragmentation to help forest managers identify landscapes in which priority forest habitats are threatened by human development.[44] It is important to note that while each habitat layer identifies areas of importance for wildlife, neither layer, on its own, provides any information about the type or intensity of management activity that may be needed or appropriate for any given wildlife species. Those determinations should be made by land managers using more detailed information about the specific needs of the target species.

Habitat for Imperiled Species

The first wildlife habitat layer identifies forest landscapes that represent or significantly contribute to viable habitats for focal conservation species (e.g., Threatened and Endangered species, state species of concern or keystone species that are representative of a healthy ecosystem). Emphasis was on areas of high species richness or endemism, and areas that are essential to the survival of a highly imperiled species. The key components[45] of the analysis are Tier 1 and Tier 2 species from the Colorado Wildlife Action Plan that rely on forests for primary habitat.

The Comprehensive Wildlife Conservation Strategy planning process resulted in a list of 210 Species of Greatest Conservation Need for Colorado. In order to help direct the future conservation efforts of the Colorado Division of Wildlife and its partners, this list has been prioritized using a two-tier system. Eight criteria were used to draft the initial list of Tier I species.

1. Knowledge of management techniques necessary for recovery
2. Impacts on federal recovery
3. Cost of recovery or management action implementation
4. Direct cost of recovery action to others
5. Public appeal or interest in the species
6. Economic impacts of listing (cost incurred by listing)
7. Importance to state biological diversity
8. Multiple species benefits from management of target species

Fifty-two Species of Greatest Conservation Need were identified as Tier 1 species using these criteria. In addition, all federally listed species and species identified by experts during the science forums as “of most concern” were added to the Tier 1 list for a total of 107 Tier 1 species. The remaining 103 Species of Greatest Need were placed in Tier 2.

What primarily separates Tier 1 from Tier 2 species is the species’ status in a declining trend as designated by federal or state listing designation, our perceived ability to effectively implement conservation/recovery actions on the ground, and our ability to contribute to a meaningful change in federal status through actions in Colorado. Tier 2 species remain important in light of forestalling population trends or habitat conditions that may lead to a Threatened or Endangered listing status, but the urgency of such action in the face of limited personnel and funding was determined to be less significant. When planning future conservation work, these tier rankings should be considered along with other important factors, including ability to impact,

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[44] This fragmentation analysis is partially based on a measure of the human modification of cover, which goes beyond the change in housing density to include the general transportation and utility infrastructure necessary for residential development. See Appendix B at http://csfs.colostate.edu/pages/statewide-forest-assessment.html for a more detailed explanation of this analysis.

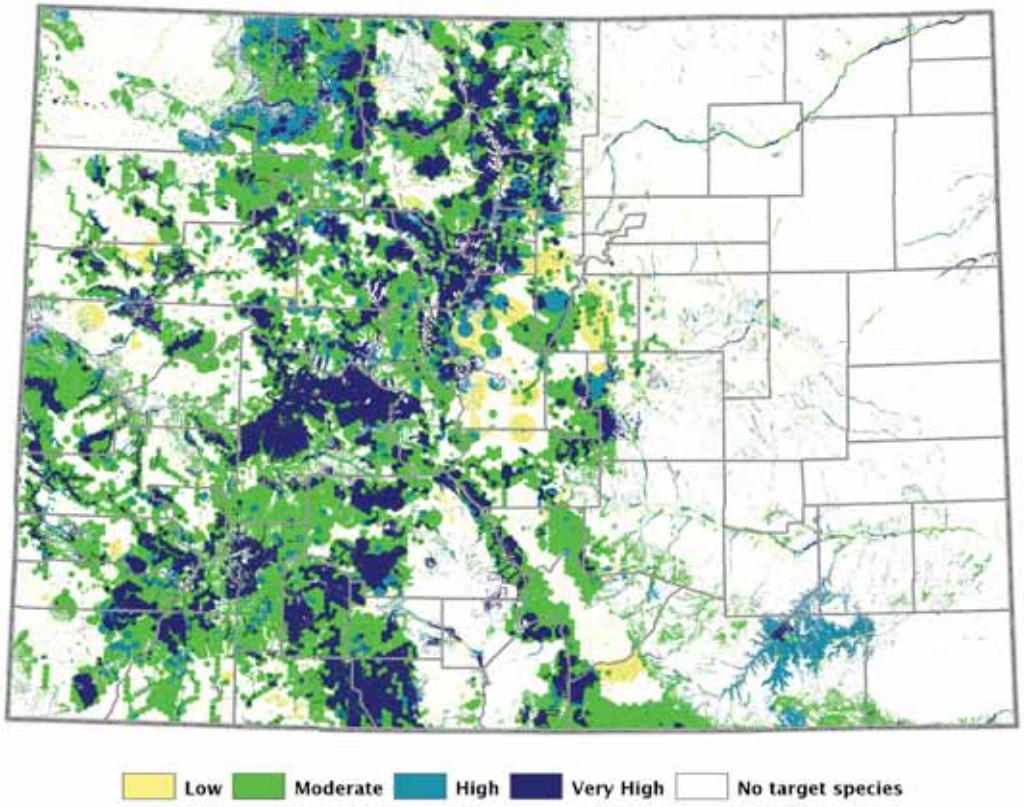
[45] See Appendix B at http://csfs.colostate.edu/pages/statewide-forest-assessment.html for a complete listing of the species incorporated in this analysis.

potential funding and partnership opportunities, and responsiveness to "one-time-only" opportunities. The following actions for many species already have been identified in associated recovery or conservation plans.

- Twenty of Colorado's rarest plants that are associated exclusively with forested habitats
- Riparian forest plant communities
- CNHP Potential Conservation Areas containing at least 50 percent forest
- TNC priority landscapes associated with forests

The resulting layer shows 7.7 million acres of forest land that are of high to very high importance for Colorado's imperiled wildlife. Of these acres, the majority are in spruce-fir (2.2 million) and aspen (1.8 million) forest types, followed by piñon-juniper and lodgepole pine at approximately 820,000 acres each. The USFS has responsibility for 60 percent (4.6 million acres) of these high-priority acres, but private landowners also play a significant role with 23 percent (1.7 million acres).

When combined with data showing areas projected to be significantly impacted by future human development and modification, the resulting layer reveals 2.5 million acres of highly ranked habitat for imperiled wildlife species that also is highly threatened by fragmentation.



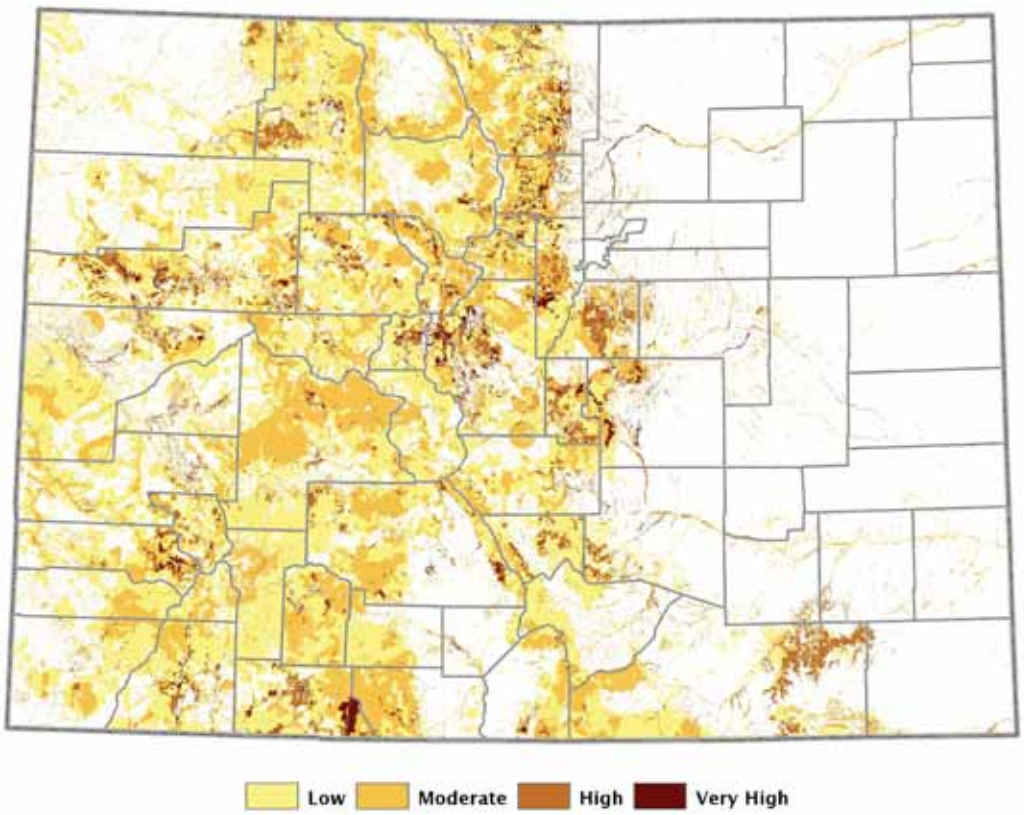
Map 23 – Important Habitat for Imperiled Species

Forest Type	Low	Moderate	High	Very High	Total
Spruce-Fir	46,604	2,018,400	383,438	1,817,992	**4,266,433**
Lodgepole	43,360	637,922	177,765	642,713	**1,501,760**
Aspen	135,143	2,074,379	467,967	1,353,562	**4,031,051**
Mixed Conifer	95,295	770,657	134,765	350,907	**1,351,624**
Ponderosa Pine	225,377	891,312	237,388	313,970	**1,668,048**
Montane Riparian	101,897	256,247	157,817	226,242	**742,203**
Piñon-Juniper	150,521	1,766,044	404,896	413,999	**2,735,460**
Oak Shrubland	145,878	776,721	273,538	243,071	**1,439,208**
Plains Riparian	61,562	53,869	64,313	38,930	**218,673**
Introduced Riparian	13,225	23,546	25,461	22,683	**84,915**
Total	**1,018,861**	**9,269,097**	**2,327,347**	**5,424,070**	**18,039,375**

Table 23a – Important Habitat for Imperiled Species by Forest Type (acres)

Owner	Low	Moderate	High	Very High	Total
USFS	256,453	4,567,501	1,050,313	3,608,759	**9,483,026**
BLM	118,965	1,515,576	274,199	514,479	**2,423,219**
NPS	5,998	111,901	20,712	157,840	**296,451**
USFWS	2,026	3,769	3,830	1,970	**11,594**
DOD	2,071	19,924	19,045	7,067	**48,107**
Federal-Other	299	4,362	2,004	1,835	**8,499**
State	30,723	229,031	79,242	121,785	**460,781**
Tribe	12,078	106,880	8,646	20,828	**148,432**
Local Govt.	18,868	43,385	21,716	62,312	**146,282**
Private	571,251	2,664,427	847,222	927,016	**5,009,916**
Total	**1,018,732**	**9,266,756**	**2,326,928**	**5,423,891**	**18,036,308**

Table 23b – Important Habitat for Imperiled Species by Ownership (acres)



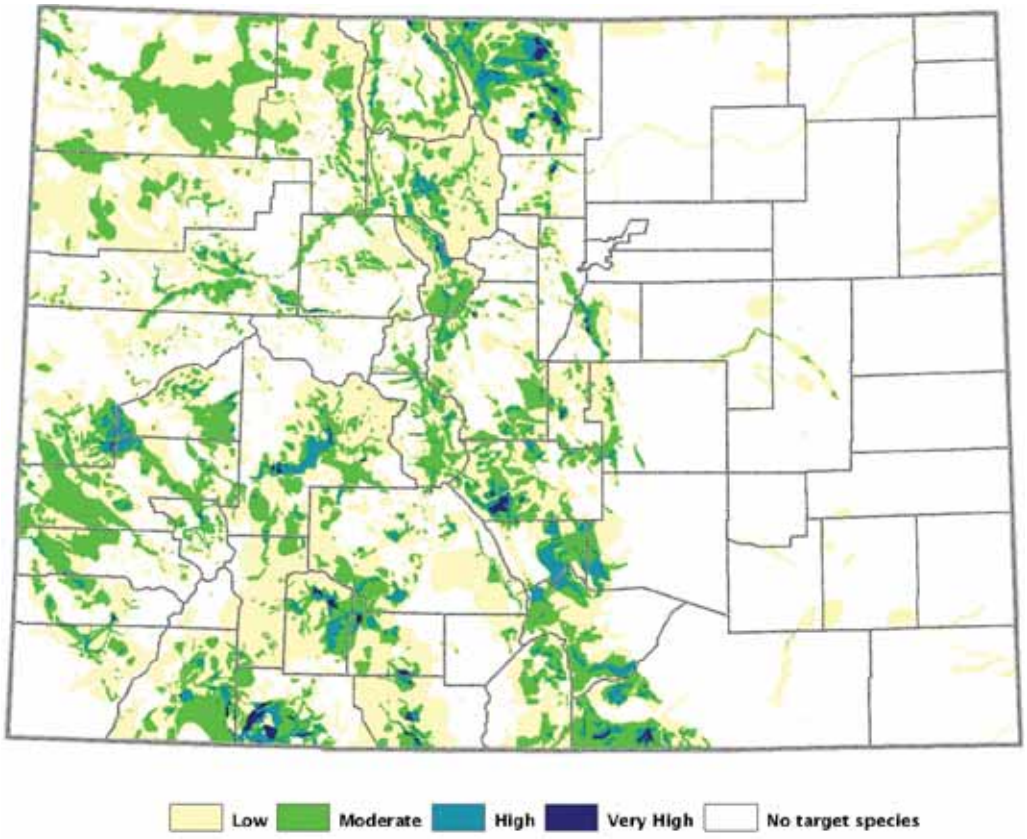
Map 24 – Habitat for Imperiled Species with Risk from Fragmentation (Human Modification)

ACRES	*Change in Impact of Human Modification 2000 to 2030*				
Wildlife Habitat	**Low**	**Moderate**	**High**	**Very High**	**Total**
Low	2,635	132,261	193,873	288,971	**617,740**
Moderate	13,764	723,818	597,594	612,593	**1,947,769**
High	4,940	574,870	163,004	229,741	**972,556**
Very High	7,686	189,427	220,618	201,784	**619,515**
Total	**29,024**	**1,620,376**	**1,175,090**	**1,333,090**	**4,157,579**

Table 24 –Threat from Human Modification to Habitat for Imperiled Species (acres)

Habitat for Economically Important Species

The second wildlife habitat layer focuses on forested landscapes that are significant during some or all of the lifecycle of economically important wildlife species as identified by the CDOW. These species are black bear, bighorn sheep, elk, moose, mule deer and turkey. Gold medal trout streams also were included. For each species, TNC worked with the CDOW to select the portions of the species' habitat or lifecycle specifically tied to forests. With moose, for example, migration corridors, production areas, winter concentration areas and severe winter range were identified. Using this information, a data layer was created for each target species. These layers then were combined to produce a species richness layer indicating forested habitats significant to multiple economically important species.



Map 25 – Important Habitat for Economically Significant Species

The resulting layer shows 1.2 million forested acres that are of high and very high importance to economically significant wildlife species. Of these acres, the majority are in piñon-juniper, ponderosa pine and aspen forests. Private landowners control a slight majority of these acres (488,951 or 40 percent), followed by the USFS (440,169 or 37 percent).

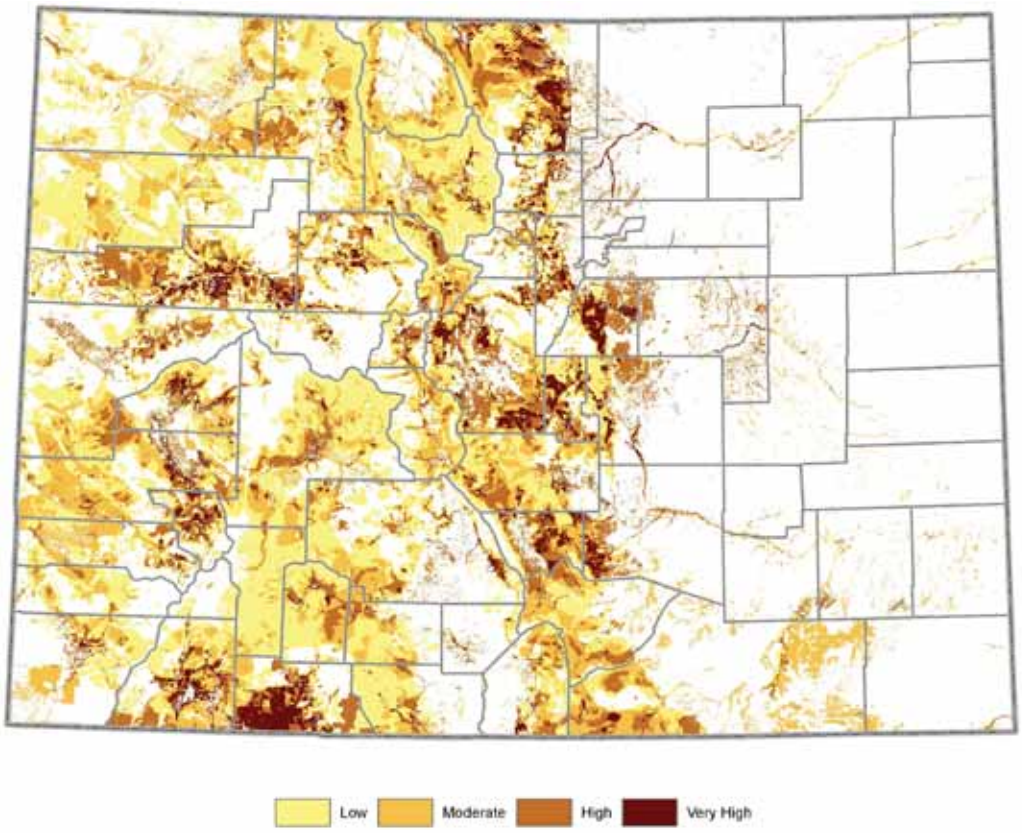
When combined with data showing areas projected to be significantly impacted by future human development and modification, the resulting layer reveals 391,023 acres of priority habitat for economically important wildlife species that is highly threatened by fragmentation.

Forest Type	Low	Moderate	High	Very High	Total
Spruce-Fir	2,079,709	559,400	77,744	928	**2,717,782**
Lodgepole	839,315	364,578	90,789	1,884	**4,014,347**
Aspen	2,062,317	996,044	171,876	10,003	**4,536,806**
Mixed Conifer	654,052	500,664	135,122	13,080	**4,543,159**
Ponderosa Pine	828,932	608,156	241,289	36,087	**3,017,383**
Montane Riparian	341,929	199,741	48,211	5,104	**2,309,448**
Piñon-Juniper	1,755,310	1,303,690	289,734	42,631	**3,986,349**
Oak Shrubland	901,184	413,702	66,843	4,221	**4,777,314**
Plains Riparian	82,105	13,348	3,431	23	**1,484,858**
Introduced Riparian	33,997	16,118	2,272	59	**151,353**
Total	**9,578,850**	**4,975,441**	**1,127,310**	**114,021**	**15,795,622**

Table 25a – Habitat for Economically Important Species by Forest Type (acres)

Owner	Low	Moderate	High	Very High	Total
USFS	4,773,364	1,932,479	406,286	33,883	**7,146,012**
BLM	1,702,093	966,270	161,229	10,459	**2,840,051**
NPS	157,377	32,551	3,967	31	**193,925**
USFWS	4,376	506	2,989	-	**7,871**
DOD	12,861	10,084	3,429	45	**26,419**
Federal-Other	4,601	679	72	-	**5,352**
State	226,126	159,459	56,941	14,175	**456,701**
Tribal	81,619	72,243	33,988	14,373	**202,223**
Local Govt.	64,171	31,548	8,832	1,647	**106,197**
Private	2,552,000	1,769,463	449,546	39,405	**4,810,413**
Total	**9,578,589**	**4,975,281**	**1,127,279**	**114,017**	**15,795,166**

Table 25b – Habitat for Economically Important Species by Ownership/Management (acres)



Map 26 – Important Habitat for Economically Significant Species

ACRES	*Change in Impact of Human Modification - 2000 to 2030*				
Imp. Habitat for Econ. Imp. Species	**Low**	**Moderate**	**High**	**Very High**	**Total**
Low	18,431	1,000,094	891,036	726,035	**2,635,597**
Moderate	15,709	403,833	442,631	491,317	**1,353,490**
High	3,680	53,504	150,523	139,664	**347,372**
Very High	169	3,228	25,848	14,405	**43,651**
Total	**37,990**	**1,460,659**	**1,510,039**	**1,371,422**	**4,380,110**

Table 26 – Threat from Human Modification to Habitat for Economic Species (acres)

Data Gaps

- Need more consistent data on priority habitat locations for all of Colorado's Species of Greatest Conservation Need associated with forests.
- Need more complete information on forest-related threats to aquatic habitats.

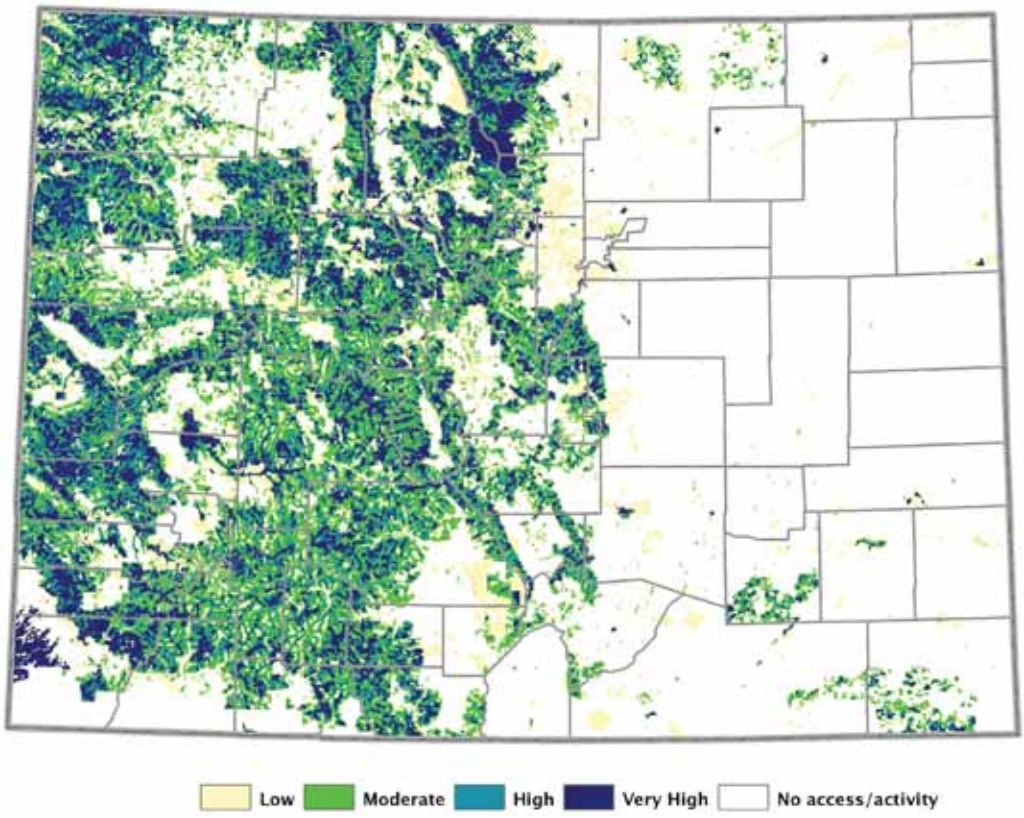
Protect and Enhance Forest-Based Recreation Opportunities

Overview: According to Colorado's 2008 Statewide Comprehensive Outdoor Recreation Plan (SCORP), many of the state's most popular recreation destinations are directly tied to forests. The USFS manages the majority (14.4 million acres) of public lands available for outdoor recreation in Colorado. These national forests receive more visitors (27.1 million) each year than those of any other state in the nation (Jaffe 2009). In addition to providing benefits for health and well-being, forest-based recreation contributes significantly to Colorado's economy. An Outdoor Industry Foundation report for the state suggests that Colorado receives more than $10 billion annually from activities solely associated with "active outdoor recreation" (Babcock and Newman 2008). Skiing, in particular, is big business in the state. Twenty-two ski areas in Colorado are under permit on national forests and experience more than 12 million skier visits annually. Tourism revenue associated with skiing regularly tops $2 billion annually in the state (USFS 2008).

The top five planning issues of concern identified in the 2008 SCORP include forest health, insect infestations and wildfire related to "Environmental Change." Among the potential adverse affects to recreation associated with any decline in Colorado's forest health are:

- diminished scenic value and elevated wildfire risk;
- a decline in hunting related to habitat loss;
- a decline in overnight camping associated with campfire bans, loss of access to some public areas because of wildfires and a decline in the number of areas that provide shade and privacy;
- a decline in scenic touring and park visits associated with impacts from wildfires;
- heightened concerns for public safety related to standing dead and fallen trees; and
- facility closures related to wildfires.

Analysis: Forest management can provide positive benefits for outdoor recreation: it can reduce risks from wildfire and insect and disease infestations; address safety concerns such as hazardous trees; maintain or enhance wildlife and fish habitat; improve recreation facilities and trails; and promote scenic diversity. No statewide assessment of forest-based recreation opportunities currently exists for Colorado. To provide a basis for assessing this forest value, data regarding publicly accessible, forest-based recreation opportunities from a number of entities was collected and combined to produce a map that shows where the greatest density of forest-based recreation opportunities exists across the state. This analysis shows nearly 10 million acres with a high to very high density of forest-based recreation opportunities. The majority of these acres are in spruce-fir, aspen and piñon-juniper forests, with the vast majority under USFS management. It should be noted that this analysis does not incorporate any measure of visitor use, which, if available, would indicate where recreation areas experience the greatest demand.



Map 27 – Density of Forest-Based Recreation Opportunity

Forest Type	Low	Moderate	High	Very High	Total
Spruce-Fir	519,602	1,526,558	1,358,911	1,004,218	**4,409,289**
Lodgepole	233,352	340,973	430,058	577,318	**1,581,701**
Aspen	860,915	1,107,401	1,216,205	1,012,802	**4,197,323**
Mixed Conifer	343,178	363,601	371,825	290,146	**1,368,751**
Ponderosa Pine	546,789	367,818	391,566	365,069	**1,671,242**
Montane Riparian	177,760	117,011	204,689	217,211	**716,671**
Piñon-Juniper	760,013	947,362	1,038,715	895,362	**3,641,452**
Oak Shrubland	528,863	342,902	288,806	208,470	**1,369,041**
Plains Riparian	62,704	3,111	5,339	8,369	**79,524**
Introduced Riparian	32,674	5,403	9,104	13,436	**60,617**
Total	**4,065,850**	**5,122,140**	**5,315,219**	**4,592,401**	**19,095,610**

Table 27a – Density of Recreation Opportunity by Forest Type (acres)

Owner	Low	Moderate	High	Very High	Total
USFS	653,229	3,464,773	3,826,417	3,348,742	**11,293,161**
BLM	305,500	1,564,022	1,376,019	1,000,044	**4,245,586**
NPS	41,549	47,199	86,838	212,727	**388,313**
USFWS	10,661	72	185	21	**10,939**
DOD	1,784	33	3	-	**1,820**
Federal-Other	6,285	443	648	553	**7,929**
State	355,860	4,797	2,933	15,507	**379,097**
Tribal	11,672	131	46	16	**11,864**
Local Govt.	117,746	5,917	5,133	5,515	**134,311**
Private	2,555,472	34,634	16,966	9,258	**2,616,330**
Total	**4,059,760**	**5,122,019**	**5,315,187**	**4,592,384**	**19,089,350**

Table 27b – Density of Recreation Opportunity by Ownership (acres)

Data Gaps

- Need consistent data on forest-based recreation facilities and related opportunities for all ownerships in the state.
- Need consistent data on visitor use, particularly from public agencies and private industry, for forest-based recreation facilities and related opportunities on all ownerships in the state.

Connect People to Trees and Forests through Engagement in Community-Based Environmental Stewardship

Overview: Trees and forests provide much more than beauty and shade to Colorado's cities and towns; they also help improve public health, enhance environmental quality and promote economic sustainability (Alexander).[46] Researchers have found that trees in urban and suburban environments can promote feelings of relaxation and well-being, improve relationships between neighbors, reduce noise pollution and speed recovery from illness. Strategic planting and maintenance of trees also can slow stormwater runoff, reduce air pollution, sequester carbon and trim energy use, all of which provide much

[46] Much of the information contained in this paragraph is adapted from the Colorado Tree Coalition (CTC) website at www.coloradotrees.org.

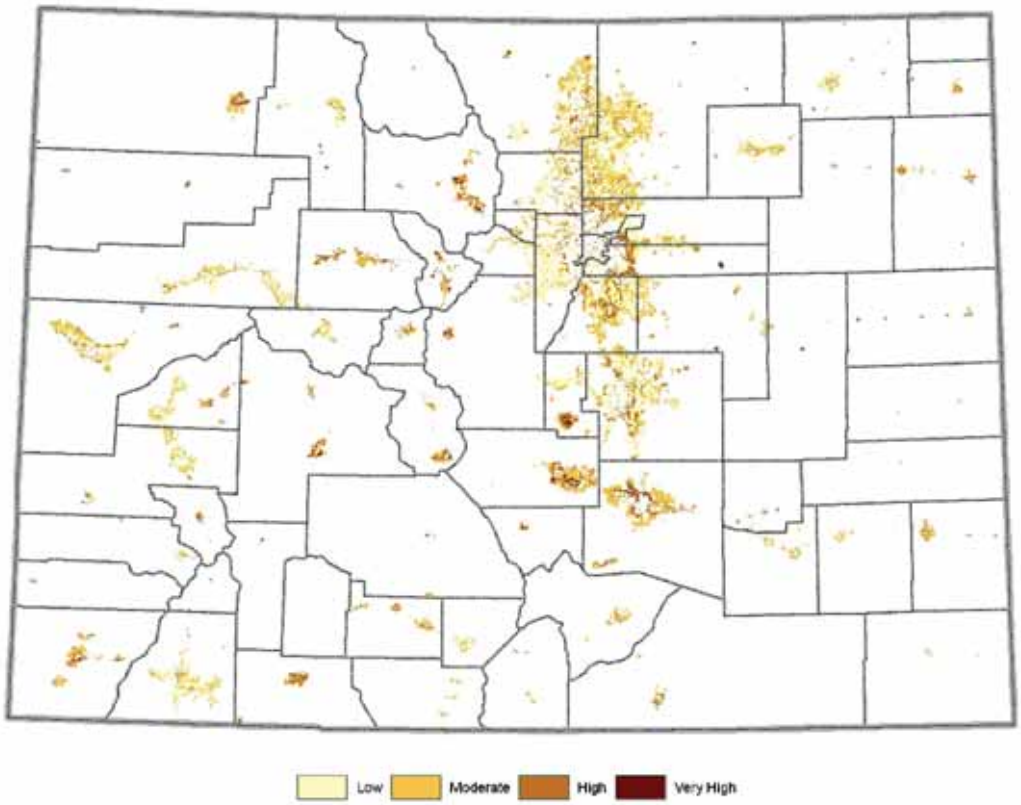
needed cost-savings to local governments. Community trees and forests provide food and cover for myriad birds, squirrels, bats, butterflies and other animals, and they often serve as critical corridors that enable wildlife to safely navigate through developed areas. Trees also support local economies by attracting businesses and tourists, increasing real estate values, improving worker productivity and reducing energy and maintenance costs.

Because of their ability to reduce the environmental impacts of urban growth and improve quality of life, many believe that trees and forests should be considered an essential part of the community's infrastructure – its *green* infrastructure. A number of efforts are underway to help towns and cities quantify these benefits so they can plan for the use and maintenance of trees and forests over the long-term, as they do other infrastructure components. A 2001 examination of the Denver metropolitan area and northern Front Range found that trees provide $3.2 million in annual stormwater management services, facilitate $4.5 million in residential summer energy savings and mitigate 2.2 million pounds of pollutants at a value of $5.3 million per year. Unfortunately, no similar studies are available to quantify this value for the entire state.

One way communities can increase the benefits they receive from their tree and forest resources is by hiring or contracting with trained foresters and/or arborists to assist decision-makers in strategically planting and maintaining community trees. In Colorado, very few communities possess this kind of expertise on staff, nor is it available through private contract; the majority of communities with this capacity exist in the larger metropolitan cities and towns. The CSFS and its partners offer both technical and financial assistance programs to help communities plan and care for their trees and forests.[47] Many of the state's communities are projected to grow significantly by 2030, so it is important that more communities take advantage of these resources to ensure that they are as prepared as possible to mitigate the environmental, social and economic impacts of urban development and growth.

Analysis: To assist the CSFS and its partners in focusing available resources on the communities most in need, subject-matter experts from the CSFS and USFS developed a data layer highlighting Community Forestry Opportunity Areas. The U.S. Geological Survey's Night Lights data set for Colorado was used to identify urban and suburban areas, as well as the community influence zone that surrounds and impacts the health and sustainability of the communities in those areas. The foundation then was overlaid with data on projected housing change between 2000 and 2030 to identify communities that are likely to experience significant growth. This combined layer then was analyzed with a mask indicating which communities currently have paid forestry expertise on staff.

[47] For more information on CSFS programs for urban and community forestry, please see the agency's website at http://csfs.colostate.edu/pages/urban-community-forestry.html.



Map 28 – Community Forestry Opportunity Areas

Forest Type	Low	Moderate	High	Very High	Total
Spruce-Fir	224	399	84	47	**754**
Lodgepole	1,146	1,941	612	125	**3,824**
Aspen	3,229	2,525	966	187	**6,907**
Mixed Conifer	4,055	1,473	317	48	**5,894**
Ponderosa Pine	13,061	4,635	1,278	66	**19,040**
Montane Riparian	1,998	1,149	465	58	**3,670**
Piñon-Juniper	4,069	3,851	1,206	106	**9,233**
Oak Shrubland	5,296	3,464	1,208	51	**10,019**
Plains Riparian	2,057	1,466	610	46	**4,179**
Introduced Riparian	633	607	163	9	**1,412**
Total	**35,769**	**21,509**	**6,909**	**745**	**64,932**

Table 28a – Community Forestry Opportunity Areas by Forest Type (acres)

Capacity	None	Low	Moderate	High	Total
None	1,225,903	457,298	159,627	33,302	**1,876,129**
Existing	1,399,752	1,415,179	597,006	210,349	**3,622,286**
Total	**2,625,655**	**1,872,477**	**756,633**	**243,650**	**5,498,415**

Table 28b – Community Forestry Opportunity Areas with High Projected Growth and Limited Capacity (acres)

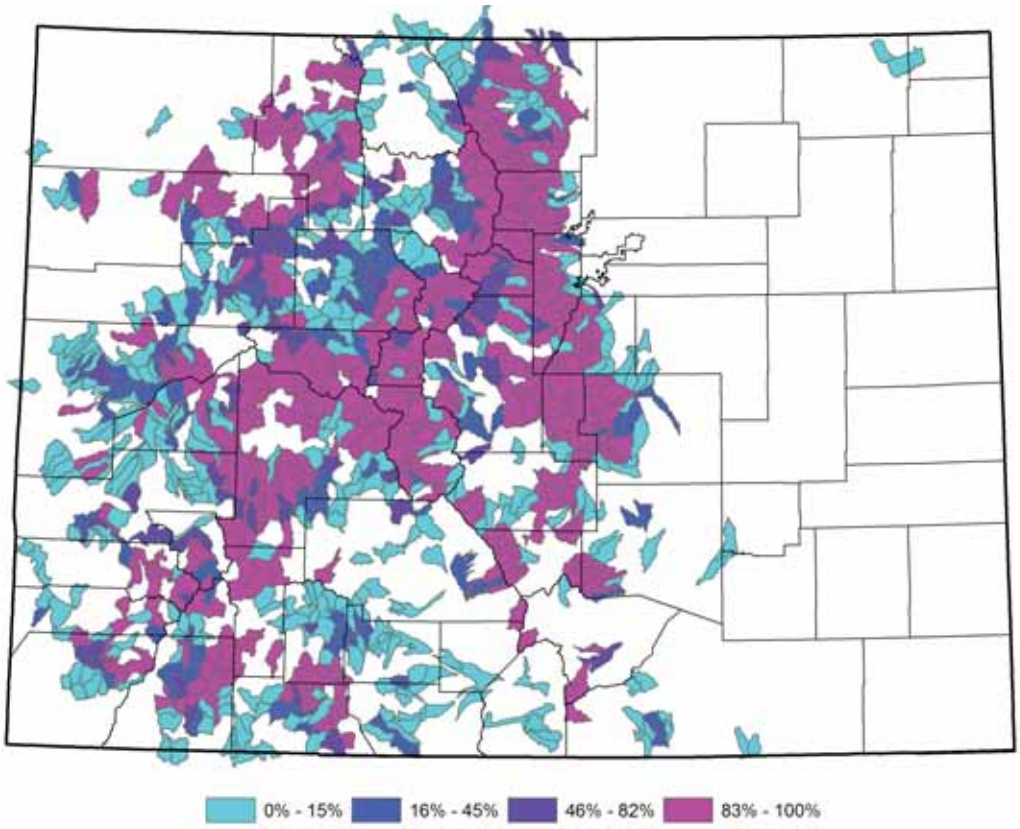
Areas with high potential for growth but no capacity to address the resulting forestry and other environmental impacts were ranked the highest in the final analysis. This final layer reveals at least 650,000 acres with some opportunity for investment in community forestry; 30 percent of these acres are in the moderate and high categories for projected growth. As would be expected, virtually all of these acres are in private ownership. Where opportunity areas overlap with traditional forest types, forests tend to be lower-elevation types such as ponderosa pine, oak shrubland and piñon-juniper. It also is important to note that a significant portion of these acres consist of a more urban mix of native and ornamental tree species that does not fit into the forest vegetation scheme used throughout this assessment.

Data Gaps

- Need a clear definition of and spatial data on the location and extent of what constitutes a “community” for the purposes of this analysis.
- Need a statewide inventory of urban and community forests to provide information on the quality, extent and threats associated with these forests.
- Need a statewide analysis to quantify the environmental benefits provided by urban and community forests.

Enhance Public Benefits from Trees and Forests: Combined Theme Map

Five of the data sets in this section, including, potential for post-fire erosion in watersheds of importance for drinking water, habitat for imperiled wildlife species, habitat for economically important wildlife species, density of recreation opportunity and wildland-urban interface were combined and weighted to produce the final map.



Map 29 – Enhance Public Benefits from Trees and Forests: Combined Theme Map

Data Set Layer	Layer Weight Percent
Potential for post-fire erosion in watersheds of importance for drinking water	42%
Habitat for imperiled wildlife species	18%
Habitat for economically important wildlife species	10%
Density of recreation opportunity	8%
Wildland-urban interface	22%

V. Priority Landscapes/Emphasis Areas for Colorado

The Colorado State Forest Service used 11 data layers and combined them according to the three national themes. The following four pages display the theme maps. The percentages following each data layer represent the weight applied to the layer.

For ***Conserve Working Forest Landscapes***, we combined three data layers, including Colorado Forest Legacy areas (44 percent), Colorado spatial analysis project (34 percent) and projected change in degree of human modification (22 percent).

For the ***Protect Forests from Harm*** map, we used wildfire susceptibility index (33 percent), wildfire intensity index (40 percent), and insect and disease mitigation potential (27 percent).

Data used in the ***Enhance Public Benefits from Trees and Forests*** included potential for post-fire erosion risk in watersheds of importance for drinking water (42 percent), habitat for imperiled species (18 percent), habitat for economically important species (10 percent), density of recreation opportunity (8 percent) and wildland-urban interface (22 percent).

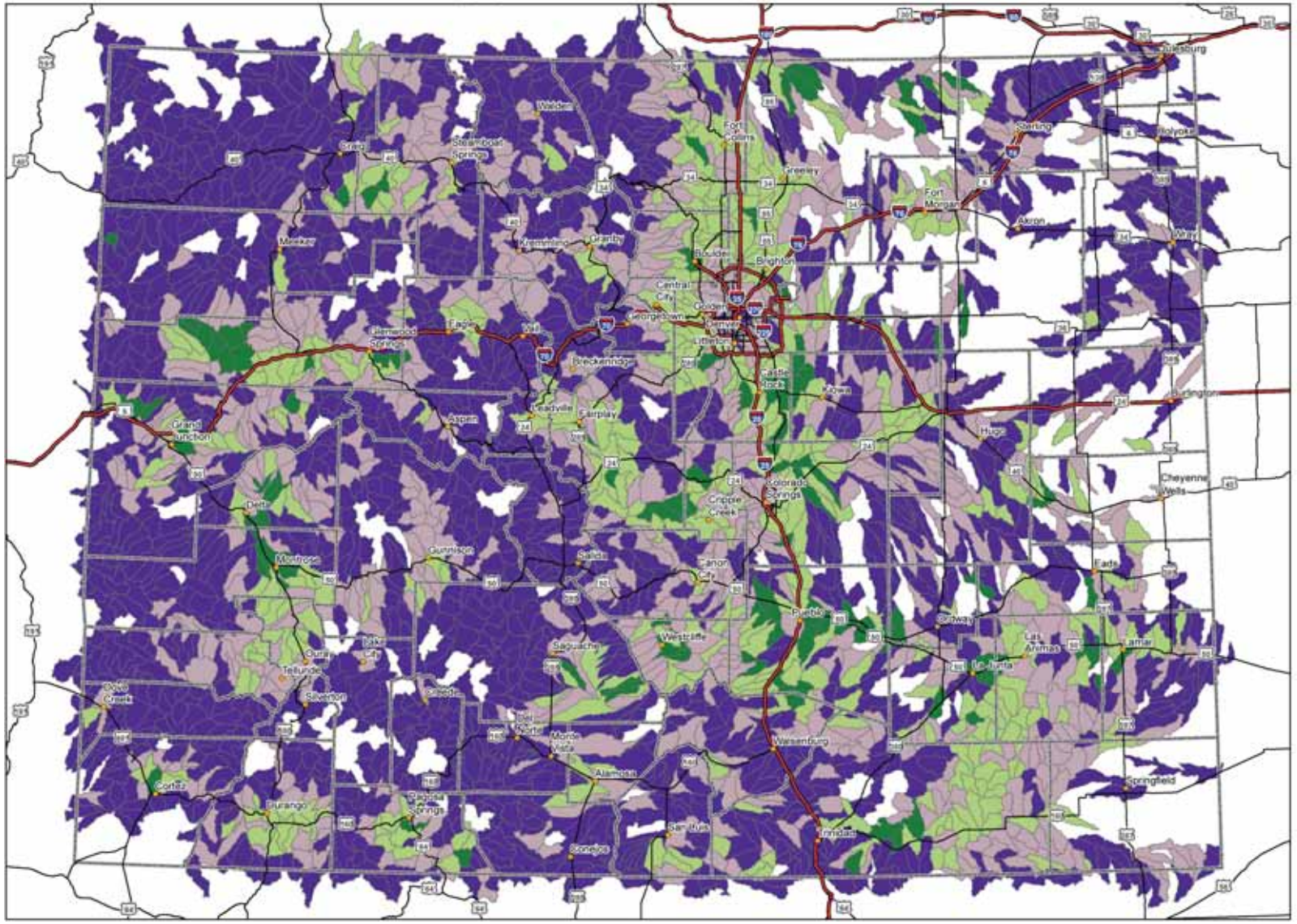
The fourth map is an aggregate of all theme inputs, which were equally weighted.

USFS national guidance allowed flexibility for states to determine the appropriate data to use and the proper method to combine the data to identify their important forest landscapes. Potentially unlimited numbers of approaches exist to combine the data. The CSFS chose this data combination method for Colorado, as we believe it best represents the three national themes.

We look forward to improving the process and the results as new data become available. The CSFS will maintain this assessment as a living document, which will allow us to incorporate new information and make that data easily accessible on our website at http://csfs.colostate.edu.

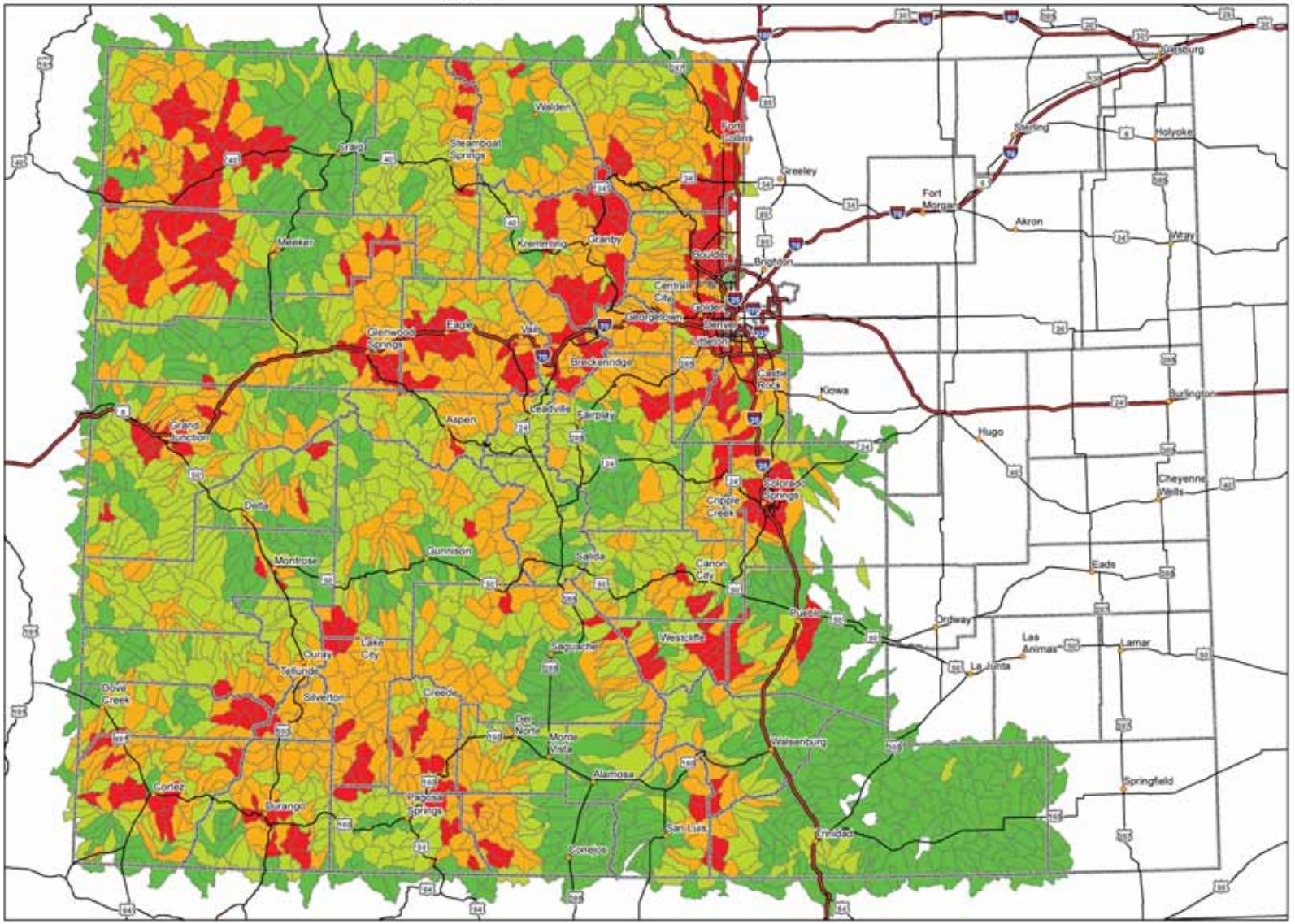
Theme - Conserve Working Forest Lands - Percent High Value in Forest

Aggregated to HUC 12 (6th Level) Watersheds



Theme - Protect Forests from Harm - Percent High Value in Forest

Aggregated to HUC 12 (6th Level) Watersheds



Methods: High and very high values were extracted from the final weighted grid. These values then were summarized by watershed to determine high value acres by watershed. High value acres then were divided by the total forested acres to determine percentage of forested area in the watershed that was high value. Legend is created using natural breaks.

Legend

Aggregation Unit HUC12

Protect - % Forest High Value

- 0.0 - 15.7
- 15.8 - 32.9
- 33.0 - 51.4
- 51.5 - 90.7
- None, No Data, or Not Included
- Cities
- Colorado Counties

Highways

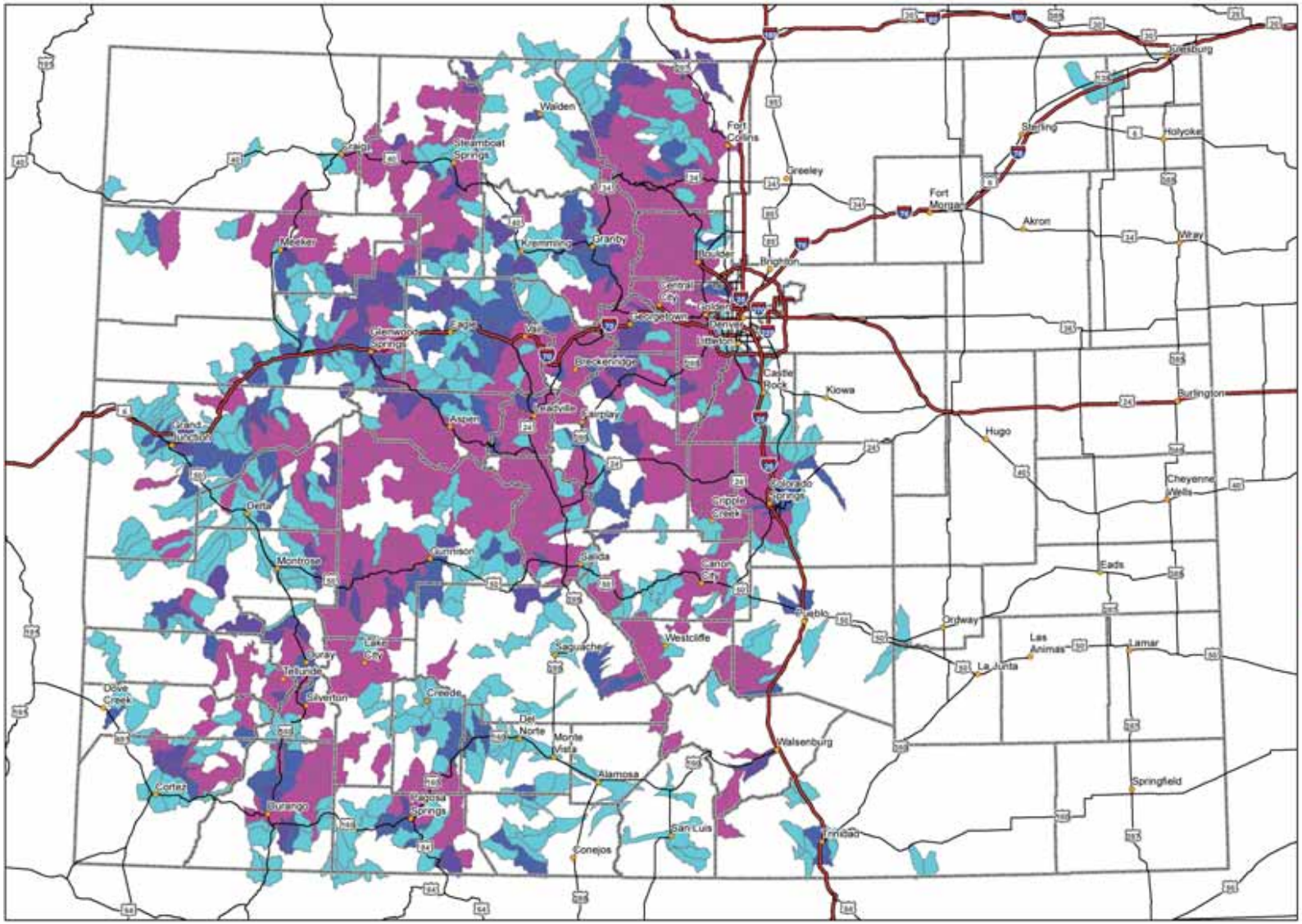
- Primary Limited Access or Interstate
- Primary US and State Highways

N

0 10 20 40 Miles

Theme - Enhance Benefits from Trees and Forests - Percent High Value in Forest

Aggregated to HUC 12 (6th Level) Watersheds



Methods: High and very high values were extracted from the final weighted grid. These values then were summarized by watershed to determine high value acres by watershed. High value acres then were divided by the total forested acres to determine percentage of forested area in the watershed that was high value. Legend is created using natural breaks.

Legend

Aggregation Unit HUC12

Enhance - % Forest High Value

- 0.0 - 15.0
- 15.1 - 44.9
- 45.0 - 81.9
- 82.0 - 108.3
- None, No Data, or Not Included
- Cities
- Colorado Counties

Highways

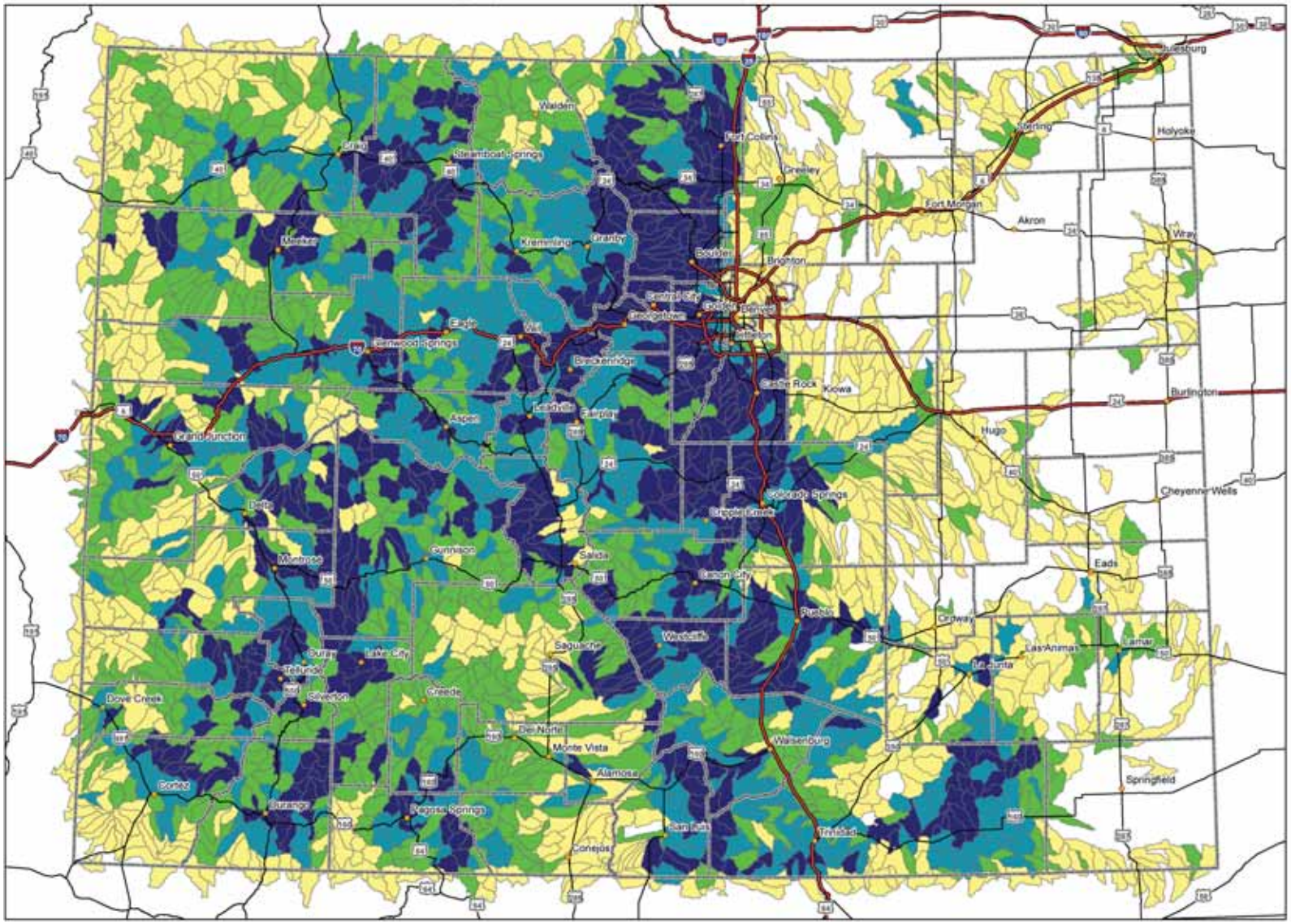
- Primary Limited Access or Interstate
- Primary US and State Highways

N

0 10 20 40 Miles

Final - Input Themes Weighted Equally - Percent High Value in Forest

Aggregated to HUC 12 (6th Level) Watersheds



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VII. Statewide Assessment Steering Team and Other Participants

Statewide Assessment Steering Team

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Jenny Briggs, *U.S. Geological Survey*
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Cheri Ford, *U.S. Forest Service*
Claire Harper, *U.S. Forest Service*
Merrill Kaufmann, *The Nature Conservancy* and *U.S. Forest Service (retired)*
Brian Kent, *U.S. Forest Service Rocky Mountain Research Station*
Jeff Kitchens, *Bureau of Land Management*
Jan Koenig, *The Nature Conservancy*
Damon Lange, *Colorado State Forest Service*
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Angie Gee, *U.S. Forest Service* (fire risk)
Marla Downing, *U.S. Forest Service* (insect and disease)
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Leslie Ellwood, *U.S. Fish and Wildlife Service* (wildlife)
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Tom Veblen, *University of Colorado—Boulder* (ecology)
Lane Wyatt, *Northwest Colorado Council of Governments* (water)

VIII. Listing of Outreach Presentations and Workshops

Assessment Steering Team (7/14/08, 10/30/08, 11/10/08, 12/9/08, 2/12/09, 5/21/09)

CFRI Collaboration Workshop (4/23/09)

Colorado Forest Health Advisory Council (3/24/08, 12/16/08, 3/20/09, 6/23/09, 9/28/09, 12/11/09)

Colorado Forestry Association (5/2/09)

Colorado Natural Resources Group (1/21/09)

Colorado State Forest Service Field Staff (6/15/09)

Colorado State Forest Stewardship Committee (2/17/09)

Colorado State Technical Committee (3/3/09, 10/15/09)

Front Range Fuels Treatment Partnership Roundtable (2/6/09)

Front Range Watershed Wildfire Protection Working Group (1/14/09)

Northern Front Range Mountain Pine Beetle Working Group (4/7/09)

USFS Regional Forester & Staff (5/26/09)

Southern Ute Tribe (1/5/09, 12/3/09)

Ute Mountain Ute Tribe (2/10/09, 12/3/09)

Farm Bill Requirement & Redesign Components:
STATE ASSESSMENTS & RESOURCE STRATEGIES
Final Guidance

State assessments and resource strategies are integral to the State and Private Forestry (S&PF) Redesign and required as an amendment to the Cooperative Forestry Assistance Act (CFAA), as enacted in the 2008 Farm Bill. This document provides national guidance to States to develop their state assessments and resource strategies.

There are three components to the assessment and planning required by the State and Private Forestry (S&PF) Redesign approach to identify priority forest landscape areas and highlight work needed to address national, regional, and state forest management priorities:

- **State-wide Assessment of Forest Resources**[1]—provides an analysis of forest conditions and trends in the state and delineates priority rural and urban forest landscape areas.
- **State-wide Forest Resource Strategy**[2]—provides long-term strategies for investing state, federal, and other resources to manage priority landscapes identified in the assessment, focusing where federal investment can most effectively stimulate or leverage desired action and engage multiple partners.
- **Annual Report on Use of Funds**[3]—describes how S&PF funds were used to address the assessment and strategy, including the leveraging of funding and resources through partnerships, for any given fiscal year.

Each State is required to complete a State Assessment and Resource Strategy within two years after enactment of the 2008 Farm Bill (June 18, 2008) to receive funds under CFAA.

State-wide Assessment of Forest Resources

To ensure that federal and state resources are being focused on important landscape areas with the greatest opportunity to address shared management priorities and achieve measurable outcomes, each state and territory will work collaboratively with key partners and stakeholders to develop a statewide forest

[1] Previously titled "State Forest Resource Assessment". The title was changed to reflect Farm Bill terminology
[2] Previously titled "State Response Plan". The title was changed to reflect Farm Bill terminology
[3] Previously titled "Annual Action Strategy". The title was changed to reflect Farm Bill terminology

resource assessment. The state forest resource assessment should provide a comprehensive analysis of the forest-related conditions, trends, threats, and opportunities within the state.

At a minimum, state forest resource assessments will:

- Provide an analysis of present and future forest conditions, trends, and threats on all ownerships in the state using publicly available information.
- Identify forest related threats, benefits, and services consistent with the S&PF Redesign national themes.
- Delineate priority rural and urban forest landscape areas to be addressed by the state resource strategy. States can also identify linkages between terrestrial and aquatic habitat, as appropriate.
- Work with neighboring States and governments to identify any multi-state areas that are a regional priority.
- Incorporate existing statewide plans including Wildlife Action Plans, Community Wildfire Protection Plans, and address existing S&PF program planning requirements. States can also utilize relevant national and regional assessments as appropriate.

A combination of qualitative, quantitative, and geospatial data can be used in the statewide assessment to provide information relevant to key state issues and national themes. In addition, non-geospatial information can be used in combination with geospatial data to identify priorities. States may identify separate priority areas for different programs and issues.

Appendix B contains suggested guidance for identifying state and regional priority forest landscape areas.

State-wide Forest Resource Strategy

A state's forest resource strategy will provide a long-term, comprehensive, coordinated strategy for investing state, federal, and leveraged partner resources to address the management and landscape priorities identified in its assessment. The resource strategy should incorporate existing statewide forest and resource management plans and provide the basis for future program, agency, and partner coordination.

At a minimum, state resource strategies should:

- Outline long-term strategies for addressing priority landscapes identified in the state forest resource assessment and the following national themes and associated management objectives (the intent and policy implications of each of these national objectives are described in Appendix A):
    - ***Conserve Working Forest Lands:*** conserving and managing working forest landscapes for multiple values and uses.

        - Identify and conserve high priority forest ecosystems and landscapes.
        - Actively and sustainably manage forests.
    - ***Protect Forests From Harm:*** protect forests from threats, including catastrophic storms, flooding, insect or disease outbreak, and invasive species.
        - Restore fire-adapted lands and reduce risk of wildfire impacts.
        - Identify, manage and reduce threats to forest and ecosystem health.
    - ***Enhance Public Benefits from Trees and Forests:*** including air and water quality, soil conservation, biological diversity, carbon storage, and forest products, forestry-related jobs, production of renewable energy, and wildlife.
        - Protect and enhance water quality and quantity.
        - Improve air quality and conserve energy.
        - Assist communities in planning for and reducing wildfire risks.
        - Maintain and enhance the economic benefits and values of trees and forests.
        - Protect, conserve, and enhance wildlife and fish habitat.
        - Connect people to trees and forests, and engage them in environmental stewardship activities.
        - Manage and restore trees and forests to mitigate and adapt to global climate change.

- Describe how the state proposes to invest federal funding, along with other resources, to address state, regional, and national forest management priorities.
- Include a long-term timeline for project and program implementation.
- Identify partner and stakeholder involvement.
- Identify strategies for monitoring outcomes within priority forest landscape areas and how action will be revised when needed.
- Describe how the state's proposed activities will accomplish national State and Private Forestry program objectives and respond to specified performance measures and indicators.
- Describe how State and Private Forestry programs will be used to address priority landscape and management objectives.
- Incorporate existing statewide plans including Wildlife Action Plans, community wildfire protection plans, and address existing S&PF program planning requirements.

Annual Report on Use of Funds

The annual report should describe how the State used all S&PF program funding, for any given fiscal year. The annual report should describe specific actions taken within the fiscal year, under each program, to address the state assessment and resource strategy. The annual report should include a comprehensive budget with known contributions from all federal, state, and nongovernmental partners.

Additional Guidance

Coordination and Stakeholder/Public Involvement—State forestry agencies shall coordinate with the State Forest Stewardship Coordinating Committee, State Technical Committee, the State wildlife agency, applicable Federal land management agencies such as the Forest Service and Bureau of Land Management, and State Urban Forestry Council to ensure that assessments and resource strategies address the rural-to-urban landscape continuum and identify opportunities for program coordination and integration. State forestry agencies should also involve other key partners, including Tribes and natural resource and related entities in their state to ensure that the state's assessment and strategy integrate, build upon, and complement other natural resource plans (e.g., State Wildlife Plans). This input is not necessary for the annual report.

In states where the lead agency for the Forest Legacy Program (FLP), or other CFAA program, is not the state forestry agency, state assessments should be developed in partnership with the state lead agency. In addition, the FLP section or other relevant sections, of the resource strategy should be developed by the state lead agency, even if it is not the state forestry agency and include all program-specific requirements.

Timeline and Updates—State forest resource assessments and resource strategies are to be completed no later than two years after enactment of the 2008 Farm Bill (June 18, 2008). Assessments and strategies shall be reviewed and updated at least every five years, or as determined by the Secretary of Agriculture. Annual reports for a given fiscal year must be developed and submitted by the end of the first quarter of the next federal fiscal year.

Approval Process—State resource assessments and resource strategies will be approved by the State Forester, with final approval by the Secretary of Agriculture. Once approved by the Secretary, the State-wide assessment and State-wide resource strategy shall satisfy all relevant S&PF planning and assessment requirements. The annual report should be submitted through the Forest Region or Area, to the S&PF Deputy Chief.

In states where the lead agency for the Forest Legacy Program (FLP) is not the state forestry agency, the state lead agency shall concur on all aspects of

assessments and resource strategies that pertain to the Forest Legacy Program, including the identification of Forest Legacy Areas. If the state assessment incorporates a state's Forest Legacy Assessment of Need, the approval process is that which is required for the Forest Legacy Program.

Grant Narrative—States are encouraged to use a single annual grant narrative, which outlines actions to address the state assessment and resource strategy, for all S&PF programs that are authorized to receive funding under a consolidated grant option.

Forest Service Support—Each geographic region and the islands shall have an S&PF point of contact to assist states with development of assessments and resource strategies and to coordinate with Forest Service program staff.

National Themes and Strategic Objectives

This document describes the national strategic objectives that tier to the three Redesign themes. The descriptions include suggestions on how states may address the objectives in their assessments and resource strategies. There is also a list of potential data layers that could be used in the assessments for addressing each objective. States will likely have unique state or regional issues that may also be addressed in their assessments and strategies.

National Theme: Conserve Working Forest Lands

Identify and conserve high priority forest ecosystems and landscapes.

In many parts of the United States, forests and other open space are being fragmented and converted to development. Forestry agencies can work with partners, stakeholders and communities to identify and protect priority forest landscapes through land acquisition, conservation easements, and land use policies. Forestry agencies can also provide technical assistance to communities to help them strategically plan for and conserve forests and other open space.

Factors contributing to loss include residential, commercial and industrial development; expansion of utility infrastructure and transportation networks; and planning, zoning, and policies that favor conversion. Consequences include the outright loss of public benefits associated with forests or the marginalization of those values provided by contiguous forested landscapes. Fragmentation also includes "parcelization," or the fracturing of large singular ownerships into numerous smaller ones.

Assessments and strategies should attempt to identify, protect and connect ecologically important forest landscapes, and open space, thus maintaining a green infrastructure, particularly around and within areas of, population growth and development.

Potential data layers: Green infrastructure composite, protected areas, including Forest Legacy Areas, open space conservation plans, community forests, development risk, forest fragmentation, roads and other infrastructure.

Actively and sustainably manage forests.

Forestry agencies and partners can provide landowner assistance and incentives to help keep working forests working. Providing forestry assistance to landowners can improve the economics of, and encourage sustainable forest management. In urban and suburban areas, forest agencies can assist communities to develop sustainable forest management and green infrastructure programs.

Assessments and strategies can identify viable and high potential working forest landscape where landowner assistance programs, such as Forest Stewardship can be targeted to yield the most benefit in terms of economic opportunities and ecosystem services. Assessment and strategies can also identify opportunities for multi-landowner, landscape scale planning and landowner aggregation for access to emerging ecosystem service markets.

Potential data layers: Spatial Analysis Project (high potential for Forest Stewardship), forest cover

National Theme: Protect Forests from Harm

Restore fire-adapted lands and reduce risk of wildfire impacts.

The strategic management of wildfires is crucial to the health of our nation's forests, the safety of our citizens and the contributions of forests to our economy. Assessments should identify areas where management can significantly reduce the risk of catastrophic wildfire while enhancing multiple associated forest values and services.

Many forest ecosystems are dependent on fire for their health and sustainability. Decades of fire suppression and a changing climate have disrupted natural fire regimes, resulting in fuel buildup, loss of biological diversity, changed species composition, and loss of some fire-dependent species. Assessments should identify areas where these effects of fire exclusion can feasibly be mitigated or countered through sound management, particularly where there are opportunities for federal, state and community partnerships. Resource strategies should identify appropriate treatment strategies for priority landscapes, including the use of fire as a management tool.

Potential data layers: Wildfire risk

Identify, manage and reduce threats to forest and ecosystem health.

A healthy forest landscape has the capacity for renewal and for recovery from a wide range of disturbances, while continuing to provide public benefits and ecosystem services. Threats to forest health include insects, disease, invasive plant and animal species, air pollution, and climate change.

Assessments should identify high value forest landscape areas that are especially vulnerable to existing or potential, forest health risk factors, where forest management practices are most likely to prevent and mitigate impacts. Assessments should also identify areas where management could successfully restore impacted forests.

Resource strategies should include feasible long term strategies for addressing forest health risks and opportunities within important forest landscape areas.

Potential data layers: Forest health risk

National Theme: Enhance Public Benefits from Trees and Forests

Protect and enhance water quality and quantity.

Forests and forestry practices can help protect, restore, and sustain water quality, water flows, and watershed health. Healthy urban and rural forested watersheds absorb rainfall and snow melt, slow storm runoff, recharge aquifers, sustain stream flows, and filter pollutants.

Assessments should identify watersheds where continued forest conservation and management is important to the future supply of clean municipal drinking water, or where restoration or protection activities will improve or restore a critical water source. Resource strategies should include actions for managing and conserving these priority watersheds for water quality and supply, and other ecosystem services.

Potential data layers: Priority watersheds, water quantity and quality by source, drinking water

Improve air quality and conserve energy.
Urban and exurban forest cover, including agroforests can improve air quality, reduce energy consumption and produce biomass for energy production. Assessments should identify areas where management or restoration of the urban or exurban forest canopy will have significantly positive and measurable impact on air quality and produce substantial energy savings. **Potential data layers:** Impervious surfaces, heat islands, population density, non-attainment areas, canopy cover, ozone concentration

Assist communities in planning for and reducing wildfire risks.
Communities play an essential role in reducing the risks of catastrophic wildfire. State & Private Forestry programs assist communities in identifying wildfire risks, developing Community Wildfire Protection Plans (CWPPs), and promoting FIREWISE and other risk reducing policies and actions. . Some communities are especially prone to loss of life and property from wildfire. Local or state laws, regulations and ordinances, landowner attitudes and priorities, and public policies all play important roles in managing fire risk near communities. Assessments should identify communities where State and Private programs can substantially mitigate the risk of catastrophic wildfire occurrence and associated risks to human safety and property. Assessments should incorporate existing CWPPs and identify communities in especially vulnerable areas that need a CWPP. Resource strategies should include a plan for effectively addressing those communities that are most at risk. **Potential data layers:** Wildland-urban interface, Existing CWPPs, fire potential

Maintain and enhance the economic benefits and values of trees and forests.
Assessments should identify forest landscape areas where there is a real, near term potential to access and supply traditional, non-timber, and/or emerging markets such as those for biomass or ecosystem services. These might be areas where necessary infrastructure currently exists, is planned or developing, where group certification of landowners has created market supply aggregation potential, or where retention and management of forest cover presents a money saving alternative to an engineered fix – such as a water filtration facility. Strengthening and developing new market opportunities for forest products and benefits provide incentives for forest stewardship and conservation. **Potential data layers:** Biomass potential, site productivity, existing or planned mills and other forestry infrastructure, Biomass energy facilities, CROP areas, municipal water supply intakes

Protect, conserve, and enhance wildlife and fish habitat.
Protection, conservation, and restoration of forested wildlife habitat are critical to maintaining and enhancing the rich biodiversity of our nation. Major threats to fish and wildlife habitat include the patchwork of public-private ownership, threats associated with urbanization, and uncharacteristic wildfire. Assessments and resource strategies should identify forest landscapes that represent or contribute to viable wildlife habitats (contiguous or connected), contain high species richness, endemism, and/or that represent core habitat for focal conservation species (i.e. species of concern, threatened and endangered species or keystone species that are representative of a healthy ecosystem). Assessments and resource strategies should incorporate State Wildlife Action Plans. Resource strategies should include actions for conserving and enhancing habitat attributes in priority landscape areas. **Potential data layers:** Threatened and endangered species habitat, State Wildlife Action Plan data

Connect people to trees and forests, and engage them in environmental stewardship activities.
Our nation's federal, state, urban and private forests are the natural backyards for many communities and serve as society's connection to nature. Assessments and resource strategies can attempt to conserve and enhance a green infrastructure that effectively connects people with their natural environment. Resource strategies can include programs that provide opportunities for children, teens and adults to recreate while gaining an appreciation for the importance of forests and open space with respect to the health, security and well-being of society. **Potential data layers:** Census data, recreation and trail networks, hunting and fishing areas, cultural and heritage sites

Manage and restore trees and forests to mitigate and adapt to global climate change.
America's forests offset a significant portion of the nation's annual carbon emissions. Additional climate change mitigation benefits could be achieved through partnerships and management measures. These measures include supporting the development of markets for carbon offsets, utilizing woody biomass for energy, wood product substitution, and promoting tree growth in urban areas. Assessments should identify opportunities for promoting carbon emissions offsets through forestry. The important benefits that forests provide, such as biodiversity, wildlife habitat, and water storage and flows are affected by climate change. Forest range, type and composition are projected to change significantly– with corresponding changes in wildlife habitat, biodiversity, water flows, and fire regimes. Assessments should consider how climate change will affect important public benefits from forests. Resource strategies should attempt to maintain and enhance resilient and connected forest ecosystems that will continue to provide public benefits in a changing climate. **Potential data layers:** Climate change modeling such as the Climate Change Atlas, Northern and Southern Forest Futures forecast data

Suggested Guidance for State Assessments

State forest resource assessments will identify, describe, and spatially define forest landscape areas where forestry program outreach and activity will be emphasized and coordinated. Establishment of these priority areas is intended to (1) enable the efficient, strategic, and focused use of limited program resources; (2) address current state and national resource management priorities; and (3) produce the most benefit in terms of critical forest resource values and public benefits. This component of a state's assessment should be geospatially based.

The geospatial analysis to delineate priority forest landscape areas may include at least one data layer that addresses each of the national objectives:

- ***Conserve Working Forest Lands:*** conserving and managing working forest landscapes for multiple values and uses.
  - Identify and conserve high priority forest ecosystems and landscapes.
  - Actively and sustainably manage forests.
- ***Protect Forests From Harm:*** protect forests from threats, including catastrophic storms, flooding, insect or disease outbreak, and invasive species.
  - Restore fire-adapted lands and reduce risk of wildfire impacts.
  - Identify, manage and reduce threats to forest and ecosystem health.
- ***Enhance Public Benefits from Trees and Forests:*** including air and water quality, soil conservation, biological diversity, carbon storage, and forest products, forestry-related jobs, production of renewable energy, and wildlife.
  - Protect and enhance water quality and quantity.
  - Improve air quality and conserve energy.
  - Assist communities in planning for and reducing wildfire risks.
  - Maintain and enhance the economic benefits and values of trees and forests.
  - Protect, conserve, and enhance wildlife and fish habitat.
  - Connect people to trees and forests, and engage them in environmental stewardship activities.
  - Manage and restore trees and forests to mitigate and adapt to global climate change.

Regional and multi-state analyses that delineate multi-state priority landscape areas, where states can share resources to address regional threats and opportunities, are strongly encouraged. In addition, priority landscape areas may include urban areas and non-forested lands, such as grasslands, agricultural lands and riparian areas, where agroforestry, afforestation, or reforestation will produce environmental benefits.

States are encouraged to draw from existing data sources and layers, including those provided by the National Assessment or developed for the Forest Stewardship Spatial Analysis Project, regional forest resource assessments, Forest Legacy Assessments of Need, and State Wildlife Action Plans as technically valid and appropriate. A state's geospatial assessment can include one or more weighted overlay analyses that delineate priority landscape areas. A state may choose to conduct separate analyses to address specific resource management or unique program-related questions, or use analyses already completed for individual programs, such as those completed for the Forest Stewardship Spatial Analysis Project or the Southern Forest Resource Assessment.

In order to facilitate inter-state and multi-state analyses and data summaries, data used in state assessments should be at a scale of 1:100,000 or better and overlay analyses should be conducted at the 30-meter cell size or finer. For example, states may wish to consider using one-meter or parcel-based analysis units in urban areas. A state's forest resource assessment should include a description of all spatial analysis methods and logic and one or more maps that identify priority forest landscape areas. States should identify information gaps as part of their assessment process. These geospatial information gaps will help focus future data development work at regional and national levels.

It is expected that states have important information critical to assessing forest resource conditions, trends, and benefits that is not available geospatially. In addition to the core issues or themes listed above, states should consider other environmental and social factors as appropriate—such as cultural resources, demographic opportunities, poverty, public health, crime, recreation, and air quality.

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