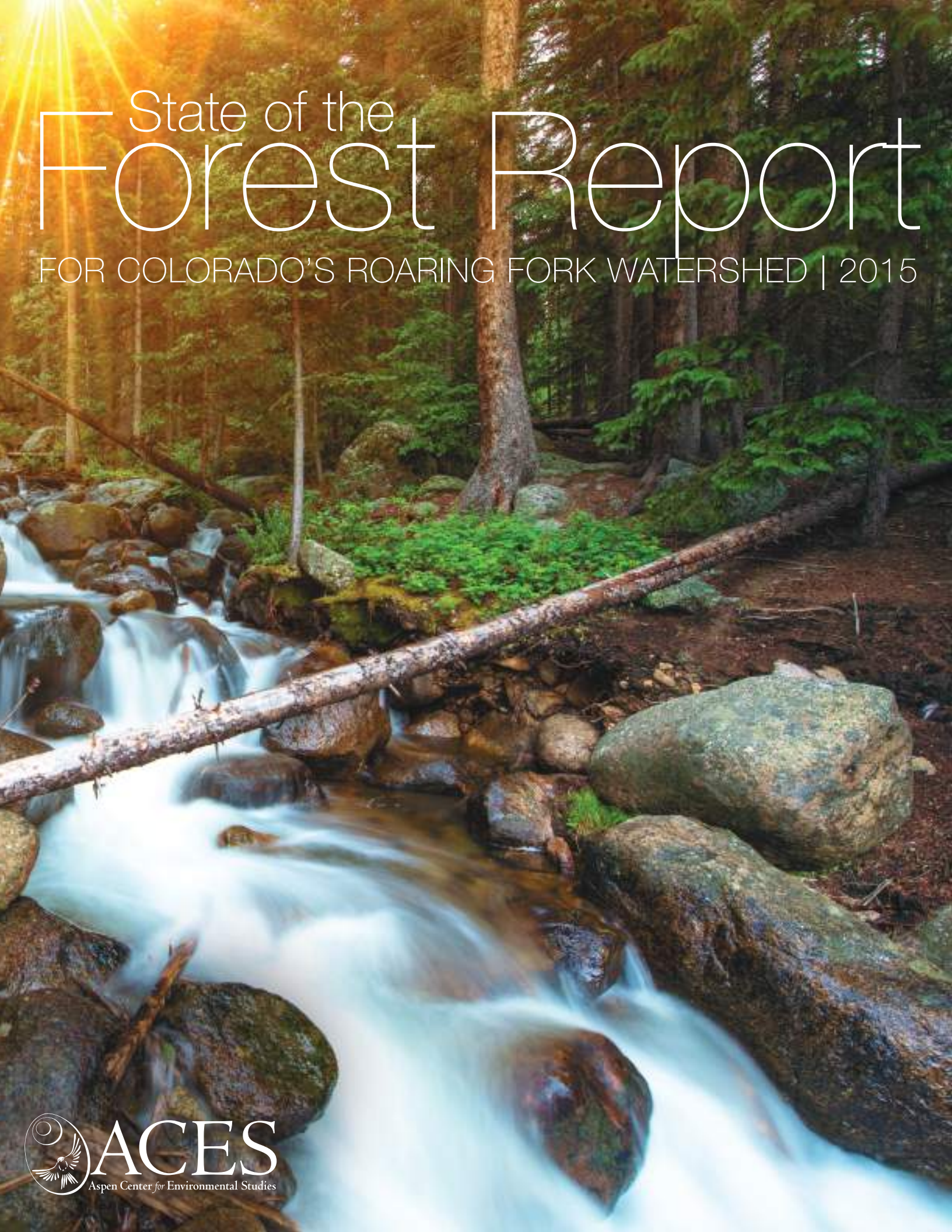


State of the Forest Report

FOR COLORADO'S ROARING FORK WATERSHED | 2015

ACES
Aspen Center *for* Environmental Studies

Contents

State of the Forest Report

FOR COLORADO'S ROARING FORK WATERSHED | 2015

Cover: A mountain stream rushes by a grove of conifer trees. Healthy forests provide critical shade that helps keep streams cool enough to support native aquatic life.
Opposite page: Fall colors along the Crystal River with Mt. Sopris in the background. Healthy forests act as reservoirs for snowpack, gradually releasing runoff into local streams and ensuring consistent water supplies for agriculture, recreation, and human use.

Dying trees are interspersed with green ones near Trailrider Pass, part of the famed Four Pass Loop. Over 26,000 acres of Roaring Fork Watershed forest were impacted by insect and disease infestations in 2013.

Photo: Jonny Kloodjanz

Our Forests Are Melting

By now, everyone has seen the dramatic time-lapse photos of glaciers receding, melting before our very eyes. What has existed for thousands of years is gone in a matter of a few decades caused by a human-induced warming planet.

But what few people outside of a small cadre of dendrochronologists have seen is our forests "melting" in their own way at a similar rate as glaciers. Trees are "running" up hills, literally migrating to higher elevations and more northern latitudes.

Trees "melt" when they are being decimated by climate-induced insect infestations, disease, unnatural catastrophic crown fires, and drought. This causes forests to change type, resulting in entire species of trees being removed from a particular area.

This isn't the stuff of science fiction or doomsday environmental rhetoric. This is the new reality in a warming world of the Anthropocene epoch.

The implications of a world with rapidly changing forests are concerning. For example, the population density of the Sahara Desert is less than one person per square mile, the lowest population density on earth. Why? Because there are no forests! Forests provide the basic ecosystem services required for life: from nutrient cycling, erosion control, soil formation and water regulation to provision of raw materials, food, and drinking water. Forests also play a critical role in fighting climate change, sequestering 11 percent of the carbon the U.S. emits each year! Simply stated, forests are the ecological foundation for plant, animal and, yes, your own life.

Nationally, the trends are sobering:

- The summer wildfire season is now on average 78 days longer than just 20 years ago;
- Forest stress from heat and drought contributes to unprecedented insect epidemics which have ravaged 50 million acres of forests in the western U.S. and Canada;
- Under worst-case climate models, the western U.S. could lose up to 40% of its forests by 2080.

ACES' *For the Forest* program is tackling these issues, boldly working on forest health projects on a regional and national level. Our work on the current state of America's forests has been featured in *USA Today*, *Grist.org*, and on NPR's *On Point* live radio broadcast. Our Forest Forecasts project was featured in the Aspen Ideas Festival, and both the *Denver Business Journal* and *5280* magazine covered the Forest Health Index. We are also in the process of implementing a science standards-based forest health curriculum in our K-4 ACES Ed program in regional schools.

Our new Forest Forecasts project (in partnership with the University of Arizona, page 31) is a revolutionary inventory of western forest assets. When coupled with the latest climate models, a high-resolution picture emerges of what our Western forests are likely to look like in the future. Go to *www.forestforecasts.org* to see where your favorite tree species will most likely be in future years.

Our second iteration of the Forest Health Index (see page 32), a new way to monitor our forests by tracking a set of ecosystem indicators closely over time, is complete. It informs the public about the current conditions in our regional forests. The Index will help inform adaptive management efforts to create, among other things, greater forest resiliency, improved wildlife habitat and reduced wildfire danger in our valley.

This second edition of ACES' *State of the Forest Report* provides comparative analyses of current and past conditions of Roaring Fork Watershed forests and ecosystems in a more readable magazine styled format. It examines recent activity regarding insect and disease infestation and also explains what citizens and land managers can do to be a part of the solution. Most of all, it is our hope that this report will educate citizens, policy makers, federal, state and local governments, and land managers to take action on forest health and conservation issues.

Our goal is nothing less than playing a critical and leveraging role in ensuring that our forests provide ecological and human benefits for generations to come, halting the forest "melting" and keeping deserts where they belong.

Chris Lane,
CEO
Aspen Center for Environmental Studies

Executive Summary

The last of the winter snowpack lingers near Independence Pass. High elevation snowpack is melting earlier, with profound consequences for water supplies.

As climate change continues to trigger dramatic changes in our forest ecosystems, Aspen Center for Environmental Studies' *For the Forest* program is committed to producing groundbreaking scientific research on forest issues and actively restoring our forest landscapes. This *State of the Forest Report* for Colorado's Roaring Fork Watershed examines trends in climatic variables and insect and disease infestations while delving deeper into topics such as the history of our local forests, the complex interactions between forest health and water provision, and the importance of prescribed fire as a management tool. It also outlines the steps ACES is taking to ensure the continued well-being of our local forests and the critical ecosystem services they provide.

The Roaring Fork Watershed comprises a sweep of elevations ranging from 5,700 feet at the confluence of the Roaring Fork and Colorado Rivers at Glenwood Springs to the alpine heights of the 14,000-foot peaks capping the upper reaches of the valley. Across

this gain of over 8,000 feet in elevation, habitats include diverse sets of riparian and wetland ecosystems, mountain shrubland, and upland life zones from montane to sub-alpine to alpine conditions. A staggering 71% of the watershed's 1,451 total square miles is forested, highlighting the importance of this critical resource. This *State of the Forest Report* provides in-depth discussion on how climate, beetles, and fire are impacting our forest as well as the action items ACES' *For the Forest* program is taking to ensure its resiliency.

It's impossible to address the changing state of our forest ecosystems without first addressing climate. Monitoring climatic variables such as temperature and precipitation, including the timing and extremities of certain events, provides a closer look at the root causes of many changes taking place in our forest. While snowpack levels were 78% of normal in 2013, our forests still haven't recovered from the drought conditions of 2012. With the West predicted to get increasingly hotter and drier in the coming decades, our forests will continue to struggle. For more information on how climate is affecting our forests, please see page 8.

Statewide, 16 million acres of Colorado forest have been affected by insect and disease infestations since 1996, with damage rates ranging from a few scattered trees to entire stands. Over 26,000 acres of Roaring Fork Watershed forest (29%) were impacted by insect and disease infestations in 2013. While there are currently low levels of mountain pine beetle and spruce beetle activity in our local forests, the Douglas fir beetle emerged as the second biggest threat to Roaring Fork Watershed forests. Subalpine fir decline was responsible for the most damage to local forests for the 16th consecutive year. For more information on local forest insect and disease infestations, please see page 10.

Another factor contributing to higher rates of insect and disease damage is lack of species and age class diversity in our forests. The underlying reason behind the even-aged forests in our area can be traced back to the late 1800's, when demand for timber skyrocketed during Aspen's population boom at the height of the silver mining era. Much of our watershed's forest was clear-cut, and as a result, many trees in our area are around 125 years old. For more information on how historical forest management activities continue to impact current forest ecosystems, please see page 14.

As the American West continues to face unprecedented levels of drought, local snowpack levels and timing of runoff are monitored with ever-increasing concern. Colorado provides water to 18 states, and our high elevation forests act as reservoirs for snowpack. Water managers, farmers, and recreationists rely on steady rates of runoff to get them through the dry summer months, but factors such as frost-free days, dust on snow events, and impacts to forest health are speeding up snowmelt rates. For more information on the complex relationship between forest health and water provision, please see page 19.

As increased drought conditions and warmer temperatures continue to impact the American West, hotter and more intense wildfires have become the new normal. With only 20% of Colorado's wildland-urban interface currently developed, increased wildfire risk has moved to the forefront of community concern. In addition, many of our local forest ecosystems are fire-adapted, meaning they rely on periodic fire to reproduce, generate species and age class diversity, and maintain resilience to insect and disease infestations. However, decades of fire suppression have led to greatly increased fuel loads in our forests, which makes it impractical to allow natural ignitions to burn freely. Prescribed fire is one of the best tools land managers have in their arsenal to combat this issue. For more information on the ecological benefits of prescribed fire and the use of prescribed fire in our watershed, please see page 22.

When discussing the challenges facing our forest ecosystems, it's also important to acknowledge the impact that humans have on our forests from both resource extraction and recreational use. Colorado's 24.4 million acres of forest provide numerous ecosystem services for human benefit, from drinking water to wood products. The aesthetic values and spectacular scenery provided by our forests also entice recreationists and boost the local tourist economy, but increased human presence is degrading fragile forest ecosystems. For more information on the various ways humans impact our forests, please see page 27.

ACES' *For the Forest* program is taking action to address the issues impacting our local and regional forests, from scientific monitoring to on-the-ground restoration. The Hunter-Smuggler Cooperative Plan will improve forest health, wildlife habitat, recreation, and education opportunities for 4,861 acres of federal land adjacent to Aspen. Our Forest Forecasts model visualizes current and future species distributions of 100 Western tree species under both best- and worst-case climate change scenarios. Our Forest Health Index provides an annual "report card" for our watershed's forests, utilizing data from over 20 climatic, ecological, and socioeconomic indicators. For more information on the steps ACES is taking to improve the health of local forests, please see page 30.

As our climate and forests continue to change, we face a critical choice in how we as a society will respond. ACES' *For the Forest* program is committed to tackling the issues facing the health of our forests head-on, through education, scientific research, and active restoration.

For more information on ACES' forest initiatives, please visit www.aspennature.org.

Jamie Cundiff

Jamie Cundiff
ACES *For the Forest* Program Director

THE ROOT CAUSE: CLIMATE

The changing state of Earth's **climate** triggers a feedback loop in **forest ecosystems**. Climate change leads to **drought**, making trees more susceptible to **insect and disease** infestation, which leads to increased **tree mortality**, which releases more **carbon dioxide** into the atmosphere, perpetuating the cycle of **climate change**. This increases the risk of **catastrophic fire**, which can lead to erosion, flooding, degradation of water supplies and loss of human structures.

ACES' *For the Forest* program closely monitors climatic variables such as temperature and precipitation, including the timing and extremities of certain events. This provides a closer look at the root causes of many changes taking place in our forest. The following graphic outlines how various climatic indicators of forest health fared in the past year.

In 2013...

High elevation snowpack was **78%** of normal

There were **43 more critical fire risk days** than average

5.7 DAYS

SNOWMELT

Onset of snowmelt occurred 5.7 days later than average

37 DAYS

FROST-FREE DAYS

The length of the frost free period in Aspen was 37 days longer than normal

4 DAYS

HOT DAYS

There were 4 days that reached 85°F or above in Aspen (4 less than average)

24 DAYS

COLD DAYS

There were 24 days that reached 0°F or below in Aspen (4 less than average)

2"

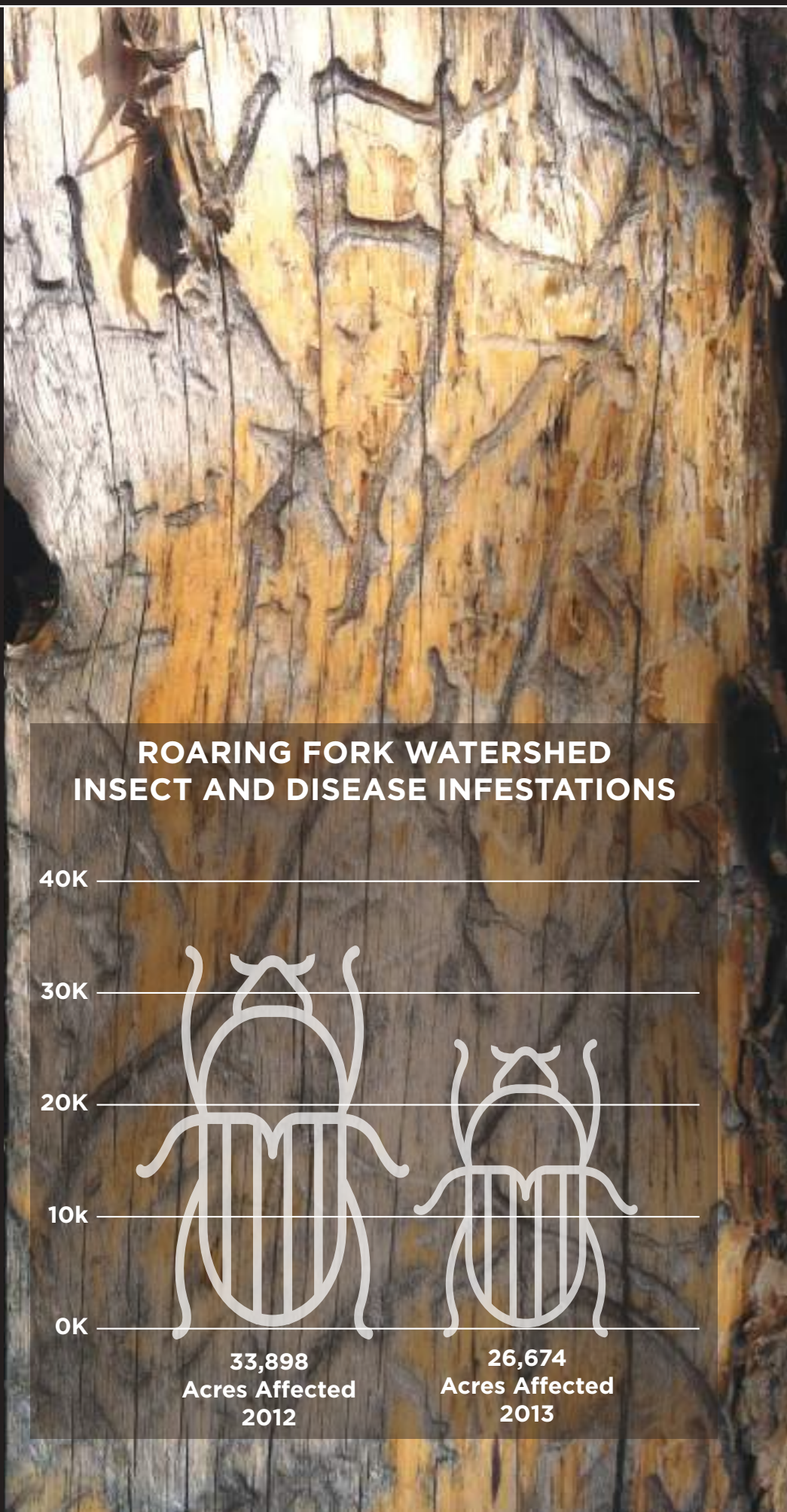
There were **2 more inches of precipitation** in Aspen than average

There were **37% fewer acres** affected by insects and disease than average

Roaring Fork Watershed forests absorbed **10% less carbon** than average

Insect Check!

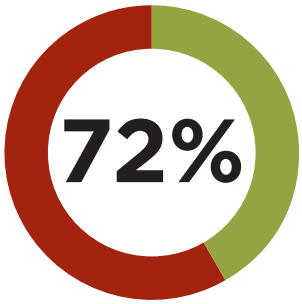
Under the long-term climatic stresses faced by western forests, it is more and more difficult for trees to defend themselves against insect and disease infestations. Statewide, 16 million acres of Colorado forest have been affected since 1996. Locally, 26,674 acres of Roaring Fork Watershed forest were impacted by insect and disease infestations in 2013, down 7,000 acres from 2012. While above average precipitation levels in 2013 likely helped trees better defend themselves, forest ecosystems still haven't recovered from the drought conditions of 2012. With the West predicted to get increasingly hotter and drier in the coming decades, our forests will continue to struggle to defend themselves. This section delves into further detail on the beetles, caterpillars, and fungi currently threatening our local forests and the critical ecosystem services they provide.



Subalpine Fir Decline

For the 16th consecutive year, subalpine fir decline was far and away the most destructive force in Roaring Fork Watershed forests. The term subalpine fir decline does not refer to a specific pest or disease, but rather the collective mortality and degradation of the species. The biggest culprit is the combined efforts of root disease fungi (*Armillaria spp.* and *Heterobasision parviporum*) and western balsam bark beetles (*Dryocoetes confuses*). The root fungi weaken the trees' defenses and allow the beetles to launch a successful attack.

Subalpine fir decline was responsible for 72% of all insect and disease damage in 2013. That being said, significantly fewer acres were affected in 2013 (19,318 acres) compared with 2012 (29,196 acres). In fact, acres impacted by subalpine fir decline have been steadily decreasing since 2010. This is welcome news as widespread subalpine fir mortality poses a significant threat to recreation in terms of the hazards associated with falling dead trees and loss of aesthetic value.



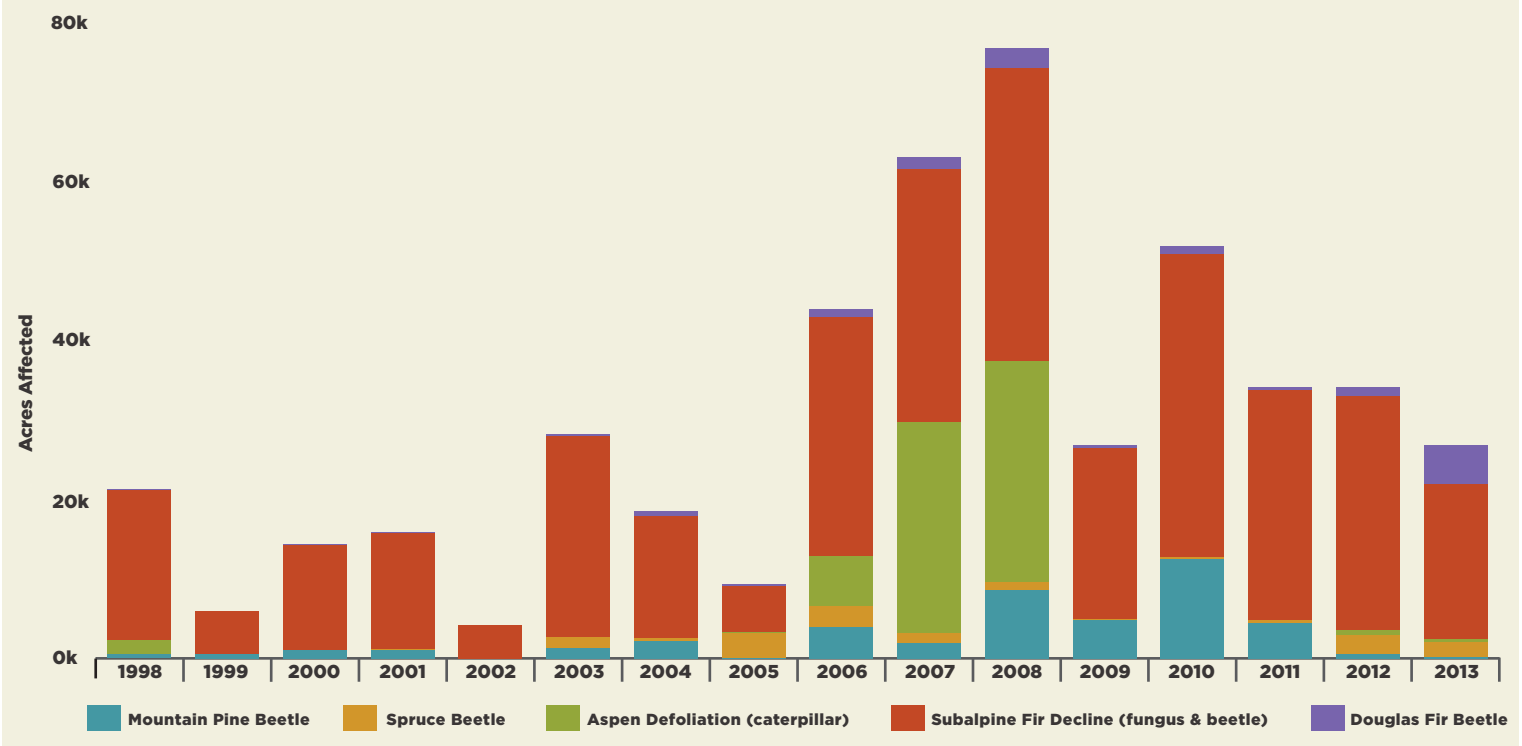
72% of all insect and disease damage in the Roaring Fork watershed in 2013 was subalpine fir decline.

Douglas Fir Beetle

While less of an issue statewide, Douglas fir beetle emerged as the second biggest threat to Roaring Fork Watershed forests in 2013. The impacted area spiked at 4,900 acres, well above the previous high of 2,487 acres in 2008. Mature Douglas fir forests are especially susceptible to beetle infestations following periods of below-normal precipitation. Considering that Aspen experienced record-low levels of precipitation in 2012, this dramatic increase in Douglas fir beetle activity is not surprising. Keeping close tabs on climatic indicators such as precipitation and snowpack is crucial when it comes to knowing what to expect in terms of future beetle activity.

Douglas fir beetle emerged as the **second biggest threat** to Roaring Fork Watershed forests in 2013. The impacted area spiked at **4,900 acres.**

Roaring Fork Watershed Insect & Disease Damage



The needles of trees attacked by beetles first turn red, as pictured here, and then fall off.

ACRES OF ROARING FORK WATERSHED FOREST IMPACTED BY SPRUCE BEETLE:

1,850
IN 2013

2,317
AT PEAK IN 2012

Spruce Beetle

For the past two years, spruce beetle has surpassed the mountain pine beetle as the most destructive forest insect in Colorado. In 2013, 398,000 acres were impacted by the spruce beetle, an all time annual high. Due to the states' high concentration of spruce-fir forests, the epidemic is not expected to subside soon. Multiple years of drought have weakened trees' ability to use their sap to expel, or "pitch out" beetles. Trees that have blown down in storms, called "windthrow", also provide ideal breeding grounds for spruce beetles. Due to a heavy winter storm with high winds in 2011, windthrow is plentiful in Colorado's spruce-fir and mixed conifer forests, increasing the chance of infestation.

Currently, large-scale spruce beetle outbreaks have been centered in southwest Colorado but are steadily moving north and east. In the Roaring Fork Watershed, 1,850 acres of forest were impacted by the spruce beetle in 2013, down from a high of 2,317 acres in 2012. While we certainly hope that the spruce beetle follows the "peak and decline" pattern demonstrated locally and statewide by the mountain pine beetle, continued monitoring of the 40% of our watershed comprised of spruce-fir forest is essential. These high-elevation forests act as reservoirs for locales as far away as Los Angeles, and widespread mortality degrades water supply and increases the risk of wildfire.

Aspen Defoliation

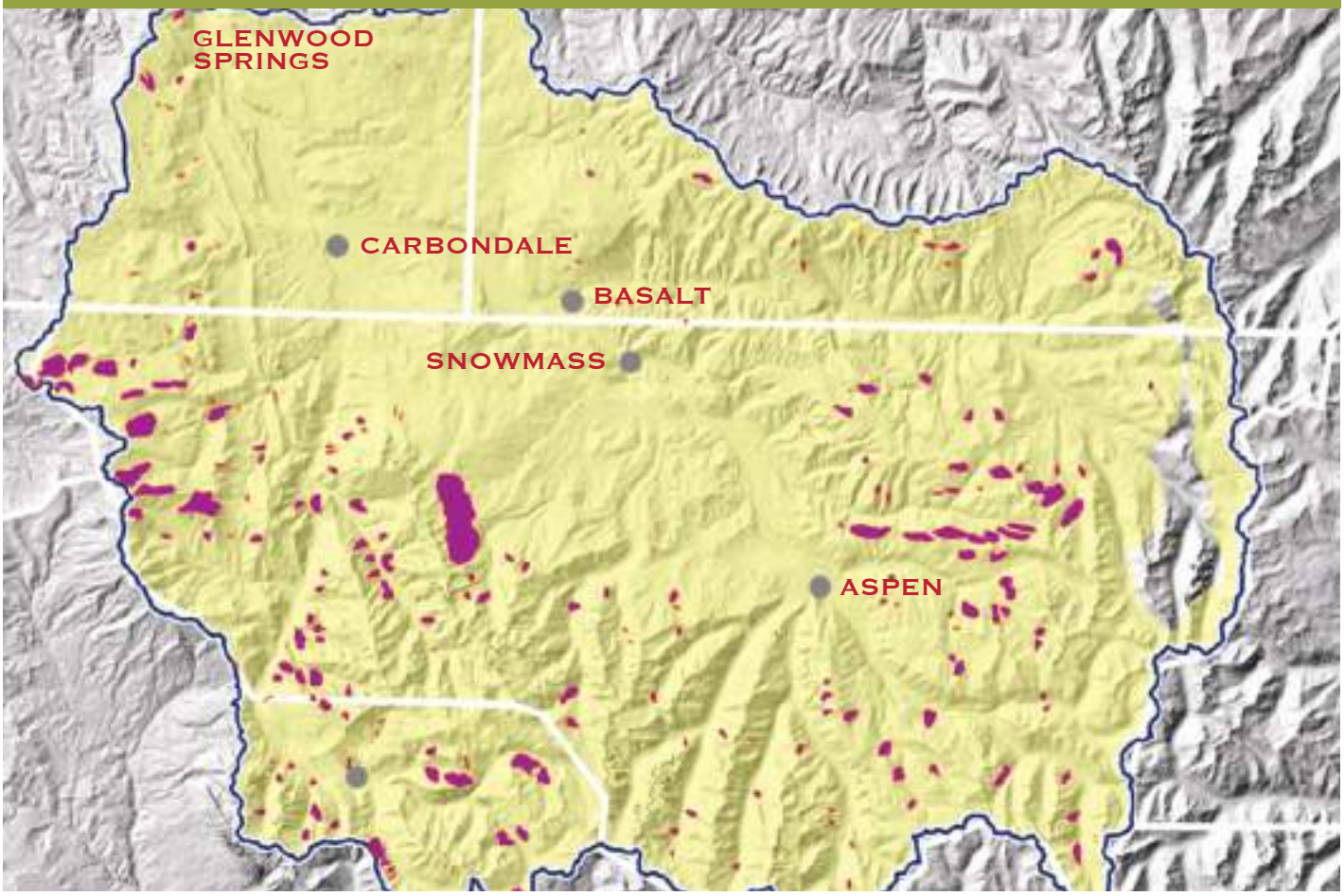
The acreage impacted by leaf-eating insects in regional aspen forests continues to decline, with 430 acres affected in 2013 (down from a high of 27,590 in 2008). In the Roaring Fork Watershed, the primary agent of aspen defoliation is the western tent caterpillar (*Malacosoma californicum*), an insect whose larvae feed on the leaves of aspen trees and other mountain shrubs, including chokecherry and mountain mahogany. Fortunately, extreme outbreaks generally only last 2-3 years, evidenced locally by high levels of impact from 2006-2008 followed by a dramatic decline to the relatively low levels observed in the last year. This is good news for our aspen forests given the ecological and aesthetic significance of the species to our area. Second only to riparian areas in terms of biological diversity, they provide critical habitat to a wide variety of plant and animal species.

Mountain Pine Beetle

Although the mountain pine beetle has impacted 3.4 million acres of Colorado forest since 1996, it's annual rate of destruction continues to decline. Statewide, mortality rates peaked in 2008 and have declined every year since. In 2013, Colorado had the lowest rate of mountain pine beetle damage since 1999. Most of this damage occurred in the northern part of the state. While this is certainly good news for our forests, this decrease in mountain pine beetle activity is mostly due to the depletion of available host trees, meaning the beetles have essentially eaten their way through a large portion of Colorado's lodgepole and ponderosa pine forests.

In the Roaring Fork Watershed, only 152 acres of forest were impacted by mountain pine beetle in 2013, compared to a high of 12,432 acres in 2010. At current endemic, or natural, levels, the beetles play an important role in forest disturbance and nutrient cycling regimes by opening up space for sunlight to reach the forest floor and for new trees to grow. This process results in age class diversity in our forests, which help make them less susceptible to future widespread beetle epidemics.

2013 Roaring Fork Watershed Insect & Disease Infestation



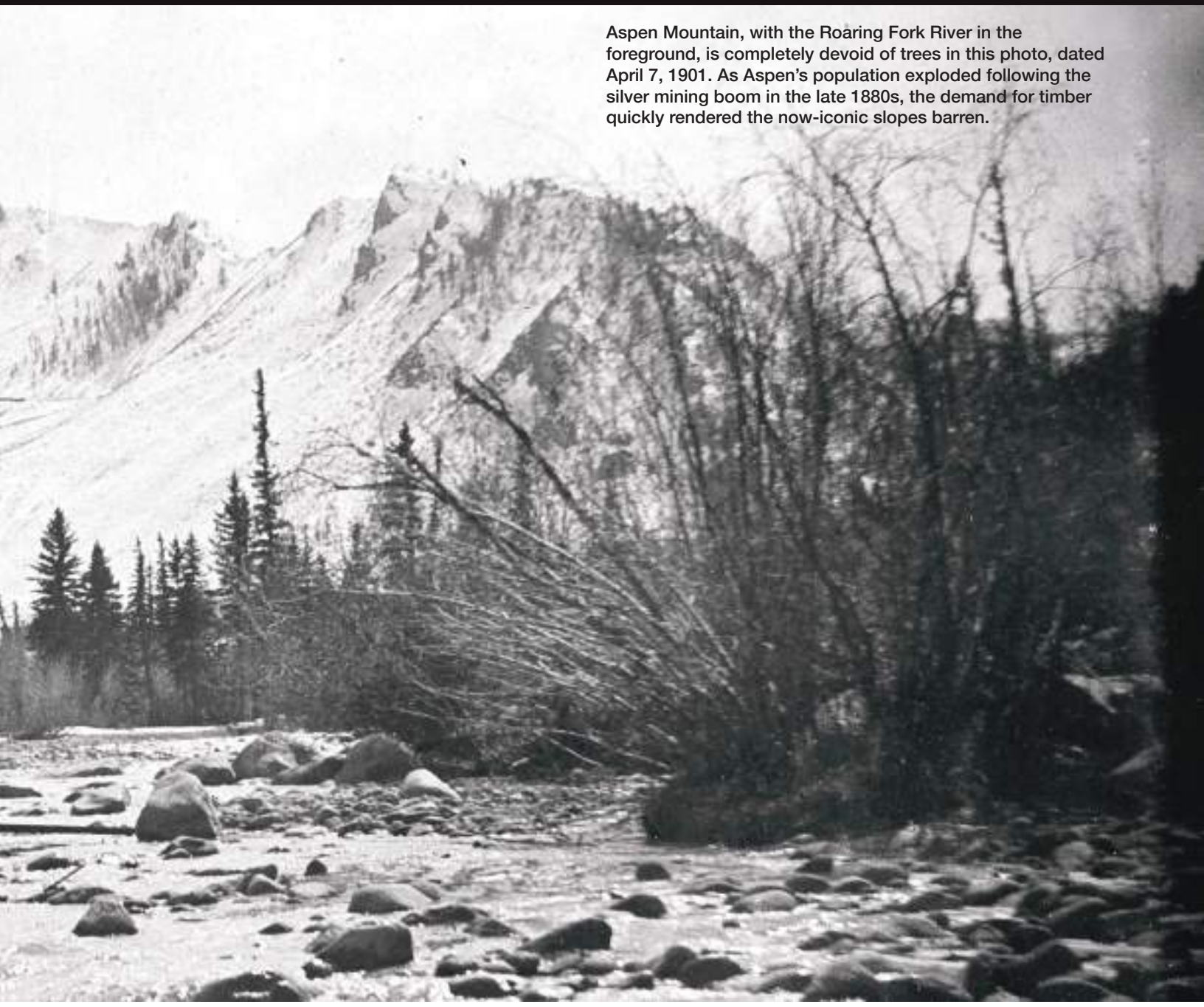
Source: USFS Forest Inventory & Analysis

Forest Insect and Disease Progression in Colorado 1996 – 2013

Source: Colorado State Forest Service (image has been altered to highlight local detail)

A CLEAR CUT HISTORY *of* ASPEN'S FORESTS

Imagine Aspen's iconic ski slopes devoid of trees. Bare dirt. Stumps as far as the eye can see. Is this something out of The Lorax? Quite the contrary.



Aspen Mountain, with the Roaring Fork River in the foreground, is completely devoid of trees in this photo, dated April 7, 1901. As Aspen's population exploded following the silver mining boom in the late 1880s, the demand for timber quickly rendered the now-iconic slopes barren.

Following Aspen's silver mining boom in the late 1880's, what had been a transient mining camp rapidly transitioned into an urbanized industrial center. With this growth in population and prosperity came great demand for natural resources. In his book Aspen: The History of a Silver Mining Town 1879-1893, Malcolm J. Rohrbough writes of the demand for timber:

"Into the Eden-like valley of the Roaring Fork came all the by-products of late-nineteenth-century American industrial life [including] … the systematic cutting of timber on the sides of the mountains to meet the ravenous appetites of the mines that left the surrounding hillsides as bare as a stretch of artic tundra."

Photo courtesy of Aspen Historical Society

Local hillsides were heavily logged in the late 1880s to support the expansion of silver mining operations, as these historic and present-day photos of Shadow Mountain illustrate. While our forests have filled back in over the past 125 years, the resulting lack of age diversity has profound ecological consequences.

The construction of the underground access tunnels of the Smuggler Mine alone consumed 100,000 board feet of timber per month. This rapid rate of consumption quickly rendered Aspen's iconic slopes barren.

As difficult as it is for Aspenites today to picture a treeless Ajax, that was the reality faced by early residents, as the accompanying photos illustrate.

While today's residents and visitors are skiing amongst the firs on Aspen Mountain and mountain biking through the pines of Smuggler, these ecosystems are still reeling from Aspen's mining era.

Photos courtesy of Aspen Historical Society

Here's the problem: Because our local forests were logged for timber in a relatively short time period, the majority of Aspen's modern day forests are all the same age. Ski past a lodgepole pine stand on the lower flanks of Aspen Highlands and you'll notice that all the trunks are of similar size. Foresters refer to this phenomenon as a lack of age class diversity.

Ecologically speaking, a forest that lacks age class diversity is more susceptible to widespread mortality from insects and disease.

Given that many of Aspen's local forests are even-aged, one may wonder why this area was spared the severity of the mountain pine beetle epidemic faced by other regions of Colorado over the past few decades. The answer lies in species diversity.

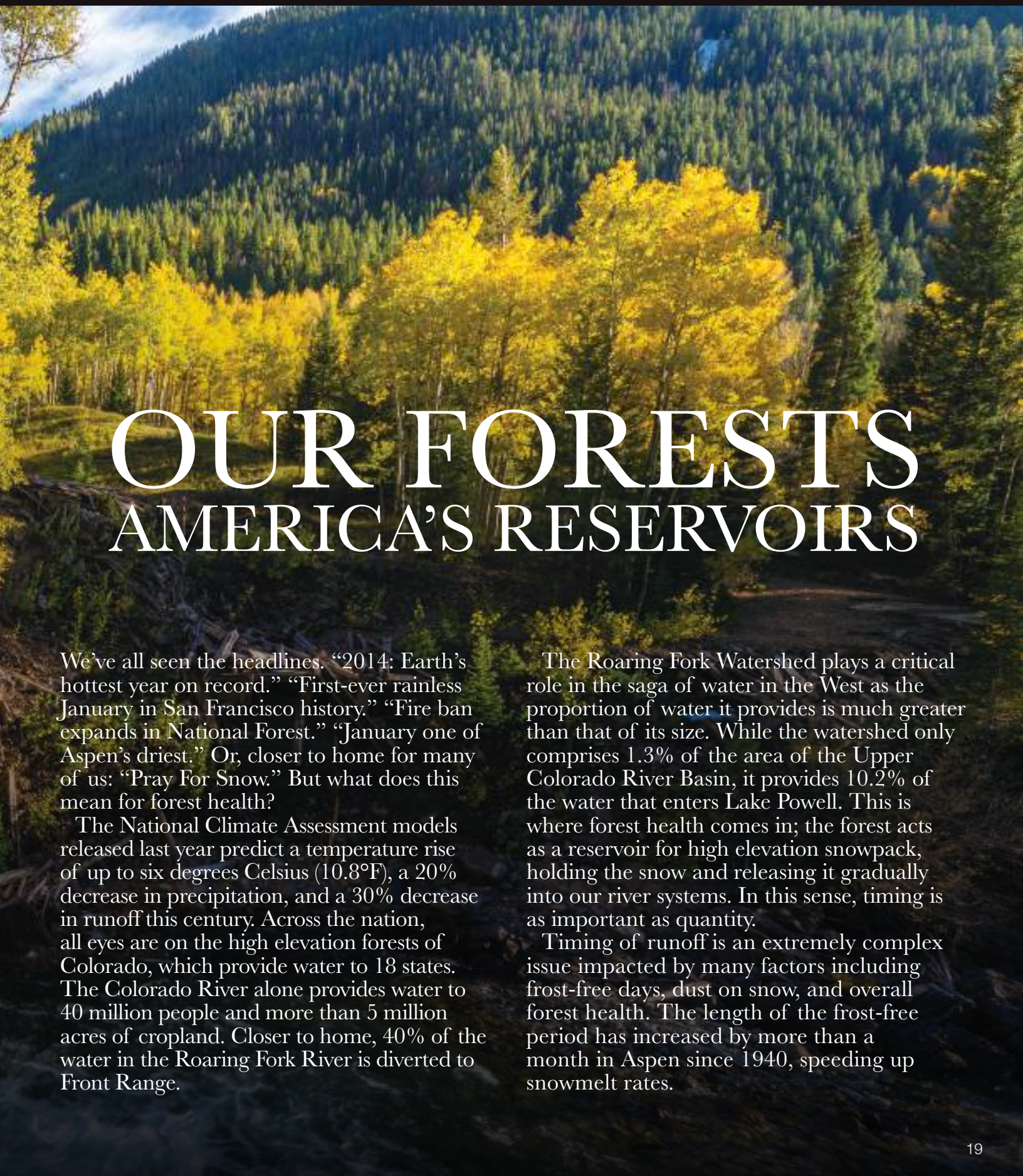
An excellent analogy of the benefits of species diversity can be drawn from the agriculture realm. If a farmer maintains an orchard of exclusively peach trees that is infested by fruit flies, the entire crop may be lost. But if the farmer planted a diversity of crops, only a fraction of the crop would be lost.

The same is true for forests. Consider the example of the mountain pine beetle, which favors lodgepole and ponderosa pine trees. Other forests composed exclusively of these two species are at a much higher risk of mortality from the beetle. Here in the Roaring Fork Watershed, only 7% of our forests are lodgepole pine, which spared us from extensive mountain pine beetle mortality.

Lack of species and age class diversity caused by clear-cutting and other human interventions such as fire prevention and development can trigger ripple effects throughout the ecosystem. For example, an even-aged lodgepole pine stand growing close together prevents any sunlight from reaching the forest floor. This results in an ecologically barren understory that makes it difficult for many foraging animals to survive.

Fortunately, Aspen Center for Environmental Studies' *For the Forest* program is helping land managers take steps to restore our local forests to more diverse, pre-mining conditions through select mechanical thinning and, where appropriate, prescribed fire. Such treatments aim to create a more patchy forest landscape where different species and ages of trees can thrive. For more information on ACES' restoration efforts, please see page 30.

Healthy forests do more than look good. They sequester carbon, purify our air, and store our drinking water. Simply put, a healthy forest means a healthy Aspen.



OUR FORESTS
AMERICA'S RESERVOIRS

We've all seen the headlines. "2014: Earth's hottest year on record." "First-ever rainless January in San Francisco history." "Fire ban expands in National Forest." "January one of Aspen's driest." Or, closer to home for many of us: "Pray For Snow." But what does this mean for forest health?

The National Climate Assessment models released last year predict a temperature rise of up to six degrees Celsius (10.8°F), a 20% decrease in precipitation, and a 30% decrease in runoff this century. Across the nation, all eyes are on the high elevation forests of Colorado, which provide water to 18 states. The Colorado River alone provides water to 40 million people and more than 5 million acres of cropland. Closer to home, 40% of the water in the Roaring Fork River is diverted to Front Range.

The Roaring Fork Watershed plays a critical role in the saga of water in the West as the proportion of water it provides is much greater than that of its size. While the watershed only comprises 1.3% of the area of the Upper Colorado River Basin, it provides 10.2% of the water that enters Lake Powell. This is where forest health comes in; the forest acts as a reservoir for high elevation snowpack, holding the snow and releasing it gradually into our river systems. In this sense, timing is as important as quantity.

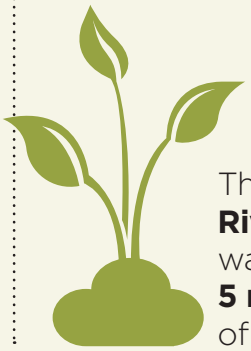
Timing of runoff is an extremely complex issue impacted by many factors including frost-free days, dust on snow, and overall forest health. The length of the frost-free period has increased by more than a month in Aspen since 1940, speeding up snowmelt rates.

1% = 10%

The Roaring Fork Watershed makes up just **1.3% of the area** of the Upper Colorado River Basin, but provides **10.2% of the water** that enters Lake Powell.

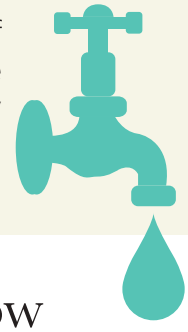
Colorado's River System Provides Water to 18 States

Map courtesy of CSFS



The **Colorado River** provides water to **5 million acres** of cropland.

The **water lost** as a result of early runoff is more than the **water consumed** annually by Las Vegas, Denver, Phoenix, and Tucson combined.



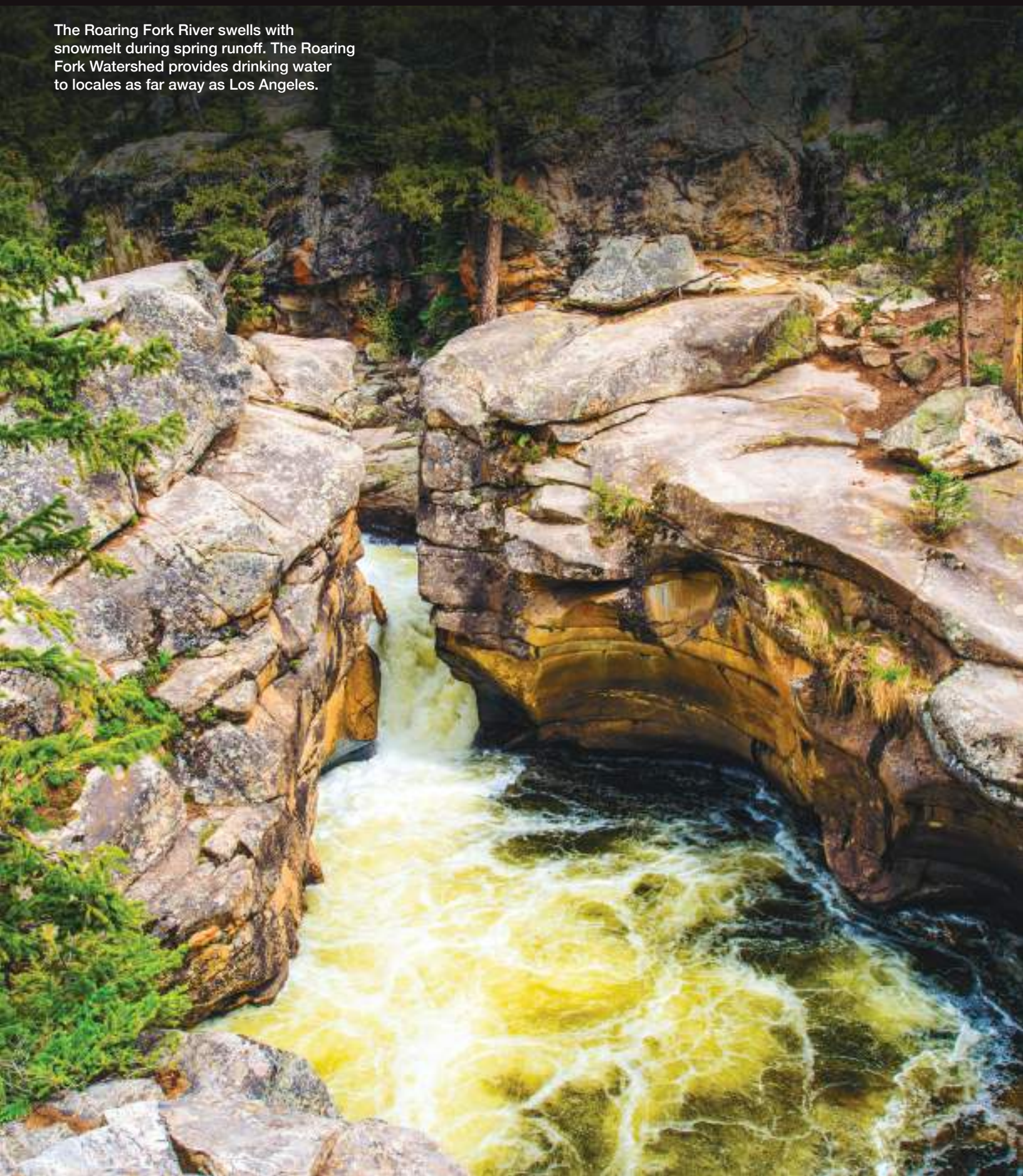
There has been a 500% increase in dust on snow events since 2010, and this increase has moved peak runoff six weeks earlier since settlement in the 1880s.

Dust on snow events also rapidly accelerate snowmelt, as the dark particles in the dust absorb solar radiation and melt the surrounding snow. There has been a 500% increase in dust on snow events since 2010, and this increase has moved peak runoff six weeks earlier since settlement in the 1880s. While difficult to track the exact source of the dust, most local dust on snow events originate from agricultural activity in the American southwest and regional oil and gas exploration and motorized recreation.

In addition, healthy forests act as high-elevation reservoirs, "holding" snow and water and releasing them into rivers at a gradual rate. Snowpack in forests negatively impacted by wildfire, insects and diseases is much more exposed to the sun and therefore melts more quickly. This results in an early "pulse" of runoff to rivers, making water supplies difficult to predict for urban, agricultural, and recreational use.

Even though earlier snowmelt means that our rivers receive a pulse of runoff all at once, it translates to major water losses in the big picture. Faster snowmelt means the soil is exposed to sunlight earlier and for longer periods of time. This leads to rapid rates of evapotranspiration, or evaporation of water from the soil. As a result, current regional rates of snowmelt and peak runoff are manifested in a 5% reduction in Colorado River Basin annual flow. While this may seem like a small percentage, the water lost as a result of early runoff is more than the water consumed annually by Las Vegas, Denver, Phoenix, and Tucson combined.

We are extremely lucky in the Roaring Fork Watershed to have a pristine supply of water in our backyard. By actively managing for forest health and continuing to take action against climate change, ACES' *For the Forest* program is helping ensure the continued security of this critical resource for our local community and beyond.



The Roaring Fork River swells with snowmelt during spring runoff. The Roaring Fork Watershed provides drinking water to locales as far away as Los Angeles.

FOREST REPORT

FIRE

FIGHTING FIRE WITH FIRE

THE BENEFITS OF PRESCRIBED BURNING

James Genung

Prescribed fire provides a host of benefits, from habitat improvement to fuel reduction; Above Right: Wildflowers bloom on Basalt Mountain six weeks after a prescribed burn.

As increased drought conditions and warmer temperatures continue to impact the American West, hotter and more intense wildfires have become the new normal. The 2013 Black Forest fire on the outskirts of Colorado Springs burned 14,280 acres, destroyed 509 homes, and killed two people. And with only 20% of Colorado's wildland-urban interface currently developed (according to Headwaters Economics), increased wildfire risk has moved to the forefront of community concern throughout Colorado.

Adding to the complexity of the issue, many of the forest ecosystems in the Roaring Fork Watershed are fire-adapted, meaning they rely on periodic fire to reproduce, generate species and age class diversity, and maintain resilience to insect and disease infestations. However, decades of fire suppression have led to greatly increased fuel loads in our forests, which makes it impractical to allow natural ignitions to burn freely.

A firefighter patrols the flank of a prescribed burn. Many shrubs rapidly re-sprout following a fire, providing valuable forage for wildlife.

Land managers have several tools to combat this issue. While mechanical thinning is quite effective at removing excess fuel, especially in areas immediately adjacent to homes where prescribed fire is risky, it is more costly and does not pack the ecological benefits of fire. When excess vegetation burns, nitrogen and other nutrients are released into the soil, helping new plants grow. Some species, such as lodgepole pine, require bare soil for their seeds to germinate, and fire is the best way to help that process along.

Prescribed fire also produces a mosaic of vegetation patterns across the landscape that create diverse habitat for plants and animals. Many shrubs rapidly resprout following fire, providing valuable forage for wildlife. At the same time, the patchy nature of prescribed fire leaves critical cover in place for small animals and nesting birds.

Unlike wildfires that originate from lightning strikes or careless campfires, prescribed burns are carefully planned to account for wind conditions and fuel moisture content. A team of ecologists and firefighters carefully evaluate risks to public safety, establish burn areas with adequate fire lines and ensure response teams are in place to monitor and control the spread of the fire.

Accounting for smoke volume and direction is also an important part of every prescribed burn. Before each burn, land managers look carefully at what they plan to burn and the proximity of houses, roads, and other smoke sensitive sites to the planned burn area. A burn prescription is then written to mitigate negative impacts of smoke, especially those to human health.

PRESCRIBED FIRE IN THE ROARING FORK VALLEY

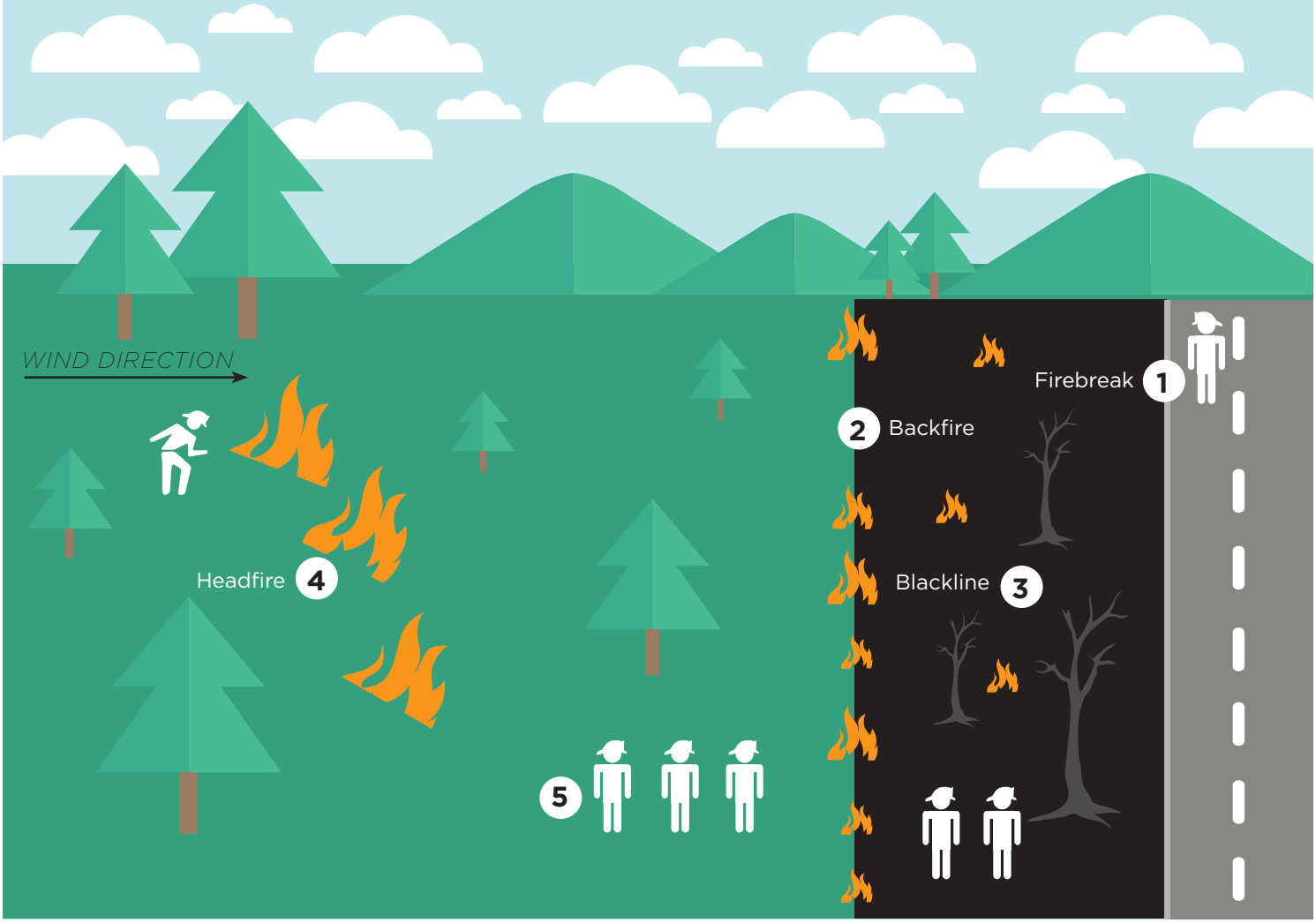
Higher fuel moisture content, lower levels of drought stress, and lingering snowpack in the Roaring Fork Valley made for ideal prescribed burning conditions in Spring 2014 and 2015. Following several years of strict fire bans, the Forest Service capitalized on the opportunity to remove excess fuels and improve wildlife habitat in mixed shrubland habitat on the flanks of Basalt Mountain.

The prescribed burns, conducted on May 5, 2014 and April 14, 2015, covered 120 and 1,100 acres, respectively, of Gambel oak, sagebrush, and aspen. The purpose of these burns was to reduce potential wildfire fuels and improve wildlife habitat for elk. The fires burned at various intensities across the burn units, resulting in the desired mosaic effect, and stayed well within target boundaries. Wildlife and fire ecologists will continue to monitor vegetative response to the burns.

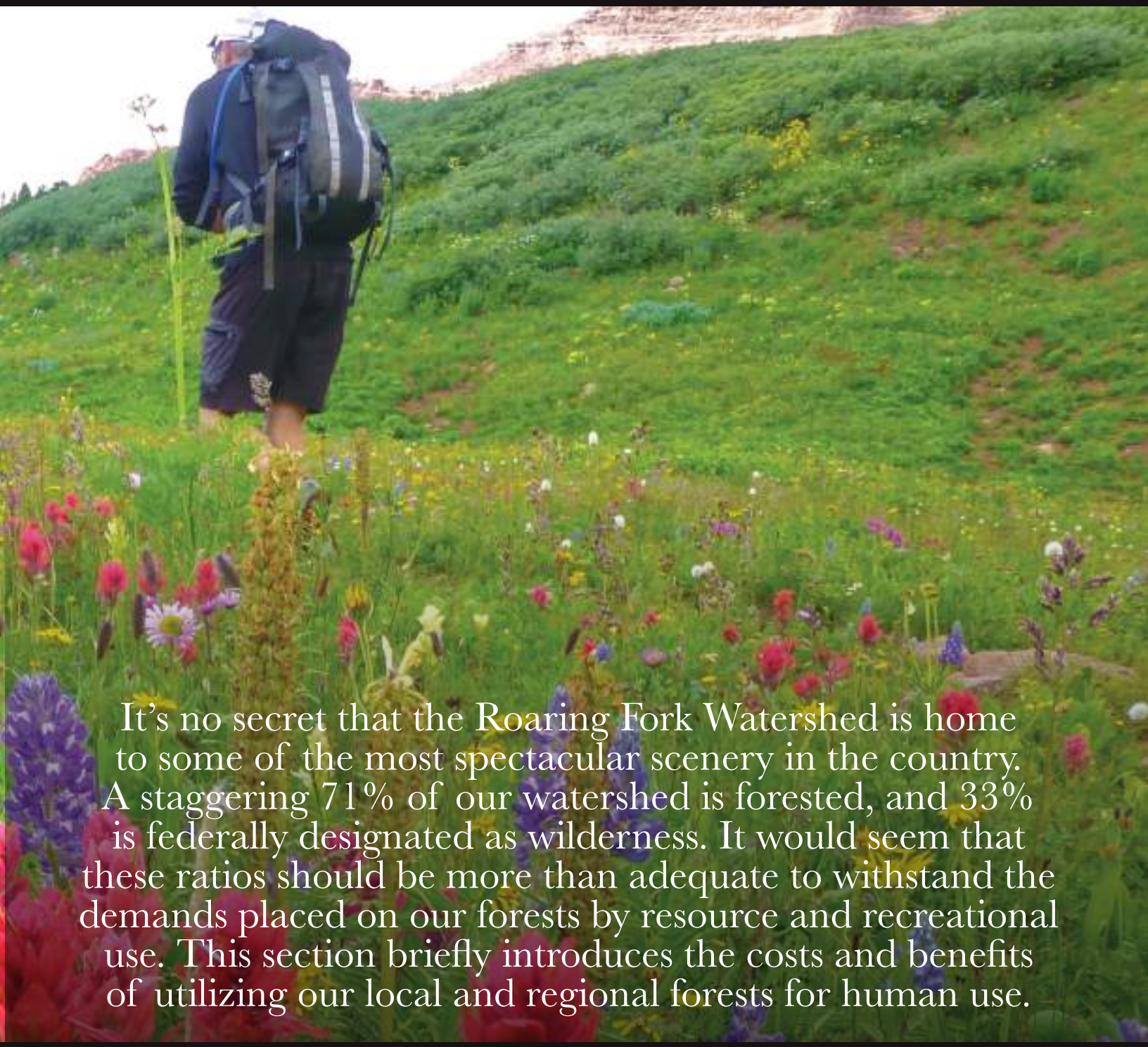
Given appropriate climatic conditions, the Forest Service hopes to undertake similar prescribed burning activities in other Roaring Fork Watershed locations in the future.

How Prescribed Fire Works

First, prescribed burn managers select an area with existing firebreaks, such as a road (1). Given appropriate weather and fuel conditions, a backfire (2) is set from the road to create an additional firebreak. Because this fire is set against the wind, it only burns a small area, called a blackline (3). The main fire, or headfire (4) is then lit either by hand or helicopter downwind of the blackline. Wind and topography (fire moves uphill) guide the headfire back towards the blackline. Fire personnel patrol the flanks of the fire to ensure it does not escape (5).



Overuse at popular sites in the Maroon Bells - Snowmass Wilderness is degrading fragile forest ecosystems. Pictured above: a crowd at Conundrum Hot Springs, a packed parking lot at Conundrum Trailhead, and trash left behind by wilderness visitors.

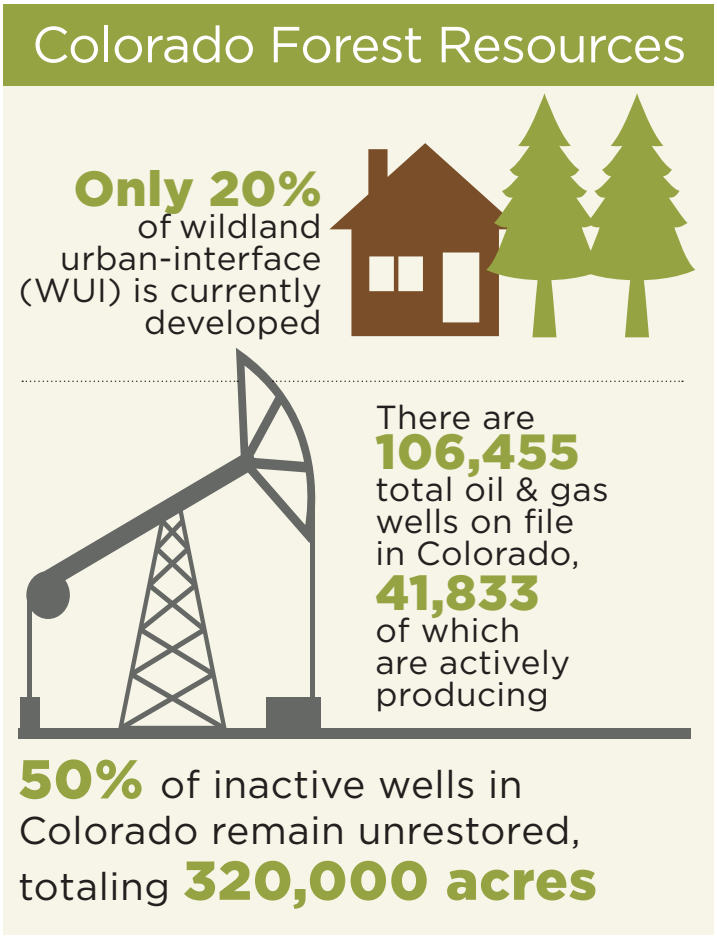


It's no secret that the Roaring Fork Watershed is home to some of the most spectacular scenery in the country. A staggering 71% of our watershed is forested, and 33% is federally designated as wilderness. It would seem that these ratios should be more than adequate to withstand the demands placed on our forests by resource and recreational use. This section briefly introduces the costs and benefits of utilizing our local and regional forests for human use.

LOVED TO DEATH: FORESTS IN PERIL

WOOD PRODUCTS

Colorado's 24.4 million acres of forest lands are impacted by human use in a variety of ways, from urban and energy development to recreation to wood utilization. While extensive insect and disease mortality has fundamentally altered the ecological function and aesthetic values of Colorado's forests, the resulting increase in active management has revitalized the state's wood products industry. As communities work to mitigate large swaths of dead timber along trails, roads, and campsites that pose a hazard to recreationists and utilities, long-closed mills have reopened to accept incoming timber. Defensible space measures, active management to promote forest resiliency, and demand for blue-stained beetlekill for wood products also drives increased supply for mills. These activities bolster local and state economies and further incentivize active forest management on private property. While the Roaring Fork Watershed does not have a very robust timber market, the recent opening of a biomass power plant in nearby Gypsum allows for timber products resulting from local restoration projects to be utilized with minimal transportation.



ENERGY DEVELOPMENT

Statewide, the energy sector is one of the largest sources of human impact on our forests. Colorado set a record for oil production in 2013, producing 62.3 million barrels of crude oil and 1.6 trillion cubic feet of natural gas. While this provides a benefit to Colorado in terms of revenue and energy security, it's not without its downfalls. New roads built for oil and gas exploration fragment wildlife habitat and are a major source of dust-on-snow. Hydrologic fracturing, or "fracking", can leak methane gas, and toxic chemicals can leach out from the system and contaminate nearby groundwater. But the greatest impact may be the sheer quantity of ground compacted, eroded, and exposed to noxious weeds by drilling operations: there are currently 106,455 total wells on file in Colorado, 41,833 of which are actively producing. And although the state requires oil and gas companies to fully restore the land around inactive wells, the Colorado Oil and Gas Conservation Commission currently does not enforce a set timeline for restoration, and over 50% of inactive wells remain unrestored. In the Roaring Fork Watershed, communities have been vocal opponents of potential oil and gas exploration in our region, forging a successful campaign to protect the Thompson Divide area from future oil and gas leases.

Colorado's **24.4 million acres** of forest lands are impacted by **human use** in a variety of ways, from **urban** and **energy development** to **recreation** to **wood utilization**.

URBAN DEVELOPMENT

The impact of people living in close proximity to forested lands has important implications for both management and policy. The wildland-urban interface, or WUI, is any area where human structures are built close to, or within, natural landscapes. Only 20% of Colorado's WUI is currently developed. As our state's population continues to grow (there was a 6.5% increase between 2010 and 2014), it is likely that more of the lands bordering our forests will be sited for housing. Besides the on-the-ground impacts of development, expansion of residences into the WUI increases potential damage from wildfire and flooding. Fortunately, between an expanded wood products industry as well as local and state government incentives, active forest management on private property to increase resiliency and defensible space is further incentivized. In the Roaring Fork Watershed, ACES' *For the Forest* program partners with local land managers on wildlife habitat and fuel reduction projects to help maintain balance in the WUI. For more information, see page 30.

RECREATION

The scenic vistas and bountiful recreational opportunities offered by the Roaring Fork Watershed are beloved by locals and visitors alike. In recent years, however, our local forests have become so popular that intense overuse is degrading fragile forest ecosystems. While many seek quiet and solitude in our forests, group encounters in high use areas have skyrocketed. Campsite proliferation compacts the soil and disturbs fragile high elevation vegetation. Hundreds of pounds of trash are left behind by visitors each year, and mismanagement of food and subsequent wildlife encounters have forced closures of popular campsites. As opposed to educating wilderness visitors of the impacts of their behavior, precious ranger resources are spent dealing with the less glamorous aspects of wilderness use, such as human waste, illegal fire rings, and trailhead parking.

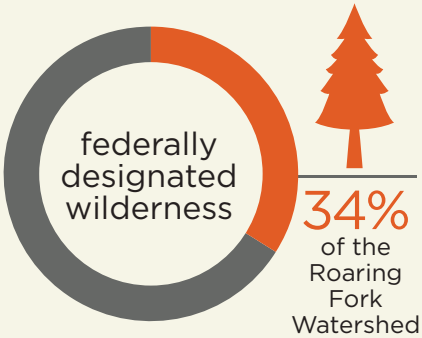
Balance is key when addressing the complex issues of human impact on our forests. By practicing Leave No Trace principles, we can ensure the continued health of our forest resources and the countless benefits they provide.

Human Impact in Maroon Bells-Snowmass Wilderness

2014 Trail Users

CRATER LAKE **362** AVERAGE/ DAY **1,322** PEAK DAY	**SNOWMASS CREEK** **33** AVERAGE/ DAY **318** PEAK DAY
CAPITOL DITCH **53** AVERAGE/ DAY **196** PEAK DAY	**CONUNDRUM** **41** AVERAGE/ DAY **108** PEAK DAY

277 Illegal Campfire Rings



34% of the Roaring Fork Watershed

CAMPSITE PROLIFERATION:

559,000 ft.
(35 football fields)
Area of disturbed vegetation and soil compaction

59% are within 100 ft of trails, lakes, and streams.

Hunter-Smuggler Cooperative Plan

In April 2014, the US Forest Service conducted an extensive Environmental Assessment and formally approved the 20-year stewardship plan submitted by ACES' *For the Forest* program that outlines improvements to forest health, wildlife habitat, recreation, and education opportunities for 4,861 acres of federal land adjacent to Aspen. ACES now leads an Implementation Team that convenes semiannually to determine projects for the upcoming field season.

In September 2014, forest restoration work began on five units of lodgepole pine forest on Smuggler Mountain. The goal of these treatments is to promote forest resiliency by encouraging new growth in otherwise even-aged stands. This simultaneously increases our forest's ability to defend itself against insect and disease infestations while providing more robust wildlife habitat. This project is located in areas with high rates of mortality, removing potential wildfire fuel and hazard trees. Pre- and post-treatment monitoring is being conducted by Colorado State University ecologists to determine the efficiency of the treatments and to inform future management decisions.

The Implementation Team is also working toward a 50+ acre oakbrush mastication, which removes overmature vegetation by mechanically "chewing" it up, in the Hunter Creek Valley for Fall 2015. Oakbrush is quick to resprout following disturbance, and this project will increase forage for elk, bear, and other wildlife.

Top: Even-aged lodgepole stand on Smuggler Mountain. *Middle:* Scouting out future projects in Hunter Creek Valley. *Bottom:* An oak masticator at work on Sky Mountain Park.

Jonathan Lowsky

ForestForecasts.org

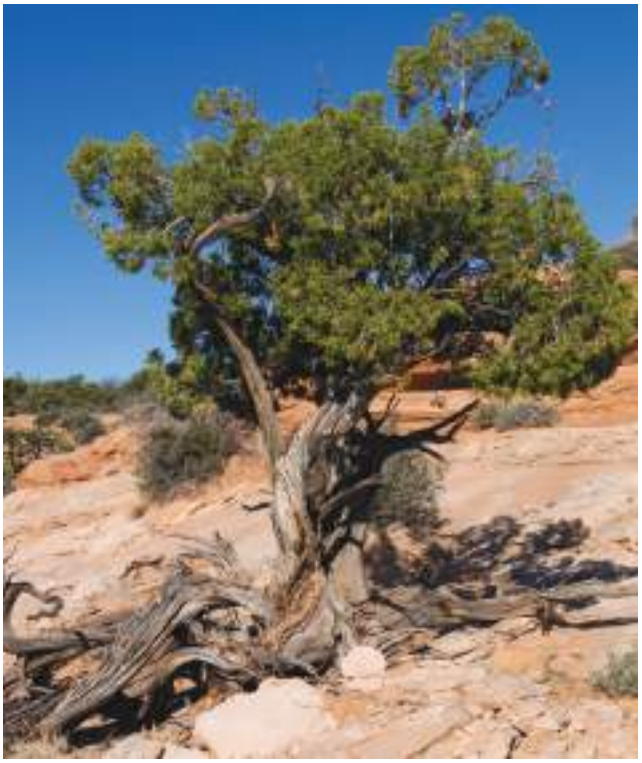
The "Weather Channel" for our Nation's forests

Within our lifetime, forests are going to change. But how much they will change is up to us. Forests may experience dramatic reductions in cover and enhanced mortality events due to increased drought and changing temperatures.

In partnership with the University of Arizona, ACES' *For the Forest* program has developed a revolutionary inventory of forest assets for western North America, utilizing millions of species occurrence records to create first-of-its-kind maps of our current forests. When coupled with the most cutting-edge climate models, a high-resolution picture emerges of what our Western forests are likely to look like in the future.

The model includes current and future species distributions (in ten-year increments) of 100 Western tree species under both best- and worst-case climate change scenarios. The resulting animations paint a sobering picture of our future forests if global action is not taken. We are also working with a 3D visualization platform and are producing movies illustrating how various communities will look as our forests change under different climate scenarios.

The website housing both the interactive geospatial portal and the results of our initial scientific analyses can be explored at *www.forestforecasts.org*.



As the West continues to get hotter and drier due to climate change, ACES' Forest Forecasts model shows that Aspen's climate will become increasingly hospitable to woodland tree species such as juniper and pinyon pine.

The green areas on these maps illustrate the dramatic reduction in habitat suitability for quaking aspen trees (*Populus tremuloides*) over a 70 year period under the worst-case climate change scenario. Forest change animations for 100 tree species can be explored at *www.forestforecasts.org*.

THE WEST COULD LOSE 40% OF OUR FORESTS BY 2080

Forest Health Index

ACES' Forest Health Index provides an annual "report card" for our watershed's forests, utilizing data from over 20 climatic, ecological, and socioeconomic indicators. The second annual Forest Health Index for the Roaring Fork Watershed was released in January 2015 with an overall score of 82 (a four point improvement). In addition to updating existing indicators, we added several new indicators including more in-depth treatments of streamflow and snowpack. The City of Aspen has formally adopted the Index as an ecological health metric for their Sustainability Dashboard, and ACES co-authored an academic paper on the science behind the Index that will be published in the Journal of Forestry this year.

Our forest is the dominant feature of our local landscape, providing critical ecosystem services such as clean air and water as well as aesthetic and recreational benefits. Forest health, in large part, equates to environmental health.

Essential aspects of forest health such as resiliency are difficult to measure, especially within systems as large and complex as a forest. To create

A snapshot of this year's Forest Health Index score for the Roaring Fork Watershed. Over 20 climatic, ecological, and socioeconomic indicators of forest health can be explored at *www.foresthealthindex.org.*

The second annual Forest Health Index for the Roaring Fork Watershed produced an overall score of 82, up from 78 in 2013.

a scoring system that applies across such diverse datasets, the score for any given indicator is based on the magnitude of change between the current state of that indicator and it's historic or "normal" state. An indicator with a score of 100 signifies virtually no departure from "normal" conditions. To that end, the Forest Health Index is truly a metric of forest change.

This first-of-its-kind numerical index can be explored at *www.foresthealthindex.org*.

The Forest Health Index is a project of ACES' *For the Forest* program. ACES partners with Aspen Global Change Institute to design the index, gather and analyze data, engage with stakeholders, and evaluate its scientific accuracy.

Students from Aspen Middle School use ACES' Forest Health Index website to practice reading graphs while learning about their local forest ecosystems.

The Forest Health Index helps illustrate the connection between forest health and ecosystem services. For example, the healthy forest below shades the snowpack better than the unhealthy forest above, allowing the forest to act as a reservoir for water.

ACES recently installed a stream gauge on the Roaring Fork River, which records flow levels every 20 minutes.

ACES expands forest monitoring initiatives

STREAM GAUGE

In November 2014, ACES, in partnership with the City of Aspen, installed a gauge on the Roaring Fork River to aid in several aspects of ACES' forest health and science education programs. The gauge, which is located on the bridge connecting the old Powerhouse site with the John Denver Park in Aspen, records stream flow every 20 minutes. Photos of the river are also taken at this site three times per day to accompany the flow data and tell a more complete story of what different flows look like. Both stream flow data and photos are sent via cell signal to a computer for storage and analysis.

Most of the climatic, ecological, and socioeconomic datasets utilized by ACES' Forest Health Index project are collected by outside agencies. The addition of this ACES-generated dataset will help tell the ecological story of our valley in a more complete fashion. This real-time data is displayed on the ACES website and in our Hallam Lake visitor center, where 25,000 residents and visitors per year visit. Interpretive signs (to be installed near the gauge in Summer 2015) will educate visitors on the issues impacting our local rivers, and also direct them to where they can view the data online.

NATURENET

ACES has partnered with researchers from the University of North Carolina Charlotte, the University of Colorado, and the University of Maryland to bring an exciting new citizen science application called NatureNet to ACES' Hallam Lake visitor center. NatureNet allows visitors to parks, preserves, and open

spaces to share their observations and photos of the natural world, comment on other's observations, and ask questions.

Visitors to Hallam Lake can borrow a smartphone to take with them on a walk around ACES' 25-acre nature preserve. They can then upload their plant and animal observations via the easy-to-use NatureNet app on the smartphone. Their photos and observations appear instantly on a tabletop computer back at the visitor center, where other visitors can view and comment. This method of crowdsourcing information engages visitors' sense of place while providing researchers with valuable biodiversity data.

In today's increasingly gadget-based world, we hope that applications like NatureNet will help bridge the divide between technology and the natural environment. NatureNet is part of a National Science Foundation research project.

WILDLIFE CAMERAS

Another valuable tool for monitoring biodiversity on ACES' sites are the wildlife cameras installed in summer 2014. These "trail cams" are motion sensitive cameras on the preserve that spot wildlife in their natural setting. These cameras help scientists, naturalists, and nature-enthusiasts better understand wildlife habits. Each picture is stamped with a date, time and temperature.

Since the cameras have been in use, ACES has captured videos of bears, beavers, coyotes, foxes, raccoons, elk, deer, squirrels, and even a pine marten. The cameras are frequently moved to monitor a variety of habitat types, and the stunning diversity routinely captured by the cameras highlight the importance of smaller parcels of open space. ACES' Hallam Lake preserve is only 25 acres and located in the middle of Aspen, but it is still a true haven for wildlife.

To view ACES' Hallam Lake wildlife footage, visit aspennature.org.

ACOUSTIC ECOLOGY

Portable field recording technology also supports new areas of study and inquiry. ACES is partnering with acoustic ecologist Thompson Bishop on a multi-year acoustic recording project at Hallam Lake. The purpose of this project is two-fold: to assess the acoustic soundscape of the preserve as it is today and to begin tracking the long-term change of this soundscape. This project aims to create a one-of-a-kind dataset recorded both acoustically (as we hear) and quantitatively (sound pressure level data).

The continued encroachment of human-produced sounds into the natural world has profound consequences to quality of wildlife habitat. By gathering long term acoustic data, we can better understand the delicate balance of life in the wildland-urban interface.

Data Providers

- Aspen Global Change Institute
- Aspen Historical Society
- Bureau of Land Management
- City of Aspen
- Colorado Oil and Gas Conservation Commission
- Colorado Parks and Wildlife
- Colorado State Demographer
- Colorado State Forest Service
- Colorado State University
- Headwaters Economics
- National Atmospheric Deposition Program
- National Aeronautic and Space Administration
- National Climate Assessment
- National Climatic Data Center
- National Resource Conservation Services
- Pitkin County
- Roaring Fork Conservancy
- University of Arizona
- Upper Colorado River Interagency Fire Management Unit
- United States Forest Service
- United States Geological Survey

For detailed information on data collection for this report, please visit *www.foresthealthindex.org.*

Join Us in Protecting Our Forests

www.ASPENNATURE.ORG

www.FORESTHEALTHINDEX.ORG

www.FORESTFORECASTS.ORG

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