

FORCIA DO'S

ROARING FORK WATERSHED

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Cover: Hunter Creek flows through a mixed conifer forest in Aspen's wildland-urban interface. Healthy, diverse forests provide numerous ecosystem services for human benefit, including clean water.

Right: Healthy high elevation spruce-fir forests act as reservoirs for snowpack, shading and gradually releasing it for municipal, agricultural, and recreational use. Currently, the biggest threat to these forests in Colorado is the spruce beetle.





INTRODUCTION



Trees: Climate Refugees on the Run

Question: How fast can a tree "run" uphill? The answer: 0.000000135 mph.

While that may sound slow, it is 500 vertical feet in 80 years. According to a recent study by the CA Dept. of Fish and Wildlife, key tree species in the Sierra Nevada Mountains have moved that far as new saplings take root farther up mountainsides.

This should be very concerning to you!

Why are trees running for their lives? Mainly because last year was, yet again, the hottest year on record. In my 25-year career in sustainability, I have said that statement in various reports and presentations in 12 different years as global mean temperatures continue to rise.

Trees respond to these temperature increases by moving to cooler, more suitable habitats, in some cases uphill to higher altitudes and in other cases to more northern latitudes.

According to ACES own Forest Forecasts model (see page 14), the saguaro cactus, once seen only around Arizona, may move as far north as Oregon; quaking aspen may no longer reside in the valleys around Aspen; and, under a worst case scenario, high elevation spruce-fir forests could be reduced in area by as much as 90 percent – all in the next 70 years.

This is a problem because forests support life. U.S. forests absorb more than 13 percent of human-caused U.S. emissions of carbon dioxide, and therefore are considered to play a crucial role in mitigating the magnitude of climate change. Forests store water in the form of snow, and no snow means no healthy rivers in our mountainous state.

This is also a problem because 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 recreation. Simply stated, forests are the ecological foundation for plant, animal and, yes, your own life.

But a forest can go from being a climate asset to a carbon producer very quickly when they die. We are already seeing this effect in California where a lethal combination of drought, heat, and voracious bark beetles has killed 26 million trees in the Sierra Nevada over the last eight months and 66 million trees since 2010. Here in Colorado, a million acres of forest were damaged by insects and diseases in 2015 alone.

In June 2016, Agriculture Secretary Tom Vilsack said, "Tree die-offs of this magnitude are unprecedented."

At ACES, we are working on forest health projects on a local, regional and national level. This past spring, ACES, in partnership with Pitkin County, the City of Aspen, and the U.S. Forest Service, conducted a 900-acre prescribed fire in Aspen's Hunter Creek Valley to improve wildlife habitat and reduce hazardous fuels (see page 22). Merely months later, the site is already regenerating plentiful forage for wildlife.

Tom Tidwell, the Chief of U.S. Forest Service, highlighted the burn in two of his weekly newsletters as an example of federal agencies, local governments, and nonprofits working together across jurisdictional boundaries.

ACES is currently working on its fourth iteration of the Forest Health Index, online at www.ForestHealthIndex.org (see page 32). Organizations from across the country have taken notice of this innovative tool and ACES is consulting on several similar efforts.

ACES Forest Forecasts model at *www.ForestForecasts.org* (see page 31) is currently utilized by over 6,000 individual users and has been featured in numerous publications in addition to peer-reviewed academic papers.

ACES continues to expand our forest health education initiatives both in the classroom and out in the field. ACES Educators and Naturalists receive comprehensive training on our forest initiatives. Our Kid's Naturalist Field School program features an entire week devoted to forest health. Our "Know Your Trees" program attracts numerous participants every week in the summer.

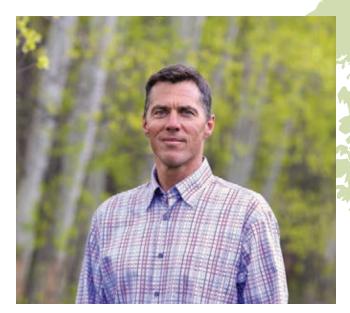
This third edition of ACES *State of the Forest Report* provides updates on climatic conditions and insects and diseases affecting local forests. It dives deeper into future forests, analyzes the interaction between spruce beetles and wildfire, and offers insight into collaborative solutions to the Forest Service funding crisis.

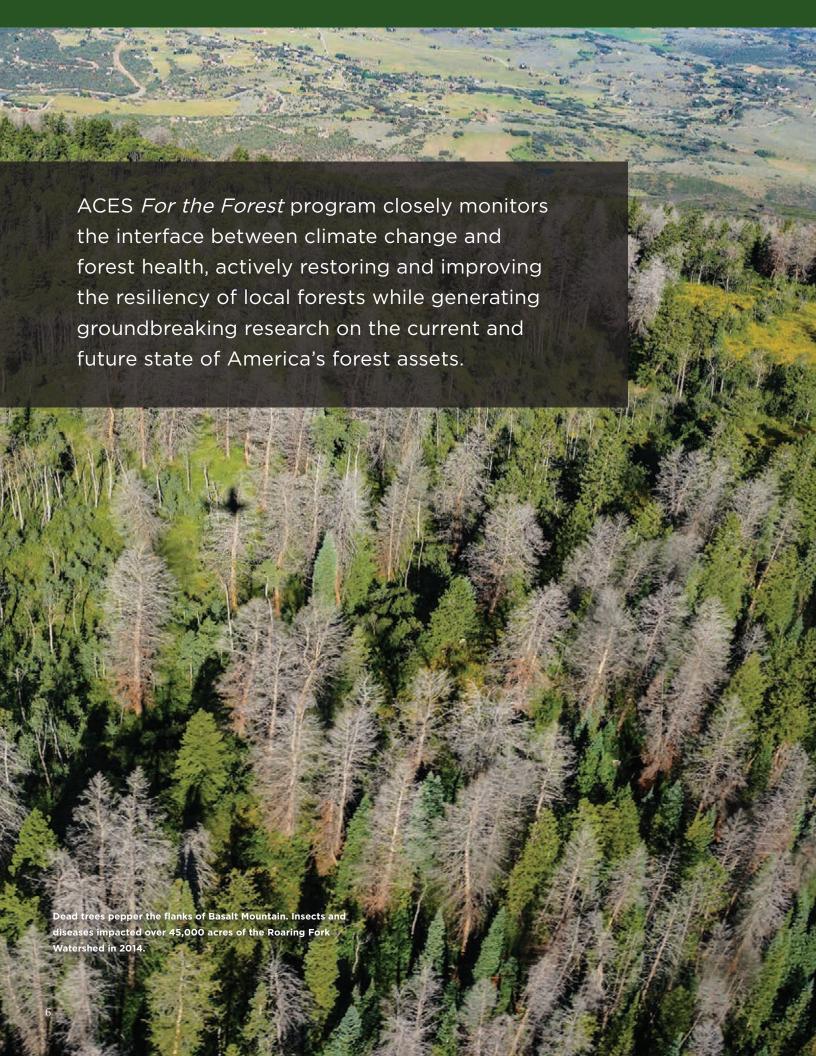
Most of all, it is our hope that this report will educate citizens, policy makers, federal, state and local governments, and land managers to take action on forest health and conservation issues.

Together, we can help awaken the world to our tree refugees, running for their lives.

CHRIS LANE,

CEO, Aspen Center for Environmental Studies





EXECUTIVE SUMMARY

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 the research, management, and policy issues informing local forest health. A staggering 71% of the watershed's 1,451 total square miles is forested, underscoring the importance of this critical resource.

It's impossible to address the changing state of our forests without first addressing its root cause: climate. This report utilizes data from 2014, which is the most recently available iteration of this comprehensive dataset. Local climatic trends in 2014 trended towards average, although global temperatures continue to rise. Snowpack was 82% of average, and since forests rely on plentiful snowmelt to defend themselves, this likely contributed to the regional increase in insect and disease infestation seen in 2014. For more information on the current state of our local climate, please see page 8.

Roaring Fork Watershed forests saw a 19,000-acre increase in insect and disease damage from 2013 to 2014, the first year affected acreage has increased since 2010. Most of this damage can be attributed to a dramatic increase in subalpine fir decline. For more information on local forest insect and disease infestations, please see page 10.

The main factor driving this increased mortality is the hotter and drier conditions brought on by climate change. To further understand the potential future consequences of climate change on forest distribution, ACES partnered with the University of Arizona to create *ForestForecasts.org*, an interactive tool that illustrates future forest change under best-and worst-case carbon emissions scenarios. For more on this groundbreaking tool and how international climate policy can impact the fate of our future forests, please see page 14.

ACES continues to endeavor to incorporate cutting-edge academic research into our educational initiatives and on-the-ground restoration projects. A recent study by ecologists at the University of Colorado on the relationship between spruce beetle infestations and wildfire severity found that instead of one phenomenon influencing the other, they are both symptoms of a bigger issue: climate change induced warming and drought. For more on the complex ecological relationship between climate change, beetle infestations, and wildfire activity, please see page 18.

ACES is also tackling regional forest health issues through on-the-ground restoration efforts to increase forest resiliency. This spring, following an extensive planning process, ACES partnered with the U.S. Forest Service on a 900-acre prescribed fire in the Hunter Creek Valley. For more on this effort, which serves as a powerful example of collaborative restoration, please see page 22.

In 2015, a record \$2.1 million was spent battling wildfires in the United States. Wildfire is treated differently than other natural disasters in that all costs incurred fighting fires comes straight out of the U.S. Forest Service budget, taking away from funding for preventative fuels mitigation, habitat restoration, and recreation management. For more on how ACES is addressing the implications of this funding mechanism on regional forest health, please see page 26.

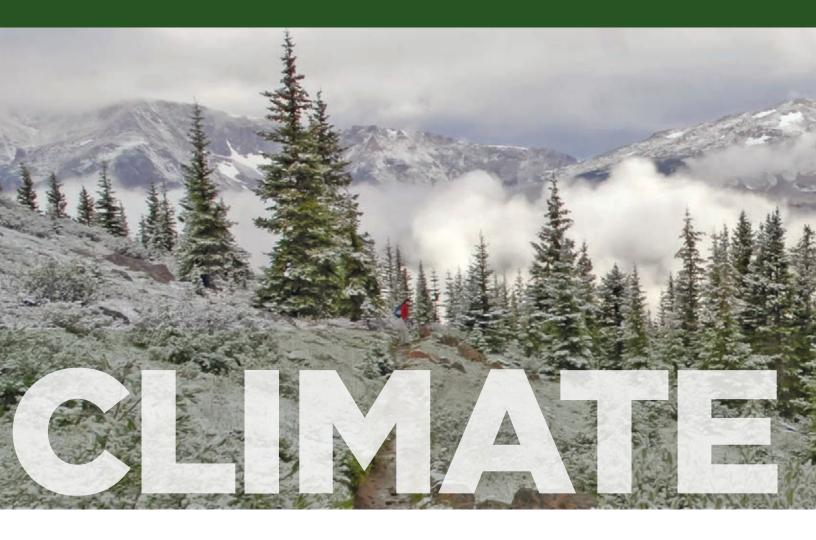
Through scientific research, regional monitoring programs, and on-the-ground restoration, ACES is committed to aggressively tackling the issues impacting forest health both regionally and on a national level. For more information on ACES forest health action initiatives, including Forest Forecasts, the Forest Health Index, and the Hunter-Smuggler Cooperative Plan, please see page 30.

As our climate continues to warm, our forests will continue to change, but how much they change is up to us. Through our extensive public outreach campaigns, educational programs, and science-informed restoration efforts, ACES is establishing a new paradigm for communicating and collaboratively addressing the challenges facing our forests today.

For more information on ACES' forest initiatives, please visit www.AspenNature.org/restore.

JAMIE WERNER
ACES Forest Programs Director





THE DRIVING FORCE IMPACTING FOREST HEALTH

The changing state of Earth's climate can trigger a feedback loop in forest ecosystems. Climate change leads to drought, making trees more susceptible to insect and disease infestation and catastrophic fire.

This leads to increased tree mortality, which releases more carbon dioxide into the atmosphere, perpetuating the cycle of climate change. Other increased risks include erosion, flooding, degradation of water supplies and loss of human structures.

ACES 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. This following graphic outlines how various climatic indicators of forest health fared in 2014.

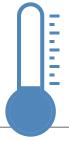


High elevation **snowpack** was **82% OF AVERAGE**



2014 Climate Impacts to our Watershed

There were 72% FEWER DAYS that reached zero degrees or below in Aspen



There were two more inches of PRECIPITATION IN ASPEN than average



18

The length of the **FROST FREE** period in Aspen was

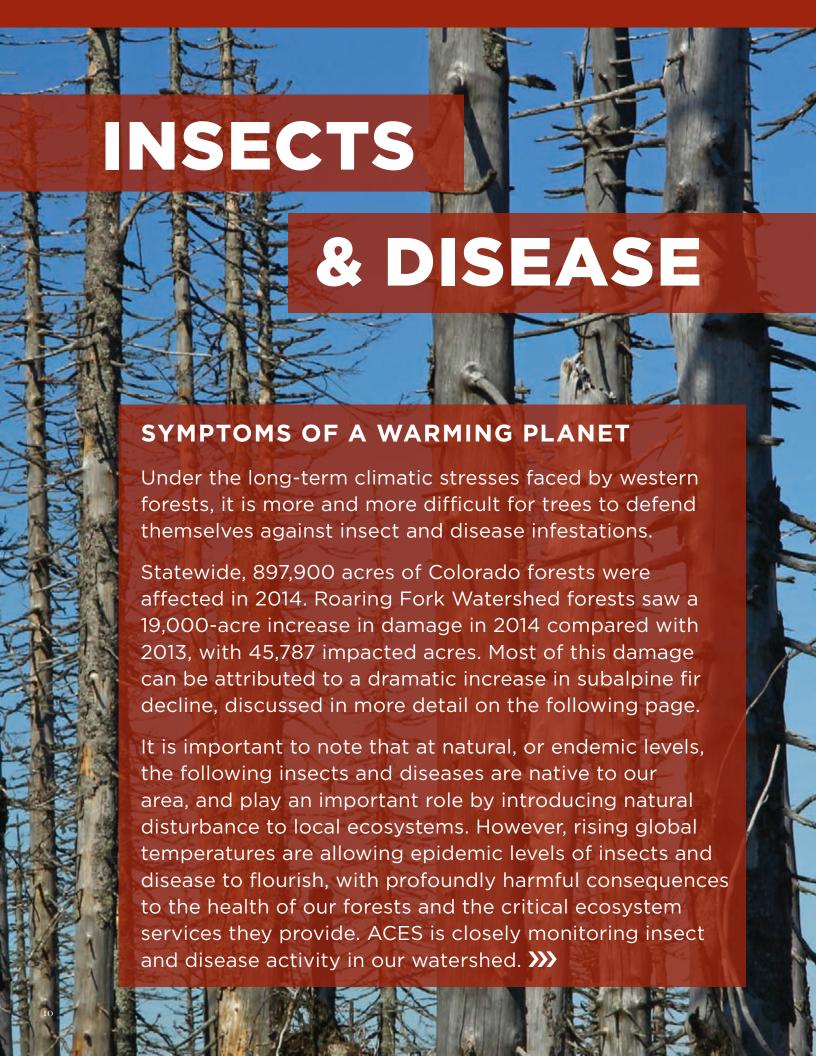
18 days longer than average

Onset of **SNOWMELT** occurred **two days earlier** than average



INSECTS & DISEASES affected 6.9% of our watershed's forests (about average)









SUBALPINE FIR DECLINE

Watershed Acres Affected: 34,316

For the 17th consecutive year, subalpine fir decline was far and away the most destructive force in Roaring Fork Watershed forests, comprising 75% of all insect and disease damage in 2014. The area impacted by subalpine fir decline nearly doubled in 2014 (34,316 acres) compared with 2013 (19,318 acres). This is the first increase since 2010. This is unwelcome 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, in addition to degradation of water availability and quality.

"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 confusus). The root fungi weaken the trees' defenses and allow the beetles to launch a successful attack.



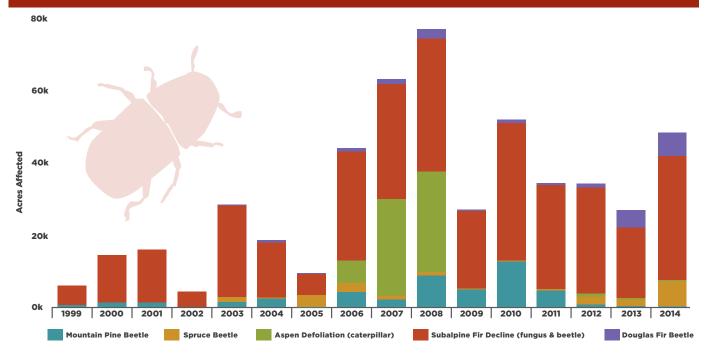
DOUGLAS FIR BEETLE

Watershed Acres Affected: 4,424

While less of an issue statewide, Douglas fir beetle (*Dendroctonus pseudotsugae*) was the third biggest threat to Roaring Fork Watershed forests in 2014. The impacted area totaled 4,424 acres, a 500-acre decrease from 2013. Despite the slight decline in damage, the past two years of infestation have been the highest on record for our watershed. 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 anticipating future beetle activity.

Left: A forest decimated by the spruce beetle. The absence of needles, bark, and branches tells us that this particular infestation is several years old. Below: Regional increases in acreage impacted by subalpine fir decline, Douglas fir beetle, and the spruce beetle (discussed in detail above and on the following page) contributed to the increase in local insect and disease damage in 2014.

Roaring Fork Watershed Insect & Disease Damage



INSECTS & DISEASE



SPRUCE BEETLEWatershed Acres Affected: 6,898

For the third consecutive year, the spruce beetle (*Dendroctonus rufipennis*) was by far the most destructive epidemic impacting Colorado forests. In 2014, 485,000 acres of the state's high-elevation Engelmann spruce forests were damaged by the spruce beetle, a 87,000-acre increase from 2013. Due to Colorado's high concentration of spruce forests, the epidemic is not expected to subside soon. Multiple years of drought have weakened the trees' ability to use their sap to expel, or "pitch out" the beetles. Trees that have blown down in storms, called windthrow, also provide ideal breeding grounds for the spruce beetle. In 2011, a storm with high winds generated plentiful windthrow in Colorado's 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, 6,898 acres of forest were impacted by the spruce beetle in 2014, up significantly from 1,850 acres in 2013. With 40% of our watershed comprised of spruce-fir forest, this increase is very concerning. These high-elevation forests act as reservoirs for locales as far away as Los Angeles, and widespread forest mortality degrades water quality and compromises supply.





MOUNTAIN PINE BEETLEWatershed Acres Affected: 11

The mountain pine beetle (*Dendroctonus ponderosae*) has impacted an astounding 3.4 million acres of Colorado forest since 1996, bringing with it devastating impacts to carbon storage, water supplies, and recreation. Statewide, mortality rates were at their lowest since 1996 in 2014, impacting 15,000 acres, with most of the damage occurring in northern Colorado. 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, which is to say that the beetles have essentially eaten their way through most of Colorado's lodgepole and ponderosa pine forests.

In the Roaring Fork Watershed, a mere 11 acres of forest were impacted by mountain pine beetle in 2014. This is especially impressive when compared with the 12,432 acres locally impacted by the mountain pine beetle at its peak in 2010. At this endemic, or natural, level, 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.

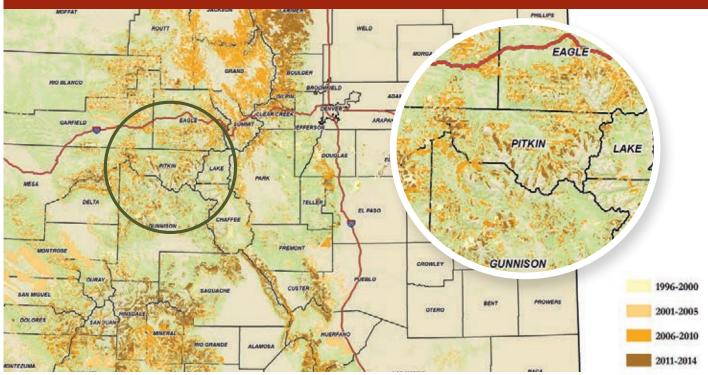
ASPEN DEFOLIATION

Watershed Acres Affected: 138

In 2014, 138 acres of aspen forests in our watershed were impacted by defoliating insects (down from a high of 27,590 in 2008). 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. Fortunately, extreme outbreaks generally only last 2-3 years, evidenced locally by high levels of impact from 2006-2008 followed by a dramatic decline (see chart on page 11).

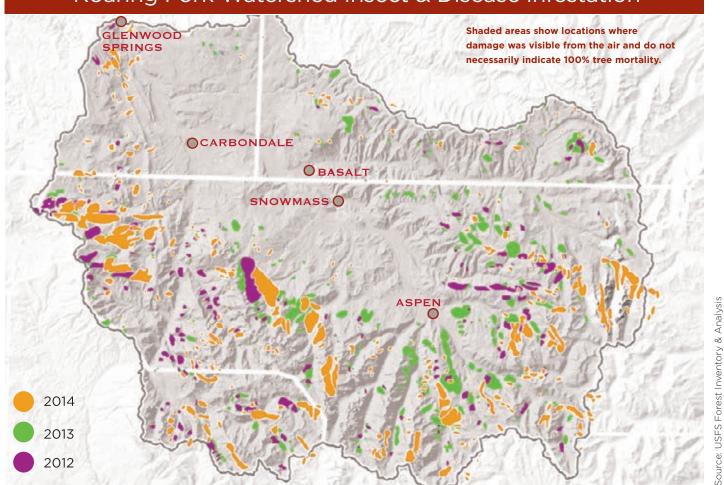
This is good news for our aspen forests given the ecological and aesthetic significance of the species to our area. In addition to providing critical wildlife habitat, these iconic trees are responsible for much of the scenic beauty that draws visitors to our area, contributing to the economic well-being of our region.

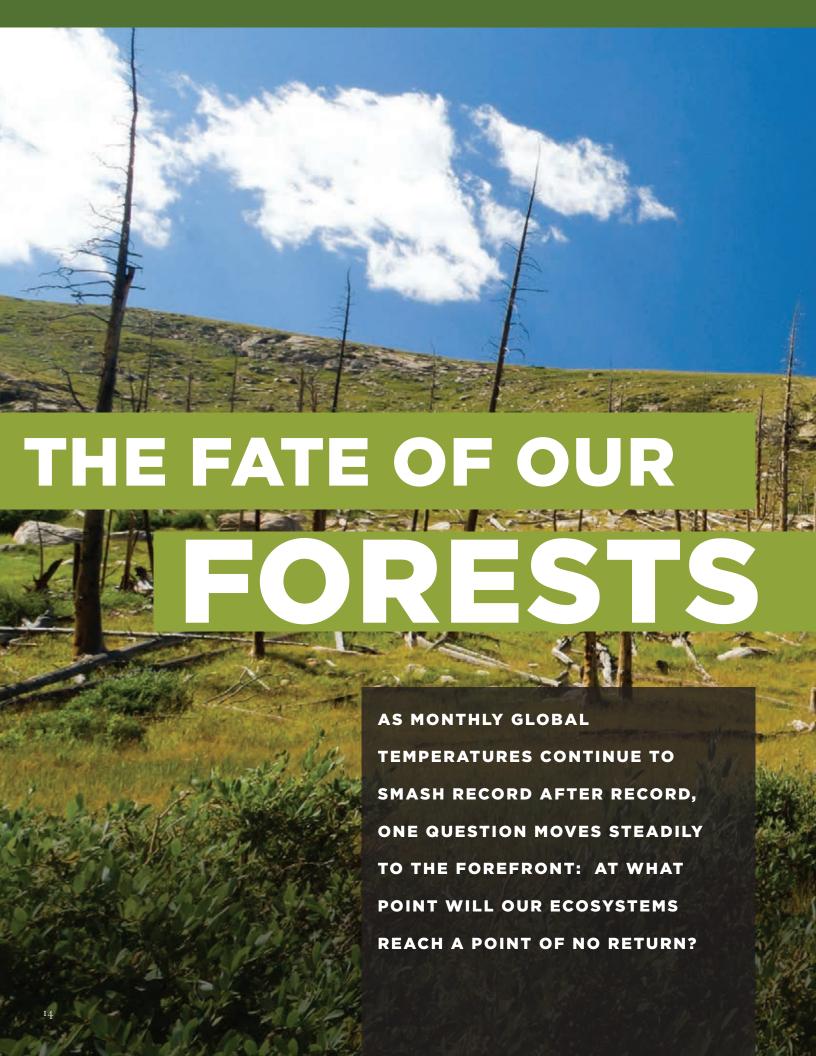
Forest Insect and Disease Progression in Colorado 1996 - 2014



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









THE FATE OF OUR FORESTS

The threshold beyond which global warming becomes catastrophic and irreversible is estimated to be 3.6°F above pre-industrial levels. If global carbon emissions remain on their current trajectory, we are heading for a rise of around 7.2°F by the end of the century, with profound consequences for our forests and the ecosystem services they provide.





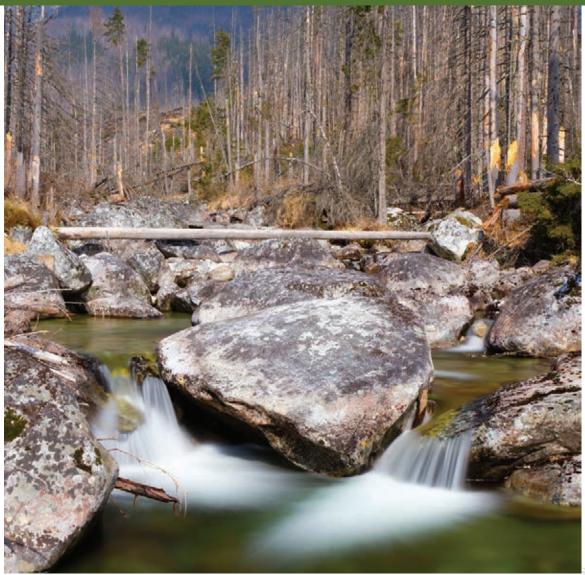
The above screengrabs from forestforecasts.org illustrate the dramatic reduction in habitat suitability (depicted in green) for Engelmann spruce between now and 2080 under the worst-case "business as usual" climate change scenario. The interactive online tool produces animations of the future ranges of 100 tree species under two carbon emissions scenarios.

In a recent field study published in *Nature Climate Change*, scientists from Los Alamos National Laboratory examined the impacts of drought on tree mortality rates in New Mexico. In a five-year period, they found that a 48% reduction in rainfall resulted in the deaths of 80% of the piñon pines in the study area and 25% of juniper trees. By extrapolating these findings using regional climate models, they concluded that 72% of evergreen forests in the American Southwest would likely experience widespread mortality by 2050. These same models predicted nearly 100% mortality by the year 2100.

ACES Forest Forecasts model, which can be explored at www.forestforecasts.org, examines the relationship between climate change and forest mortality for 100 tree species in the western United States. The interactive tool, created in partnership with scientists from the University of Arizona, combines millions of tree species observations with the latest climate models to illustrate how our forests are expected to respond to climate change under best-and worst-case emissions scenarios.

While the results of the accompanying data analyses are sobering, they also drive home the point that we have a choice as to how much our forests will change depending on how aggressively we tackle climate change. For example, under the best-case carbon emissions scenario, forest coverage in the Western U.S. is expected to decrease by 15-20%. Under the worst-case emissions scenario, however, loss of forest coverage jumps to 40%.

Forest loss on this scale will drastically impact the critical ecosystem services that forests provide, and we can expect to see more fires, loss of drinking water, and further feedbacks to the climate change loop. Our treasured landscapes will look drastically different, and recreation and economic opportunities connected to our forests will suffer.

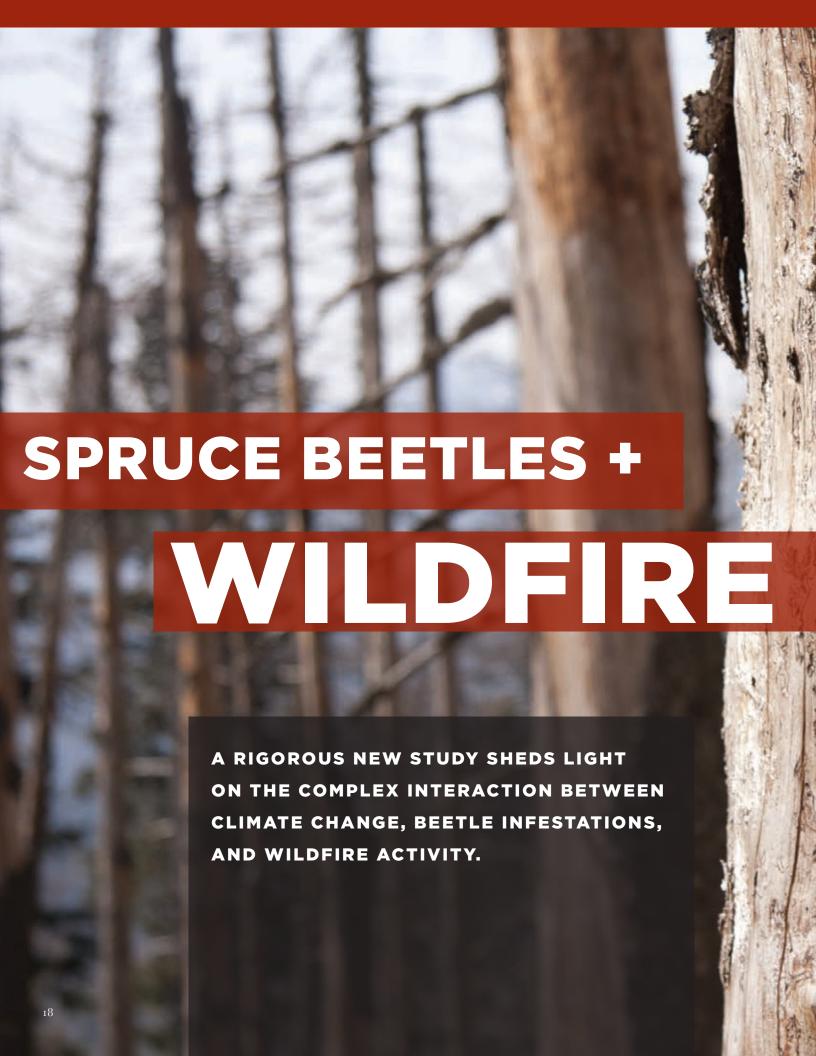


Changes in forest cover can also impact stream health by changing runnoff patterns and water temperatures.

International emissions policies and conservation efforts play a critical role in the fate of our future forests. At the climate talks held recently in Paris, more than 60 countries voiced their commitment to forest conservation. Globally, one of the biggest steps to curbing climate change and improving forest health is reducing rates of deforestation, particularly in equatorial regions. Living trees absorb atmospheric carbon but dead trees release it, further perpetuating the cycle of climate change. It is estimated that our planet's forests absorb a quarter of human-produced carbon dioxide, close to the same amount emitted by all the world's automobiles.

One of the biggest hurdles facing the effort to curb deforestation rates and capitalize on our forests' carbon-storage capacity is the lack of a market to further incentivize global financial aid to developing countries for forest conservation. Funds are needed to help enforce anti-deforestation laws and boost economic development, which would provide an alternative to illegal logging practices. While the final agreement language is still being negotiated, Britain, Norway, and Germany have already pledged \$5 billion for forest conservation in poor countries through 2020.

But the question still remains: what can be done at the local level to preserve forest health? Most importantly, citizens can encourage their elected officials to support policy that calls for drastic reductions in carbon emissions. Secondly, local elected officials can prioritize restoration efforts that increase the resiliency of local forests. ACES is facilitating this work as the leader of the Hunter-Smuggler Cooperative Plan, a 20-year stewardship plan to improve forest health, increase wildlife habitat, and reduce catastrophic wildfire risk on over 4,000 acres in Aspen's wildland-urban interface. **





SPRUCE BEETLES & WILDFIRE

ACES endeavors to incorporate cutting-edge academic research into our educational initiatives and on-the-ground restoration projects, particularly as it relates to large-scale disturbances such as insect and disease infestations and wildfire.

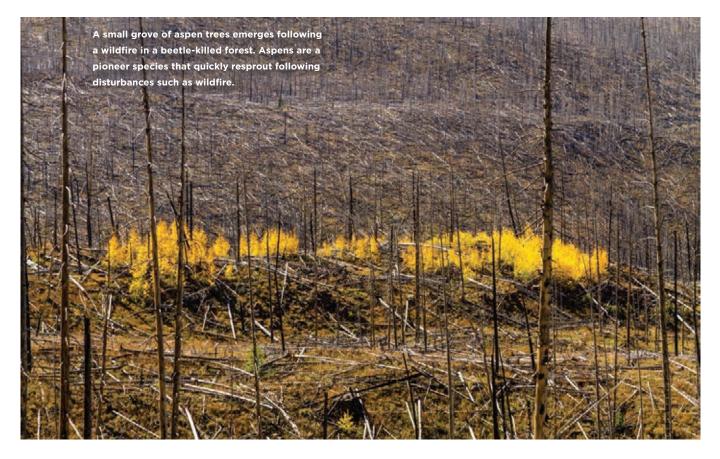
A new study published this year by University of Colorado ecologists (Andrus et al. 2015) indicates that beetle infestations and the severity of wildfires are unrelated symptoms of a larger issue: climate change induced warming and drought.

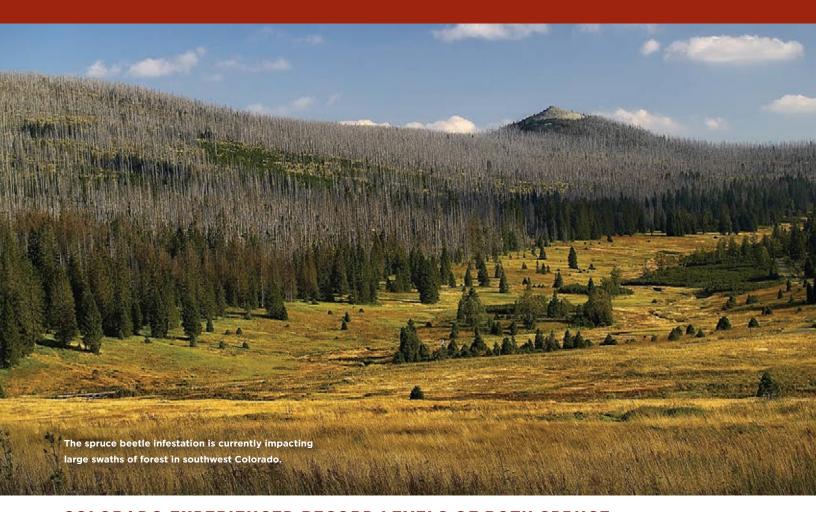
On the surface, it seemed to be a simple hypothesis: dead, beetle-killed forests will produce more severe wildfires than living ones. Anyone who has built a campfire with dry versus live kindling would probably agree.

Prior to this study, there was disagreement over whether beetle mortality was a key driver of wildfire severity, with implications to land management practices and resource allocation. This study found that pre-fire spruce beetle infestation in southwest Colorado was unrelated to fire severity.

The Western U.S. has seen a dramatic rise in both forest insect and disease infestations and wildfire activity in recent years. In Colorado, the mountain pine beetle epidemic is subsiding, but spruce beetle activity is on the rise, affecting 409,000 acres of Engelmann spruce forest in 2015. Both of these beetles are native to Colorado and outbreaks typically occur following warm and dry climate events, which will likely be more frequent as temperatures warm.

Wildfire activity follows a similar trend, with over 10 million acres burned in Colorado in 2015 (an all-time high). It is important to remember that fire plays an important ecological role in many forest ecosystems in Colorado, but its relationship varies. In high-elevation spruce-fir forests, cool, moist conditions typically prevent fire activity. However, when severe drought combines with hot, dry, and





COLORADO EXPERIENCED RECORD LEVELS OF BOTH SPRUCE BEETLE INFESTATION AND WILDFIRE IN 2015.

windy conditions, large areas may burn. Lengthy firefree periods in these forest ecosystems naturally allow dense forests and large quantities of fuel to build up, leading to an infrequent, high-severity fire regime.

The previously mentioned study sought to address the uncertainty associated with the complex interaction between two forest disturbances by examining whether spruce beetle severity influenced fire severity. The location of the study, in the eastern San Juan Mountains of southwest Colorado, has recently experienced several high-elevation fires, including the West Fork Complex Fires (the second largest fire in state history at 110,405 acres). Much of the area that burned had experienced recent and widespread spruce beetle mortality as well.

To determine spruce beetle severity in the burn area, scientists peeled sections of bark off each dead tree and checked for beetle galleries to determine the proportion of trees that were killed by beetles in advance of the fire. When compared with the total number of trees killed by the fire (the definition of fire severity in this study), they could determine whether spruce-fir stands with higher spruce beetle infestation lead to more severe wildfire.

The study found that forest stands with higher spruce beetle infestation did not lead to more ecologically severe fire. Instead, weather conditions during the fires (hot, dry, and windy conditions), rugged mountainous terrain, and stand structure (tree size and density) had a much greater influence on fire severity then previous beetle infestation.

It should be noted that this study does not consider fire behavior or firefighter safety, which remain extremely relevant to policy and management approaches. What it does do is help inform both the scientific community and the general public about the complex ecological relationship between beetle infestations and wildfire activity, particularly in the face of climate change. **

Special thanks to University of Colorado ecologist Robert Andrus for lending his technical expertise to this piece.

Andrus, R. A., Veblen, T. T., Harvey, B. J. and Hart, S. J. (2016), Fire severity unaffected by spruce beetle outbreak in spruce-fir forests in southwestern Colorado. Ecol Appl, 26: 700–711. doi:10.1890/15-1121



and monitoring process, a suitable spring burn window presented itself for the U.S. Forest Service White River National Forest to conduct a prescribed fire on the south-facing slopes in the Hunter Creek Valley. The operation, part of the ACES-led Hunter-Smuggler Cooperative Plan, sought to enhance wildlife habitat and reduce hazardous wildfire fuels in aspen and mountain shrub ecosystems. The burn successfully treated 900 acres in the wildland-urban interface adjacent to Aspen.



HUNTER CREEK PRESCRIBED FIRE

As increased drought conditions and warmer temperatures continue to impact the American West, hotter and more intense wildfires have become the new normal. Adding to the complexity of the issue, many of the forest ecosystems in our 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, it is impractical to allow natural ignitions to burn freely in the wildland-urban interface adjacent to Aspen.

ACES continues to partner with local land managers to tackle this issue from a variety of perspectives. On Smuggler Mountain, mechanical treatments such patch cuts were employed in even-aged lodgepole pine stands to reduce fuels and increase age-class diversity. However, this approach is more costly and does not provide the ecological benefits of fire. Research shows that when excess vegetation burns, nitrogen and other nutrients are released into the soil, helping new plants grow. Some species even 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 creates 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.

Following months of preparation, personnel from multiple agencies gathered at the Aspen Ranger Station on the morning of the Hunter Creek Prescribed Fire for an operational briefing on safety, weather, burn objectives, logistics, and communication. Once in the field, a test fire was set to assess fire behavior and smoke dispersal. With test fire fuels and smoke responding as desired, a hand crew began lighting a swath called a blackline, designed to help contain the spread of subsequent aerial ignitions.

With black-lining and hand-lighting complete, aerial ignition operations via helicopter commenced. A device called a Plastic Sphere Dispenser was mounted to the side of the helicopter. The dispenser is filled with ping pong-like balls, called plastic spheres, which are incendiary devices used to start fires from the air. The number of spheres dropped helps determine the intensity of the burn. This is both an efficient and safe way to ignite a prescribed fire.

Left: Fire personnel used flares and drip torches to construct a blackline to help contain the fire before aerial ignitions began. Right: Most of the burn was ignited by helicopter, a safe, efficient, and precise means of putting fire on the ground.



The helicopter gradually worked its way upvalley, always progressing down the slope, traversing and dropping lines of plastic spheres. Fire behavior continued to produce the desired mosaic effect throughout the day. Natural barriers, such as snow, moisture-holding drainages, and previously blacklined firebreaks confined the fire to the desired units.

After a few hours, aerial ignitions were complete. By that time, the first area to be ignited was already reduced to a smolder. The desired mosaic effect was already clearly visible: the darker areas were burned, while the lighter areas were not, resulting in a healthier, more diverse ecosystem. The fire was closely monitored that night, and the cold, wet storm system in subsequent days helped cool any hot spots remaining within the burn area. The valley was cleared for recreation a few days later; however, users were advised to exercise caution and be aware of fireweakened aspen trees falling in the treatment area.

Fire personnel reported that the operation was successful; there were no safety mishaps, operations were done within prescription, wildlife objectives were met, and the weather cooperated as forecasted. Smoke impacts were minimal, and there were very few 911 calls due to extensive advance outreach.

The fire will improve habitat for elk, deer, and other native wildlife by stimulating brush and aspen regeneration and returning nutrients to the soil. The burn also cleared out a buildup of hazardous fuels, providing a buffer between the Hunter-Fryingpan Wilderness and the City of Aspen in the event of a future wildfire.

The prescribed fire was jointly funded by ACES, Pitkin County Open Space and Trails, and the City of Aspen, with additional outreach support coming from the USFS White River National Forest, Wilderness Workshop, and Aspen Fire. The successful implementation of this burn is the result of years of work on the part of these organizations and represents a victory for restoration and collaboration. *



PRESCRIBED FIRES IN THE U.S.

1998 878,290 ACRES TREATED **4,277 PRESCRIBED FIRES**



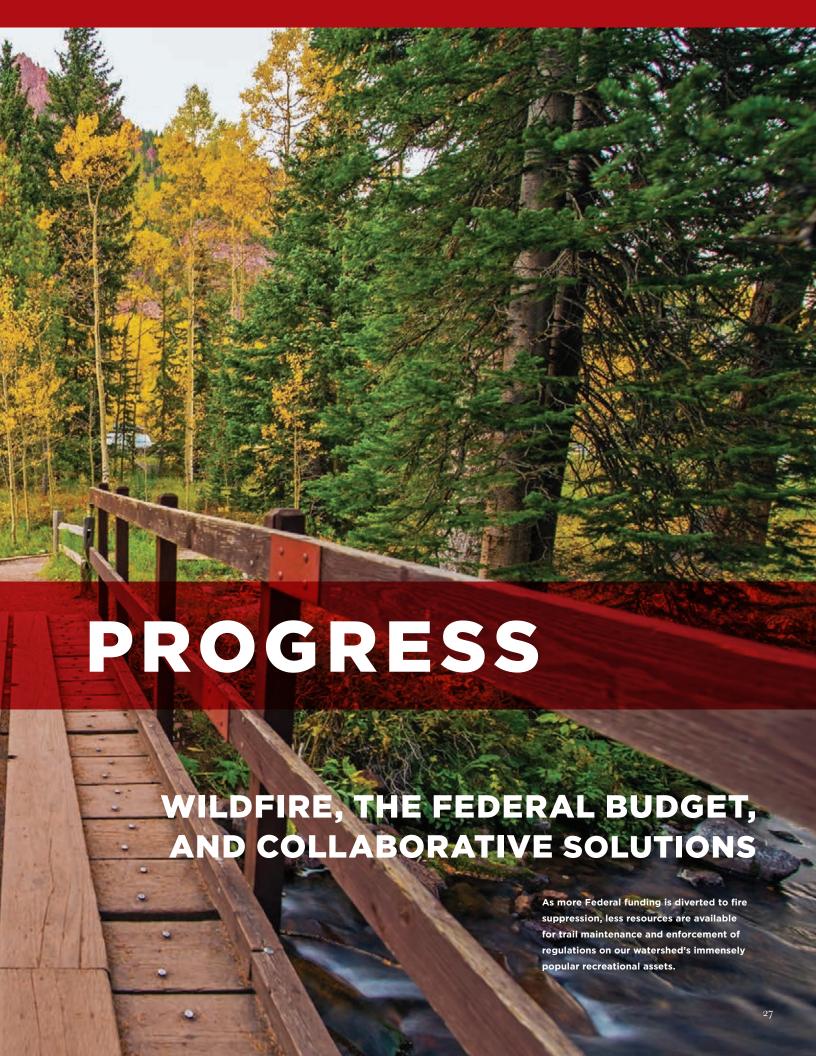
2008 **1,935,001 ACRES TREATED** 7,669 PRESCRIBED FIRES



2015 **2,958,260 ACRES TREATED** 37,263 PRESCRIBED FIRES







SUPPRESSING PROGRESS

BE IT A TORNADO IN OKLAHOMA, a flood in Louisana, a hurricane in New York, or an earthquake in California, one organization comes to mind when it comes to disaster recovery: FEMA, the Federal Emergency Management Agency. Part of the U.S. Department of Homeland Security and boasting an annual budget of \$13 billion, the agency's primary responsibility is to step in and provide disaster relief assistance when need overwhelms local and state resources.

Given the steady increase in catastrophic wildfire activity nationwide (over 10 million acres burned in the U.S. in 2015, the most ever), wouldn't it seem that FEMA would have their hands full helping with the \$2.1 billion spent suppressing those blazes? Surprisingly, no.

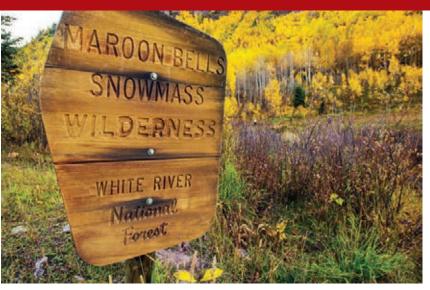
Wildfire is treated differently than any other natural disaster in that all costs incurred fighting them come straight out of the U.S. Forest Service (USFS) budget. No other Federal agency funding mechanism is structured in this way. Because of this, escalating suppression costs are consuming more and more of the USFS budget. In 2015, wildfire suppression comprised 52% of the total USFS budget, up 36% from 20 years ago. It's projected to rise to 67% in the next decade.

So what does this mean for forest health? The more funds directed out of the budget for wildfire suppression, the less funds available for preventative fuels mitigation, habitat restoration, and recreation management. This creates a crippling feedback loop: the USFS is unable to undertake management projects to create increased forest resiliency, which increases susceptibility to

wildfire, which further increases suppression costs, ultimately leading to an even higher percentage of the budget being diverted to suppression.

Furthering the struggle for the USFS to accomplish forest management objectives is the fact that 95% of the income generated locally goes into a common Treasury fund that is then nationally reallocated. The 2.3 million-acre White River National Forest (WRNF) is the most visited in the nation (with over 13 million annual visitors), and regularly brings in \$10 million more in income than it spends. This essentially translates to a profit for taxpayers. However, the WRNF annual budget continues to be slashed: from 2010 to 2016, the annual budget went from \$30 million to \$18 million, and 40 positions remain vacant due to lack of funding. At the same time, visitation continues to rise, and along with it, demand for resources and projects. The economic analysis isn't difficult: supply and demand are headed in vastly different directions.

From a policy standpoint, the problem is so systemic that it will take an act of Congress to fix, and that in all likelihood won't happen anytime soon. In the meantime,



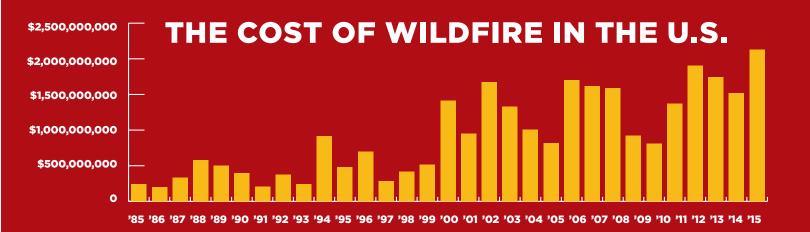


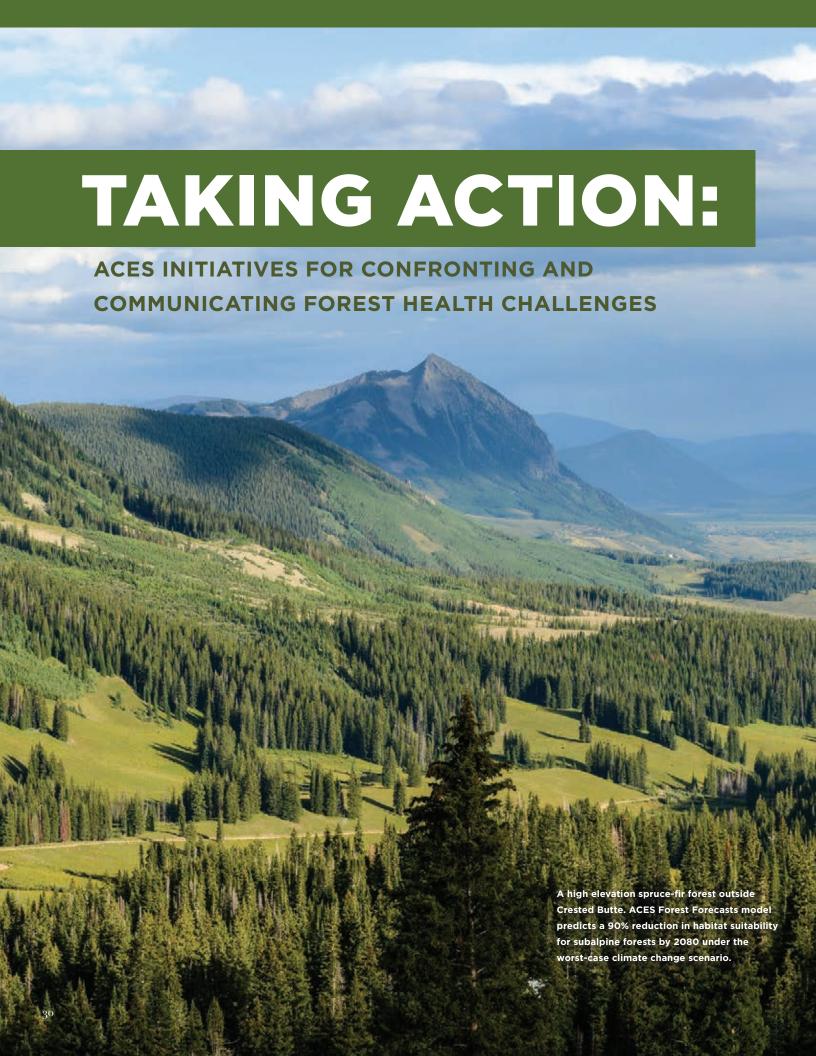
Left: The 2.3 million-acre White River National Forest sees over 13 million annual visitors, but its budget has been cut nearly in half since 2010. Right: Proposed legistration would allow national forests to retain a portion of revenue generated by ski area permit fees, helping to bridge the funding gap.

stakeholders are exploring other avenues to address the ever-increasing shortages, including potential legislation that would allow National Forests to keep a percentage of local ski area fees in discretionary funds that would be used to help manage increased recreational use. Many ski areas are on Federal land, and they pay a fee to the USFS to lease the land. In 2015, ski areas in the WRNF paid \$18 million in fees, but all of that money went to the U.S. Treasury as opposed to the WRNF. A new bill introduced in Congress this year, the Recreation Not Red-Tape Act, is currently under consideration and would allow a national forest to retain as much as 80 percent of the ski area permit fees collected at that forest.

While this approach would certainly help with enhancing recreational opportunities and interpretive activities, it doesn't do much to address management needs from a forest health and resiliency perspective, including fuels reduction and habitat improvement projects. To help bridge this gap locally, ACES led a multi-year approval process that resulted in the Hunter-Smuggler Cooperative Plan (see page 33), which essentially created a mechanism for outside entities to fund desperately-needed restoration projects on Federal land. For instance, ACES, Pitkin County, and the City of Aspen jointly funded the recent goo-acre Hunter Creek Prescribed Fire conducted by the USFS, which will improve wildlife habitat and reduce hazardous fuels in Aspen's wildland-urban interface.

This collaborative, cross-jurisdictional, watershed-scale approach to restoration set the precedent for legislation introduced as part of the Farm Bill that would help other non-Federal partners fund management projects on our National Forests. ACES strives to continue to be at the forefront of creative solutions to the budgetary challenges faced by Federal land managers. **





FOREST FORECASTS

As climate change continues to cause global temperatures to rise (2015 was the hottest year on record), increased drought and changing temperatures are predicted to trigger dramatic changes in forest cover and composition over the next few decades. These changes are happening on timescales within our lifetime—our forests are going to change, but how much they change is up to us.

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

The model currently includes current and future species distributions (in ten-year time slices) 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 have also been analyzing the local impact these changes may have on ecosystem services as well as integrating this valuable teaching tool into regional classrooms.



The website housing this interactive geospatial portal can be explored at ForestForecasts.org.



To view ACES award-winning animated short film *What's Happening in Our Forest?* visit youtube.com/user/aces81611.



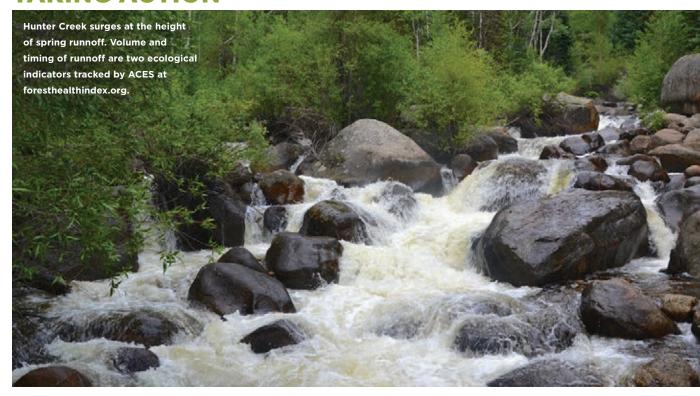






These screenshots from ACES interactive tool, forestforecasts.org, shows the habitat suitability (depicted in green) for aspen trees moving uphill in response to climate change.

TAKING ACTION



FOREST HEALTH INDEX

ACES FOREST HEALTH INDEX

provides an annual "report card" for the health of our watershed's forests, utilizing data from over 20 climatic, ecological, and socioeconomic indicators.

The 3rd annual Forest Health Index for the Roaring Fork Watershed was released in January 2016, boasting an overall score of 86 (a four point improvement!). A peer-reviewed academic paper co-authored by ACES was published in the September 2015 issue of the *Journal of Forestry*, adding substantial scientific credibility to

our work. In addition, the City of Aspen has formally adopted the Index as the ecological health metric for their Sustainability Dashboard.

The Forest Health Index is an interactive online tool developed by ACES to help the Roaring Fork Valley community make sense of the complex environmental conditions affecting our local forest. Essential aspects of

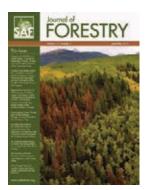
forest health such as resiliency are difficult to measure, especially within systems as large and complex as a forest. To create a scoring system that applies across such diverse datasets, the score for any given indicator is based on the magnitude of change between the current state of that indicator 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.

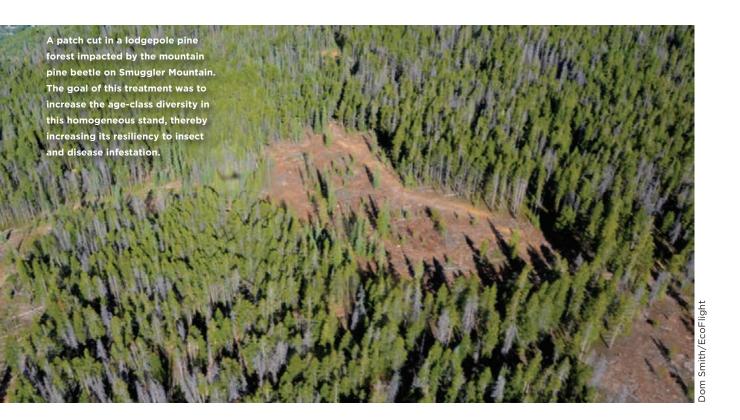
ACES is currently working with our Science Advisory Board to refine the scoring methodology for the Index. We are also working with educators to develop and implement standards-based curriculum for local students, using the Index as a means to connect scientific and technological skills to locally relevant data.

The Forest Health Index is a project of Aspen Center for Environmental Studies. ACES is partnering with Aspen Global Change Institute to design the index, gather and analyze data, engage with stakeholders, and evaluate its scientific accuracy.



This first-of-its-kind numerical Index can be explored at ForestHealthIndex.org.





HUNTER-SMUGGLER COOPERATIVE PLAN

IN APRIL 2014, the U.S. Forest Service formally approved the 20-year stewardship plan submitted by ACES Forest Program that outlines improvements to forest health, wildlife habitat, recreation, and education opportunities for 4,861 acres of federal land adjacent to Aspen.

This innovative process inspired new Farm Bill legislation that makes it easier for outside entities to undertake restoration projects on budget-strapped Federal lands. ACES leads an Implementation Team that convenes semiannually to determine projects for the upcoming field season.

In 2015, ACES and the U.S. Forest Service (along with several other local organizations) set plans in motion to conduct a prescribed fire in the Hunter Creek Valley to improve habitat, increase resiliency, and reduce fuels in aspen and oakbrush ecosystems. Fire is part of a natural and healthy ecosystem. In the absence of natural fire in this area, the forest and shrubs become dominated by older trees which provide less and lower quality food for wildlife. Fresh leaves, berries, and acorns become rare. Prescribed fire stimulates new and nutritional growth and also reduces the buildup of hazardous fuels. This decreases the chance of catastrophic wildfires, which pose a significant risk to neighboring communities.

On May 14th 2016, the U.S. Forest Service, in partnership with ACES, conducted a prescribed fire that successfully treated 900 acres of mountain shrub and aspen ecosystems, improving wildlife habitat and reducing hazardous wildfire fuels. This effort serves as a powerful example of collaborative restoration and showcases the value of prescribed fire as an effective tool for ecologically sound land management in our area. For more on the Hunter Creek Fire, please see page 22.

In advance of the prescribed burn, ACES and several partner organizations conducted a Community Weed Pull to reduce the noxious weed seed bank in the area. Volunteers returned in July 2016 to pull noxious weeds around the perimeter of the burn. In addition, 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.

EXPANDING OUR DATASETS

WILDLIFE CAMERAS

In 2014, ACES installed two wildlife cameras to help monitor biodiversity at our Hallam Lake site. Since then, the program has expanded to include Hallam Lake, Rock Bottom Ranch, and two of the elementary schools where ACES teaches. These "trail cams" are motion sensitive cameras 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 at Hallam Lake, ACES has captured videos of bears, beavers, coyotes, foxes, raccoons, elk, deer, squirrels, pine martens, weasels, hummingbirds, Great Blue Herons, and even a Great Horned Owl with a trout in its talons. Some of our cameras are set up on the same location year round in order to document animal movements and behavior over time. Other cameras are frequently

moved to monitor a variety of habitat types. The stunning diversity routinely captured by the cameras highlights the importance of wildlife habitat in urban interfaces. ACES at Hallam Lake is only a 25-acre preserve located in the middle of Aspen, but it is still a true haven for wildlife.

In addition, last year ACES partnered with Pitkin County Open Space and Trails, the Pitkin County Healthy Rivers and Streams Board, Pitkin County Information Technology, and Holy Cross Energy to install a wildlife camera on a pole adjacent to an active Osprey nest. The nest, located in Emma, Colorado, sits on a platform between Highway 82 and the Roaring Fork River in a riparian ecosystem. The camera will stream live footage each spring and summer season, capturing the real-time activities of a pair of nesting Ospreys that return to this nest each year to breed.



To view ACES Hallam Lake wildlife footage, visit youtube.com/user/aces81611.









The Emma Osprey Cam streams live video of an active Osprey nest.





Data and photos from the Roaring Fork River Gauge can be explored via an online data portal. The photo on the left was captured on April 26, 2015 prior to the start of runnoff, and the photo on right was taken on June 18, 2015 during peak runnoff.

ROARING FORK RIVER 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 our 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 two 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, educating over 25,000 residents and visitors each year on the issues impacting our local rivers.

The data from the gauge provides a fascinating insight into the interplay between temperature, snowpack and runoff. For instance, initial analysis of last year's data shows that 70% of the years' flow occurred over 15% of the days. In 2015, peak runoff occurred on June 18th. By comparing the annual fluctuations in this data, we can get a better idea of how factors such as climate change are impacting our forests and the ecosystem services they provide.



Data Providers

- Asnen Global Change Institute
- Bureau of Land Management
- California Dept. of Fish and Wildlife
- City of Aspen
- Colorado Parks and Wildlife
- Colorado State Demographer
- Colorado State Forest Service
- Colorado State University
- EcoFliaht
- National Atmospheric Deposition Program
- National Aeronautic and Space Administration
- National Climate Assessment

- National Climatic Data Center
- National Interagency Fire Center
- Natural Resources Conservation Service
- Nature Climate Change
- Pitkin County
- Roaring Fork Conservancy
- University of Arizona
- Upper Colorado River Interagency
 Fire Management Unit
- United States Forest Service
- United States Geological Survey
- University of Arizona

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

