RESTORING FORESTS *for the* FUTURE

Profiles in climate-smart restoration
on America's National Forests


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Contents

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Introduction

America's national forests are of vital importance to sustaining wildlife, providing clean water, recreation, producing wood products and offering social and economic benefits. Climate change, including rising temperatures, changing precipitation patterns and more extreme storms, is having profound consequences for these public lands. Our national forests and grasslands also have a crucial role to play in slowing the pace of climate change by sequestering and storing carbon and are expected to play an increasingly important role in the nation's efforts to meet its ambitious climate goals.

Decades of fire suppression, historical land management practices and other stressors, however, have left many of our national forest lands in need of proactive management and revitalization. As a result, there is a need to dramatically increase the pace, scale and quality of restoration on our national forests, and to ensure that this restoration is carried out in an ecologically appropriate and climate-smart manner.

Restoring our national forests in ways that enhance their resilience to climate change and sustain their capacity to capture and store carbon will be a central challenge for the U.S. Forest Service and its state and local conservation partners. This collection of case studies — developed as a collaboration among American Forests, National Wildlife Federation and The Nature Conservancy — is designed to highlight some of the most promising examples of such climate-informed on-the-ground restoration efforts.

As part of that collaboration, our organizations have also conducted an in-depth review and synthesis of the science underlying climate-smart forest restoration, and developed a set of principles for putting these approaches into practice (see Box).[1] The case studies profiled here are organized around these science-based principles to illustrate how forest conservation and restoration practitioners can incorporate climate-smart practices in their own collaborations and on-the-ground restoration projects.

Ensuring the resilience and sustainability of America's national forests will require that we restore our forests with an eye to the future and not just the past. These case studies offer a powerful set of examples for how that can be done.

[1] Glick, P., B.A. Stein, and K.R.Hall. 2021. Toward a Shared Understanding of Climate-Smart Restoration on America's national Forests: A Science Review and Synthesis. Washington, DC: National Wildlife Federaion.

Principles for Climate-Smart Forest Restoration

- **Look to the future while learning from the past.** Forest planners and their partners should develop forward-looking goals for management that build on an understanding of the historical range of variability and past responses to disturbance, but account for and anticipate future climate-related changes.

- **Embrace functional restoration of ecological integrity.** As climatic conditions continue to change, it will become increasingly difficult to restore the ecological integrity of forest systems based on historical species compositions and structures. Rather, goals for ecological integrity should emphasize the capacity of forest systems to adapt and adjust, including through enhancing functional diversity and habitat complexity.

- **Restore and manage forests in the context of larger landscapes and longer time frames.** Climate change necessitates that planners and managers consider larger spatial scales (e.g., watersheds, landscapes and regions) and longer time frames to ensure that localized and near-term actions do not compromise the capacity of forests to accommodate and adjust to changing conditions.

- **Adopt agile planning and management approaches that accommodate and address uncertainty.** Restoring and managing forests in the face of continuous climatic change requires decision-making under uncertainty, underscoring the importance of adaptive planning and management, including the consideration of multiple plausible scenarios of future conditions.

- **Address climate risks by linking adaptation strategies to key climate-related impacts.** Understanding climate vulnerabilities and risks to priority forest resources and values serves as the basis for developing and implementing adaptation strategies that are capable of reducing risks and sustaining the ecological, social and economic systems associated with national forests.

- **Manage for change, not just persistence.** As climatic conditions exceed historical ranges of variability, national forest planners will need to consider how to reconcile "desired" future conditions with climatically achievable future conditions. Planners and managers increasingly will need to determine when and where it may be possible to manage for the persistence of current/historical forest conditions, and when it may be necessary to manage for change by accepting or even facilitating ecological transitions.

- **Optimize, rather than maximize, carbon sequestration opportunities.** National forests will play an increasingly important role in achieving the nation's climate mitigation goals. Attempting to maximize carbon sequestration and storage, however, can undermine other important ecosystem services and national forest values. Managers should instead seek to optimize sequestration opportunities by balancing carbon goals with other important forest restoration, management and resilience outcomes.

- **Enhance collaboration to identify shared values, navigate trade-offs and maximize synergies in the context of changing conditions.** Managing forests for multiple, sustained ecosystem services will necessarily entail trade-offs, particularly given the challenges and uncertainties associated with changing climatic conditions. Engaging local communities and diverse constituencies as early as possible in the forest planning process helps gain buy-in and identify opportunities to minimize trade-offs and maximize synergies, including acknowledgment and discussion of the potential for fundamental changes in national forest conditions.

Reviving ancient traditions of fire to restore the land

A tribe's forest management aligns with its Climate Change Strategic Adaptation Plan

For thousands of years, Native Americans used an ingenious array of stewardship methods to maintain their lands. In the West, many tribes relied on small, low-intensity fires to create different forest and prairie types. The seasonal burns encouraged larger trees, richer grasslands for wild game and more favorable growing conditions for native foods.

Designated tribal members applied time-honored, site-specific knowledge of how and when to use fire, passing on their knowledge to ensure that the land would continue to provide vital sustenance and medicines for the community. But European settlers discouraged the ancestral practices and soon suppressed burns altogether. The ancient knowledge of "cultural fire" faded and came dangerously close to disappearing.

> "Fire is a connection to the land that our tribe has had for generations and generations. Today, we're bringing fire back to encourage natural regeneration, in addition to our work on thinning and site preparation."
>
> **— TONY INCASHOLA, JR., THE CONFEDERATED SALISH AND KOOTENAI TRIBES**

In recent decades, forest managers on reservations from California to British Columbia have once again turned to traditional stewardship techniques. Guided by the collected wisdom of tribal elders, they are combining these methods with contemporary, western science-based approaches to address forest health and the challenges of wildfire.

Among these practitioners is Tony Incashola, Jr., forest manager for the Confederated Salish and Kootenai Tribes (CSKT) in northwest Montana. He grew up learning from his father, who directed the Salish-Pend d'Oreille Cultural Committee, about the ecological traditions of his people and their connection to land management issues. Today, Incashola combines those insights with modern forest science practices, leading a range of actions to protect the tribes' natural inheritance. It's a legacy that he respects deeply.

"Fire is a connection to the land that our tribe has had for generations and generations," he explained. "Our tribe was nomadic and traveled with the plants and seasons. They understood how fire brought life back. We're the keepers of that knowledge. Today, we're bringing fire back to encourage natural regeneration, in addition to our work on thinning and site preparation."

The benefits of these controlled fires, he said, are many: a reduction of hazardous fuel, improved grassland for bighorn sheep and elk, removal of encroached timber on old prairie lands, and enhanced lowland habitat for birds and small animals.

APPLYING TRADITION TO CLIMATE ADAPTATION

Two aspects make the CSKT program unique. The first is that it covers an enormous area. The tribes' natural resource staff is applying a combination of traditional and scientific knowledge over the 1.3-million-acre Flathead Reservation, 600,000 acres of which are forested. Incashola estimates that his team oversees the burning of 3,000 to 5,000 acres each year. "It's a large land base," he noted. "We do a lot of burning on a lot of acres — our timber land base is not a checkerboard."

Even more impressively, the CSKT forest management plan is tied directly to the tribes' own Climate Change Strategic Adaptation Plan. Created in 2013, updated in 2016, and now undergoing its third revision, it's a comprehensive framework of policies, strategies and goals to respond to the climate impacts. CSKT was only the third tribe in the U.S. to undertake such a plan. It continues to be an active participant in the Crown Managers Partnership, which works to address landscape-scale environmental issues (including climate change) across state, tribal and national borders.

The plan's goal was to protect the resources which are the basis of the tribes' spiritual life — not only forest health, but also air and water quality, habitat for wildlife, agriculture, human health and more. CSKT's forestry department worked with American Forests, The Nature Conservancy, Bureau of Land Management, the U.S. Forest Service and National Park Service to build the adaptation plan, and workshops offered by The Institute for Tribal Environmental Professionals helped guide the process. "We gathered as much information as we could, because we take pride in being partners with all our neighbors," Incashola explained. "And it's especially important because many of the federal agencies are policy drivers for aboriginal territory."

KNOWLEDGE FROM THE ELDERS

Michael Durglo, Jr., is CSKT's tribal preservation department head and chairman of its Climate Change Advisory Committee. A co-author of the Strategic Adaptation Plan, he said that the most rewarding part of the process was the chance to tap into the traditional knowledge possessed by the elders of the tribes. "Learning from them was part of our plan from the beginning," he noted. "We did video sessions with six of the elders, which we also transcribed. We learned what it was like when they grew up, and how the land had changed. We asked how they viewed the impacts on traditional medicines and food sources like bitterroot and camas, as well as fish and water. Some of them told us that they remembered hearing from great-grandparents that in the future, the earth would warm — that summers would become hot, and winters milder." Durglo pointed out that reverence for knowledge and experience is a hallmark of tribal culture.

Right: Robert D. McCrea / CSKT Division of Fire

Following an overstory harvest, the Confederated Salish-Kootenai Tribes' forest management team conducted an under burn modeled on traditional practices.

Arrowleaf balsamroot spreads a lush carpet following an understory burn.

"We have monthly elder meetings for a multitude of tribal programs — fisheries, land and so on," he said. "That's how we live."

In recent years, the people of the CSKT realized that many of the climate impacts predicted for the distant future and addressed in the strategic plan were already apparent on the Flathead Reservation. They committed to an update, now in progress. The revisions, guided by local impact assessments, reflect the input of elders, leaders, administrators, scientists, regional experts and more than 125 tribal members.

Such intensive community outreach, coupled with an increased incidence of wildfires, has increased awareness of the preventative role that cultural fire can play. "There's widespread support for burning at the right time of the year, the windows in spring and fall," said Incashola. "Our conversations with the elders tell us that fire was even used in summer in certain areas, but current forest structure isn't the same, so people support mechanical treatment in some sites."

Application of traditional knowledge has yielded results, Incashola noted. "We've treated areas where the elders told us camas, a traditional food, once grew, and more camas came back than we've ever seen. It changed conditions for cattle, too. It's amazing to see how the land bounces back. You can talk and show data for days, but when you see what's happening, it really convinces people."

BRIDGING THE CENTURIES

An important component of the tribes' restoration actions is ensuring traditional knowledge about forest stewardship is shared with the younger generation. In 2006, the National Interagency Fire Center awarded CSKT a grant to develop a package of educational materials to achieve that purpose. "Fire on the Land," an integrated multimedia curriculum framed by the cultural values of the Salish and Pend d'Oreille people, explores the tribes' relationship to fire through stories, images, historical accounts and student activities. This resource, including the video of CSKT elders sharing their stories, is now used by high schools as well as the Universities of Washington and Montana. "Students are all in. They're connecting the dots, learning about everything from high-elevation forests to recycling," Incashola said.

Other educational activities include a tribal forestry program centered on whitebark pine restoration. Partnering with the local college and aided by the volunteer efforts of a high school group, the tribes have cleaned, stored and cultivated thousands of seeds from cones and have already planted 2,000 trees from those starts. In the process, students are learning to identify and appreciate the value of whitebark pine seeds, which were a first food for their ancestors.

"Indigenous people of the world have a special moral stature on this issue (climate change) and may have a special role to play in coming together to advocate for action," said a statement issued by the Salish-Pend d'Oreille Cultural Committee. CSKT members, observing the changes on their lands, are revisiting the knowledge of their ancestors to define that role. As snowpacks decline, water temperatures rise and the risk of deadly fire continues to increase, they're applying ancient wisdom alongside forest management science to restore their lands.

Photos taken during (top) and after (bottom) an understory burn in the Hatier area show how vegetation flourished after treatment.

Left: Ron Swaney / CSKT Division of Fire; right (both photos): Robert D. McCrea / CSKT Division of Fire

Assisted regeneration in fire-scarred landscapes

Availability of seeds emerges as crucial need

As the frequency and size of high-severity wildfires in the West increase, the effects extend far beyond tree loss. The cascading consequences of catastrophic fire includes soil erosion and flooding in vital watersheds, shrinking habitat for plants and animals and diminished capacity for carbon storage as forests disappear. In Colorado's Front Range and in parts of the Southern Rockies, the damage may be even more acute. Years after sections of forest in the ponderosa pine ecosystem were leveled by mega-blazes, some burned areas are failing to regenerate, leading to concerns that grass or shrublands could permanently replace native forest.

Wildfire has been the largest driver of forest loss along the Front Range since 1978. There are over 60,700 hectares of ponderosa pine forest that burned at high severity on the Front Range, and it is estimated that only about 2% have been replanted. In many inaccessible sections, fire scars occur well beyond the typical seed-dispersal area of ponderosa pine, crippling the forest's ability to recover. Without active, climate-informed management to reduce the risk of catastrophic wildfire and to increase post-fire ecosystem recovery, large portions of forest might never return.

Scars from the 2011 Las Conchas fire in New Mexico are being replanted with native seeds stockpiled by the Santa Clara Pueblo.

Numerous partnerships — of local, state and federal organizations — and volunteers have embarked on pre-fire restoration projects to protect existing forest. In Colorado's Upper South Platte watershed, residents, forest managers and fire professionals have united to build fire-adapted communities — communities with a lasting commitment to a proactive approach to fire — and to develop area-specific protection plans to reduce the impact of wildfire on neighborhoods and homes. Several fire protection districts have created new "wildfire modules," with skilled crews that work to control fire and spend winter months on critical projects to thin and remove trees and brush. "This was a unique opportunity for my crew members to gain local knowledge," said Jayson Papenfus of the Elk Creek Fire Protection District. "Now if we had a fire, they all know the area, fuels and terrain. It's the best thing we could have done for a proactive response to wildfire."

> "This approach is based on having enough seeds, and we have less than 10% of what we need. The reality is, we need an efficient workforce and more collaboration between federal and other partners to start to build seed stocks."
>
> **— CATHERINE SCHOEGEL, THE NATURE CONSERVANCY**

To encourage the survival of seed trees after wildfire and to regenerate badly burned areas, land managers are looking at the concept of savannas, where tree cover is less than or equal to 20%. Based on data that indicates large trees within and near savannas are more resilient to fire and provide a diversity of forest habitat, the approach could help to reduce losses from big blazes and support the recovery of wildlife populations.

"Targeting where to expand savannas is a new idea," said Catherine Schoegel, watershed forest manager for The Nature Conservancy (TNC) in Colorado. "In our work, we're refocusing our thinning and prescribed burn efforts to create resilient islands, taking savannas as our model. They're low density. They're clumpy. And as we confront a changing climate, they're the kind of adaptations we need to make."

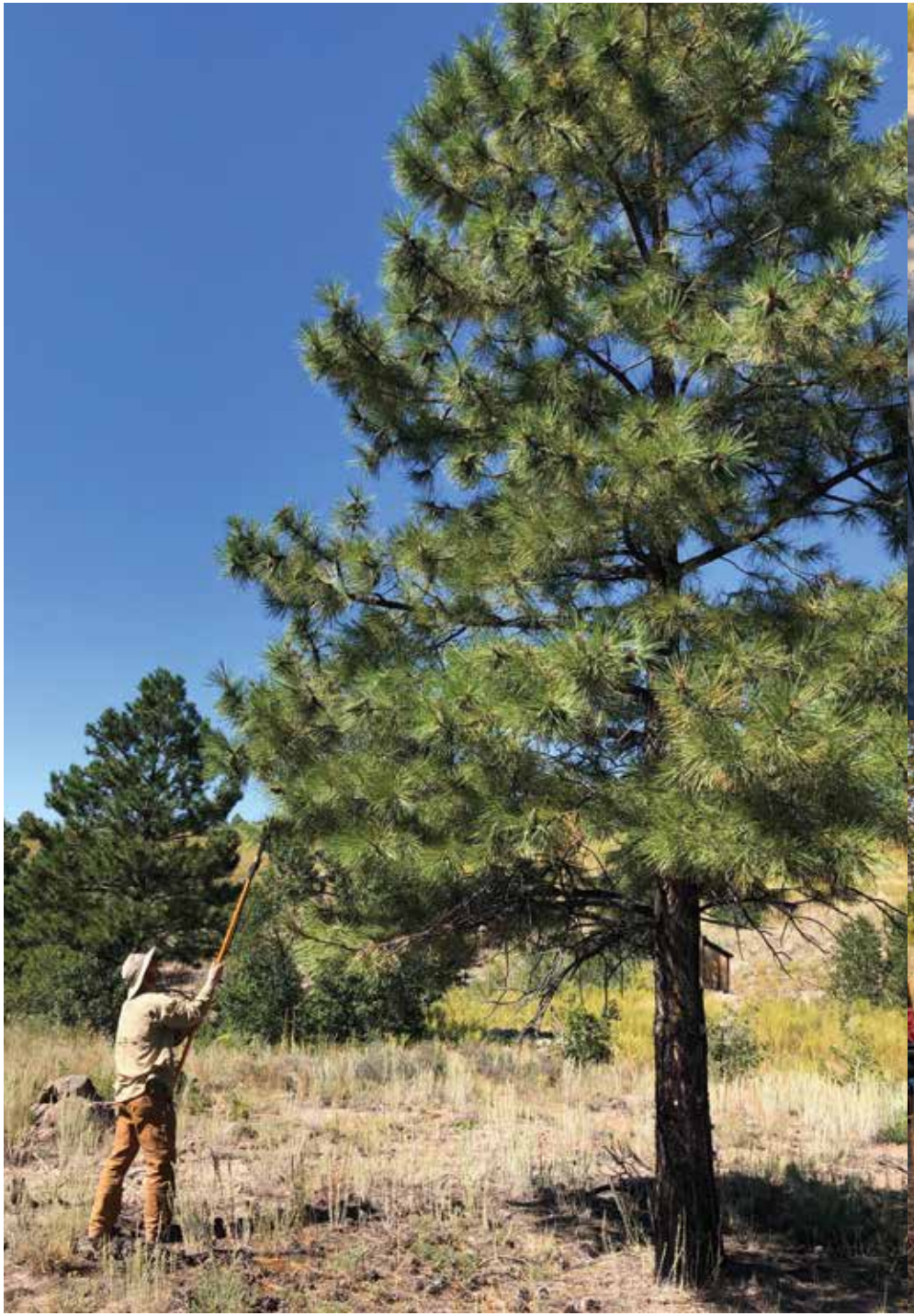
REPLANTING FIRE SCARS

In addition to savanna habitat restoration, a TNC Colorado project is testing a novel approach to accelerate post-fire regeneration, concentrating on the assisted seeding of ponderosa pine in fire scars. Seedlings of this species typically grow less than 50 meters from their seed source, which limits natural post-fire recovery in places where trees have vanished. In these areas, it could take as many as 500 years for natural regeneration to occur.

But the strategy has a daunting first step: sourcing the enormous quantity of seed needed for assisted replanting. Ponderosa pines produce large quantities of cones only during times of mast seeding, usually every eight to 10 years. In 2019, the moment arrived: the pines produced a bumper

Left: John Fowler / Flickr; Facing page: Lauryn Wachs / TNC

Ponderosa pine cones collected in Colorado yield seeds for post-fire recovery projects.



Facing page, bottom right, and below: Lauryn Wachs / TNC; other photos, facing page: Collin Haffey / TNC

crop of seeds throughout the Rockies after back-to-back seasons of average to above-average precipitation, which provided a rare opportunity to harvest seed stock.

In September 2019, volunteers from Colorado colleges and universities joined TNC, local coalitions and national forest personnel to collect seeds in Fourmile Canyon and the Ben Delatour Scout Ranch and worked with forest staff to support seed collection on the Pike National Forest. Timing their actions to the exact week when the cones matured required a high degree of coordination: organizers trained and scheduled volunteers, and the U.S. Forest Service contracted tree climbers for deployment at the optimal time. In addition to taking cones from standing trees, participants also gathered seeds from trees that had recently been felled for thinning projects — a side benefit of fuel reduction treatments. Approximately 5.5 million seeds were collected by TNC and U.S. Forest Service partners. Approximately 20,000 seedlings are now being raised in nurseries for outplanting in 2021, while the majority of the seed is held in storage for future restoration actions.

Schloegel estimates that millions of seeds will be needed to replant fire scars in the Southern Rockies on the scale necessary. "Collection is the lynchpin," she said. "This approach is based on having enough seeds, and we have less than 10% of what we need. The reality is, we need an efficient workforce and more collaboration between federal and other partners to start to build seed stocks." But the clock is ticking: as hotter, drier conditions increase the threat of catastrophic fires, available seed sources may shrink.

In theory, Schloegel said, having quantities of seed at hand could vastly accelerate regeneration after a fire event. "Planting quickly after fire is an important step," she said. "We could get seed out immediately, and we could do it across a larger landscape by using a drone." However, with the current scarcity of seed, that option is on hold. "Before we use a drone, we have to dramatically increase the number of seeds collected. We don't have enough seeds to reforest burn scars with seedlings and experiment with drone seeding."

BANKING SEEDS IN NEW MEXICO

In northern New Mexico, where the 2011 Las Conchas fire devastated sections of Santa Fe National Forest, TNC and partners are helping to organize seed collection for climate-smart reforestation across an immense, severely burned landscape. In 2019, Collin Haffey, who works on TNC reforestation efforts in the Rio Grande watershed, helped organize a seed collection with members of Santa Clara Pueblo and the Institute for Applied Ecology. With funding from Bandelier National Monument and the New Mexico Game and Fish Department, field crews gathered approximately 350,000 ponderosa pine seeds. Now in storage at the New Mexico State University nursery, they will be used for forest regeneration projects in 2021 and beyond.

Santa Clara Pueblo has stockpiled native seed for two decades, even before much of its watershed was destroyed by the Las Conchas fire. With a goal of assisting regeneration efforts, it has built up a seed bank of ponderosa, Douglas-fir, spruce and other pines from 2.5 million trees.

"We're learning a ton from our partners in Santa Clara Pueblo Forestry Department," said Haffey. "Santa Clara has planted 1 million trees since 2000, when an earlier fire tore through their watershed. They have been collecting seed for this reforestation effort, and they are also looking at establishing grow houses or even a tree nursery. They're teaching us how to problem-solve some of the hurdles of workforce development and about restoration techniques following a series of fires and floods." It's possible, he said, that the sale of the seeds or seedlings could eventually provide the pueblo with an additional revenue stream to support its forestry program.

Over the next two years, a consortium of private, tribal, federal and university partners will collaborate in a pilot to plant 100,000 seedlings across 4,000 acres in the Las Conchas burn scar, including 25,000 seedlings in both Bandelier National Monument and Santa Clara Pueblo. They'll go into the ground in clumps, or "tree islands," mimicking the same savanna pattern being tried in Colorado.

"It's this hopeful thing that seems to be getting a lot of people excited because this is a problem that is collectively within our span of control," said Haffey. "It feels good to bite into a problem that has a solution, even if it also has a lot of complicated challenges."

Facing page, clockwise from far left: Volunteers in New Mexico harvest cones; Dr. Joshua Hall tests cones with kerosene to determine their maturity; A cross-section reveals seeds to harvest; Cleaned cones await processing; Colorado volunteers strip needles from cones.
Left: Seeds from the cones are being raised in nurseries or stored for future use.

Strategic watershed restoration for climate resilience

A detailed climate vulnerability study gives rise to a nature-based solution for enhanced water storage

Decreased flows in rivers, especially during the hottest months of the year, are straining the ecosystems of public and private lands throughout the West. As drought years become more frequent, the diminished snowpack reduces flows to streams, limiting critical water supplies for people, fish and wildlife. National forests play a key role in delivering that water, and forest managers are seeking innovative solutions to keep it on the land.

In Montana's Lolo National Forest, a partnership of practitioners and scientists is looking to beavers, North America's largest rodents, for help in changing the hydrology of its meadows and valleys and improving watershed resilience. A colony of beavers can transform the landscape by building dams that slow streams, create new ponds, channel nutrients and restore groundwater. As such, they're engines of natural restoration. Man-made projects that mimic beaver dams and enable expanded beaver activity offer a low-cost, low-tech path to enhancing natural water storage.

> "The BDA initiative is a great example of how USFS leadership and operations work with very competent partners to achieve successful stream protections and restoration."
>
> **— TRACI SYLTE, U.S. FOREST SERVICE**

Once, re-watering the ground was the main work of beavers, but as their numbers dropped, so did their impact. The beavers' impoundments helped curb the flow of water, providing flood control and natural storage areas. They allowed runoff to seep into the ground, recharging groundwater, and spread it across the floodplain to nourish grasses and trees.

Now, without the flooding from beaver dams, streams cut deeper into the ground, causing erosion and preventing flows from connecting to the riparian zone. The resulting loss of lush wetland habitat affects everything from insects and birds to livestock, elk and wolves.

For decades, restoration programs have attempted to replicate the beavers' work. Some projects have imported beavers to build their dams; others focus on constructing dams in areas where beavers are already present. In the Lolo National Forest, a strategic initiative is exploring the build-it-and-they-will-come strategy, closely monitoring the effects of both natural and human-built structures on water retention as well as local fish populations.

CLIMATE IMPACTS AND STREAM RESTORATION

The beaver dam analog (BDA) project grew out of a detailed Watershed Climate Change Vulnerability Assessment for the 2-million-acre Lolo National Forest, conducted by U.S. Forest Service (USFS) and the nonprofit Clark Fork Coalition (CFC) in 2010. The authors set out to identify potential future impacts from climatic change in vulnerable areas, with the goal of providing practitioners with a solid foundation for climatic change adaptation management and planning. The strategy that emerged from the assessment targeted watershed restoration activities most likely to improve native fisheries, water supply and natural infrastructure.

"One of the original purposes of the USFS is to protect forests as sources of water," noted Sarah Bates of National Wildlife Federation. "The changing climate is altering snowpack and runoff conditions, with consequences for people, fish and wildlife downstream." Through the watershed vulnerability assessment, restored beaver habitat, proven to slow and store water naturally, arose as a possible adaptation solution.

To restore drought-strained ecosystems, forest managers are employing new methods to enhance natural water storage.

Left and right: Andrew Lahr

Beaver dams provide flood control and recharge groundwater; beaver dam analogs (BDAs) could mimic these effects.

With funding support from USFS, a consortium of nonprofit groups and University of Montana researchers developed experimental beaver dam mimicry projects in several locations around the forest; Trout Unlimited also studied BDA's potential. An associated research-focused partnership sought to determine whether BDAs might have detrimental effects on fish spawning and migration. Hydrologists from the Lolo National Forest, biologists and CFC staff helped with the permitting process, and the CFC assisted with project design and funding.

In 2017, researchers began by monitoring residence time, measuring the water flows moving in and out at potential sites. After a year-long assessment of conditions, Lolo National Forest and the CFC joined with University of Montana professor Lisa Eby and graduate students to install and monitor multiple BDAs. Using posts, mud and woody debris, they constructed eight to 13 structures across three test areas. "The advantages were that there were no navigable water issues, and the beavers are already there — we're not moving them in," said Eby. "And it's a relatively low-cost project. Montana Conservation Corps crews and university students took part in the construction, which made it more affordable."

"Our research is focused on what can we achieve by restoring the functionality of beaver dams," Eby continued. "What changes are we seeing from BDAs in the landscape? How fast is it happening? What kind of scale and time frame do we need? How can we make it self-sustaining? If we can store more water longer in the watershed, creating a sponge with larger wetlands, more complex streams and fewer incised streams, the water will percolate out throughout the year."

Eby said that the combined efforts of several nonprofits, including the CFC, Trout Unlimited, The Nature Conservancy and National Wildlife Federation, have been key in exploring BDAs' value in climate adaptation: "Nonprofits play a big role in Montana, and they're great to work with. They can pull in different funding and work crews."

Traci Sylte, a USFS hydologist with the Lolo National Forest, has worked closely with the BDA project since its inception. She cited the far-ranging impact of the consequential management actions developed after the 2010 vulnerability study.

"Management actions have many 'restorative' implications — for fisheries, water supply and infrastructure," she noted. "The BDA initiative is a great example of how USFS leadership and operations work with very competent partners to achieve successful stream protections and restoration." Sylte stressed that evidence-based knowledge and management are helping practitioners build adaptation and address climate stressors amid changing conditions.

The Lolo National Forest's beaver dam mimicry project, which began with a focus on enhancing water supplies, continues as an ongoing learning process — one that is working to bring back beavers as a natural component of forest hydrology.

Right: Scientists use backpack electrofishing units and inspections to measure the impact of BDAs on fisheries and water flows. Facing page: Man-made structures impound water and distribute it over meadows.

This and facing page: Andrew Lahr

Co-benefits of large-scale restoration

Arizona studies indicate carbon storage and water supply increase after thinning, prescribed burns

In Arizona, June marks the peak fire season. Blistering temperatures, low humidity and scant rainfall bake vegetation and trees, turning them into a tinderbox to fuel wildfire growth.

That pattern, which has intensified over the past decade, held true in 2020, as the fifth-largest wildfire in Arizona's history raged across 193,000 acres during the last week of June. The Bush Fire in Tonto National Forest, northeast of Phoenix, burned an area 13 times larger than the island of Manhattan.

The Bush Fire burned mostly in lower-elevation desert shrub communities, higher-elevation Wilderness Areas or steep, inaccessible terrain, none of which had been subject to restoration treatments. But in other sections of Tonto and three other national forests, a massive, ongoing restoration effort is trying to lower the incidence of devastating wildfires. The Four Forest Restoration Initiative (4FRI), the largest restoration project ever undertaken by the U.S. Forest Service (USFS), was launched in 2010 under the Collaborative Forest Landscape Restoration Program. Its goal is to accelerate the restoration of forest and reduce the risk of uncharacteristic wildfire across 2.4 million acres in the Apache-Sitgreaves, Coconino, Kaibab and Tonto national forests. More than 40 federal and state agencies, stakeholders and nonprofit groups — from the Arizona Game and Fish Department to the City of Flagstaff — are involved.

In the last century, ponderosa pine forests in this area have shifted dramatically. Once naturally open stands are now crowded with high densities of small-diameter trees, due to fire suppression, harvesting and episodic regeneration events. Working on a scale never attempted before, the 4FRI has thinned more than 230,000 acres to reduce densities and lower fire risk and is also managing fire (prescribed and wildfire) on over 570,000 acres. At the same time, it is working to meet land management objectives. Its goal is to restore 2.2 million acres over 20 years.

"This is fire risk reduction for the long term," said Travis Woolley, forest ecologist for The Nature Conservancy's (TNC) Arizona Forest and Climate Program. Most of the thinning has been achieved through a science-based plan of accelerated harvest and prescribed fire. The timber industry has a share in the initiative, harvesting, processing and selling wood products derived from thinning. This helps to defray treatment costs and provides restoration-based job opportunities. However, progress has been slowed by the logistical challenge of removing harvested wood cut mechanically.

"The low value of harvested wood is the primary issue," said Woolley. "With the globalization of the timber industry, many businesses have walked away from working on federal lands. There's no forest product industry presence in Arizona to help get the job done." Although TNC and USFS have contractual relationships with harvesters, Woolley continued, "there's not enough money to solve this problem. Without the mechanical thinning, we're likely to lose the forests, but we need business and industry to assume a role." Establishing additional partnerships could reduce treatment costs and provide restoration-based job opportunities.

EXPLORING ASSOCIATED BENEFITS

Using data from 4FRI, scientists at TNC evaluated the extent to which restoration efforts aimed at restoring natural fire regimes could benefit other key ecosystem services, like carbon

A panoramic view from Moqui Lookout Tower in Coconino National Forest in Arizona.

Left and right: USFS

Timber sales help to support the Four Forest Restoration Initiative, but removing harvested wood presents logistical challenges.

storage and water supply. Quantifying these benefits is an important next step in developing additional revenue streams to pay for forest restoration.

For forest carbon, in particular, removing biomass presents a double-edged sword. It's necessary to remove excess fuels (using thinning and prescribed fire) to prevent severe wildfires, but in the short term, these actions will reduce forest carbon storage. However, a new study by Lisa McCauley of the Arizona Forest and Climate Program and colleagues indicates that over time, thinning treatments can actually *increase* the stability of the forest to store carbon. The authors examined how the effects of climate change, coupled with restoration of approximately 1 million acres under the 4FRI program, would influence carbon dynamics and wildfire severity in the region during the 21st century. They found that accelerated harvest and prescribed fire did cause carbon loss initially. But in subsequent decades, such restoration activities resulted in greater carbon storage, because future fires would burn less severely with less available biomass. Essentially, there's a trade-off: short-term carbon losses due to thinning ensure lower carbon losses in the future. Their conclusion: restoration is likely to stabilize carbon, and the benefits are greater when the pace of restoration is faster.

Facing page, clockwise from top left: Smoke from a prescribed burn drifts through the Baderville subdivision just northwest of Flagstaff, Ariz.; Pile burning of logging residue in Coconino National Forest; A seedling is ready for planting in scars left by the 2010 Schultz Fire, which burned over 15,000 acres near Flagstaff; A stand is shown one week after a prescribed fire. The treatment is one of the tools used in the Four Forest Restoration Initiative.

In addition to benefiting carbon storage, large-scale restoration can also help sustain vital water supplies. Long-term drought and warmer temperatures are stressing Arizona's forests, leading to severe fires and changing the water cycle. The state's overcrowded ponderosa pine forests suck up limited soil moisture, leaving less excess water for river flow. That could have significant effects in the high-elevation 4FRI ponderosa forests, which are located in the headwater watersheds of the Verde and Salt Rivers. These rivers produce about 30% of the annual water supply for Phoenix, a city of 1.6 million residents. A 2014 TNC study found that thinning in 4FRI forests would increase flows in headwater streams by about 20%, likely because less moisture is consumed by trees. These increases would be temporary as forests regrow but could potentially be sustained with further thinning and prescribed fire.

> "Here we have tools that will allow managers to regain forest resilience and are likely to have multiple benefits. They can reduce fire risk and also improve water supplies and carbon storage."
>
> **— TRAVIS WOOLLEY, THE NATURE CONSERVANCY**

Forest restoration projects are the start of a recovery process, not an end point. Woolley said that the findings of these studies only strengthen the case for active, large-scale forest restoration treatments. "Here we have tools that will allow managers to regain forest resilience and are likely to have multiple benefits," he said. "They can reduce fire risk and also improve water supplies and carbon storage."

Researchers are comparing the health of thinned and non-thinned sites across 4FRI's Mountainaire Project.

All photos, facing page, and right: USFS, Southwest Region

Bringing back a climate-resilient forest

Private landholders may hold the key to restoration success

Stretching across 92 million acres from Texas to Virginia, the longleaf pine forest once dominated the landscape of the Southeast. Today, it occupies approximately 5% of its historic range. Over the past century, land clearing for agriculture and homes, conversion to faster growing pines to feed the paper industry, and the suppression of fire have taken a devastating toll on longleaf's natural environment.

Yet even in its diminished state, the longleaf forest remains one of the most biodiverse ecosystems in the United States and is uniquely equipped to survive in the coming decades. Longleaf is more likely than other southern pines to withstand the effects of a changing climate, such as temperature increases, shifts in precipitation, more severe storms and sea-level rise. It grows under very dry and wet conditions, is tolerant of and even dependent on frequent fire, can weather severe storms, and is more resistant to beetle infestations exacerbated by warmer conditions. Its longevity makes it a valuable tool for carbon sequestration in climate-smart restoration planning.

Longleaf is more likely than other southern pines to withstand the effects of a changing climate, such as temperature increases, shifts in precipitation, more severe storms and sea-level rise. Its longevity makes it a valuable tool for carbon sequestration in climate-smart restoration planning.

The longleaf system supports more than 30 species of native wildlife, including the endangered red-cockaded woodpecker, black pine snake and gopher tortoise. Nine hundred plant species also flourish, thanks to open understory areas in natural stands that allow sunlight to reach the forest floor. In areas where the longleaf forest has been cleared for agriculture or harvesting, or regular fire regimens have not been implemented, an overgrowth of vegetation chokes this rich habitat.

The timber industry has shaped these lands. Pine forests across the South produce approximately 16% of the global industrial wood supply, and the pine timber industry is one of the region's most valued economic resources. Intensive cultivation and large-scale fire suppression over the past century have enabled two species — loblolly and slash pine — to displace longleaf pine and become the preferred resource for the forest industry.

A HOST OF PARTNERSHIPS

Longleaf restoration on privately held lands, which comprise 85% of existing longleaf territory, is recognized as an essential part of bringing back the health of the forest. Across the Southeast, private owners have joined forces with public partners to lead a number of broad, multi-state initiatives to restore longleaf across its former range. America's Longleaf Restoration Initiative (ALRI), one of the largest, has planted more than 1.3 million acres of new longleaf stands in the past 10 years and used prescribed burns to manage nearly 12 million forest acres. With federal and state agencies, non-government organizations, universities, private industry and private landowners, the partnership works to establish, enhance and maintain 8 million acres of longleaf pine habitat on the landscape by 2025. ALRI projects focus on expanding current longleaf strongholds by adding land adjacent to state and national forests, replanting, reducing competition from other species, and using prescribed burns and other proven strategies.

"Longleaf restoration requires careful management on larger, intact blocks of land and in adjacent corridors," noted Colette DeGarady of The Nature Conservancy. With so much of the remaining forest privately held, she said, progress depends in part on finding ways to incentivize longleaf planting among landholders. Additional revenue opportunities, such as limited harvesting, selling pine straw and leasing land for hunting and recreation, can generate cash for conservation-minded landowners and increase the longleaf's range.

DeGarady noted that the slow-growing conifers, valued for their excellent wood quality, are a niche market. "We can supply growth and yield data to landowners to help make the economic case for growing longleaf," she said.

Stewardship agreements have also proven to be an important tool to accelerate management and restoration of longleaf on national forests. In Florida's Osceola National Forest, a longleaf stronghold, they allow a third party like The Nature Conservancy to assist the U.S. Forest Service with timber harvests and then apply the revenue to restoration. Funded through the Accelerating Longleaf Pine Restoration Collaborative Forest Landscape Restoration Program, stewardship agreements reduce fire suppression costs while sustaining local jobs, supporting bioenergy development and protecting water quality and wildlife habitat.

The Natural Resources Conservation Service collaborates with agricultural producers and conservation partners to restore longleaf pine forests through its Longleaf Pine Initiative (LLPI), which was launched in 2010. It provides technical and financial assistance to producers on private

USFS personnel discuss forest management practices and longleaf pine restoration during a field trip to the Francis Marion National Forest.

All photos, pages 20-23 Colette DeGarady / TNC

land in nine states, helping them identify and implement a variety of conservation practices to restore, improve or maintain the understory and overstory of longleaf pine ecosystems. These practices include forest stand improvement, prescribed burning, restoration and management of rare or declining habitats, and tree and shrub establishment. Since 2010, landowners have restored and protected more than 400,000 acres to support longleaf goals through LLPI.

New actions on public lands are also accelerating longleaf restoration. In South Carolina's Francis Marion National Forest, the U.S. Forest Service is implementing a 2017 plan to guide sustainable forest management, applying the Template for Assessing Climate Change Impacts and Management Options (TACCIMO) web tool. Francis Marion lost 80% of its tree canopy during Hurricane Hugo in 1989. It was one of the first national forests to revise its forest plan under the 2012 Planning Rule, which emphasizes collaboration and public involvement, use of the best available science to inform decisions, and a stronger role for monitoring. Today, the management plan includes longleaf restoration on federal, state and private properties through the planting of longleaf seedlings, as well as the use of adaptive strategies such as thinning and prescribed fire. It has increased staffing in the forest management and timber sale program to enhance the delivery of forest products through updates in policy and business practices.

"We can supply growth and yield data to landowners to help make the economic case for growing longleaf."

— COLETTE DEGARADY, THE NATURE CONSERVANCY

Despite the strength of these partnerships, the longleaf forest faces immense pressures. Projections suggest that by 2060, over 20 million acres of forestland in the southern U.S., an area equivalent to the size of the state of South Carolina, will be converted to other uses. Restoring and expanding healthy longleaf pine forests can provide crucial habitat, ensure long-term economic returns for landowners, and make communities more resilient to global warming.

Facing page: TNC staffers check the progress of longleaf pine restoration on a property to be transferred to the USFS to expand the Francis Marion National Forest.
Right: Native grasses and associated understory species are abundant in a mature longleaf pine forest stand in the Francis Marion National Forest.

Planning now to navigate an uncertain future

Experiments test adaptation strategies for a threatened species

The stability of forests in many parts of the United States Northern Rockies — and the resilience of many wildlife species that depend on that habitat, like Canada lynx and westslope cutthroat trout — could depend on our ability to help forest ecosystems adapt to climate change. In Montana's Flathead National Forest, part of the Crown of the Continent ecosystem, scientists and planners are engaged in a long-term effort to understand and respond to warming conditions. Their goal is to identify science-based management options that will increase the forest's resilience.

> "Forest managers aren't really sure how they will be impacted by climate change. They're looking for the science to help them get through it all. They want to know more."
>
> **— AMANDA ROLLWAGE, FLATHEAD NATIONAL FOREST**

Flathead is one of eight sites across the country participating in a national study called Adaptive Silviculture for Climate Change (ASCC). Beginning in 2016, Linda Nagel of Colorado State University, the ASCC network lead, brought together regional stakeholders, managers and scientists to create locally relevant approaches to climate adaptation. Together, they identified forest types dominated by drought- and fire-tolerant trees as high priorities for restoration. The western larch (*Larix occidentalis*), found on the Flathead National Forest, was a prime species for inclusion.

As Montana experts and practitioners convened the first ASCC workshop, they began by evaluating risks: what had the forest's past history with fire been? What might that mean for the future? Much of the discussion focused on what was most valuable about the larch as a species — notably, its remarkable resiliency.

Growing up to 200 feet (61m) tall and over 6 feet (2.1m) in diameter, with relict trees as old as 900 years, the larch is a conifer that resists insect infestation and wildfire. It's able to rebuild scorched crowns quickly because of its deciduous habit, and regenerates well from its prolific, lightweight, windblown seed. It's classified as a pioneer tree that flourishes where fires open up canopies, and its presence indicates where wildfires have occurred in the past.

However, a changing climate with hotter, drier conditions could have acute impacts on the survival of the larch; warmer temperatures with more sporadic or less frequent precipitation could drastically affect its growth. Testing a range of proactive forest treatments on the Flathead National Forest, as the ASCC project is doing, could help to lessen a potential climate-related decline of the western larch community and build a body of knowledge for practitioners. It's also consistent with the national mandate that requires federal land managers to consider the effects of a changing climate on forest ecosystems and maintain ecosystem integrity for the future.

A RANGE OF ADAPTATION APPROACHES

To assess actions that could prevent loss of the larch, a panel of scientists and managers developed a plan for a range of adaptation treatments in the Coram Experimental Forest and Flathead National Forest. The project was led by Flathead National Forest staff with assistance from U.S. Forest Service (USFS) Northern Region, USFS Pacific Northwest and Rocky Mountain Research Stations in collaboration with the University of Montana.

The group plotted a network of study sites so that key variables — productivity, health, composition and structure — could be compared. The goal was to create locally-specific forest treatments with four approaches to climate adaptation: no action (allowing forests to respond

Testing a range of proactive forest treatments on the Flathead National Forest could help to lessen potential climate-related declines.

Facing page: Paul Donnellon; left: Karl Anderson

A panel of Montana scientists and forest managers is studying multiple sites to establish a framework for future forests.

to climate change without direct management intervention), resistance (maintaining relatively unchanged conditions over time), resilience (allowing some change in current conditions, but encouraging an eventual return to reference conditions after disturbance), and transition (actively facilitating change to encourage adaptive responses).

Flathead National Forest silviculturist Amanda Rollwage, who has been involved in the project from the beginning, said the ultimate goal of the experiments is to provide the practical, real-world information that forest managers are looking for. "After cutting, what should we plant? And what's the science to back that up? That's what I'm interested in," she said. "Forest managers aren't really sure how they will be impacted by climate change. They're looking for the science to help them get through it all. They want to know more."

Justin Crotteau, a research forester with the USFS Rocky Mountain Research Station, explained that the group's aim is to establish a proactive framework — not a prescription — for future actions. "This isn't written in stone. The options we identify will have flexibility and will be a guide for planners as the climate changes."

ENCOURAGING SPECIES DIVERSITY

The Flathead team selected test sites of 50- to 70-year-old, second growth larch that were due or past due for thinning. In total, the harvest area covered 250 acres, with each unit consisting of approximately 30 acres plus a non-treated control site. Commercial harvesting, which supports the cost of the study, is now underway; in 2022, a variety of growth-improved seedlings of several species will be planted. In addition to larch, they will include western white pine and ponderosa pine, which are commonly found at drier sites in the landscape. "The planting options were chosen with the future in mind," said Crotteau. "At present, we don't expect the environment will be best for ponderosa seedlings, but in the future, it might be. We'll stick with it for a while and see what happens." Seeds for the effort were collected directly from Flathead National Forest and raised in Coeur d'Alene, Idaho.

After planting, Flathead scientists will monitor test sites and measure the growth of different species. They've developed a variant of an official USFS stand exam so that their findings can be entered into official USFS databases in the correct format, making it easier for everyone to access in the future.

GENERATING MOMENTUM

As they launched the ASCC project, the Flathead team was faced with several hurdles. Developing an Environmental Analysis for the forest land management plan was a lengthy process, requiring detailed summaries of the work planned and scientific justifications for action. Harvesting at the test sites, which provided the funding to support the study, was slowed by market variations and COVID-related delays. Planting expenses, including genetic testing of seeds, were higher than anticipated. And there's ongoing uncertainty about how long the study can be carried on in the future.

But despite the difficulties, there's an abiding belief in the importance of the work. "I'd describe this as a larch community project," said Crotteau, noting the involvement of an unusually wide range of local and regional stakeholders in the adaptation plans. "We can't assume we'll always have larch with us, but we want to be proactive in taking steps to help both the ecosystem and society adjust to the future."

Near-term results on survivorship are not expected until at least three years after planting, and mid-term results will not be available for more than a decade after that. Nevertheless, organizers hope to continue the study for as long as USFS support is available. Rollwage said that forest managers are eager to hear preliminary findings as soon as they're ready. When they are, she hopes that the Flathead team will help spread the word about adaptation solutions and their role in a changing environment.

Facing page: The drought- and fire-tolerant western larch was a prime species for inclusion in the Adaptive Silviculture for Climate Change study.
Right: In a stand of western larch in Flathead National Forest, logs are yarded with a forwarder instead of skidder to reduce soil impact.

Facing page: Paul Donnellon; right: Melissa Jenkins

Building a large-scale restoration strategy

A decade of collaboration leads to a comprehensive plan for the 4.6-million-acre Rogue Basin

For millennia, recurring wildfires — some sparked by lightning, others tended by indigenous peoples — thinned and maintained productive, open forests in the drier inland Pacific Northwest. As contemporary communities sought to suppress all fire, larger and more severe blazes became more common. Residents now live with the growing threat of wildfires that destroy homes, livelihoods and natural resources.

Southwest Oregon's Rogue River-Siskiyou National Forest is one of these places: a dry, mixed-conifer and hardwood forest including ponderosa pine, sugar pine, Douglas-fir, incense cedar, Pacific madrone and California black oak. Tourism in the area is important to the local economy, but several consecutive summers with multiple fires and unhealthy air have battered the industry. Although support for large-scale forest restoration and the use of prescribed fire is increasing, a mix of public and private lands and interests complicates implementation of collaboration ecological thinning and managed fire at the pace and scale that are needed.

"Surveys were a unique and useful piece of our outreach, engagement and monitoring."

– DR. KERRY METLEN, THE NATURE CONSERVANCY

Over the last 16 years, Rogue Valley communities have begun to retool their relationship with the forest landscape through an active, community-based effort that relies on broad partnerships, science-based risk assessment and strategy. An important step forward was the Ashland Forest Resiliency Stewardship Project (AFR). Based on a community-developed approach, it focused on protecting the city of Ashland's municipal watershed and reducing the risk of severe wildfire to water quality, older forests, large trees, critical riparian habitat, wildlife, people and property.

In 2010, the Ashland City Council voted unanimously to join the AFR partnership, which united the U.S. Forest Service (USFS), the Lomakatsi Restoration Project, The Nature Conservancy (TNC) and the city in a 10-year stewardship agreement. The format of the agreement gave flexibility to the undertaking, increasing partners, expertise and matching funds. At the outset, AFR's goal was to complete restoration work on 7,600 acres of federal land across Ashland's 15,000-acre watershed; later, partners expanded the project's reach by adding more than 6,000 acres for restoration treatments on key private and city lands — one-quarter of the 53,000-acre, all-lands project area.

The city urgently needed a way to provide lasting protection for its watershed, the source of nearly all of its drinking water. As the AFR program expanded, the local utility instituted a customer surcharge that funded a co-investment of $175,000 annually to support AFR's restoration work and long-term maintenance. Thinning and prescribed fire were designated as the primary tools.

Over the course of the program, critical funding came from diverse sources: the American Recovery and Reinvestment Act, the USFS Hazardous Fuels and Forest Health Protection programs, USFS State and Private Forest program, USDA's Natural Resources Conservation Service, and the Oregon Watershed Enhancement Board (OWEB), as well as matching funds and staff time from AFR partners. Revenues from the sale of restoration byproduct timber — more than 14 million board feet — were retained under stewardship authority to pay for part of the work on the ground.

COMMUNICATION AND ENGAGEMENT

Outreach and transparency were central to AFR's success. Communities across Oregon were still recovering from the timber wars of the 1980s, and remnants of those bitter divisions linger. Stakeholders who had once been on opposite sides worked to reach agreement on project objectives, implementation tactics and interpretation of monitoring data.

According to TNC Restoration Forest Conservation Director Darren Borgias, the Healthy Forest Restoration Act helped the group move forward by allowing communities to submit alternatives to federal plans. "Ashland took advantage of the opportunity to integrate its local objectives with the USFS plan. That allowed varied perspectives to be heard and created more buy-in," he said. Implementation was collaborative, too, as the partners worked closely with USFS to develop plans, choose contractors and administer contracts.

TNC Forest Ecologist Dr. Kerry Metlen led a multi-party monitoring effort that engaged the community and volunteers with best science, added transparency and ensured that results informed ongoing management actions.

A series of surveys tracked popular opinion on AFR's efforts. In 2012, 2013 and 2019, teams from Southern Oregon University's Research Center polled citizens on their views of the project and forest restoration. Results showed that over time, popular support for restoration, fuel reduction and selectively cutting trees (while leaving the largest intact) increased. So did public trust in the professionals managing the plan. The surveys also underscored that for the community, reducing wildfire risks was by far the most effective argument for restoration. "Surveys were a unique and useful piece of our outreach, engagement and monitoring," said Metlen.

Right: Darren Campbell

In 2010, the city of Ashland, Ore., joined a 10-year stewardship partnership to restore forested lands across its watershed. As the program expanded, customer surcharges from the local utility helped to fund it.

Facing page, clockwise from top left: Darren Borgias / TNC; Marty Main; Josh Budziak / Lomakatsi Restoration Project; Evan Barrientos / TNC

MODELING A 20-YEAR PLAN

From the beginning, the AFR team hoped that the Ashland project would lay the groundwork for a large-scale forest restoration plan. By 2017, AFR partners were working with the Southern Oregon Forest Restoration Collaborative (SOFRC) and regional partners to create The Rogue Basin Cohesive Forest Restoration Strategy, a new vision for integrated forest management in key parts of southwestern Oregon.

The partners calculated potential costs and benefits of strategic, landscape-scale forest restoration and fuel reduction treatments across the 4.6-million-acre Rogue Basin, informed by need and access. They proposed a 20-year program of thinning, controlled burning and other activities over more than 1 million acres, a quarter of the forest landscape, with an emphasis on nearby communities at risk. Highly collaborative, locally specific approaches integrated wildfire risk reduction with endangered species recovery and climate adaptation.

Early workshops for the strategy involved dozens of stakeholders representing a range of local, state and federal agencies and non-governmental organizations. The sessions identified high-value resources and assets, then assessed their relative importance, extent and likely response to wildfire. Calculations indicated that current wildfire risk and likely benefits across the Rogue Basin varied dramatically among resources and assets. The "all-lands" approach, with treatments across all ownerships and a focus on communities at risk, showed the potential to reduce wildfire risk to human communities and old-growth habitats by 50%.

Designed as a tool for regional land managers, the Rogue Basin Strategy provides an ideological foundation for actions to create more resilient forests. It prioritizes them on their ability to achieve five critical landscape management objectives: 1) mitigating risk of local fires within communities; 2) mitigating risk of large wildfires sweeping into communities; 3) promoting landscape resilience by restoring open forest; 4) protecting existing habitat and promoting development of future habitat for the northern spotted owl and other complex, forest-dependent species; and 5) promoting landscapes resilient to a changing climate.

The strategy was adopted by Rogue Forest Partners, a partnership of conservation organizations, including the SOFRC, with representation by environmental, timber industry, local fire chiefs and community groups, and the lead forestry and natural resource agencies. The group launched its Rogue Forest Restoration Initiative in 2019 and successfully secured $6 million for strategic priorities from the OWEB, backed with $3.8 million in match from partners as well as additional funds. Community engagement and treatments have begun, with staged implementation of six projects underway. Full implementation of the Rogue Basin Strategy will require far greater investment, estimated at $750 million over 20 years. But the cost of restoration treatments must be weighed against the growing cost of inaction as losses from severe fire mount.

Metlen said that the demonstrated success of 10 years of proactive, restorative mechanical treatments, combined with the growing impacts of fires, smoke and poor air quality across the state, have boosted popular support for the work in the Rogue Valley. "Most people agree that something needs to be done to make forests more resilient, but there's less understanding about what is possible and the science behind it," said Metlen. With a framework based on a decade of results, the Rogue Basin Cohesive Forest Restoration Strategy provides that big-picture, science-based plan. By co-investing in shared forest management objectives, communities in southwestern Oregon are proving that residents can work together to address unprecedented challenges and resolve tensions between resource use and conservation.

Darren Borgias / TNC

Facing page, clockwise from top left: Dr. Kerry Metlen describes thinning completed for Ashland Forest All-lands Restoration (AFAR) for a group of independent reviewers; Helicopter yarding in the city of Ashland's forested watershed; Under AFAR, legacy ponderosa pines were released by cutting smaller trees; Controlled burns were conducted with an emphasis on protecting at-risk communities. Left: The Southern Oregon Forest Restoration Collaborative and partners convened the Integrated Rogue Leadership Forum and Workshop to build on common ground created in the Rogue Basin Strategy.

Adaptation strategies for the Northwoods' warming climate

Exploring new approaches to boost resilience, allow transition

Over the last century, Minnesota's Northwoods have heated up at an alarming rate — twice the global average. A 2020 *Washington Post* analysis of historical temperature data found that seven counties in the state have warmed more than 2 degrees Celsius since the late 1800s. Winters have warmed even faster, with 59 of the state's counties — about two-thirds — surpassing the 2C threshold from December through February.

The trend spells danger for the iconic boreal forests of northern Minnesota. To help the Northwoods survive in a changing climate, scientists and land managers have embarked on a pair of projects that investigate how two adaptation strategies — transition and resilience — can be applied jointly or separately to help tree species adapt to a warmer environment.

Given the region's complex ownership patterns, the projects have embraced a multifaceted approach. Federal, state, tribal and local partners involved include the U.S. Forest Service, Superior National Forest, Northern Institute of Applied Climate Science, Minnesota Department of Natural Resources Division of Forestry, St. Louis County Land Department, Lake County Land Department, 1854 Treaty Authority (Tribal), University of Minnesota-St. Paul, University of Minnesota-Duluth, and the University of Minnesota Department of Forest Resources.

In the Adaptation Forestry Project, begun six years ago by investigators from The Nature Conservancy (TNC), University of Minnesota-Duluth and the Northern Institute of Applied Climate Science, seedlings from warmer, drier climates — primarily bur oak, red oak and white pine — were introduced to the southern range of the boreal forest in northern Minnesota. The transition experiment on the Superior National Forest and state and county lands is an attempt to improve adaptation within the state's boreal-north temperate transition zone. If it succeeds, the composition of future forests in the region could look very different from today's: The survival of within-range, native, climate-adapted species could help catalyze a shift to a temperate forest matrix.

The approach, known as "assisted population migration," is a relatively new and untried strategy for climate change adaptation. It selects plants from within their current range and tests to see how they fare in conditions that match or anticipate future climate change. Approximately 110,000 seedlings sourced both locally and from further south were planted on 46 sites across northern Minnesota. Researchers are now measuring their survival and growth, identifying the places that yield seeds most likely to thrive in warming temperatures. Finding the right balance could ease the forest's transition to a new mixture of species, ensuring that forests retain their ability to support wildlife habitat, carbon storage, the timber economy and water quality.

> "With the structure and composition of northern forests at stake, this work will help land managers make informed decisions about forest management and enhance landscape resilience in a changing climate."
>
> — MARK WHITE, THE NATURE CONSERVANCY

TNC's Mark White, a co-investigator on the project, noted that the biggest practical challenge of the assisted migration strategy is finding sufficient quantities of planting material for preferred tree species. "Publicly supported nurseries have been downsized in recent years, and commercial nurseries in Minnesota have not picked up the slack. It can be difficult to find quantities of seedlings for tree species we want to plant — oaks, for example," he said. Obtaining seedlings from specific geographic locations that may be better adapted to current and future climates is another impediment.

HELPING CONIFERS THRIVE

In a separate initiative, scientists are exploring ways to increase climate resilience in the Northwoods by focusing on northern conifers threatened by rapidly warming conditions. The Conifer Strongholds Project focuses on strategies to maintain boreal tree species on resilient sites across the landscape. Its underlying premise is that northern conifers have the highest probability of persisting in sites with suitable microclimates: cooler spots, such as north- or east-facing slopes and moist areas, where stands could continue to thrive. Managing for these species on climate-resilient sites could be a cost-effective way to maintain a diversity of native trees at multiple scales.

More than 158,000 boreal conifer seedlings, such as white pine, jack pine, white spruce, tamarack and white cedar, were

Left: A bur oak seedling takes root near the St. Louis River headwaters in northern Minnesota. Facing page: A Reoh Forestry crew plants bur and red oak from local and southern seed sources in a recently harvested northern hardwood stand north of Two Harbors, Minn.

All photos, pages 32-35: Mark White / TNC

planted in areas near their warm range limits. Plots representing a range of site conditions and temperature variability are now being monitored.

The mighty evergreens have long been a proud emblem of northern Minnesota, but their value is more than symbolic. Keeping conifers in the Northwoods adds to the forest's resilience, making it better able to adjust and remain healthy in a changing climate. It also provides habitat for a range of native wildlife species, from songbirds to mammals including moose and Canada lynx.

Writing for the *Journal of Forestry*, White and TNC colleague Meredith Cornett compared the Adaptation Forestry and Conifer Stronghold Projects, offering insights on how the findings can inform decisions about forest management and enhanced landscape resilience in a changing climate. "I think we were initially surprised at the high survival levels for bur and red oak, even in our northernmost and coolest sites," White said. "But given the level of warming that has occurred in this region, maybe that shouldn't be so surprising." The authors cited research from the Conifer Strongholds Project that indicates cooler, moister site conditions can have a big impact on survival and growth of species at the warm-range limits.

IMPLICATIONS FOR LONG-TERM MANAGEMENT

Applying the lessons learned from transition and resilience experiments to on-the-ground management will require further funding. "At the national level, greater federal resources directed through specific policy initiatives would go a long way to scaling up this kind of work. Large amounts of federal dollars tend to be directed toward fire suppression activities," White said. "Minnesota is unique because we do have sources of state funding that are dedicated to habitat restoration, and we can use these funds to leverage other funding and resources." White believes public policies that support implementation of resilience-based forest management practices could accelerate progress, as could a more diversified local market for forest products.

Many forest advocates and land managers who are following the adaptation studies believe that, deployed together, the resilience and transition strategies can help the Northwoods shift towards future forest conditions. Sharing the results of both projects' research may help boost public awareness of the need to help northern Minnesota forests adjust to a warming climate. "I've been heartened at the acceptance and interest in both the Adaptation Forestry and Conifer Strongholds projects," White said. "With the structure and composition of northern forests at stake, this work will help land managers make informed decisions about forest management and enhance landscape resilience in a changing climate."

Facing page, far left: University of Minnesota graduate student Laura Kavajecz and field assistant Ada Tse survey understory vegetation conditions at a bur oak-red oak planting site.
Left: Research assistant Ginny Alexander measures understory vegetation at a Conifer Strongholds planting site.
Right: Research Assistant Kristen Campbell checks the height and diameter of a bur oak seedling. Plots representing a range of site conditions and temperature variability are being monitored.

Planning future-ready forests in the aftermath of megafires

Camp Fire burn scar is a laboratory for new approaches

Climate-resilient reforestation is going to look different in every part of the United States. But it will be — and already is — important everywhere, as wildfires exacerbated by climate change continue to proliferate.

In California, the summer of 2020 brought such devastation on a massive scale. Lightning strikes sparked hundreds of wildfires that ravaged over 4.7 million acres and destroyed countless trees. The blazes came just two years after the state's deadliest and most destructive megafire: the 2018 Camp Fire, which shocked the nation and showed what might be in store as climate change heats up. The fire killed 85 people and leveled the towns of Paradise and Concow. And in 2020, as fires raged nearby, people living there were forced to evacuate once again.

> "The gift that the Camp Fire gave us is that it helped us to see what isn't working."
>
> **— WOLFY ROUGLE, , BUTTE COUNTY RESOURCE CONSERVATION DISTRICT**

Today, the Camp Fire burn scar has emerged as a landscape-sized laboratory where a group of forward-looking forest scientists and land managers are pioneering ways to grow future-ready forests that can withstand the impacts of climate change. "The gift that the Camp Fire gave us is that it helped us to see what isn't working," said Wolfy Rougle, the forest health watershed coordinator with the Butte County Resource Conservation District. In 2019, Rougle assembled local land managers, climate scientists and nonprofit leaders to envision what a more climate-resilient forest might look like and how to get there. What they learn may guide forest adaptation across California's low-elevation foothills — areas that are warming up and drying out faster than almost anywhere in the state, outside of the Mojave Desert.

BRING BACK THE OAKS

Given the hostile new climate coming into focus — one with earlier springs, hotter summers and more severe droughts — the Concow Resilience Project is focused on identifying actions that will increase the forest's resilience in an altered environment. "We have a moral obligation to replant the Concow region through a climate-smart lens," said Brittany Dyer, California director for American Forests. "Conditions are changing under our feet, literally, but by finding climate-smart solutions, we can redefine what it means to live in Paradise for years to come."

The group is testing three different reforestation approaches in the hardest-hit parts of the region, especially areas that are unlikely to regenerate on their own. Most of the pilot plots are less than 1,000 acres, with some more than 3,000 acres, and all have been identified as priority areas. The regeneration strategy here is short and sweet: "Plant trees. Not too many. Mostly oaks." The aim is to learn as much as possible and to do so as quickly as possible.

The project's first approach is to nurture oak trees that survived and re-sprouted after the Camp Fire. In most parts of the burn, they are the only trees that are coming back. Even when their tops burn completely, oaks can re-sprout from their root systems. Rougle plans to give the oaks a boost by thinning competing shrubs so that the young trees have more room to grow, pruning to encourage them to grow up and out of the reach of flames. This could jump-start a grassy understory, with a few large trees can accommodate fire much better than an overgrown forest.

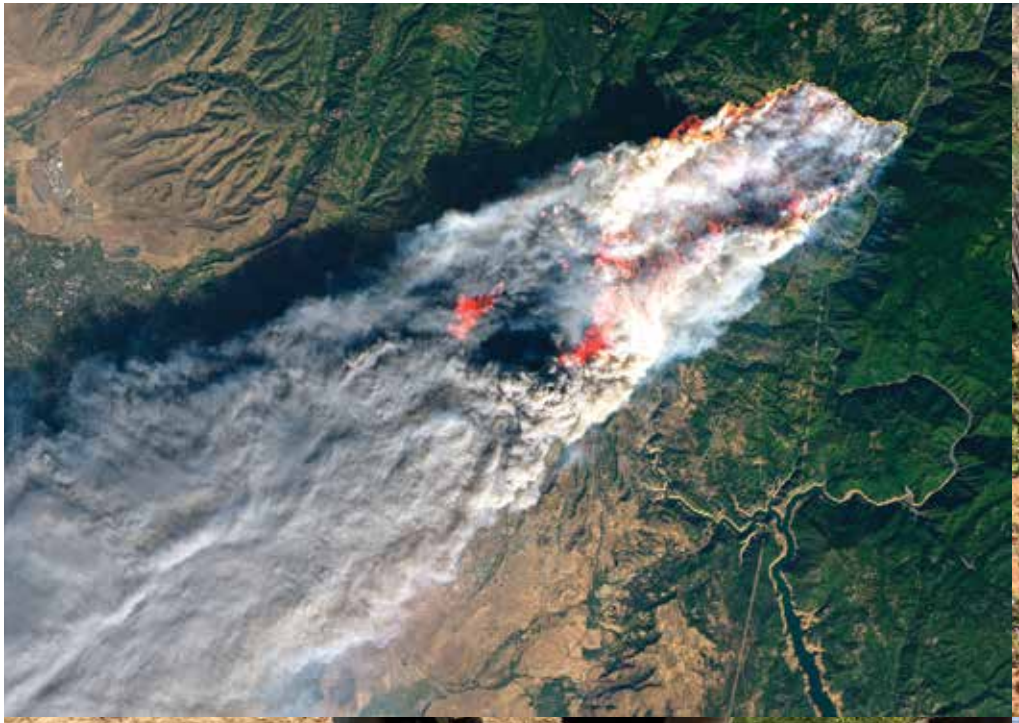
The second reforestation model in Concow explores whether young trees can survive, and possibly even benefit from, prescribed or controlled fires. Many foresters would be shocked by the idea of intentionally setting fires near planted trees. But in California and many other parts of the American West, future reforestation efforts will need to include this type of "good fire." Public land managers and landowners in the Camp Fire area are eager to figure out how it can be done effectively. The Butte County Resource Conservation District, where Rougle works, has started a prescribed fire association for landowners to come together to complete small, home-scale burns. Their hope is that regular application of good fire by a community of local forest tenders could help the region escape the accelerating cycle of catastrophic wildfire.

Cluster planting, which involves planting seedlings in clumps or patches at a distance from each other, may also offer a way to reconcile the seemingly conflicting goals of reforestation and prescribed fire. Simply put, cluster planting is like social distancing for trees. And it eliminates a major drawback of traditional planting, where foresters plant in neat, densely packed rows to help trees outcompete other vegetation. The wisdom of this practice — "pines in lines" — hinges on the ability to thin out young trees before they start to crowd each other. If they grow too close, fires can easily spread from tree to tree, putting the whole stand at risk of burning. But thinning is expensive, and foresters are often forced to let the majority of young stands fend for themselves.

The final approach being tested in Concow focuses on whether conifer seed sources from warmer and drier sites might outperform the traditional, local seed sources. Research led by Dr. Jessica Wright of the U.S.D.A Forest Service Pacific Southwest Research Station reveals that forests growing today are already out of sync with the current climate, much less the climate expected to exist 50 years from now. Wright and her team are carefully selecting Ponderosa pine seeds from various parts of California to see if any lead to better growth and higher survival in

Right: Austin Rempel / American Forests

At a California Bureau of Land Management site, a crew sets out with seedlings to restore burned terrain.




FILA

Concow. Trees from southerly latitudes and lower elevations may grow faster, invest more of their energy into root growth in preparation for drought, or have needles that surrender less water. And seeds sourced from mother trees that may possess "survivor" genetics could speed up adaptation even faster, helping forests thrive in the coming century.

LIFEBOATS FOR TREES

A mile and a half west of Concow, American Forests is working with the federal Bureau of Land Management (BLM) to formulate a plan to restore the burned land that is under the bureau's care. At an elevation of 2,500 ft., this area is currently a conifer transition zone. In 30 to 40 years, however, warmer conditions may mean few conifers survive there. "We're planning on conditions that resemble 1,500 ft," said Austin Rempel, Forest Restoration Manager for American Forests. "The question is, just how far should we be looking downhill?"

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>
> **— AUSTIN REMPEL, AMERICAN FORESTS**

One of the more promising approaches is to pinpoint places where seedlings may have an edge because they are shielded from the worst climate impacts. Scientists call these special spots "refugia," which could act as lifeboats when large landscapes experience big, forest-killing events. Some of these safe zones are apparent in the Camp Fire scar. For example, trees surrounding the Concow Reservoir have repeatedly escaped the worst of the fires, likely due to higher humidity and cooler air temperatures around the lake. Some gray pines have avoided the brunt of the blazes by growing apart from other plants, on the harshest, driest soils and the steepest slopes. American Forests is identifying other refugia where sensitive seedlings like Douglas-fir, which is projected to disappear from the region as temperatures rise, could thrive.

With the majority of the pilot planting in the Camp Fire area not scheduled to begin until 2021, it will be many years until forest scientists can assess the most effective innovations. Their work, coupled with the commitment of local landowners, will provide a firm foundation for future restoration actions and a beacon of hope for California forests.

Facing page, clockwise from top left: A satellite image of California's 2018 Camp Fire; Seedlings from various elevations are planted and monitored for growth; A crew re-plants burn scars left by the 2018 Carr Fire, 80 miles north of Paradise, Calif.; Container-grown Douglas-fir seedlings can withstand drought and competition from wild plants.
Right: In the Sierra foothills, scientists are testing whether a Douglas-fir grown from seed collected on the coast can thrive in a changing climate.

Facing page, top left: NASA; all other photos, this page and facing page: Austin Rempel / American Forests

Accelerating conservation of privately owned forests

Sustainable management plans and new income streams help forest owners keep carbon in the ground

The wooded hills and valleys of Pennsylvania's Pocono Mountains offer hunting, fishing and recreation for millions of people in New York's metropolitan corridor. Scores of small private forests, many of which have been in the possession of the same families for decades, are a part of this mosaic. Owners of these properties cherish their lands, and many actively seek sustainable ways to protect them.

Family forests like these hold real potential in the fight to keep carbon in the ground. In Pennsylvania, they comprise 70% of the state's forests; across the United States, they account for 38%of all forested land — more than 1.5 times the area of Texas, and more than any other ownership type, including national forests. Holders of small and medium-sized non-industrial forests, who can range from families to water providers and hunting clubs, are showing that, given the right conditions, they're ready to work with partners to manage their lands and conserve them for generations to come.

> "Working Woodlands is of interest to people who have a conservation vision, value their legacy and want a conservation partner."
>
> **— JOSH PARRISH, THE NATURE CONSERVANCY**

The Nature Conservancy's (TNC) Working Woodlands program was designed to help private landholders manage their small and medium-sized forests sustainably in return for a commitment to a permanent conservation easement. "Landowners need to be confident that an easement is the best outcome for the land and for them," explained TNC's Josh Parrish, who directs the program. "Working Woodlands is of interest to people who have a conservation vision, value their legacy and want a conservation partner." By providing owners with a custom management plan, ongoing assistance and the possibility of ongoing revenue, the program offers incentives for owners to maintain the health of their forest while still enjoying an income stream.

In 2010, Working Woodlands enrolled its first property in the Pocono region: a 22,000-acre watershed forest managed by the Bethlehem Water Authority. "They were looking for a roadmap to manage a healthy, protected forest and diversify revenue, just as the concept of carbon credits was beginning to take hold," said Parrish. Through the agreement, the Authority received a climate-resilient forest management plan that helps it protect water quality for more than 117,000 users, while also earning substantial revenue from timber byproducts and the sale of carbon credits. Currently, 18 properties are enrolled, including those of families, individuals, water providers, Native American tribal lands and TNC projects in Alabama, Michigan, Minnesota, New York, Pennsylvania, Tennessee and Vermont.

Appalachian deciduous forests, like the Bethlehem watershed tract, face serious threats from the impacts of climate change. Working Woodlands' experts address these threats with a plan of action to prevent encroachment of non-native invasive plants, increase the variety of species, extend the rotational age of trees, and support structural diversity from the forest floor to the overstory. The goal is a forest that mimics nature, minus modern-day stresses, and will remain forest. Part of the power of this approach is that because so much private forest land suffers from poor forest stewardship, the improvements that are made here provide economic value potential because of increased carbon storage and sequestration. Sustainable forest management provides direct climate mitigation benefits that accompany all other environmental co-benefits, while also generating funds for the landowners to cover costs of this improved forest management.

The Working Woodlands program ensures that the land will remain in its natural, scenic condition, protecting its unique ecology and avoiding fragmentation and development. It also permits sustainable harvesting, following the standards of the Forest Stewardship Council (FSC). With FSC certification, wood products harvested from the property may command higher prices or market access premiums.

An additional incentive for enrollment is the chance to earn income for the carbon sequestration that forests provide — a process that can be prohibitively complex for landholders. Working Woodlands facilitates the sale of carbon credits meeting the global Verified Carbon Standard, American Carbon Registry or the California Air Resources Board, which can then be purchased by corporations to offset their carbon emissions. By entering the program, Bethlehem Water Authority's watershed forest has generated over $1 million in carbon credit revenue from several large corporations since 2011.

The Borough of Duncannon, near Harrisburg, joined Working Woodlands in 2019. Its goal was to get professional assistance in returning a tract that had been regularly harvested to its full ecological and economic potential. The resulting conservation easement has not only helped the town manage the forest, but also ensured permanent public access for hikers on the Appalachian Trail. Habitat for fish and wildlife has benefitted as well. "That area contains the Kittatinny Ridge, one of the most important wildlife corridors in the northeastern U.S.," noted Parrish, "and protects a portion of the local watershed that flows into the Susquehanna River and the Chesapeake Bay."

Program-related investments from the Doris Duke Charitable Foundation helped to fund conservation of the Ataya property, part of the Cumberland Forest Project.

FAMILY FOREST CARBON PROGRAM

As Parrish spoke with landowners interested in the Working Woodlands program, he realized that the program worked well for landowners who own 3,000 acres or more and wanted to permanently protect their forest. However, the majority of private forest owners held less than 3,000 acres and viewed permanent conservation easements as a barrier to participation. Knowing that the cash benefits the program offered were a reliably strong incentive, Parrish worked with the American Forest Foundation and TNC to propose a similar program that offered landowners professional assistance and income but had a shorter, 20-year commitment. The Family Forest Carbon Program gives family forest owners who own as little as 30 acres an opportunity to earn income from their land, in exchange for implementing sustainable forest practices that help sequester and store more carbon. With a new carbon accounting methodology, companies in turn can purchase this carbon in the form of verified carbon credits.

Supported by a $10 million grant from Amazon, The Family Forest Carbon Program launched in April 2020 in select counties in Pennsylvania, recruiting landowners based on the size of their acreage and goals for their land. Participants are paid for adopting one or both of two forestry practices that increase carbon storage: growing mature forests and enhancing future forests. The program covers most of the cost of each practice and pays for a consulting forester to help each landowner develop a management plan that enhances not only carbon storage, but also wildlife, water quality and other ecosystem services. In just a few months, despite the onset of the 2020 pandemic, it attracted more than 400 qualified applicants. "It's a lot of landowner interest velocity for a brand-new program launched during a global pandemic," said Parrish.

"This program is another tool in our tool kit as threats to forests expand," noted Parrish. "It opens up carbon credit markets to small family forest owners." It's also an example of how lessons learned through one approach can accelerate the success of another. Working Woodlands and the Family Forest Carbon Program present a new value proposition — a way to balance the competing needs of people and forests. By encouraging healthy and productive lands that can reduce carbon in the atmosphere, they're providing an effective solution for climate challenges.

These successful and emerging efforts demonstrate how better care of forests can return valuable environmental benefits, including better carbon sequestration and storage to mitigate climate change, while also generating funds to cover management costs. Such programs help rural landowners, create jobs and improve wildlife habitats, water conditions and more. They also provide great examples for public forest managers and national and state policy creators to evaluate and emulate, even in the vast National Forest System.

Facing page: Maintaining the health of Appalachia's forests boosts protection of wildlife corridors as well as local watersheds.
Above: One of the first participants in the Family Forest Carbon Program contemplates her Pennsylvania landscape.

Watershed restoration and avoided costs

Partnerships with utilities protect fire-prone communities

The disastrous Hayman Fire, which ravaged 138,114 acres in Colorado's Front Range in 2002, illustrated the interdependence of three natural forces: forests, water and fire. Less than 25 miles from Denver, it burned more than 600 structures and caused private property losses valued at $40.4 million. In its aftermath, rainstorms drove tons of sediment from charred slopes into the reservoir that supplies the needs of more than a million Denver residents. The local utility, Denver Water, spent several years and more than $27.7 million to remove sediment and debris and restore municipal water resources.

The Hayman Fire focused public attention on the vital connection between the region's forest and the water sources it protects. It led to a new collaboration between Denver Water and the U.S. Forest Service (USFS) — one of the first in the nation to engage utilities in forest restoration. The partnership, Forests to Faucets (F2F), supports long-term, ongoing maintenance and monitoring on federal, state and private lands to help trees to survive wildfire and prevent sedimentation after fire events.

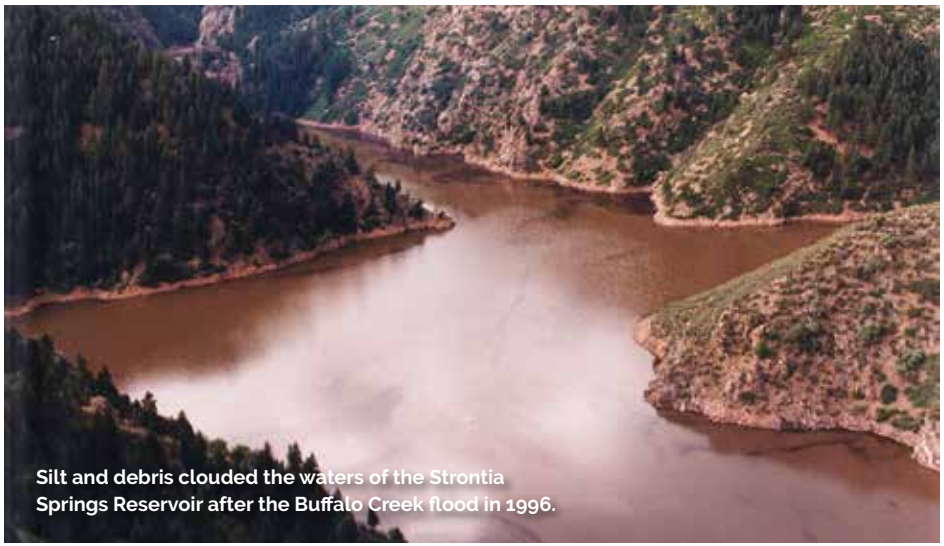
The F2F program addresses wildfire dangers in the Denver area that are shared by many cities across the West, where a legacy of fire suppression, an influx of residents and a boom in development bring people closer and closer to wild lands. As the effects of climate change intensify, analysts estimate that the number of wildfires in Colorado could increase 50% to 200% by 2050, threatening billions of dollars in property damage.

FUNDING TO PROTECT WATERSHEDS

F2F addresses future wildfire threats by creating new financial resources to manage forests proactively. In addition to forest thinning and prescribed fire, it supports restoration of areas that are currently recovering from past wildfires; minimizes current erosion and sedimentation of reservoirs through the decommissioning and improvement of roads and trails; and monitors of the effectiveness of each intervention. To support the program, each Denver Water ratepayer pays about 14 cents per month. The utility's contribution is matched by the USFS, Colorado State Forest Service (CSFS) and Natural Resources Conservation Service (NRCS). Over an 11-year period from 2010 to 2022, the partners will have invested a total of more than $66 million to mitigate the risks of future fires.

> "One difficulty has been the cost of forest treatments. Another barrier is the steepness and inaccessibility of some of the acres that need treatment."
>
> — CHRISTINA BURRI, DENVER WATER

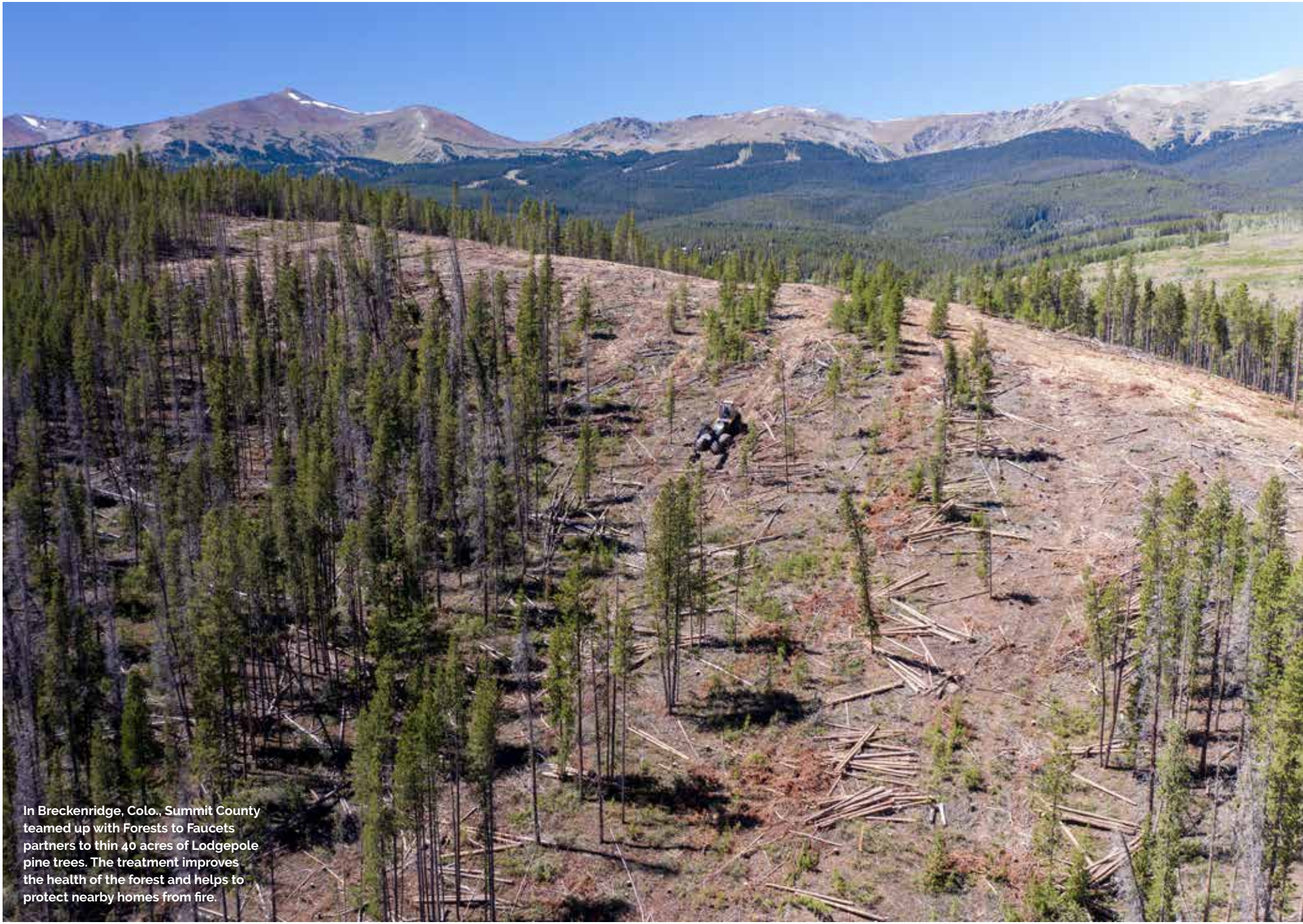
After the Hayman Fire in 2002, heavy rains carried tons of sediment down charred slopes.



Silt and debris clouded the waters of the Strontia Springs Reservoir after the Buffalo Creek flood in 1996.

All photos, pages 44-47 Denver Water

The Buffalo Creek burn area in Colorado's Pike National Forest still shows the ravages of a 12,000-acre fire in 1996.



In Breckenridge, Colo., Summit County teamed up with Forests to Faucets partners to thin 40 acres of Lodgepole pine trees. The treatment improves the health of the forest and helps to protect nearby homes from fire.

To identify priority areas for treatment, F2F analyzed and ranked locations according to wildfire hazards, flooding and debris risks, soil erodibility and water uses. Based on this assessment, it embarked on a regimen of thinning and prescribed burns, with more than 49,500 acres treated through 2019. These on-the-ground restoration actions are protecting critical water infrastructure.

Notably, F2F-funded mitigation efforts paid off in 2018, when a wildfire in Summit County raced toward two local subdivisions containing more than 1,400 homes and condominiums. Thanks to a fire break created by the program and rapid air support, crews were able to control the flames, and not a single structure in the neighborhood was damaged. Such visible results are making communities more receptive to creating fire breaks near development.

New partners have expanded the scope of F2F. In addition to USFS and Denver Water, Colorado Forest Restoration Institute at Colorado State University joined the program to assist with monitoring and evaluation. The involvement of CSFS and NRCS allowed F2F to treat state and private lands in addition to federal forest.

Despite the growth of the program, the utility faces ongoing challenges in implementing its restoration plans. "One difficulty has been the cost of forest treatments," explained Christina Burri, watershed scientist for Denver Water. "Another barrier is the steepness and inaccessibility of some of the acres that need treatment." Researchers have found that some of the areas replanted after high-intensity fires are not regenerating; they are working to understand how the dual impacts of fire and a warming climate may be transforming large areas that were once forest into grass and shrublands.

Crews plant seedlings in the area burned by the Hayman fire.

INCREASING THE SCALE OF RESTORATION

The Hayman Fire brought together Front Range scientists and managers with a shared commitment to forest health and fire risk mitigation. Their Front Range Roundtable, organized in 2004, consisted of local governments, non-governmental organizations and federal and local agencies. Together, the partners created a vision document that identified a 1.5-million-acre area for treatment and launched a 8,200-acre demonstration project in the Woodland Park area west of Colorado Springs.

In other parts of the Front Range, practitioners are examining new techniques to protect water supplies. Colorado Springs, where a watershed restoration partnership with the local utility has been underway since 2013, is currently exploring alternatives to thinning and its high associated costs.

"These actions are different than many used in the past because in some of our critical watersheds, we have forest types that are not conducive to thinning. In those locations, we are trying to use techniques such as aspen enhancement," said Brad Piehl, a planner with JW Associates. "Aspen and cottonwood trees tend to re-sprout very quickly and at high density after a fire. They can be very valuable for stream bank protection and creating sediment deposition, which benefits water quality downstream."

RESTORATION'S ROI

Recent studies indicate that dollars directed to restoration services can bring a solid return on investment for water utilities. A 2017 article in the Journal of Environmental Management undertook a simulation study to quantify how fuel reduction interventions in fire-prone areas can reduce the costs of dredging sediment from reservoirs — costs that ran to many millions of dollars after the Hayman Fire. "Avoided costs" research has also been conducted in California's Mokelumne River watershed, which supplies 90% of the water used in San Francisco's East Bay communities, as well as New Mexico's Santa Fe River watershed. Both studies suggest that fuel treatments can not only significantly reduce the size and intensity of wildfires, but are likely to provide economic benefits that can be two or three times greater than their cost.

The New Mexico analysis helped convince Santa Fe stakeholders of the value of investing in the restoration and protection of forested headwaters. It persuaded residents to support a charge of 65 cents per ratepayer per month to keep the city's water supply safe from catastrophic wildfire. The rate increases now provide $220,000 annually for forest restoration through Santa Fe's Watershed Investment Program. (Most of the Mokelumne River recommendations have yet to be implemented, although severe wildfires in California in 2020 may cause leaders and stakeholders to revisit this.)

These and other programs represent some of the many collaborations for forest restoration that have taken hold to protect water supplies in the West. Such interventions may help communities avoid costs associated with emergency fire suppression, fire recovery efforts and intensive water treatment after catastrophic wildfire.

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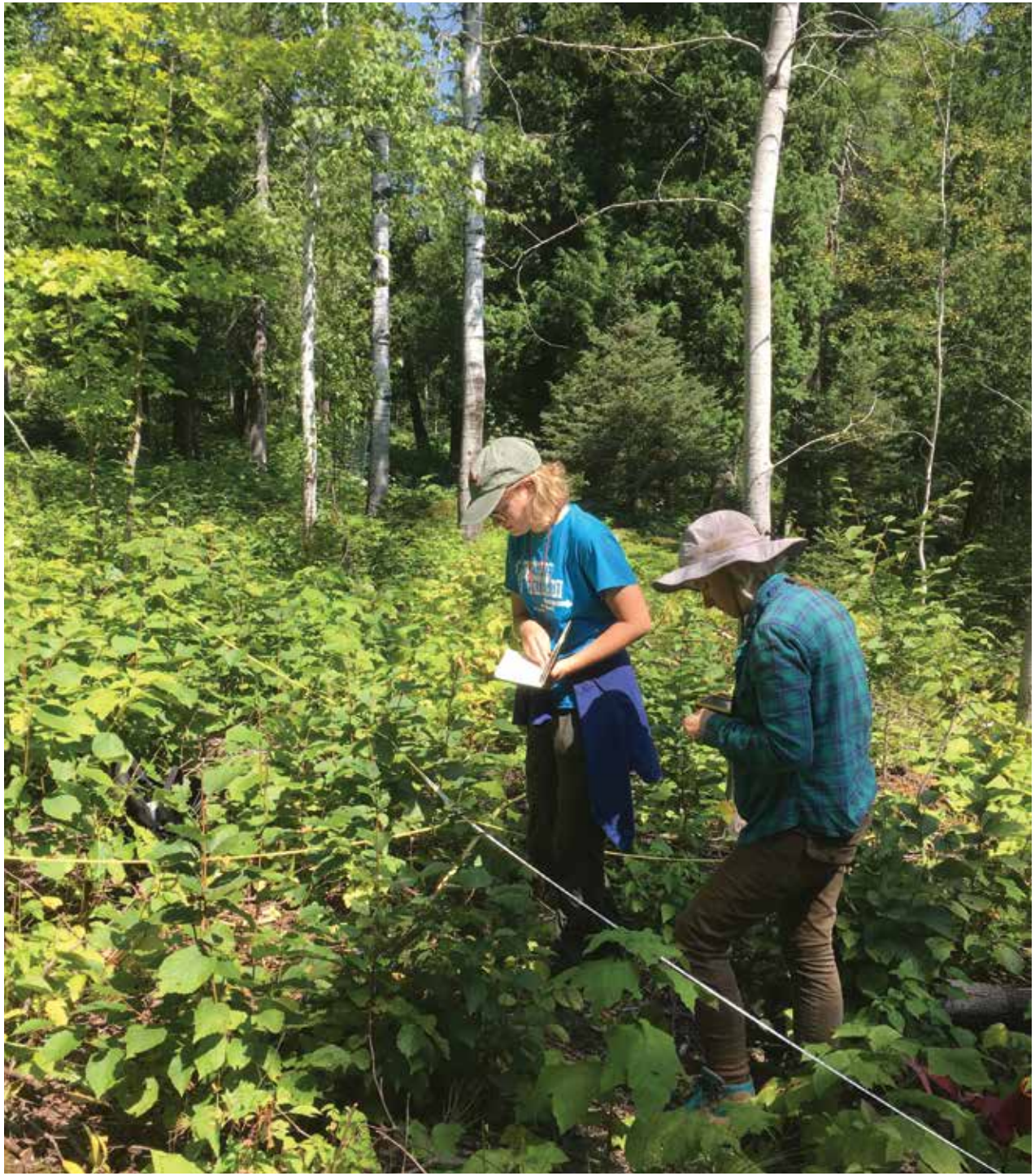

Facing page. Lauryn Wachs / TNC; left: Mark White / TNC

NATIONAL WILDLIFE FEDERATION

The Nature Conservancy

AMERICAN FORESTS