Science Update

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INSIDE

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Fuel Treatments: Are We Doing Enough?

Morris Johnson's path to becoming a fire ecologist for the U.S. Forest Service was an unlikely one. He grew up in Waterproof, Louisiana, population 591 and shrinking. "No one really talked about going to college," he said. "The big push for us upon high school graduation, unless you were the one best basketball player who got a scholarship, was Army, Air Force, or Marines." He thought he would join the Marines, or possibly find a college where he could compete on a powerlifting team.

Johnson now lives in Seattle, Washington, where he works with the Forest Service's Pacific Northwest Research Station. He has a Ph.D. in fire ecology and spends his summer days in the aftermath of large wildfires, learning from the scorched trees and patterns burned through the forest. In particular, Johnson is interested in how future fire behavior can be altered by managing forest vegetation. Known as fuel treatments, these actions attempt to reduce or redistribute the "fuel"—the grasses, shrubs, and trees—that ignite and carry wildfire.

In 2017, Johnson was keeping an eye on the Chetco Bar Fire burning in southwest Oregon as a possible site for future study. In the past three years, he has established 1,400 study plots. He studies plots in California and Arizona, and also 360 plots on Colville tribal land in Washington where he is studying the effects of salvage logging on fuel succession. "We've been all over," he said. "Ideally, I would like to get plots in all 11 Western States."

Sasha Salia

An underburn is lit at Shevlin Park, Bend, Oregon.

Key Points

- Fire has a natural role in forest renewal. Yet after decades of fire exclusion, large areas of fire-adapted forests have become susceptible to uncharacteristic wildfire: fires burning so hot or over so large an area that most or all the trees in the overstory are killed.
- Fuel treatments, including thinning, prescribed fire, and managed wildfire, can help create fire-resilient forests, but measuring their effectiveness is inherently complex.
- Forest Service scientists are studying fuel treatment effectiveness using a variety of approaches. Their research provides land managers with information on the extent to which treatments change fire behavior.
- Future wildfires will continue to alter forest landscapes. Research tools can help land managers strategically locate fuel treatments to protect the things we value and enhance ecosystem resilience to fire and other disturbances.

Lance Cheung

His research yields information that land managers need as they race to treat fuels before dense, overgrown forests are struck by fire, and the chance to protect communities and forests is gone.

Haley Wiggins

Morris Johnson stands inside a charred tree with a unique feature known as "catface" – a trunk that has been hollowed out by multiple fires.

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◄ *A member of the Geronimo Interagency Hotshot Crew conducts a prescribed burn at the Big Windy Complex Wildlands Fire, Oregon.*

Fire: Part of the landscape

Fire is a natural process that was unnaturally taken off the menu for nearly a century. Fire is now understood to be as much a part of the cycle of forest life as sun and air. Even Smokey Bear, our most famous wildfire opponent, now extends the message of fire's benefits. Smokey's website states: "Some ecosystems depend on periodic fires. In these fire-adapted areas, fire promotes plant and wildlife diversity and burns away accumulations of live and dead plant material."


Morris Johnson

Fire can play a natural role in forest renewal on fire-adapted landscapes. Here, fireweed colonizes a stand two years after a 2015 fire on the Colville National Forest, where Morris Johnson has study plots.

Today in the Western United States, "megafire" is a term that denotes a wildfire larger than 100,000 acres. The rolling 10-year average number of acres burned more than doubled from the decade of 1985 to 1994 to that of 2005 to 2014. Over the past century of forcibly excluding fire from western landscapes, fire-dependent ecosystems have missed many fire cycles. Flammable fuels have accumulated, resulting in large fires and extreme fire behavior that, although common today, were rare in previous centuries. Across the West, large areas of fire-adapted forests are highly susceptible to damage from uncharacteristic wildfire—fires burning so hot or over so large an area that most or all the trees in the overstory are killed, thus known as "stand-replacement" fires.

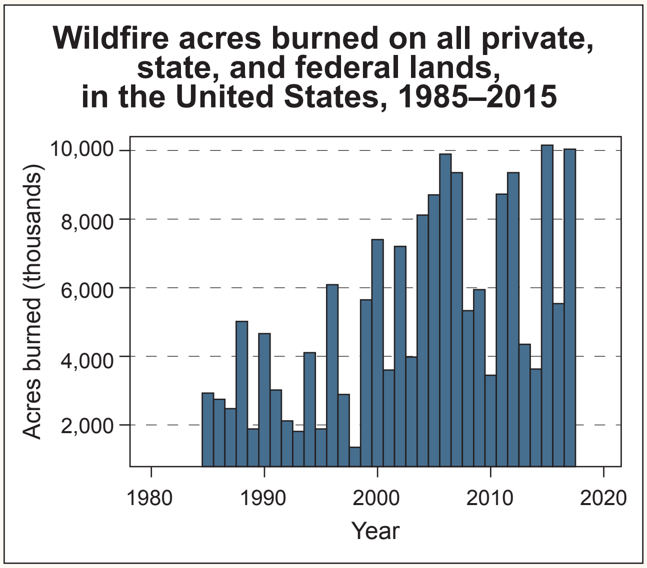
The recent increase in acres burned is understandable, perhaps even inevitable. And given fire's natural role in forest renewal, an increase in acres burned is ultimately necessary for forest health. But the question is, how can fire be brought back in the renewal role it once played across the West without risking excessive damage?

Brenda Hallmark has an experienced perspective on the status of fire-adapted forests and the complications of bringing fire back onto landscapes where it has been excluded. She is the East Fuels Program Lead for the Central Oregon Fire Management Service, a service-first partnership between federal agencies that oversees fire suppression and fire management. Hallmark directs the fuels programs for the Ochoco National Forest, the Crooked River Grassland, and the district office of the Prineville Bureau of Land Management.

Overall, Hallmark does not see fire as bad, even high-severity fire. "It's a natural process in the ecosystem," she said. "High-severity fire is not desired in every forest system, but some forest types, such as lodgepole pine,


Karen Wattenmaker

This area of the Hayman Fire (2002), the largest wildfire in Colorado's history, shows an example of stand-replacement fire.



typically burn with stand-replacement fires." However, she went on to explain that our past management actions have set up landscapes where fire is no longer as beneficial as it would have been. Because of fire exclusion over the past 100 years, the buildup of vegetation is above normal levels.

"In the Ochocos, a lot of areas were once open pine stands with scattered small trees regenerating and a bunchgrass or grass understory. But now, undergrowth is heavy," she said. "Big remnant trees are out there, but undergrowth is to the point that fire ignition under the right conditions can create a stand-replacement fire where historically a low-intensity underburn or mixed-severity burn would have occurred. You lose those big trees and take out all the regeneration and vegetation in the riparian zone."

Big trees are important for wildlife and take a very long time to replace, and riparian vegetation is critical for cooling streams and maintaining fish habitat. When fire was able to creep through frequently at lower severity, big trees would often survive again and again. In small patches, even high-severity fires can bring benefits like nutrient cycling and unique types of wildlife habitat. For example, the black-backed woodpecker uses recently burned forests, moving from place to place across the landscape following outbreaks of wood-boring beetles that invade dead or dying trees after a fire.

But when spread over entire watersheds, stand-replacement fires exacerbate the difficulties of restoring fire-adapted forests. These fires take out the large old trees and diverse patchwork of grasses, sedges, and forbs in the understory, resetting the system. So even though fire is a natural ecological phenomenon, large wildfires in unhealthy forests are problematic ecologically and in terms of control.

Fuel treatments, including prescribed fire and managed wildfire, can change the amount or arrangement of forest vegetation, thus helping mitigate wildfire behavior and expediting fire resiliency. Also, proactively reducing fuel accumulations gives land managers like Hallmark more decision room in dealing with a wildfire.

U.S. Fish and Wildlife Service

Prescribed fire on the Turnbull National Wildlife Refuge reduces hazardous fuels and improves and restores ecosystem health.

Taking measure of fuel treatment effectiveness

After high school, Morris Johnson did follow through with his powerlifting goals, winning a 1998 statewide Junior Division title in Oregon by bench-pressing an unthinkable 500 pounds.

But he did not end up joining the U.S. Marines. Instead, at the urging of his aunt, Johnson started attending Southern University in Baton Rouge, Louisiana. But the money he had saved would pay for only one semester. Seeking programs offering scholarships, he joined the first one he found: the urban forestry program at the college of agriculture. When the program required him to complete an internship, he accepted a summer forestry technician position with the U.S. Forest Service and boarded a Greyhound bus in Baton Rouge for the 2,500-mile trip to Prospect, Oregon.

During his internship as a forest technician, Johnson attended fire school, and he later spent two more summers fighting fires on hotshot crews. His experience fighting wildfires was instructive. He saw how fire interacted with forest stands that had been thinned, and learned that these stands were advantageous starting points for crews when installing fire lines because they offered more protection. These observations and experiences formed the first threads of his interest in research. He went on to win a Gates Millennium Scholarship, earning his Ph.D. at the University of Washington in fire ecology in 2008. Now he studies the wildfires he used to fight.

His research helps unravel some timely questions. The General Accounting Office has issued several reports about wildfire management and the ongoing efforts to reduce hazardous fuels. Their 2015 report said, "We found in September 2007 and September 2009 that demonstrating the effectiveness of fuel reduction treatments is inherently complex and that the agencies did not have sufficient information to evaluate fuel treatment effectiveness, such as the extent to which treatments changed fire behavior."

Johnson's research directly addresses this question. "My goal was always to find a way to test this," he said. "There are two ways. We could go to a national forest and say, 'Give me 100,000 acres and we'll install various thinning treatments and then we'll run a crown fire through it.' But no one is going to sign off on that."

The next best thing is to find wildfires that have burned over fuel treatments and then piece together what happened. "That's how you're going to be able to test these things," he said. "Because people are doing thinning treatments every day. And wildfires are burning over them. But no one really goes in and quantitatively tests the change in fire behavior."

For years, he has been doing exactly that. "Usually I am one summer behind a wildfire," Johnson said. "When I identify a large wildfire burning unimpeded by suppression in an area where fuel treatments have been done, I contact

U.S. Forest Service

Morris Johnson and his field crew measure fuel loading after wildfires using field transects. Left: One year after the Pioneer Fire (2016) on the Boise National Forest, Johnson takes a picture of a plant with his phone to identify later. Middle: Three years after the King Fire (2014) in northern California, a transect cuts across a tree top that burned in the fire and subsequently fell, adding to fuel accumulation on the ground. Right: A transect through a 2015 burn on the Colville National Forest runs through small dead woody fuels. These are 1-hour fuels, based on how long it would take for two-thirds of the dead fuel to respond to atmospheric moisture.

the fire management officer or fuel manager from the local national forest to find out if I can go there the following summer and put in study plots. My goal is to quantify the change in fire behavior from the fuel treatments, or to see if there even was a change in fire behavior at all."

The data he gathers from these plots include tree burn severity, percentage of tree crown scorched, the height of the surface-flame effects on the tree trunk, and the distance within a treatment area where fire severity decreases. Back in his office in Seattle, he will quantify fuel treatment effectiveness in changing wildfire behavior based on this data through analysis and computer simulations. His study of the Wallow Fire is one example.

In 2011, the Wallow Fire started when an abandoned campfire blew out of control in Arizona's Bear Wallow Wilderness. Before it burned out, it threatened 1,551 homes in several communities, and burned 36 structures. Eventually spreading to 538,000 acres, it remains Arizona's largest recorded wildfire as well as one of the largest single fires recorded in the lower 48 states. From Seattle, Johnson tracked the fire's progress, knowing that parts of the landscape in flames had been undergoing fuel reduction treatments since 2004.

The coincidental overlap of the Wallow Fire with previous treatments gave Johnson a perfect opportunity to quantitatively measure the effects of the treatments on fire behavior. Land managers had designed several fuel treatments to meet different goals. Some treatments emphasized reducing wildfire hazard for communities in the wildland-urban interface, while others left higher density pockets of trees to provide habitat for wildlife.

The summer after the fire, Johnson and his colleagues set up permanent study plots and ran transects through the fire's footprint in both treated and untreated areas. They tracked how the fire moved from the untreated areas into the treated areas, tracing changes in fire behavior by measuring such things as crown scorch. They found that in all of the treatment areas, the fire diminished in severity before encountering residences in the wildland-urban interface. "The fire's damage would have been substantially worse without prior forest thinning treatments," said Johnson.

His study provides empirical evidence that thinning treatments can reduce fire severity, and also that a range of different fuel treatment strategies can be effective. But as he and his coauthor Maureen Kennedy cautioned, this information only takes you so far. In a Forest Ecology and Management journal article they wrote, "While it is useful to understand that a fuel treatment lowers fire severity relative to untreated areas, this binary knowledge (fuel treatment worked or fuel treatment did not work) has limited use for managers who are designing and implementing fuel treatments."

Specifics are needed in designing a fuel treatment to meet defined, desired outcomes. Decision support tools such as BioSum can be useful (see on p. 15) in exploring alternative strategies and how they play out over time. Guidelines can also be helpful, as can parameters that define what makes a treatment effective enough to be worth doing.

Karen Wattenmaker

Hayman Fire (2002) in Colorado. A high-intensity burn turned to a low-intensity burn on the perimeter of a prescribed burn done the previous year. Fire engines were able to protect structures inside the prescribed burn. Outside that perimeter, the event became a stand-replacement fire.

Morris Johnson

On one of its study transects, Morris Johnson's field crew measured this log in 2017, one year after it burned in the Pioneer Fire on the Boise National Forest.

Two kinds of enough

Federal agencies have regularly spent more than $1 billion a year fighting fires since 2000. That year's fire season was a wake-up call: more than 7 million acres of public and private land burned, and fires were so frequent and difficult to control that suppression efforts required more than 29,000 personnel, including fire crews borrowed from Canada, Australia, Mexico, and New Zealand. As a result, the Departments of Agriculture and the Interior were directed to devise a plan to reduce the risk of wildfires to forests and communities. The resulting set of policies and programs is known as the National Fire Plan.

Under the guidance of the plan, the USDA Forest Service has nearly doubled the use of fuel treatments, with the intention of reducing the likelihood of uncharacteristic fires, protecting communities, and making suppression activities safer for firefighters.

Zachary Fried

Jeremy Fried studies fuels, fire effects, and carbon dynamics. He has developed a computer modeling framework that helps land managers design fuel treatments to meet their objectives.

Morris Johnson

A seedling grows in the aftermath of the 2014 King Fire in California. By changing the amount or arrangement of forest vegetation, fuel treatments can expedite resiliency from wildfire.

Yet, wildfires seem to be getting worse. Are these fuel treatments making a difference? Is enough being done?

"There are really two facets of enough. First, are we reducing tree density enough that if a severe fire comes through, we've modified fire behavior to the extent that a viable stand remains after that fire?" said Jeremy Fried, a Forest Service research forester with the Pacific Northwest (PNW) Research Station in Portland, Oregon. He studies fuels, fire effects, and carbon dynamics using data collected on all lands through the Forest Service's Forest Inventory and Analysis (FIA) program.

"The other facet is are we treating enough actual acres that we're going to change how big the fires get and how fast and far they spread? Those are two different questions: one about removing enough fuel from each stand to make that stand fire resistant, and the other about fire behavior on the landscape—are you effectively treating enough acres to shape where and how fast fires grow?" Fried explained.

Remove enough trees

Morris Johnson has made inroads on addressing specific thinning prescription guidelines on how many trees need to be removed from an individual stand to protect it from stand-replacement fire. As one of his earliest research projects with the Forest Service, Johnson led the largest ever study of fuel treatment effectiveness. Using a consolidated computer model called the Fire and Fuels Extension of the Forest Vegetation Simulator (FVS), he and his colleagues simulated the effects of thinning and surface fuel treatments in dry forest types in 11 Western States to test prevailing guidelines for creating a "fire-safe" forest.

FVS is a tree growth visualization tool. Widely used by land managers and researchers, it simulates forest vegetation change in response to natural succession, disturbances, and management.

The Fire and Fuels Extension of FVS links the dynamics of forest vegetation (primarily trees) with models of fuels and fire behavior. For Johnson's study, he first downloaded 30,000 FIA plots to get stand data, entered data on weather and fuel conditions, and then generated simulations based on four treatment protocols that thinned trees down to 50, 100, 200, or 300 per acre.

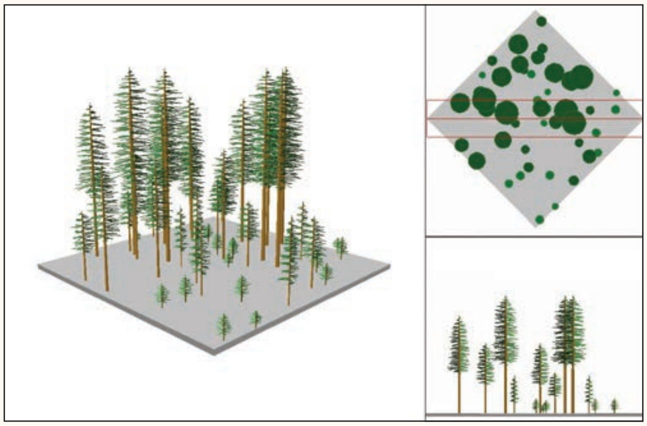
His simulations suggested that the effectiveness of fuel treatments in the West depends on thinning intensity, with the most intense treatments they modeled—leaving only 50 to 100 trees per acre—being more effective in reducing the threat of crown fires than less intense treatments.

Thinning to this level, along with the removal of post-treatment debris known as "slash," successfully reduced the amount of available fuel in the form of branches and foliage in the tree canopy (known as canopy bulk density), and lowered the probability of active crown fire.

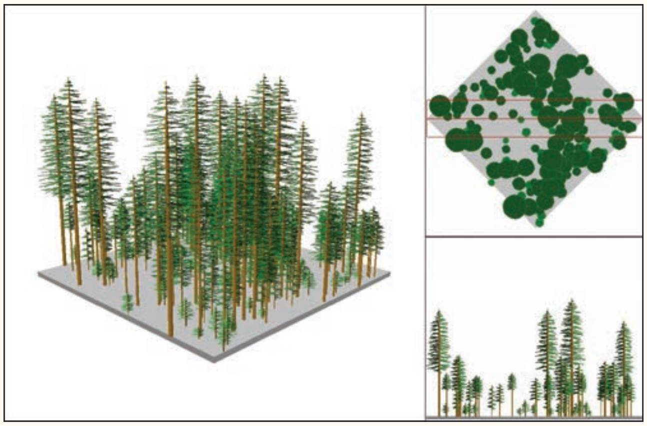
"We were trying to emphasize the principles of a fire-safe forest in terms of managing and manipulating the canopy base height and canopy bulk density," said Johnson. Canopy base height is the level in a stand of trees above which there is enough canopy fuel to transmit fire vertically. "It's not as simple as taking out all the small trees, because then you're not getting rid of enough fuel. At the time we did this study, the general idea was that all you had to do was go in and thin all the smallest trees, from 0 to 8 inches in diameter. But if you do that in a typical dense stand, you're not going to affect the bulk density, and you're not going to change fire behavior. So that's what we were trying to show. You have to get down to 50 to 100 trees per acre to manipulate the canopy base height and the bulk density."

"Most forest managers understand that dry Western landscapes need to be heavily thinned to significantly reduce the threat of crown fires," Johnson added. "Our findings now give a sense of just how much thinning is required."

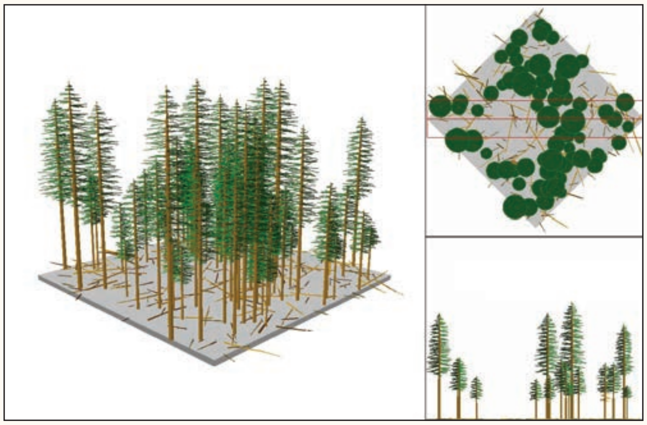
Judging by the response to the study, it filled a critical information gap: In 2011 when published, it was the most-downloaded of all PNW Research Station's publications, and the 10th most downloaded article in the Canadian Journal of Forest Research, where it was published.



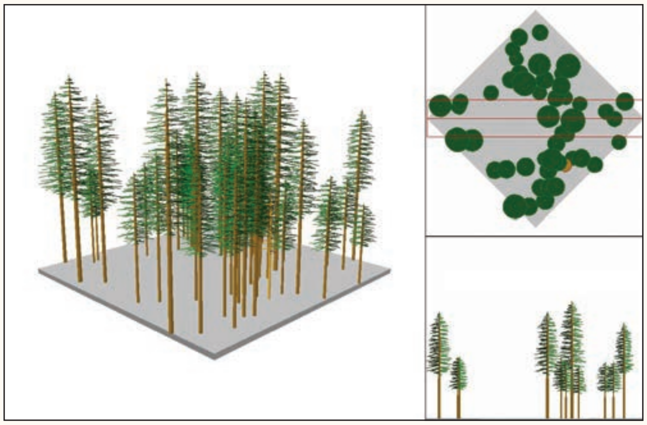
A—Morris Johnson uses the Forest Vegetation Simulator (FVS), a tree growth visualization tool. This picture shows a typical forest stand under historical conditions in which the forest burned according to its natural fire regime.



B—In comparison, FVS shows the same typical forest stand under current, much denser, conditions after a century of fire exclusion.



C—What happens if you thin all the small (0 to10 inches in diameter) trees from a current condition forest stand? This FVS simulation shows that removing small trees still leaves substantial fuel in the canopy.



D—In comparison, thinning a stand down to 50 trees per acre opens it up more. Johnson's work has shown that to significantly reduce the threat of crown fires, dense stands need to be thinned to 50 to 100 trees per acre.

Steven Hawkins

The Cornet-Windy Ridge Fire burned more than 100,000 acres in 2015, including areas on the Wallowa-Whitman National Forest that had been previously thinned and underburned. The live trees on the right were in the thinned treatment area, while the scorched trees on the left were not.

Hitting enough acres

Ecologist Nicole Vaillant recently led a study that addresses the million dollar question: Are we treating enough of the landscape to compensate for decades of fire suppression?

Vaillant's interest in fire began when she was an undergraduate at the University of California, Davis. In pursuing a degree in biochemical engineering, she took an ecology class as an elective. "That class and the passion of the professor really struck a chord with me," she said. "I always loved being outside. I grew up on a small apple orchard with redwoods in the backyard, and I loved camping and backpacking. Until I took that class, I really didn't know you could get a job working out in the forest. Nobody I knew did that kind of thing."

Vaillant ended up on a fire crew, fighting fires for several seasons, eventually on a hotshot crew. She finished her undergraduate degree in Costa Rica studying tropical ecology. "While I was in Costa Rica, my grandfather died, and I realized that even though tropical ecology was amazing, I wanted to be closer to family. I started to think about a career with the Forest Service, and wanted to continue my education and tie ecology with what I learned on the fireline."

She eventually went to graduate school, earning a Ph.D. in fire ecology. To offset time she now spends at a desk instead of working on a fireline, she has taken up triathlons, competing in four IronMan competitions. As an ecologist at PNW Research Station's Western Wildland Environmental Threat Assessment Center in Prineville, Oregon, and now with Rocky Mountain Research Station, she studies fire behavior and fuel treatments, including how effective they are over time.

Vaillant's research employs a variety of approaches, data, and tools that help her characterize fire behavior and make predictions about wildfire risk. She uses computer models to simulate vegetation responses to fire and fuel treatments, but also uses plot-level field data to measure long-term effects of fuel treatments on fuel accumulation.

To address whether enough of the landscape is being treated for fuels, Vaillant and her coauthor, Elizabeth Reinhardt, evaluated the extent of fuel treatments and wildfire on all lands administered by the Forest Service from 2008 to 2012. They then compared their findings with historical wildfire rates and severities. Each year in their study, only about 45 percent of the area that historically would have burned received a fuel treatment or experienced characteristic wildfire (fire at an appropriate severity level for that ecosystem). This indicates a disturbance deficit, one that continues to grow every year. In other words, **the current level of fuel treatment and beneficial fire is not keeping pace with the level needed to fully create and maintain resilient landscapes, especially in frequent fire rotation areas.**

The good news was that 73 percent of the area that did get burned by wildfire during this period experienced characteristic fire.

"Based on my analysis, which was a really short window, just 5 years, I was really surprised when I saw what percentage of the acres burned were characteristic. To me that was really promising, because we hear the doom and gloom of wildfire burning hotter and worse than ever," said Vaillant. "It's not as drastic in my analysis as I thought it would be."

However, the areas with the highest wildfire hazard also had the lowest percentage of area treated, and they experienced the highest proportion of uncharacteristically high-severity wildfire. This suggests that **rearranging the location of fuel treatment to prioritize the high-hazard areas might help improve fuel treatment program effectiveness.**

U.S. Forest Service

Nicole Vaillant and Morris Johnson fly over a burned area immediately after the 2015 Canyon Creek Fire. They were on a team tasked with an external review of fuel treatment effectiveness.

U.S. Forest Service

Nicole Vaillant uses a drip torch to light a prescribed burn at Sycan Marsh in Oregon. Her interest in being outdoors led to a job on a fire crew, and eventually a Ph.D. in fire ecology.

Fuel treatment benefits spill over

Vaillant points out that one fuel treatment strategy is to let wildfires burn. “In some places, you can set up fuel treatments that allow you to be comfortable with letting a natural ignition burn,” she said. “In other places, fuel treatments are designed to help suppression.”

“People are often strategic in placing fuel treatments to protect a highly valued resource or asset, and so treatments are spot based. However, in prioritizing treatments to reduce hazard for a valued resource, places in need ecologically might get overlooked.”

In a study in the Blue Mountains of northeast Oregon, Vaillant evaluated these kinds of tradeoffs in treatment objectives. She and her colleagues used computer models to simulate and compare two fuel reduction scenarios at various intensities based on prescriptions actually used by the local national forest. One scenario was designed to protect homes nestled in and near the forest—known as the wildland-urban interface. The other was for protecting and preserving large trees.

Then they simulated tens of thousands of wildfires and looked at what happened to the large trees and residential structures the treatments were meant to protect.

In general, they found that treating close to the resource to be preserved improves the chance of protecting it. “So when the treatments were surrounding the wildland-urban interface, you reduce the potential impacts of fire to the homes. If you were treating within and near your large trees, the treatments are going to preserve large trees, which to me isn’t rocket science,” Vaillant said. “But what was interesting was even treating to protect the large trees way out in the wildlands also reduced the potential impact of wildfire on the wildland-urban interface. So treatments aren’t just place based. They affect the spread of fire across the large landscape, so treatments can be many miles away and still make an impact outside the immediate vicinity.”

Further, Vaillant’s team saw that treatments on a relatively minor percentage of the landscape (10 percent) resulted in a roughly 70 percent reduction in the expected wildfire loss of large trees.

That fuel treatments can yield benefits beyond their actual footprint is invaluable information for fuel treatment planners. And the study yields insight into strategic use of fuel treatments.

It's not simple

Multiple benefits

The Deschutes National Forest encompasses 1.6 million acres, spanning a variety of ecosystems of extraordinary scenic beauty that make it a favorite destination for recreationists. It is also located within a fire-adapted system, meaning it has evolved to function best with high-frequency, low- and mixed-intensity wildfires.

Fuels program lead Deana Wall is well-acquainted with the challenges of maintaining a healthy fire-adapted forest that is interlaced with recreation infrastructure and closely surrounded by the homes and cabins of the people who are drawn to central Oregon's idyllic landscape. In partnership with Brenda Hallmark, she serves the Central Oregon Fire Management Service (COFMS), overseeing the fuels program for the Deschutes National Forest.

Managing fuels on the Deschutes National Forest is complicated and based on more than one goal. "We tend to have many purposes," said Wall. "But two are always in concert with each other. One is hazardous fuels reduction in areas where we're focused on protecting values and providing future management opportunities—understanding that wildfire is a part of our future, and a large part of our future. And the other dual-pronged purpose is restoration goals; those are more ecologically based. I think our forest does a really good job at melding these together."

In general, fuel treatments have been designed to alter fuel conditions so that wildfire is easier to manage and less disruptive and destructive. But increasingly, planners and land managers are thinking about the ecological benefits of fuel treatments, which takes them into the realm of restoration.

Jeremy Fried agrees that this is a positive development. "I think it's good to get people to challenge themselves to think more deeply about what effective treatment is. I am pretty sure people are not on the same page about this," he said. "And it's beyond just fire. There is a need to work on a wider understanding of restoration and dealing with forest threats and forest health. Often management that will make a forest more fire resistant also will make it more resistant to pests and diseases. That's another piece of looking at effectiveness: there's more than just looking at the fire piece, you can also look at how resistant a forest is to mistletoe or insects or bark beetles, for example."

Case study: The Milli Fire

In August 2017, the Milli Fire burning on the Deschutes National Forest became a state public safety priority as a total solar eclipse approached. The fire, burning near the pathway of prime eclipse viewing, shut down highways and necessitated evacuations. As it progressed, however, there was a positive note. Fuel reduction projects that had been completed west and south of Sisters earlier in the year were making a clear difference in reducing the intensity and duration of that portion of the fire. When the fire hit the treated area, it dropped from a crown fire to a surface fire, allowing crews to attack it directly and protect nearby properties. Big trees also survived.

"The Milli Fire is a great example where a fuel treatment helped," said Wall.

The fire spread across areas that had burned in the Black Crater Fire in 2006 and the Pole Creek Fire in 2012. Nicole Vaillant had been studying postfire effects of the Pole Creek Fire for five years, and the Milli Fire burned some of her field sites. "I've been out there a

U.S. Forest Service

Pete Powers, silviculturist, and Deana Wall, fuels specialist, lead a discussion with the Deschutes Collaborative Forest Project about the West Bend Vegetation Management Project at Phil's Trailhead, a renowned mountain biking destination just west of Bend.

BioSum compares fuel treatment strategies

One example of decision support tools

Jeremy Fried has spent a lot of time thinking about how to help land managers design fuel treatments to meet their objectives. Since 2001, the U.S. Forest Service research forester has been developing and continually improving a computer modeling framework called BioSum. This tool allows users to compare the performance of different treatment strategies by simulating forest conditions before and after fire under different fuel treatments.

BioSum runs on publicly available Forest Inventory and Analysis (FIA) tree inventory data. Using the Forest Vegetation Simulator (FVS), it simulates user-defined prescriptions, such as a fuel treatment that thins trees to a certain residual density, perhaps constrained by a diameter limit. It leverages these simulations into a wealth of information: it can display outcomes of each management trajectory in terms of forest resilience achieved, treatment costs, wood produced, and carbon dynamics. Anyone familiar with FVS (as are substantial numbers of federal and state resource specialists) can use it.

"You can sift and filter through the knowledge base that BioSum generates, for example, to evaluate effectiveness (and costs) of treating where hazard is greatest; where hazard reduction potential is greatest; where forests are most 'out-of-whack,' that is to say, departed from historical range of variability or desired future condition; or where risks to developments, habitats, or other highly valued resources are considered greatest," Fried explained.

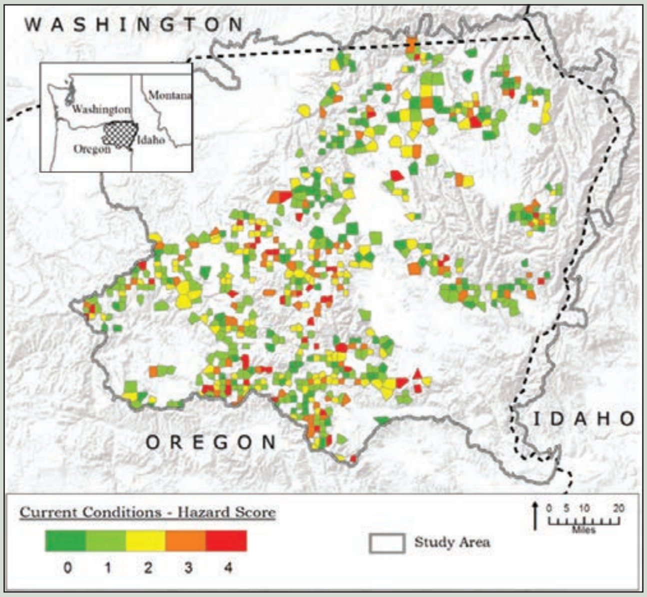
The beauty of BioSum is that it lets users game out these different alternative prioritizations and how they play out over time, so that they can see short- or long-term impacts. "Other dimensions to consider are degree of effectiveness—if you think you want to treat the acres at highest risk but only be a little bit effective, is that better than treating acres at somewhat less risk where you can be very effective or where effectiveness can be maintained for longer? Deciding what is effective and what to prioritize is a subjective and tricky process, but BioSum does help by allowing you to quantify effectiveness, treatable area, costs, and potential cross-subsidies as you explore what's possible in a forested landscape."

Besides showing planners and land managers the nitty-gritty details, BioSum also has great potential use for informing policy because it can analyze treatment outcomes over very large (more than 1 million acres) forested landscapes.

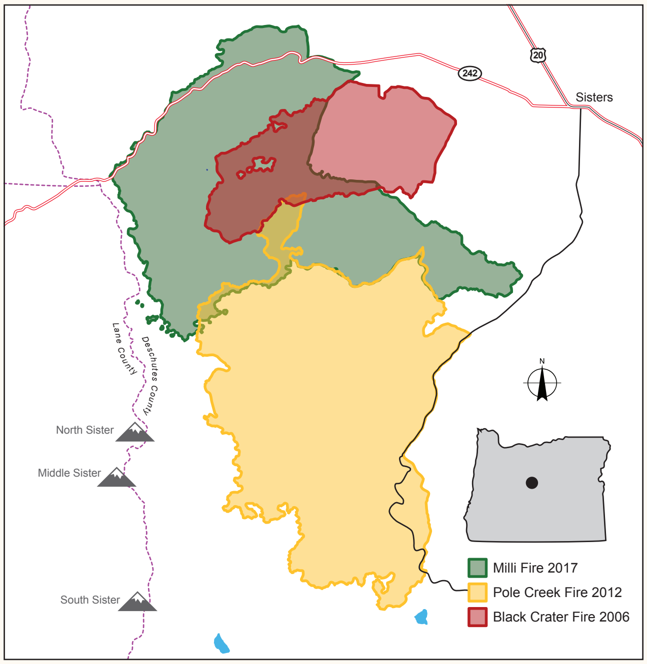
Recently, Fried and colleagues used BioSum to evaluate fuel treatments and their impacts in the Blue Mountains of northeast Oregon—including thinning and prescribed fire—on fire hazard, stand resilience, and economic benefits to rural communities. These forests are at a high risk of experiencing stand-replacement fire. The team's simulations showed that more than 35 percent of stands, representing 775,000 acres, showed a reduced hazard score 1 year after treatment. In other words, restoration treatments aimed at fire hazard reduction would reduce hazard on more than a third of the forested area.

They also found that across 85 percent of treatable acres, treatment costs could be fully paid for by selling the merchantable wood and bioenergy feedstock removed by the treatments. Three local wood processing facilities—two with bioenergy capabilities (in Elgin and Prairie Oregon), and one without (Haines)—could collectively see an increase of 13+ million cubic feet per year in merchantable wood feedstocks.

"BioSum has so far revealed that, depending on how one defines hazard and effectiveness, a large proportion of the landscape is or soon will be hazardous," said Fried. "A somewhat smaller proportion of the hazardous acres can be remediated using one or more of many types of thinning treatments. If we don't manage differently, and do so quickly, there will be continued conversion of large quantities of carbon from live to dead trees, site quality on more acres will degrade, and potential production of renewable materials and energy will be lessened." ☙

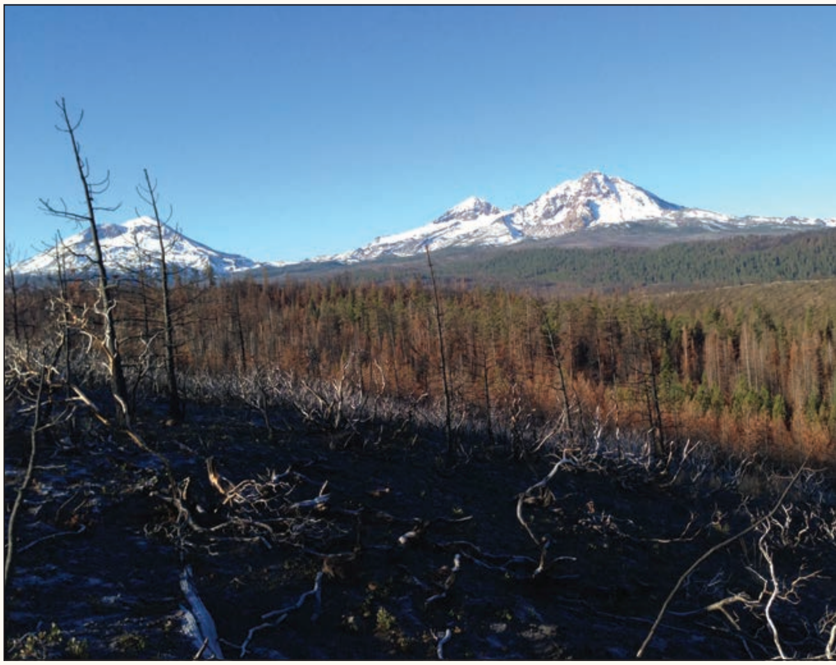


BioSum allows users to visualize the impact of fuel treatments in several ways. This map shows the potential for fuel treatments to reduce tree mortality from fire.



Nicole Vaillant has been studying postfire effects of the Pole Creek Fire since 2012. In 2017, the Milli Fire burned some of her field sites. The bulk of the southern extent of the Milli Fire perimeter was held by the Pole Creek Fire with the aid of active suppression.

Nicole Vaillant



One year after the 2012 Pole Creek Wildfire, the largest wildfire in central Oregon that year. Nicole Vaillant is studying postfire effects of the Pole Creek Fire.

couple of times since the Milli Fire," she said. "In many places, there is a stark difference in fire effects between areas burned in past wildfires to those not burned. One side of the road, in the past fire footprint, has a ton of green; the other side, which is untreated and not recently burned, has a lot of brown and black." This highlights the fact that prior wildfires can also serve as fuel treatments, minimizing fire effects when the area reburns in subsequent wildfires.

"Recent wildfires can also be used in suppression to hold and contain subsequent fires," Vaillant pointed out. "The bulk of the southern extent of the Milli Fire perimeter was held by the Pole Creek Fire with the aid of active suppression."

Many examples exist of fuel treatments and previous wildfires successfully reducing wildfire intensity, slowing its spread, and giving land managers more breathing room to manage the fire. As for whether it is "enough"—that's still a complicated question. A 2015 joint report by the Forest Service and the Nature Conservancy estimated that it would take 50 years at the current rate of restoration work to get Oregon forests to a healthy place.

"We're treating 1 percent of the landscape with prescribed fire a year," said Wall. "And ecologically speaking, these stands tend to need fire. If you're talking about mowing and prescribed fire combined, we're treating up to 5 percent of the appropriate landscape on the Deschutes."

Treating fuels can be expensive. One argument against fuel treatments contends that we will never catch up to the necessary pace and scale, especially when shackled with budget constraints.

Wall doesn't give in to this pessimistic view. "Future wildfire will mold our landscape in all likelihood more than we will mold it. Where our work becomes so highly valuable is in strategically locating fuel treatments so that they are associated with protecting values, breaking up the landscape, and creating future management possibilities," she said.

"I think if you had a pessimistic viewpoint or were not in support of funding these sorts of efforts, you could dwell on the 1 percent and say we're never going to get there. But I think it's all about recognizing that wildfire, or any form of fire, is part of our future, especially on a forest like ours. And where we're really going to make an impact is in taking a lot of care with prioritizing and locating the work we do now," Wall concluded.

In closing

In the year 2000, 7 million acres burned. That fire season was considered the worst in 50 years, catalyzing the National Fire Plan. In comparison, 2017 saw more than 10 million acres burned. Wildfires trapped hikers on the Eagle Creek trail in the Columbia Gorge, scorched Los Angeles, and forced evacuations in towns across the West. Weeks of unsafe air quality were endured by many communities, and homes, structures, photogenic views, critical wildlife habitat, large trees, powerlines, campgrounds, and access to hiking trails were lost.

A strategy of suppression alone is inadequate. As the rising costs and growing difficulties associated with fighting fire indicate, adding proactive fire and fuel management activities to investments in suppression is important. Some fuel treatments may generate revenue from thinning, but in most cases, they will require financial support. Support on a grand scale will ultimately make suppression easier, less costly, and more effective. In the long run, a successful fuel treatment program may even make it possible to reduce reliance on aggressive suppression.

Investments in restoring forests currently in an unhealthy condition are investments in a unique and enormous national treasure. It took decades for forests to arrive at their current condition. The question of whether we are treating enough to make up for a century of fire exclusion may only be the starting point. With local knowledge, research, and decision support tools—fuel planners and land managers can be strategic in locating fuel treatments and increasing the use of managed wildfire. At a time when suppression costs are now exceeding $2 billion a year and the area of burned forest in the Pacific Northwest has increased by 5,000 percent since 1970, challenges of investment in creating resiliant forests loom. As people come together to meet the many challenges of treating fires and fuels, they shape the forests of the future.

Steven Hawkins

Most of the trees in this stand, which had been thinned and underburned, survived the Cornet-Windy Ridge Fire.

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Kari Greer

Fire has a natural role in forest renewal, but it can also cause damage to forest resources that we value. The future of forests in the West will be shaped by the interplay of fire and fire-adapted ecosystems.

Science
Update

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SUMMARY

Although a natural ecological process, wildfire in unhealthy forests can be uncharacteristically destructive. Fuel treatments—such as thinning, mowing, prescribed fire, or managed wildfire—can help reduce or redistribute the flammable fuels that threaten to carry and intensify fire. Using both field-tested data and computer simulations, Pacific Northwest Research Station scientists are addressing critical questions such as Are we treating enough of the landscape to restore fire-adapted forests? Are fuel treatments effective at changing fire behavior? Together with land managers, fuel planners, and other partners, our scientists are helping public land management agencies move toward a future of fire-resilient forests and communities.

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