United States Department of Agriculture
Forest Service

PNW
Pacific Northwest Research Station

Science FINDINGS

INSIDE

issue two hundred twenty-six / april 2020

"Science affects the way we think together."
Lewis Thomas

Can Prescribed Fire Do the Work We Hired It to Do?

Tim Boyce

This prescribed burn in the Malheur National Forest in fall 2018 was conducted as part of a study examining the effects of burn season and frequency of prescribed burns on native and invasive plants.

"You can't see what you don't understand. But what you think you already understand, you'll fail to notice."
—Richard Powers

Whether ignited by lightning or people, wildfires have shaped landscapes globally for eons. By the early 20th century, catastrophic fires like the Great Fire of 1910 in Montana and Idaho, which burned 4,700 square miles, inspired the longstanding policy in the United States to suppress wildfire as much as possible. This policy, along with other land use changes, effectively removed fire from the landscape. Now, when fire does break out, it burns more intensely, feeding on accumulated fuels. Without this keystone ecosystem process, plant and forest communities that evolved with fire have changed as well.

"Fire is an Earth process that has benefits," says Becky Kerns, a research ecologist with the U.S. Forest Service Pacific Northwest (PNW) Research Station. "If we remove fire from the landscape, then we lose some of those benefits. Not only do you get a buildup of fuels but you also get a change in species composition."

Wildland fire managers are returning fire to forest systems where it had been suppressed to reduce the risk of catastrophic wildfire

IN SUMMARY

After a more than a century of fighting to keep fire out of forests, reintroducing it is now an important management goal. Yet changes over the past century have left prescribed burning with a big job to do. Development, wildfire suppression, rising global temperatures, extended droughts, exotic species invasions, and longer fire seasons add complexity to using this practice.

Managers must consider how often, how intensely, and what time of year to burn; for insights they often look to how and when fires burned historically. However, attempting to mimic historical wildfires that burned in hot, dry conditions is risky. Burning in fall or spring when temperature and humidity are low reduces the risk of prescribed fires becoming uncontrollable, but does it have the intended effects? How do forest ecosystems that historically were adapted to fire respond when fire is reintroduced after so much time without it?

Forest Service researchers Becky Kerns and Michelle Day conducted a long-term experiment in the Malheur National Forest, Oregon, to assess how season and time between prescribed burns affect understory plant communities in ponderosa pine forests. They found that some native plants persisted and recovered from fire but didn't respond vigorously, while invasive species tended to spread. These findings may help forest managers design more effective prescribed-fire treatments and avoid unintended consequences.

and catalyze desired ecological changes. Prescribed burning may improve forage and habitat for wildlife and enhance biodiversity. In some cases, fire can invigorate the growth of native perennials like bunchgrasses.

In 2017, nearly 10,000 square miles of U.S. state and federal land were burned using prescribed fire. Prescribed burning methods are informed by what is known about how fires burned in years past. But today, mimicking historical fires isn't always possible or desirable.

"We use the past to guide us and we have very good information, but it's a different world now," Kerns says. "We have climate change, invasive species, livestock grazing––and fire is being returned to many forests that have undergone substantial changes over the past century."

Given these changes, Kerns wondered if prescribed burning can do the job that it's intended to do. For example, does it increase the abundance and biodiversity of understory plant communities? Despite its widespread use, little is known about how well the practice supports specific ecological goals or how different burning techniques affect plant communities.

"There's a big push for increasing prescribed fire on the landscape," says Michelle Day, a research scientist now at the Rocky Mountain Research Station, "but in the western United States, not a lot of research has been done with repeat prescribed burns."

Except for a few studies of the effects on fuels and overstory trees, experimental testing of fire regimes—including fire frequency and season—is limited.

KEY FINDINGS

- Most perennial native plant groups recovered from a single burn and frequent reburning, regardless of season, but didn't increase in abundance or species richness as expected.
- Positive responses, including increased cover and species richness, were noted for fall burning for a handful of plant groups with fire-resistant or fire-resilient traits. But these increases didn't persist, even with frequent fall burning.
- The effects of spring burning on understory vegetation were negligible for most native plant groups.
- Prescribed fire regimes affected exotic invasive cheatgrass differently through time. Regardless of frequency, cheatgrass increased in areas burned in fall. However, in areas burned in spring, cheatgrass did not increase until after three reburns.
- The results align with a growing number of studies that show neutral responses to prescribed fire, particularly for native perennial plant groups targeted for restoration.

Kerns and Day developed a long-term study to see how burn season and frequency of reburning affected plant communities in ponderosa pine forests in the Malheur National Forest of eastern Oregon. The results point to important considerations for how fire is returned to these systems and may help forest managers avoid costly mistakes and unintended consequences such as spreading invasive species.

Burn Season and Frequency

"We want to put fire back on the landscape, but we have constraints," Kerns says. "We're not going to burn in the historical wildfire season, in the middle of summer."

Fire managers reduce the risk of an escaped fire by burning in the spring or fall when vegetation has more moisture and temperatures are lower. Yet little is known about how seasonal differences in burning affect plant communities of ponderosa pine forests in the western United States. For example, is burning in spring when plants are just emerging from winter harmful to plant communities?

Burn frequency and intensity add to the complexity. Frequent use of fire in the same area is thought to favor species that can sprout from roots, have thick protective bark, or even require fire to release their seeds. However, the

Michelle Day

A member of the field crew collects plant data in a plot that was burned in the fall at 5-year intervals.

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

PNW Science Findings is published monthly by:

Pacific Northwest Research Station
USDA Forest Service
P.O. Box 3890
Portland, Oregon 97208

Send new subscription and change of address information to:

SM.FS.pnw_pnwpubs@usda.gov

Rhonda Mazza, editor; rhonda.mazza@usda.gov

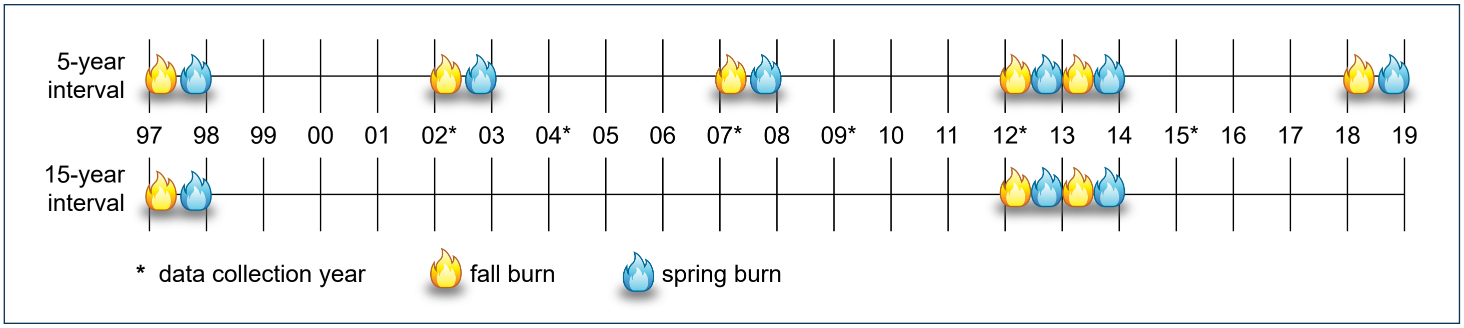
Jason Blake, layout; jason.p.blake@usda.gov

To find Science Findings online, visit https://www.fs.usda.gov/pnw/ and click on **Publications**.

Become a digital subscriber here: https://www.fs.usda.gov/pnw/publications/subscriptions.shtml

USDA United States Department of Agriculture

Forest Service



Michelle Day

Timeline showing frequency of fire treatments and data collection years in the study area from 1997 to 2019.

frequency of a managed fire-return interval for a given system depends on management goals, forest type, and other factors.

When Kerns first began working at the PNW Research Station in 1999, she learned about an existing study in the Malheur National Forest on the effects of prescribed burning on black stain root disease, a fungus that blocks water supply to trees. The opportunity to build on that study using the same stands provided a ready-made research site for what would become a long-term experiment on the effects of prescribed fire regimes on ponderosa pine forest vegetation.

The scientists designed the study to assess several factors: how burning in the fall or spring differs from not burning; how spring and fall responses differ from each other; how spring and fall responses differ based on burn frequency; and which burn routines favor native plants compared to not burning.

A fall burn in 1997 was followed by a spring burn in 1998 with fall and spring reburns every 5 years thereafter. A single 15-year reburn took place in fall and spring from 2012 to 2014, and the study included a control with no burning. Data were collected at intervals from 2002 to 2015.

Such long-term experiments are rare––this one may be the only one in the West with both season and reburn interval components according to Kerns––because they're not easy to pull off. Burn crews get called off to fight wildfires, and weather conditions have to be just right––not too hot, not too cold or wet.

"Operationally, doing a reburn study is hard because there are so many constraints," Kerns says, "especially if you're trying to burn on a 5-year schedule. We're proud that we only had one year where the weather messed up the schedule and we had to move to another year."

"Priorities change, district staff changes, and people retire, but the Malheur National Forest was committed to keeping it going and the research continued," adds Day, who joined the project in 2004 after the second 5-year reburn.

Five years after each burn and before the next, Day and Kerns and their crew painstakingly collected data in the field about the plant communities. "You're on your hands and knees and you're looking at all the tiny little things," Day says.

They identified every plant species inside a 1.1-square-yard frame, measured plant cover and height, and counted flowering stems to assess reproductive capacity. In all, the researchers collected data from three burns, or two 5-year interval reburns, as well as from a single burn.

Overcoming Ecosystem Inertia

The scientists expected to see marked differences based on season and frequency of the burns. They assumed that fall burning, which more closely resembles the intensity of historical fires, would result in positive responses, including more abundant and diverse understory plants compared to spring burning. They anticipated that frequent burning would favor herbaceous species over woody species and species with fire-resistant and fire-resilient traits, such as sprouting from roots or recolonizing from existing seed banks.

"We were expecting that if we burn these stands even just a little bit, everything's going to respond vigorously, especially with the 5-year reburning," Kerns says.

Instead, the effects they observed were subtle, neutral, or ephemeral.

Plant responses didn't differ much among the burn treatments or even compared to no burning, especially for native perennials. Any positive responses the scientists did observe were among plants with fire-resistant and fire-resilient traits, but most responses were short-lived––even with frequent reburning.

The scientists noted some important differences among the treatments in 2002, but the pattern faded within a decade. After one or two burns, short-lived natives, exotic species, open bunchgrasses, and perennials that sprout from roots or rhizomes all showed some short-term, positive responses to initial burning, but not after three burns. Very few plant groups continued to respond positively to burning throughout the study.

"Even though we were burning every 5 years, there was a diminishing trend over time on how effective the fires were," Day says. "If you're going back and burning, why aren't we seeing that more strongly in the results?"

The answer to that question may have to do with ecosystem inertia, Kerns hypothesizes. Systems that haven't burned for well over a century have gone without the benefit of fire to periodically reset certain ecological processes.

"These systems have been headed in this direction for decades and it might not be a simple thing to pull them out of that trajectory," Kerns says.

Prescribed burns like the ones in the study may not burn hot enough to overcome the ecological torpor that has settled in without periodic natural wildfires.

"It's like we're just toasting the landscape, singeing the edges," Kerns says.

After more than 100 years of fire suppression, it may not be realistic to expect low-severity prescribed burning to reinvigorate native bunchgrasses, for example, the way that wildfire did in the past.

Not being able to better mimic historical wildfire is further complicated by the ways that environmental changes, extended

Michelle Day

*Native bunchgrass Idaho fescue (*Festuca idahoensis*) sprouts from the surviving root crown following a reburn.*

Michelle Day

Fireline between a second 5-year-interval reburn and an unburned control stand. The experiment's design enabled the scientists to measure how different types of forest vegetation responded to repeated burns conducted in either spring or fall.

drought, past harvest practices, and livestock grazing may have left a mark on these dry forests and their understory vegetation. Ecological processes may have been interrupted in other ways as well. For example, some early-successional natives such as fireweed that are well adapted to fire may now lack a seed bank or be so reduced in number or vigor that they can't increase in abundance after a burn.

"If you haven't had a disturbance for decades, the seed bank might be missing from that system," says Kerns. "It's not clear how a system is going to respond or how we can get these components back, especially when your early-successional species are now exotics."

Rethinking Prescribed Burning

The paradox of prescribed burning is familiar to Upekala Wijayratne, a Forest Service ecologist with the Northeast Oregon Ecology Program who studies forest understory plant conservation.

"It can reinvigorate growth of native communities, particularly bunchgrasses, and it can also damage some plants," she says. "Many botanists are worried about spring burning negatively affecting the native plants."

Wijayratne is relieved to see that native perennials in the study were largely undamaged by the burns. Perennial native plant groups were able to resist or recover from a single burn and frequent reburning regardless of season. However, they did not increase in percentage of cover.

On the other hand, she has reservations about the effects on invasive species, which can gain a foothold. Fall burning tended to increase cover of exotic invasive cheatgrass (*Bromus tectorum*) regardless of frequency, as did three spring burns. In fact, one of the only patterns of richness and diversity detectable after 15 years was that both fall and spring reburning maintained a greater number of exotic species.

When it comes to invasive species, fall burns that imitate the frequency and intensity of historical fires may not be appropriate.

"You don't want to replicate a historical fire interval and inadvertently change the entire understory so that now you've got a new problem," Wijayratne says.

Joe Rausch, a forest botanist and invasive plant program manager on the Malheur National Forest, agrees.

"No one wants to spread more cheatgrass on the landscape," he says. "The fact that fall burning might have worse impacts when it comes to invasive plant species like cheatgrass, *Ventenata*, or medusahead rye, that's something significant that decisionmakers and fire management officials should know about."

Invasive species like cheatgrass are not only a biodiversity concern. They can also become a fire hazard by spreading into a continuous bed of readily burnable fuel.

Making management decisions is a perpetual dance of evaluating the tradeoffs of different techniques and their effects, including the unintended ones. To help develop sound action plans for the forest, Rausch credits both research such as Kerns' long-term study and the strong relationship and collaborative process that the Malheur National Forest has with local community groups such as Blue Mountain Forest Partners and Harney County Restoration. He and Kerns both recognize the complexity and uncertainty involved with refining the practice of using fire as a management tool.

Michelle Day

*A mat of the invasive annual grass, cheatgrass (*Bromus tectorum*), growing in response to a fall reburn. Burns are often more severe at the base of trees where litter and duff have accumulated.*

LAND MANAGEMENT IMPLICATIONS

- Prescribed burning may not achieve management goals to restore native plant communities, reduce invasive plant populations, or increase forage availability.
- Late spring burning is probably not detrimental to native plant groups, but more frequent reburns may be needed to achieve management goals.
- Prescribed burns conducted under low-temperature and high-humidity conditions may not allow fire to do as much "work" as historical wildfire. But better mimicking of historical wildfire in areas where long-term changes have occurred may lead to unintended consequences.
- Using prescribed burning to restore vigorous native understory plant communities in forests that have undergone long-term changes may require addressing multiple factors simultaneously (e.g., invasive species, land use, overgrazing, environmental change, understory plant vigor); evaluating potential tradeoffs (e.g., woody fuel reduction versus exotic invasion); and relying less on the past to guide effective use of prescribed fire.

Tim Boyce

The most recent 5-year reburn, fall 2018, was completed several weeks earlier in the season and burned hotter than the previous fires in this study. Although follow-up fieldwork is not planned, new data collection and analysis could reveal if these factors affect the response of the understory vegetation.

"Our results show that we may need to think about and apply prescribed burning differently, as well as better integrate it with weed management," Kerns says. "And they're consistent with a growing number of recent studies that show neutral responses to prescribed burns, particularly for native perennial plant groups targeted for restoration."

Disrupting ecosystem inertia––moving systems beyond resisting but not responding–– and limiting the spread of invasive species may require addressing multiple constraints.

"We may need to carefully reconsider when, how, and why to intervene, and shift our focus away from using the past to guide management," Kerns says.

And because this is only one study in one place, Kerns emphasizes the need for more long-term replicated experimental studies in other locations.

In an era of rapid landscape and environmental changes and as the appeal for using fire to manage fuel levels grows, the wise use of fire as management tool is crucial.

"The real voyage of discovery consists not in seeking new landscapes, but in having new eyes."

—Marcel Proust

Further Reading

Kerns, B.K.; Day, M.A. 2018. Prescribed fire regimes subtly alter ponderosa pine forest plant community structure. Ecosphere. 9: e02529. doi:10.1002/ecs2.2529. https://www.fs.usda.gov/treesearch/pubs/57694.

Kerns, B.K.; Day, M.A. 2017. The importance of disturbance by fire and other abiotic and biotic factors in driving cheatgrass invasion varies based on invasion stage. Biological Invasions. 19: 1853–1862. https://www.fs.usda.gov/treesearch/pubs/54264.

Kerns, B.K.; Buonopane, M.; Thies, W.G.; Niwa, C.G. 2011. Reintroducing fire into a ponderosa pine forest with and without cattle grazing: understory vegetation response. Ecosphere. 2(5): art59. doi:10.1890/ES10-00183.1 https://www.fs.usda.gov/treesearch/pubs/43743.

Westlind, D.; Kerns, B.K. 2017. Long-term effects of burn season and frequency on ponderosa pine forest fuels and seedlings. Fire Ecology. 13: 42–61. https://www.fs.usda.gov/treesearch/pubs/58296.

Writer's Profile

Sylvia Kantor is a science writer and editor based in Seattle, Washington.

Science
FINDINGS

U.S. Department of Agriculture
Pacific Northwest Research Station
1220 SW Third Avenue
P.O. Box 3890
Portland, OR 97208-3890

Official Business
Penalty for Private Use, $300

PRSRT STD
US POSTAGE
PAID
PORTLAND OR
PERMIT N0 G-40

Scientist Profiles

BECKY KERNS has been a research ecologist with Pacific Northwest Research Station for more than 20 years. She studies how natural and human-caused disturbances and their interactions affect the structure and function of plant communities, particularly in dry, fire-prone forests.

Kerns can be reached at:

USDA Forest Service
Pacific Northwest Research Station
3200 SW Jefferson Way
Corvallis, OR 97331

Phone: (541) 750-7497
E-mail: becky.kerns@usda.gov

MICHELLE DAY is currently a biological scientist with the Rocky Mountain Research Station, but at the time of this research was a senior faculty research assistant in the College of Forestry at Oregon State University. Her research explores vegetation responses to forest management, as well as understanding management tradeoffs in the context of wildfire risk.

Day can be reached at:

USDA Forest Service
Rocky Mountain Research Station
3200 SW Jefferson Way
Corvallis, OR 97331

Phone: (541) 758-7768
E-mail: michelle.day@usda.gov

Collaborators

Emigrant Creek Ranger District, Malheur National Forest, OR

Sabine Mellmann-Brown and Gregg Riegel, U.S. Forest Service Pacific Northwest Region, OR

Douglas Westlind, U.S. Forest Service Pacific Northwest Research Station, OR