

Science

FINDINGS

"Science affects the way we think together."

Lewis Thomas

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Reburn in the Rain Shadow



Dave W. Peterson

Standing dead trees in a high-severity patch burned in the 2015 Chelan Complex Fire on the Okanogan-Wenatchee National Forest. New research finds that postfire logging reduces future fuel loads, and when best management practices are used, minimally affects the regrowth of understory vegetation in dry forests east of the Cascade Range.

"An ounce of prevention is worth a pound of cure."

—Benjamin Franklin

Iwant to know what you're going to do about the reburn problem," the veteran forester said.

David Peterson, a new research forester at the U.S. Forest Service Pacific Northwest Research Station's Wenatchee office, looked up from his desk. "Excuse me, what reburn problem?" Peterson asked.

The man introduced himself as John Townsley, a silviculturist from the Okanogan-

Wenatchee National Forest, about 2 hours north of Peterson's office on the eastern slopes of the Cascade Range in Washington State. The year was 2002 and wildfires were burning through the sites of older wildfires. Resource managers noticed that when these fires reburned areas that had burned in the past 30 or 40 years, the fires could be hard to control and often severely burned the soil.

"These severely burned areas left a big management challenge because there was damage to the soil and increased hazards from flooding and soil erosion. As a silviculturist, Townsley was also concerned about tree regeneration after those fires," Peterson says.

IN SUMMARY

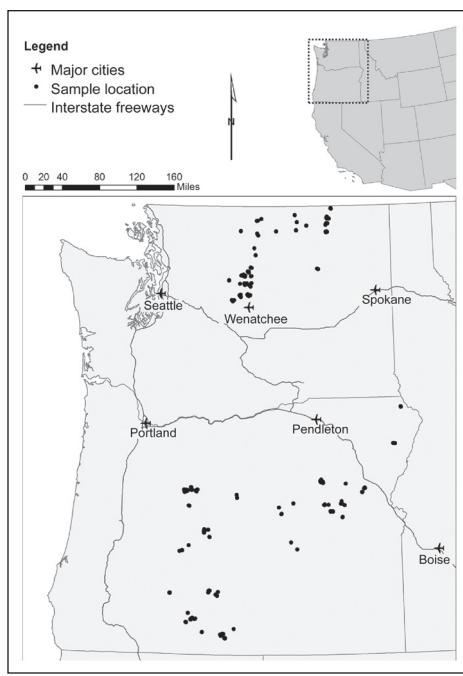
Wildfires consume existing forest fuels but also leave behind dead shrubs and trees that become fuel to future wildfires. Harvesting fire-killed trees is sometimes proposed as an economical approach for reducing future fuels and wildfire severity. Postfire logging, however, is controversial. Some question its fuel reduction benefits and its ecological impacts.

David W. Peterson, a research forester with the USDA Forest Service, and his colleagues investigated the long-term effects of postfire logging on woody fuels in 255 coniferous forest stands that burned with high fire severity in 68 wildfires between 1970 and 2007 in eastern Washington and Oregon. They found that postfire logging significantly reduced future surface woody fuel levels in forests regenerating following wildfires.

The researchers also investigated the long-term response of understory vegetation to two postfire logging treatments—commercial salvage logging with and without additional fuel reduction logging—on a long-term postfire logging experiment in northeastern Oregon.

They found that postfire logging produced minimal persistent impacts on understory vegetation, suggesting that understory vegetation can be resilient to postfire logging, particularly when best management practices, like logging over snow, are used to limit damage to soils and understory vegetation.

For the next few years, Peterson kept the reburn question on the back burner, so to speak, although Townsley “would come back and bug me about it every year or so,” Peterson says. The silviculturist’s persistence worked, because Peterson started collaborating with other researchers to look into different aspects of the reburn question that would take three studies and several more years to answer.



Study sites in eastern Washington and Oregon.

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KEY FINDINGS

- Without postfire logging in dry forests east of the Cascade Range, surface woody fuels peaked 10 to 20 years after fire, on average, as most snags fell or developed broken tops during this time. Large, rotten woody fuels became increasingly dominant over time, increasing soil heating and smoke production potential during subsequent wildfires.
- Postfire logging reduced surface woody fuels—particularly large-diameter fuels—in regenerating forests 10 to 40 years after wildfire, after increasing small-diameter fuels during the first 5 to 7 years after fire and logging.
- Experimental postfire logging treatments produced minimal or no persistent impacts on understory plant cover, species diversity, or exotic species abundance.

Two Sides of the Cascades

When people think of the Pacific Northwest, perhaps a wet, rainy landscape comes to mind. But the Okanogan-Wenatchee National Forest where Peterson works is part of a drastically different part of the region. The Cascade Range that rises in British Columbia, Canada, and continues south through Washington and Oregon into northern California isn’t just a geologic division; it’s also a meteorological one.

“We’re talking about forests in the rain shadows of the mountains, where every summer is a dry summer,” Peterson says. “We have long fire seasons every year. The forests here are dry and can burn easily if we get lightning storms or human ignitions.”

Winds from the Pacific Ocean carry moist air toward the Cascade Range, where it rises,

cools, and produces clouds and precipitation. On the western side of the range, called the windward side, abundant precipitation falls as rain or snow. As the cooler and drier air passes over the Cascades, it warms and dries out, producing a rain shadow on the eastern side of the range. Landscapes in the rain shadow are typically dry and receive much less precipitation than the windward side of the range.

Unlike western Cascades forests, where centuries can pass between wildfires, wildfires historically occurred every 5 to 40 years in the dry, low-elevation forests of the eastern Cascades. “The fires in these forests were traditionally what we would call low- or mixed-severity fires that mostly burned fuels on the ground,” Peterson says. “These fires are kind of like moving campfires, burning up a bunch of fuel—understory shrubs, dried needles, and wood sitting on the ground—but not killing many trees.”



David W. Peterson

A reburn site in Poison Creek Watershed near Chelan, Washington. The lower half of the watershed burned severely in the 1970s, killing most trees and producing a large amount of downed woody fuels. The area reburned during the 2002 Deer Point Fire, and regenerating trees were almost completely consumed.

"Even in the higher elevations where fires are less common," Peterson says, "mixed-severity fires killed smallish trees or patches of trees, but big trees with thicker bark typically survived."

"Unfortunately, because we've done a really good job of putting out most of the fires in these low-elevation dry forests, the fuels build up," Peterson says. These fuels include dead needles, branches, and logs, as well as smaller trees. All these remain in the forest, ready for the next ignition, and can carry fire from the forest floor up into the treetops.

"You get a mixture of small, medium, and large trees. As fire passes through on the ground, it can climb up these small and mixed-sized trees until it gets into the tree crowns, where all the branches, leaves, and needles are. That's why we call these ladder fuels," Peterson says. "If the tree crowns are close together, fires can spread through the tree crowns as well as on the ground, typically killing more trees than surface fires alone."

"Although these crown fires are not unheard of, they used to be fairly rare in the Pacific Northwest's dry coniferous forests. But we have gotten more and more of these fires," Peterson says, "thanks to fuel buildups and some severe drought years."

Would it make sense to remove the snags, the dead and dying trees, left in a fire's wake through postfire logging to manage the amount of fuels that future wildfires would feed on? Many forest managers felt so, but Peterson was aware that this approach would meet with some resistance. Some might question its fuel reduction benefits or be concerned that it would reduce habitat for wildlife that lived in snags. Others might be concerned about its impacts on forest ecosystem recovery. Still, the question was worth investigating.

Rotten Logs and Soil Heating

About 2 years after his conversation with the Townsley, Peterson collaborated with forest ecology professor Jim Agee and one of his graduate students at the University of Washington in Seattle to look into the effects of salvage logging, or logging trees that have been damaged by wildfire. The student, Philip Monsanto, conducted an experiment to study how reburns would affect soil heating and small tree roots. "The key finding in the study is that rotten logs ignite better and burn longer and more completely than sound logs and therefore have a bigger impact on soil heating," Peterson says. The study also showed that logs that burned in the later part



Researchers test how log size and state of decay affect soil heating. They found that rotten logs burned longer than the sound logs, leading to high soil temperatures and deeper soil heating.

of the year produced higher surface temperatures and deeper soil heating than those that burned in the spring.

The results suggest that where prescribed fire is introduced to forest stands age 20 to 30 years after wildfire, root heating from smoldering wood can be minimized by burning in spring; removing excess snags early in the postwildfire period could also reduce fuels and soil heating.

Around the time Monsanto was finishing his study, Peterson met with Forest Service colleagues who also wanted to address the reburn question. "We thought, why not take Phil's basic design and do it at a much larger scale?" Peterson says. The group eventually broke down the reburn problem into additional research questions.

First, the researchers assessed the effects of harvesting fire-killed trees on the accumulation of woody fuels at the study site. "To see if postfire logging could be considered a valid fuel reduction treatment, we needed to compare logged and unlogged sites at a regional scale," Peterson says.

Short-Term Pulse, Then Decline

Peterson and his colleagues created a large dataset by sampling surface woody fuels within 255 coniferous forest stands that burned with high fire severity in 68 wildfires between 1970 and 2007 in eastern

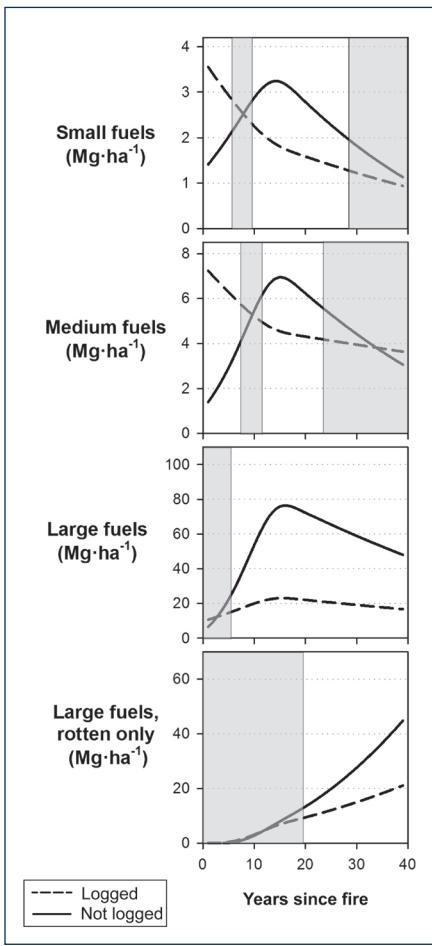
Washington and Oregon. The sampling included 96 stands that were logged after wildfires and 159 stands that were not logged. Most of the trees burned in these stands were ponderosa pines or Douglas-firs, two of the most common tree species in low-elevation forests of the eastern Cascades.

The researchers found that without logging, surface woody fuels peaked 10 to 20 years after a fire, as most snags fell or broke. Large, rotten woody fuels increasingly dominated the stands over time, increasing soil heating and smoke production potential during subsequent wildfires.

Compared to unlogged stands, postfire logging produced a short-term (5 to 7 years) increase in small-diameter fuels, mostly from residual logging slash, but then reduced surface fuels over the longer term (10 to 40+ years after fire), particularly in the larger size classes, as more snags fell and became fuel on the unlogged sites than on the logged sites.

They also observed that the amount of fuel generated by decaying snags was related to the number and size of trees killed by fire. This suggested that forest restoration treatments, such as thinning or prescribed burning, could reduce postfire fuel management problems not only by reducing fuels and tree mortality—which is the primary goal—but also by limiting the amount of dead wood generated if all trees are killed.

"The big take home here is that postfire logging can and does serve as a valid fuel reduc-



Adapted from Peterson et al. 2014

species diversity, plant community composition, or exotic species cover.

Peterson and ecologist Erich Dodson with Oregon State University found that postfire logging treatments had no significant effects on understory vegetation cover, diversity, or community composition 15 years after treatment. The researchers say the study demonstrates that understory vegetation can be resilient to postfire logging, particularly when best management practices are used to limit damage to soils.

The researchers noted that more study is needed, however, to confirm the generality of this finding for other forest types and ecosystem components. One recent study has already supported this. Between 2006 and 2012, researchers Eric Knapp and Martin Ritchie of the Pacific Southwest Research Station collected understory richness and cover data in California's Lassen National Forest, which was recovering from a wildfire in 2002. The researchers found no differences in the



One year after postfire logging on a site that burned during the 2014 Carlton Fire in Washington.

David W. Peterson



Ricky J. Harron

tion treatment. And if done with that goal in mind, it can be very effective," Peterson says. "If you remove dead trees, you're reducing future fuels. You can do it badly or you can do it well. But if you do it well, you can have a really big impact on future fuel loadings."

Probing the Understory

Next, the researchers wanted to find out if postfire logging and additional fuel reduction, such as the removal of more logs and snags, would have long-term effects on a forest's understory vegetation. The researchers sampled 172 plant species in an area burned by the 1996 Summit Fire in northeastern Oregon to see if the postfire logging treatments caused any lasting effects on understory plant cover,

Fuels and vegetation recovery 10 years after high-severity wildfire and postfire logging following the 1994 Rat-Hatchery Fire near Leavenworth, Washington, in the Okanogan-Wenatchee National Forest.

richness of both native and nonnative plant species among sites that were logged postfire and those that were not. The findings have also been cited in a guide for forest managers in British Columbia, Canada, in handling several forests burned by wildfires in July 2017.

Peterson and his colleagues' study on the effects of harvesting his fire-killed trees on the forests' woody fuels have already provided a scientific basis for forest managers wanting to include fuel reduction in their purpose and needs statement when proposing postfire logging activities in planning documents. For example, fire ecologists in the Rogue River-Siskiyou National Forest in Oregon used the findings in their guide to postfire salvage operations in the Kalmiopsis Wilderness, which was razed by wildfires in July 2017. The findings were used in an assessment of forest fuels in the Boise National Forest in Idaho and in a fire salvage and restoration report for the Idaho Panhandle National Forests. The study has also been cited in several recent review and synthesis journal papers related to postfire logging, forest restoration, and fire ecology of the Western United States.

"Our research will likely encourage more postfire logging for fuel reduction, where it is ecologically appropriate," Peterson says. "It's comforting to know that if you make some attempt at doing these treatments well, you can do so without having a lot of fear of causing long-term environmental degradation."

"That which seems the height of absurdity in one generation often becomes the height of wisdom in the next."

—John Stuart Mill

LAND MANAGEMENT IMPLICATIONS

- Postfire logging in dry forests can serve as an effective, long-term fuel reduction treatment by reducing future woody fuel loads and broadening the range of conditions under which prescribed fire can be used as a restoration tool in regenerating forests.
- Using best management practices, postfire logging can treat future woody fuels without producing lasting harm to the recovering vegetation. More study is needed, however, to confirm the generality of this finding for other ecosystem components.
- Forest restoration treatments (e.g., thinning, prescribed burning) that reduce stand basal area and surface fuels can reduce postfire fuel management problems by reducing the amount of stand basal area killed by fire, creating a management legacy of reduced fuel loadings.



Accumulated fuels 10 years after high-severity wildfire on a site that was not logged following the 1994 Rat-Hatchery Fire.

Further Reading

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Scientist Profile



DAVID W. PETERSON is a research forester at the Pacific Northwest Research Station in Wenatchee, Washington. His research focuses on improving our understanding of how forest and rangeland vegetation responds to wildfire; how trees killed by wildfire decay and contribute to wildlife habitat, coarse woody debris, and fuels; and how post-fire management treatments can best be used to reduce threats and promote long-term ecosystem recovery. Peterson received his Ph.D. in forestry from the University of Minnesota.

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