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Science FINDINGS

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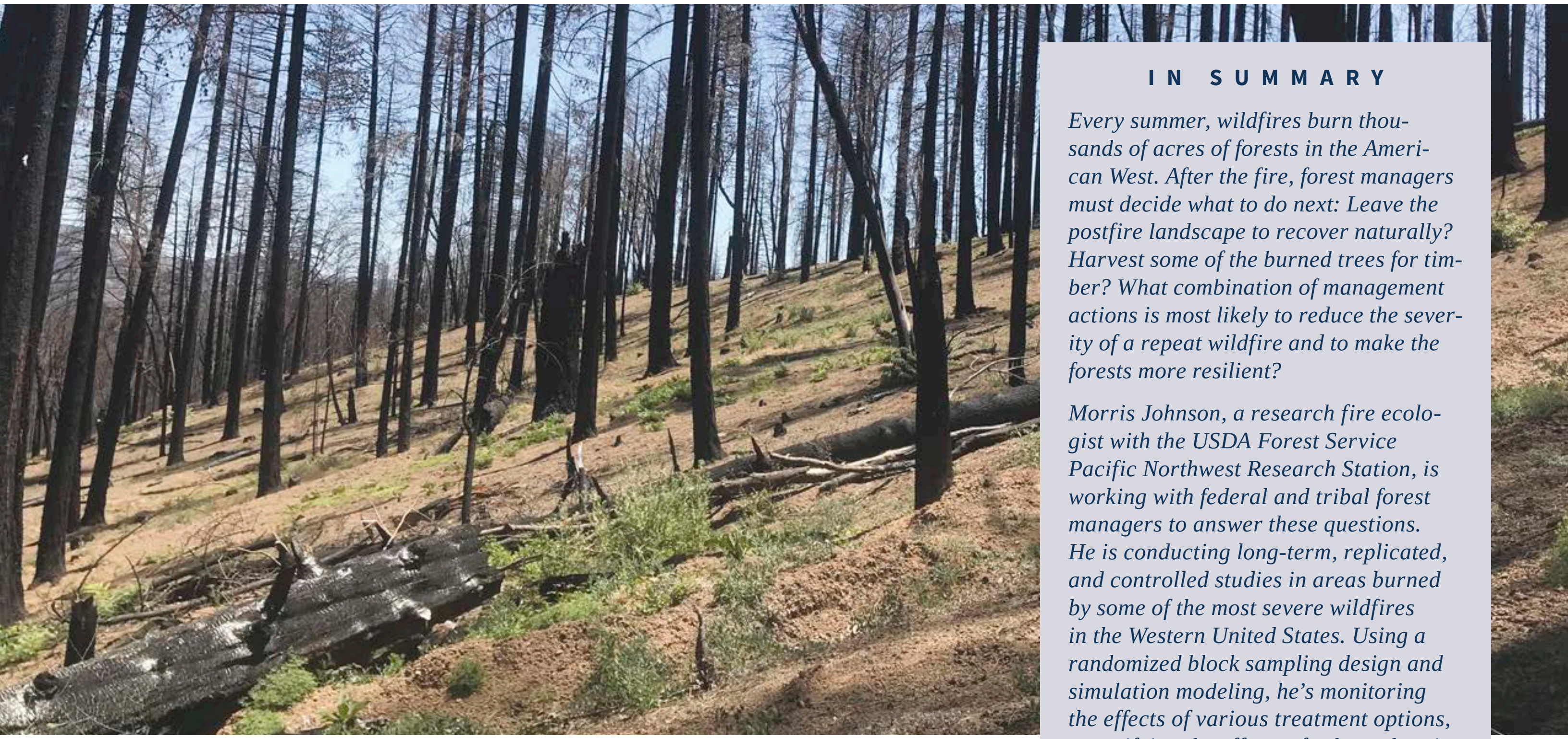
"Science affects the way we think together."
Lewis Thomas

Passive or Active Management? Understanding Consequences and Changes After Large Stand-Replacing Wildfires



A small portion of the Mendocino National Forest, California, that burned during the 2018 Mendocino Complex. Photo by Morris Johnson, USDA Forest Service.

IN SUMMARY

Every summer, wildfires burn thousands of acres of forests in the American West. After the fire, forest managers must decide what to do next: Leave the postfire landscape to recover naturally? Harvest some of the burned trees for timber? What combination of management actions is most likely to reduce the severity of a repeat wildfire and to make the forests more resilient?

Morris Johnson, a research fire ecologist with the USDA Forest Service Pacific Northwest Research Station, is working with federal and tribal forest managers to answer these questions. He is conducting long-term, replicated, and controlled studies in areas burned by some of the most severe wildfires in the Western United States. Using a randomized block sampling design and simulation modeling, he's monitoring the effects of various treatment options, quantifying the effects of salvage logging on woody fuel loadings, snag dynamics, and seedling density. Results from his study in north-central Washington indicate salvage logging reduced long-term woody fuel loading, potentially reducing the severity of future reburns.

Johnson works closely with national forests staff during postfire management planning. His central research questions are included as learning objectives in the official purpose and need documentation required by the National Environmental Policy Act. This exemplifies how scientists and managers coproduce science to address critical questions about managing forests after stand-replacing wildfires.

A woodland in full color is awesome as a forest fire, in magnitude at least, but a single tree is like a dancing tongue of flame to warm the heart.

—Hal Borland

Lightning strikes on August 15, 2015, ignited five wildfires in northeastern Washington that collectively became known as the Okanogan Complex. Over the next month, the fires burned 304,782 acres and destroyed 120 homes, setting a record for the state.

Five years later, the August Complex in Mendocino National Forest torched more than a million acres and destroyed 935 buildings. The August Complex—a conglomeration of 37 separate fires that fused into one massive burn—is the biggest fire in California history.

These fires, and many others across the American West, left millions of dead trees that became potential candidates for postfire timber harvests, sometimes referred to as salvage logging.

While fire is a natural part of forest ecosystems and standing dead trees (snags) killed by fire can provide valuable habitat for birds and other wildlife, the dead trees are waiting fuel that can make future fires in the area more severe. As warmer, drier summers become more common, postfire woody fuel accumulation and shrub regeneration have become increasingly prominent concerns for fire and forest managers.

Harvesting some fire-killed trees before they start to decay is one option for reducing future fuel loadings, while recouping the economic value of the merchantable timber. However, postfire logging also produces slash and other woody debris that may increase fire hazard and severity. Until recent studies led by Morris Johnson, few empirical studies were available to quantify the effects of postfire salvage logging on fuel loads and fuel accumulation in dry forests.

Johnson, a research fire ecologist at the USDA Forest Service Pacific Northwest Research Station in Seattle, Washington, found a unique way to fill the information gap by setting up monitoring projects on areas across the West burned by large wildfires. He started with the sites of two fires that were part of the 2015 Okanogan Complex: the Stickpin Fire in the Colville National Forest and the North Star Fire on the reservation of the Confederated Tribes of the Colville Reservation in Nespelem, Washington.

"I wanted to work with forest managers and use these recent large wildfires as opportunities to implement long-term management experiments to improve the scientific basics for decision-making and to address some of the controversy surrounding salvage logging," he says. "The core of this monitoring is simply quantitative: quantifying before- and after-treatment effects."

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After the Okanogan Complex Fire

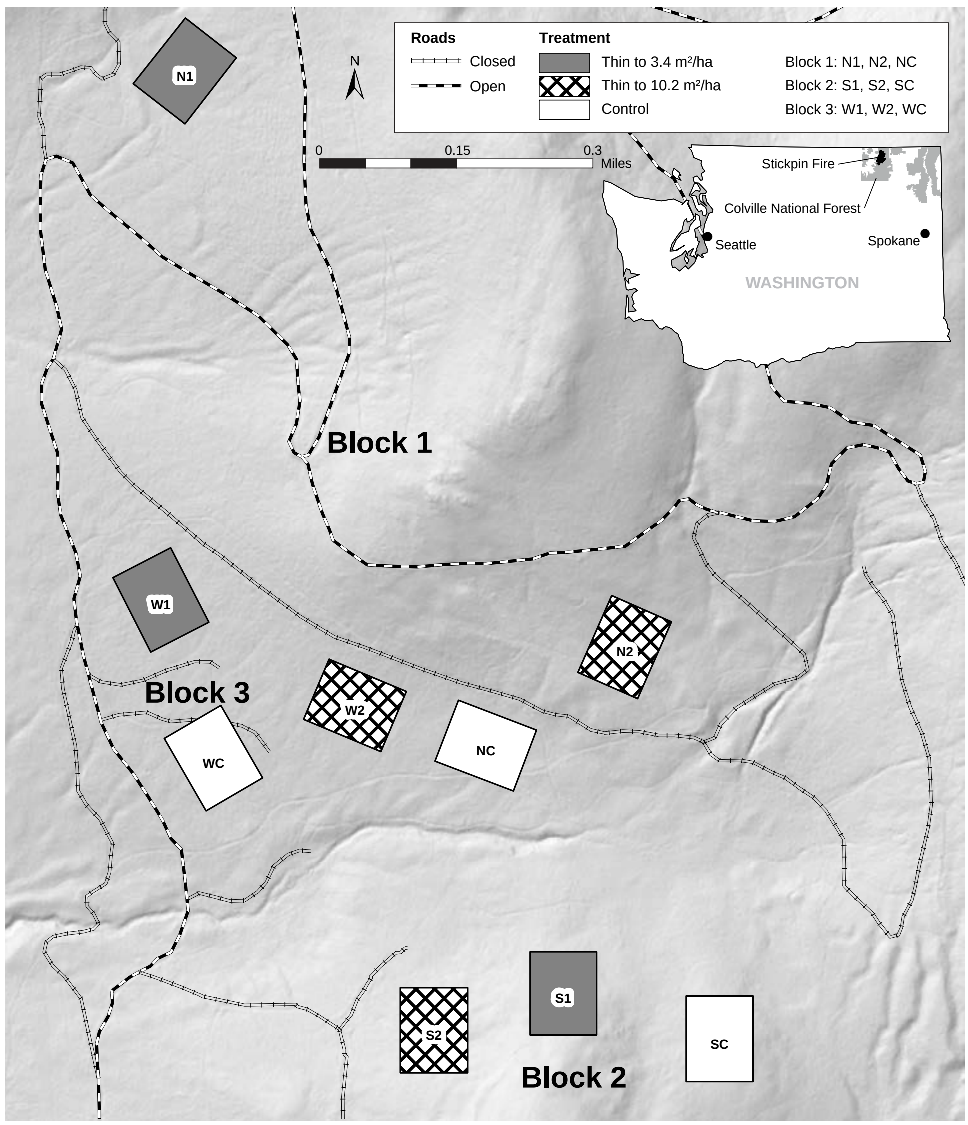
Despite its size and severity, the 2015 Okanogan Complex was not unusual—at least not for the 21st century. Large fires are now an expected norm during the summer in the American West. Scientific studies point to a century of fire suppression, past timber practices that removed large fire-resistant trees, and livestock grazing as factors contributing to the severity of wildfires today. Johnson says these factors have actually changed the structural conditions of dry interior forests, adding more dense small-diameter stems and increased woody fuel.

"These forests are susceptible to uncharacteristic, stand-replacing wildfires, which produce large mosaics of fire-killed trees," he says.

Typically, managers of federal, state, and private forests design postfire timber sales soon after the fire to recuperate the economic value of merchantable timber before it is lost to decay and insects. That was the case in the Colville National Forest and the adjacent Colville Reservation following the fires of 2015. Forestry is the biggest single revenue producer on the Colville Reservation, so when the fires burned nearly 20 percent of the managed forest land on the reservation—affecting 26 planned timber harvest projects—the tribes prepared several postfire timber sales to salvage the economic value of timber.

"Salvage logging accounted for almost all our cut volume in 2016," says Cody Desautel, natural resources director for the Confederated Colville Tribes.

That same year, Johnson and his fellow researchers collaborated with forest practitioners on both the Colville National Forest and the Colville Reservation to study the effects of different postfire management approaches. The opportunity was a rare one, Johnson says. While large fires create an ideal laboratory for studying the effects of postfire harvest and changes



A map of the study area in the Colville National Forest, Washington, showing areas designated for different thinning treatments alongside areas set aside for control.

Key Findings

- Harvesting fire-killed trees in dry, mixed-conifer forests is an effective strategy for reducing potential woody fuel loadings to levels more consistent with historical low- and mixed-severity fire regimes. The practice can help accomplish long-term restoration objectives after large stand-replacing wildfires.
- In general, woody fuel loadings tended to increase immediately in postharvest areas relative to areas that were not logged. However, total fuel loads did not exceed the limit of acceptable fire hazard. Whole-tree harvesting of fire-killed trees could be done to reduce the accumulation of dead woody fuel loadings and associated fire hazard.
- The number of seedlings decreased in all experimental units, including the control units, before and after logging.
- Simulation modeling demonstrated that postfire harvests decreased the long-term accumulation of dead woody fuel loadings.
- Simulation modeling revealed that dense plantings of seedlings after harvesting may increase reburn severity and decrease forest resilience in the early stages of postfire ecological change. Alternative planting strategies may be needed to reduce reburn severity.

in the characteristics and quantity of naturally occurring fuel (called fuel succession), setting up an actual experimental study is difficult to accomplish in a timely manner because of the hurdles of funding, administrative logistics, and coordination with other specialists on the project. In this case, however, it all came together.

Johnson mapped out random blocks within the area where all the trees had been killed, and which had similar stand conditions and vegetation types. He divided each block into three 5.4-acre experimental units and randomly assigned different treatments for each unit: standard salvage, in which most of the fire-killed trees were cut; partial salvage; and, importantly, no treatment at all. The last unit is the “control” aspect of the study. In other words, the effects of removing fire-killed trees are measured against what would happen if foresters did nothing.

The blocks are intended to be permanent so they can be monitored over time. Johnson and his fellow researchers measured the snag densities, woody fuel loadings, seedling densities, and the amount of non-tree vegetation before and after salvage logging operations.

The standard salvage and partial salvage units were harvested the following year. The snags were felled and then moved to a central processing area where the branches were removed. No additional slash reduction treatments were implemented in the blocks, giving the researchers a consistent baseline to measure fuel accumulation. Seedlings were replanted in the cut units 2 years later.

Johnson used the Fire and Fuels Extension to the Forest Vegetation Simulation (FFE-FVS) model to predict long-term postfire woody fuel loading dynamics. The Forest Service has been using this simulator for nearly 50 years. It was originally designed as a growth and yield model for predicting forest stand dynamics. The Fire and Fuels Extension was added to estimate potential fire behavior effects.

Johnson ran scenarios projecting tree growth and woody fuel loading accumulation over the next 80 years for all experimental units. He also tested the reburn hypothesis—that large areas with fire-killed trees are prone to future high-severity wildfire as dead woody fuels accumulate and shrubs regenerate over time—by conducting a second set of simulations that included a hypothetical wildfire 20 years after the salvage logging.

Johnson will revisit the sites in future years to repeat field measurements and compare the actual woody fuel loading with the FFE-FVS model projections. But in the near term, the simulation analysis provided some valuable information.

Forecasting Future Forests

The analysis showed the amount of dead woody fuel increased in the logged areas, whereas it tended to marginally decrease or not change in the unlogged areas. The computer model projected that fine woody debris and coarse woody debris would initially increase rapidly within 15 to 20 years, and then decrease after 30 years.

Severity of reburns is influenced by regenerating shrubs, woody fuel loadings, and reforestation practices. Johnson’s modeling found that replanted young (less than 1 year old) plantations may not be resilient to repeat wildfires. Altering standard reforestation practices using methods such as variable-density reforestation can increase forest heterogeneity and reduce reburn severity.

In the Colville study, his projections showed that the untreated control produced much more woody fuel over the next 80 years compared to the salvage-logged areas. The increase in woody fuel could increase fire behavior. More severe fires could ultimately trigger a forest-type conversion where the previously dominated coniferous forests fail to regenerate and are replaced by other tree species or shrubs.

The Colville findings also suggest that postfire logging in this forest type can be done in such a way that resulting fuel does not significantly increase fire hazard and reburn severity. Harvesting fire-killed trees, in itself, reduces future hazard. It’s also a practice that can be varied to meet different objectives. Postfire harvests that leave a greater number of snags per acre still reduce fuel loadings, while leaving some snags as habitat for birds and other wildlife.

The information is as important for the Colville Tribes as it is for the Forest Service. The tribes invited Johnson to continue working with them to monitor these research plots so the finding can be used to help formulate plans for the coming decades. In the summer of 2022, Johnson and Desautel will collaborate again to repeat the randomized study design on the site of the 2021 Summit Trail Fire. They will also install additional monitoring plots to track the trajectories of fuel succession outside the study areas.

“To perpetuate forests in the future, we need to know the best way to handle salvage logging and tree planting,” said Desautel. “There’s a lot of things we hope to derive from this research to guide our decisions in the future.”

A postfire timber harvest after the 2020 Archie Creek Fire, Oregon. Photo by Cheyne Rossbach, USDI Bureau of Land Management.

LAND MANAGEMENT IMPLICATIONS

- Postfire management can influence the trajectory of stand development and future wildfire hazard.
- There are potential ecological tradeoffs between passive (no action) and active management following stand-replacing wildfires.
- Results from this network of field studies and simulated modeling provide the foundation to monitor long-term fuel succession trajectories in dry conifer forests. It also provides empirical data on the effects of different postfire management strategies. This information can help inform long-term restoration strategies and environmental analyses for postfire management decisions.

Xavier Lee, 2021 Reseach with Underserved Communities Fund Intern, measures a fallen tree at a study site on the 2020 Beachie Creek Fire in the Bureau of Land Management Northwest Oregon District. USDA Forest Service photo.

Integrating Postfire Research Into Management Planning

The Colville project was not only successful in producing usable information and introducing a study method that includes controls, but equally important from Johnson's perspective is that it was codesigned with the forest managers responsible for the forests. It's a model that he's replicated and using in cooperation with federal and tribal forest managers across the West. "This is a unique coproduction relationship between managers and the research community," he says.

Since the two Colville projects, Johnson has established projects on the sites of nine large wildfires that occurred on Bureau of Land Management (BLM) and National Forest System (NFS) lands from 2018 through 2020 in Oregon, California, and Idaho. And in 2022, he will collaborate with forest managers on post-wildfire monitoring projects in six more locations.

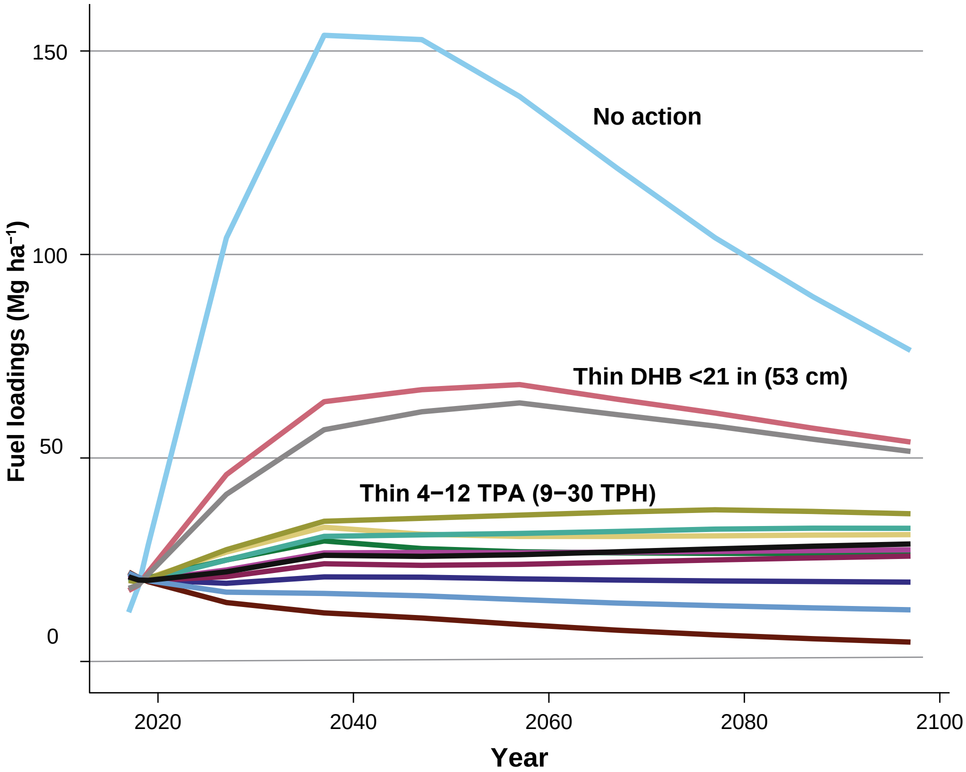
"The arduous process to initiate a monitoring project starts with an inquiry to the local forest about their potential postfire management plans following a large wildfire," Johnson explains. (The National Environmental Policy Act [NEPA] requires federal agencies to assess the environmental effects of such plans prior to making decisions.) "If the forest plans to purse salvage logging, I request to join their interdisciplinary NEPA team to monitor salvage logging treatment effects, which is really an exciting opportunity to work with the managers and build long-term relationships."

Through his engagement with forest managers, Johnson models a co-production approach to science. Johnson is an active member on 14 interdisciplinary teams responsible for assessing the environmental impacts of proposed post-wildfire management on a particular national forest or BLM unit. His research objectives are included in official NEPA documentation and may serve as a model for future fuel salvage logging projects.

Johnson contacted Hinda Darner, the fuels officer on the Upper Lake Ranger District on the Mendocino National Forest after the 2018 Ranch Fire. The fire, which burned 410,000 acres, was part of the Mendocino Complex, the largest fire in California history at the time (it was overshadowed by the August Complex fire 2 years later). At the time of Johnson's call, Darner and Frank Aebly, district ranger of Upper Lake Ranger District, were just talking about postfire recovery and NEPA requirements to initiate salvage logging.

"We have heard from environmental groups and others that they want to see the Forest Service test and calibrate models such as the Forest Vegetation Simulator FVS system," Darner says. "We have this opportunity not only to test and calibrate our models, but also

Field technicians document vegetation growing along a transect with a study plot in an area burned in the Mendocino Complex in 2020. Photo by Morris Johnson, USDA Forest Service.



Projected accumulation of woody fuels for the next several decades under various thinning options compared with taking no action, based on study areas burned by the 2018 Mendocino Complex in California. DBH = diameter at breast height; TPA = trees per acre; TPH = trees per hectare.

Sarah Harrison is measuring woody fuel loadings along a transect in a plot on the Mendocino National Forest. Photo by Morris Johnson, USDA Forest Service.

to better monitor our treatments for effectiveness. It's also a chance for us to build plot designs that test the efficacy of different treatment types and monitor that scientifically. This type of monitoring is something many forest managers would like to see but have been too short staffed and underfunded to be able to accomplish alone."

Darner continues, "We saw this partnership with Morris Johnson as an opportunity to do what we have been wanting to do for a long time. We are bringing the scientific approach to a forest and project-specific level."

Johnson became an integral member of the NEPA interdisciplinary team and worked with Darner to set up monitored plots in the same design as the Colville projects. The district later incorporated Johnson's work into the environmental assessment report for its restoration project. Johnson also answered questions about the project at a public open house.

In 2021, Johnson worked with Darner again on another randomized block design salvage logging project within the site of the August Complex. On this project, they implemented a partial salvage prescription (remove all trees less than 20 inches diameter at breast height) suggested by one of the local environmental groups in the local area.

Even if it becomes too late to harvest the fire-killed trees near the research plots, Darner says the research still has great value: "With the research plots, we're hoping to mimic what we were planning to do in the project area anyway."

Darner explains that the research plots are little snapshots that will enable mangers to compare all kinds of different management tools. "This research process is not so much a shift in how we do things, but an added element that puts science behind it," she says. "It's a win-win for all of us. It's pretty exciting to be working with Morris. The more work like this we can do, the better we are as an agency."

"Give me six hours to chop down a tree and I will spend the first four sharpening the axe."

—Abraham Lincoln

Writer's Profile

John Kirkland has been writing about science, higher education, and business for more than 20 years. He lives in Portland, Oregon.

For Further Reading

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Scientist Profile

MORRIS C. JOHNSON is a research fire ecologist with the Pacific Northwest Research Station at the Pacific Wildland Fire Sciences Laboratory. His research focuses on quantifying the effects of silvicultural treatments on changing wildfire behavior and understanding forest and fuel succession after large stand-replacing wildfires. Johnson, originally from Waterproof, Louisiana, began his Forest Service career as a forest ecologist on the Rogue River-Siskiyou National Forest, and was a member of interagency hotshot firefighting crews in Redmond, Oregon, and Redding, California. He earned a bachelor's in urban forestry at Southern University and Agricultural and Mechanical College, Baton Rouge, and a master's and Ph.D. at the University of Washington.

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