

Science You Can Use *in 5 minutes*

Trees in Distress: Prefire drought increases postfire mortality

It's no secret that wildland fires kill trees, but are more trees killed by fire when they are already stressed from drought? New research from the U.S. Department of Agriculture, Forest Service indicates that prefire drought can increase tree mortality after fire, even with the same level of tree damage.

This study, led by [Alina Cansler](#), a professor with the University of Montana, and [Sharon Hood](#), a research ecologist with the

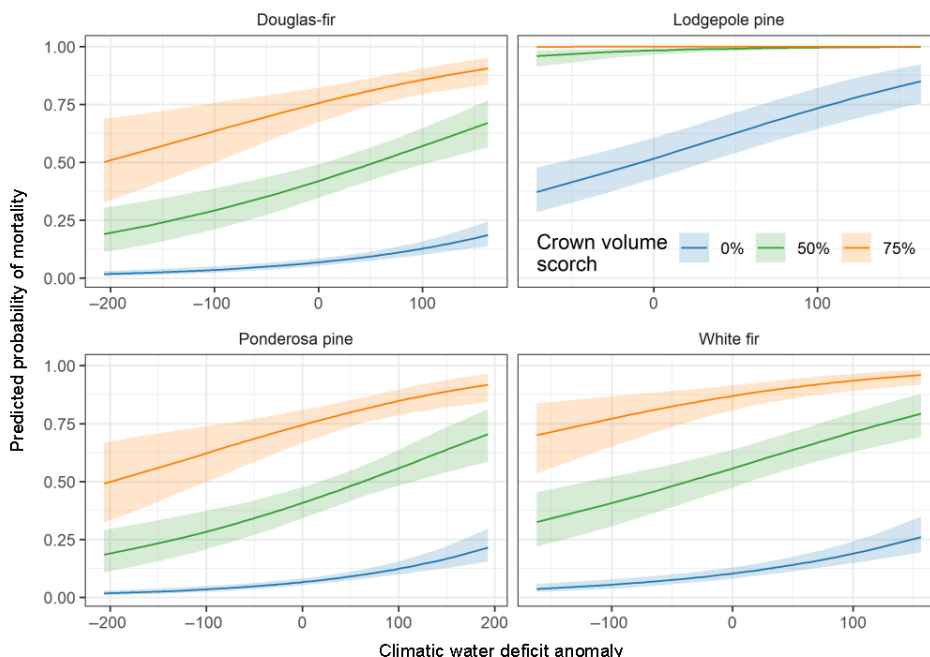
Forest Service, analyzed tree survival data from 32 years of wildfires. Four tree species were studied—lodgepole pine, white fir, Douglas-fir, and ponderosa pine. These tree species are widespread in the western U.S. and have varying degrees of resistance to fire based on characteristics like bark thickness.

When wildfires burn forests, some trees die immediately or soon after the fire. Trees that initially survive may die years

later. The team investigated whether surviving trees were more likely to die within 5 years if there was an extreme drought before the fire. They found that injuries to the crown were the strongest predictor of postfire tree mortality, with greater scorch leading to a greater likelihood of death, which is consistent with most other research. They also found that climatic water deficit, a measure of drought, was a strong indicator of mortality, supporting the idea that prefire drought leads to greater postfire tree mortality.

In fact, given the same level of crown scorch, severe prefire drought made a tree 78 percent more likely to die after a fire. For thick-barked species of Douglas-fir, white fir, and ponderosa pine with moderate crown scorch (50%), the likelihood of death increased from less than 30 percent to greater than 60 percent under severe drought. For thin-barked lodgepole pine, most trees died with moderate crown scorch regardless of drought conditions.

The team also looked at how tree resistance to fire could change under future climate scenarios in which droughts may become more frequent



Predicted probability of mortality after fire increases with climatic water deficit (CWD, a measure of drought) for Douglas-fir, ponderosa pine, and white fir trees. This means that drought-stressed trees can't survive the same level of crown scorch after a fire. Lodgepole pines are predicted to die when scorched more than 50%, regardless of drought stress.

and severe. Under current climate conditions, both Douglas-fir and ponderosa pine were likely to die when crown scorch exceeded 55 percent, and white fir was likely to die when crown scorch exceeded 45 percent. In a warmer climate scenario (+4 °C), Douglas-fir, ponderosa pine, and white fir were likely to die when crown scorch exceeded 40 percent, 35 percent, and 25 percent, respectively. “Our western forests that have thick-barked tree species may become less resilient to fire in the future because of increasing drought stress,” says Sharon Hood.

This study emphasizes the importance of considering prefire drought conditions when examining tree mortality. Under future climate scenarios with more frequent and severe drought, fire may cause greater tree mortality, reducing the resiliency of western forests.



A recent prescribed burn in Montana. Crown scorch is indicated by the orangish-colored needles that were killed during the fire. Some of the smaller trees will likely die in the next 1-2 years from crown scorch. Severe drought may increase the likelihood of tree death after fire even if crown scorch doesn't increase. USDA Forest Service photo by Sharon Hood.

Management Considerations

- Prefire moisture stress contributes to postfire tree mortality, particularly for smaller trees and trees with intermediate levels of fire-caused injury.
- Although current tree mortality models remain fairly accurate, as drought conditions increase in frequency and severity, including prefire climate conditions in tree mortality models will improve their accuracy.
- Reducing fire severity from wildfire through prescribed burning and mechanical thinning remains a top priority, though prescribed burn ignition techniques may need to be changed to mitigate tree mortality in severe drought years.
- Under severe future climate scenarios, large swaths of forest may have higher levels of tree mortality after fire due to prefire drought, with the Southwest being especially at risk.

Further Reading

Cansler, C.A.; Wright, M.C.; van Mantgem, P.J.; Shearman, T.M.; Varner, J.M.; Hood, S.M. 2024. [Drought before fire increases tree mortality after fire](#). Ecosphere. 15:e70083.

Lead Scientists

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