Pacific Northwest heat dome tree damage more about temperature than drought, scientists say

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Foliar scorch. Credit: Gabriela Ritokova

Widespread tree scorch in the Pacific Northwest that became visible shortly after multiple days of record-setting, triple-digit temperatures in

June 2021 was more attributable to heat than to drought conditions, Oregon State University researchers say.

In a paper published in *Tree Physiology*, a team led by Christopher Still of the OSU College of Forestry cites evidence that leaf discoloration and damage are consistent with direct exposure to solar radiation during the hottest afternoons of the "heat dome" that covered northwestern North America.

Still and other scientists from OSU were responding to an article published in the same journal in April 2022 that concluded the trees' problems were the result of drought and a failure in the trees' hydraulic system, which helps foliage stay cool through the exhalation of water vapor via a process known as transpiration.

The collaboration that produced the response following a literature review includes researchers from Oregon State's colleges of Engineering, Agricultural Sciences, and Earth, Ocean, and Atmospheric Sciences, as well as two other OSU-affiliated organizations, the Oregon Climate Change Research Institute and the PRISM Climate Group.

"While we think the drought/hydraulic hypothesis is partly true, we argue that multiple lines of evidence suggest the main issue was in fact direct heat damage," said Still, a tree physiologist who studies forests in the context of climate change impacts and feedbacks. "Tree physiologists have worked a lot to show that hydraulic damage in response to drought drives a lot of tree mortality, and the paper we comment on more or less fits in that vein, implying that what we saw in June 2021 was just another example of drought damage and that the heat dome was a sort of extreme drought event."

Still and OSU colleagues including ecologist and plant pathologist Posy Busby, H.J. Andrews Experimental Forest Director Mark Schulze, forest

health specialist David Shaw, hydrologist David Rupp and geospatial climatologist Chris Daly say that damage can be driven by extreme heat alone, irrespective of prior hydrologic context and water availability.

They note that the heat dome was one of the most extreme heat waves ever recorded anywhere in the world and the most intense ever in the Northwest. The scientists also point out that there is "a clear distinction in the climate and hydrometeorological literature between droughts and heat waves" and that "heat waves are not just associated with droughts, as is commonly assumed, but are increasing in frequency during both wet and dry conditions."

Foliar scorch. Credit: Gabriela Ritokova

Among coastal Douglas-fir and western hemlock plantation forests in western Oregon and Washington, the most extensive impacts of the heat

dome were in areas experiencing comparatively low levels of drought, the authors say. Conversely, many forests around Oregon's Willamette Valley and along the western slopes of the Cascade Range that were experiencing severe to exceptional drought during the heat dome showed less foliar damage.

"It's also important to remember that conifer needles can discolor for many reasons besides being dried out," Still said.

Much of the observed "foliar scorch" resembled what is caused by heat generated from fires, Still said, and also followed patterns that suggest heat was the primary driver of foliar damage during the heat dome. Trees on south- and west-facing slopes and on exposed edges near roadsides generally showed the greatest scorch, and opposite sides of the same trees, or other trees on the same hillsides, displayed little to none.

"The scorching that did occur happened fast, within days and sometimes hours, much faster than would typically be associated with a malfunction of the trees' water moving capabilities," Still said. "And the prevalence of scorching in sunlit foliage also challenges the hypothesis that drought and hydraulic failure combined to be the primary cause of leaf damage."

"Our prior work has shown drought-induced foliar browning in conifers can take weeks or even months to appear after lethal levels of drought stress," added co-author William Hammond, an assistant professor of plant ecophysiology at the University of Florida.

The scientists emphasize that they are not saying hydraulics played no role in the leaf damage, or in the subsequent death of some trees, but that extreme heat is the best explanation for the crown- and landscape-scale scorch patterns seen throughout the Pacific Northwest during and after the heat dome.

"Disentangling drought from heat damage is tricky, and we argue the research community needs to work much more on heat stress physiology," Still said. "We need to explore connections between hydraulic properties and heat tolerance—safety margins, how evolution may have helped some species with heat tolerance, canopies' ability to maintain leaf temperatures below damaging thresholds. What happened during the heat dome argues for a renewed emphasis on understanding the underlying physiological and biophysical mechanisms that can lead to heat resilience."

More information: C J Still et al, Causes of widespread foliar damage from the June 2021 Pacific Northwest Heat Dome: more heat than drought, *Tree Physiology* (2023). DOI: 10.1093/treephys/tpac143

Provided by Oregon State University

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