Hotter and drier fire seasons increase risk of severe wildfires in western US forests

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Wildfire activity has been increasing across western US forests, impacting public health, infrastructure, water quality, and the economy. While total annual area burned is often used to track wildfire trends, high-severity fire (fire that kills all or most trees) can have longer lasting impacts on forests and communities and may be a more meaningful measure. Historically, many western US forests experienced frequent, low-severity fires, which promoted resistance to drought, insect outbreaks, and future wildfires. In contrast, high-severity fires in these forest types can lead to forest loss and have negative impacts on post-fire recovery. Understanding trends in high-severity fire is therefore crucial to understanding wildfire impacts on forests and the ecosystem services they provide. Although climate is a key driver of fire behavior, no studies to date have projected how much land could burn at high severity under future climate conditions. This study asks: *how is high-severity wildfire changing under a warming climate in the western US, and what might the future look like?*

MANAGEMENT IMPLICATIONS

- Substantially scale up forest restoration: Restore forests to historic conditions to help reduce the severity of future fires. Ecologically based thinning followed by prescribed fire is generally the most effective method in forests that historically experienced frequent, low- to moderate-severity fire.
- Plan for a future where extreme fire years are the norm: Use projected burn area data to guide pre-fire management, fire response strategies, and community preparedness efforts.
- Use managed wildfire where active restoration isn't feasible: Incorporate managed wildfire as part of a broader restoration strategy when conditions allow.

To understand trends in fire severity and area burned, researchers analyzed satellite images taken before and after each fire in western US forests from 1985 to 2022. They classified areas as high severity when at least 95% of the tree canopy was lost according to a satellite-derived fire severity metric called the Composite Burn Index. To understand climate's role, they combined three key indicators during the summer fire season (vapor pressure deficit, maximum temperature, and climate water deficit) into a single metric called fire season aridity to capture how hot and dry each fire season was. This same method was used to model future fire conditions, projecting changes in total and high-severity burn areas through the mid-21st century under a 2°C warming scenario.

From 1985 to 2022, the annual area burned in western US forests increased 10-fold, while the area burned at high-severity increased 15-fold. Over this same period, median fire size increased. Additionally, researchers found that the proportion of high-severity fire increased with area burned at both the annual and individual fire scale. These results indicate that not only are warmer, drier conditions linked to increasing fire size, but these larger fires are also associated with a larger proportion of high-severity fire.

In 2020 and 2021, over 16,000 km^2 of forest burned each year, with high-severity fire making up 45% and 36% of that area, respectively. Looking ahead to the mid-21st century, models project a 2.9-fold increase in average annual area burned and a 4-fold increase in area burned at high severity compared to averages from 1985 to 2022. These projections are comparable to what was observed in extreme fire years 2020 and 2021, suggesting that years like those may become the 'new normal' by the mid-21st century. During particularly hot and dry conditions, future fire seasons may exceed even the most extreme years from recent decades (see Fig. 1).

Existing systems for community preparedness, fire response, and post-fire restoration don't likely have the capacity

to handle the projected increase in fire activity. Capacity challenges may worsen as the proportion of high-severity fire is expected to continue rising, especially in a warmer, drier climate, threatening communities, forest recovery, and key ecosystem services like carbon storage, timber, and water. The combination of a more arid climate and increased fire severity could result in widespread forest loss. In the Southwest, for example, up to 30% of forests are at risk of converting to non-forest vegetation type by the mid-21st century.

Historically, fires were more frequent in western US forests, and the annual area burned in years like 2020 and 2021 was not uncommon. However, unlike today's fires, historical fires burned at low- to moderate-severity, allowing mature trees to survive. This fire history was largely due to Indigenous fire stewardship that maintained forest health and resilience. In contrast, today's more severe fire behavior is partially the result of fire exclusion, which altered forest structure and increased fuel loads. This, combined with a hotter and drier climate, creates the conditions for severe fire behavior.

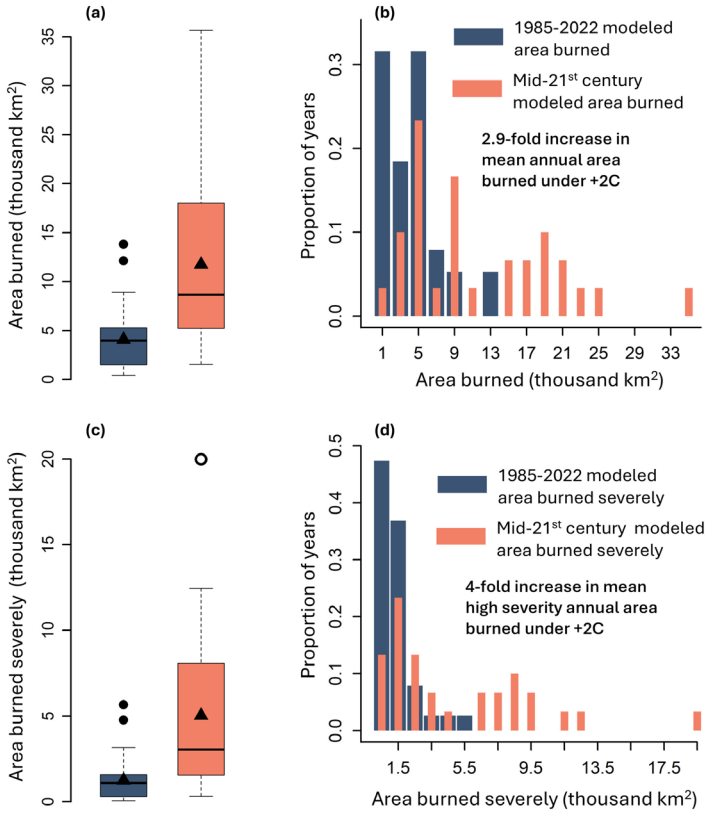

Figure 1. Modeled recent (1985–2022) and mid-21st century area burned (a, b) and area burned severely (c, d). In panels (a, c), the black triangles and horizontal lines represent the mean and median, respectively; the black dots show 2020 and 2021 predictions, and the open circle (d) represents an outlier for the mid-21st century area burned severely prediction. Note that the modeled mid-21st century mean annual area burned and mean annual area burned severely approximately matches fire activity in 2020 and 2021 (a, c).

Preparing for future fire conditions requires learning from historical fire regimes and Indigenous stewardship. For example, the long history of Indigenous fire stewardship shows that large-scale, low- to moderate-severity fires can be sustainable with proper management. Restoring forests to historic conditions can lower the risk of high-severity fire and support both ecosystem and community health. Tools for effective restoration include forest thinning, prescribed fire, and managing wildfire under safe conditions when active restoration isn't possible. While some of this work is underway, it must be significantly scaled up to reduce future fire impacts on communities and forests, prevent widespread forest loss, and protect the vital services forests provide.

Additional Information

This brief is based on the following article:

Parks, S. A., J. D. Coop, and K. T. Davis. 2025. " Intensifying Fire Season Aridity Portends Ongoing Expansion of Severe Wildfire in Western US Forests." Global Change Biology 31, no. 8: e70429. https://doi.org/10.1111/gcb.70429.

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