

Science You Can Use *in 5 minutes*

Quantifying Danger: New data on wildland firefighter injuries

When wildland firefighters head into the field, they know the work is dangerous; but until now, agencies lacked detailed data on exactly which activities and hazards posed the greatest threats. A recent analysis of five years of serious firefighter injuries offers new insights.

Researchers Erin Belval and Brad Pietruszka at the Rocky Mountain Research Station teamed up with risk management specialist Alex Viktora in the Fire and Aviation Management branch to analyze 435 injuries to Forest Service firefighters and contractors. Understanding and reducing

firefighter injuries is critical not only for preventing harm to individuals, but more broadly for maintaining the workforce needed to protect communities and landscapes.

“It sets a baseline,” Belval says. “We didn’t have any data linking wildfire management activities to how bad injuries were. Having this baseline allows us to begin speaking about risk informed by quantitative data.”

The researchers counted the number of injuries caused by each hazard type and rated their severity. Unsurprisingly, more injuries occurred in western

states where wildfires are more common. For example, Southern Oregon and Northern California accounted for 27 percent of all reported injuries. In addition to high fire activity, these regions have extreme terrain with towering trees, creating intense hazards for firefighters.

While injuries were more frequent in the west, they were not more severe. Only one type of activity caused injuries that were more severe compared to other types of activities. Aviation activities accounted for only 6 percent of injuries, but the injuries were more likely to be fatal. Injury severity was similar



Recent research shows that tree and branch strike injuries are more frequent and severe when trees fall naturally during a fire (left) compared to injuries during planned tree-felling operations (right). USDA Forest Service photos by Kari Greer and Cecilio Ricardo.

for both prescribed fires and wildfire suppression operations, despite prescribed fires being planned events.

Tree and branch strike injuries were more frequent and more severe when trees fell naturally versus during planned tree-felling operations. This highlights that the wildland fire environment is inherently hazardous and that established safety protocols (PPE, training) are effective in reducing the frequency and severity of known hazards.

Many documented injuries—stepping into hidden ash pits, equipment malfunctions, or falling trees — were not related to firefighters making mistakes or being careless.

“For many injuries it wasn’t a matter of being unsafe. It was just people being in the wildland and performing firefighting tasks,” Belval says.

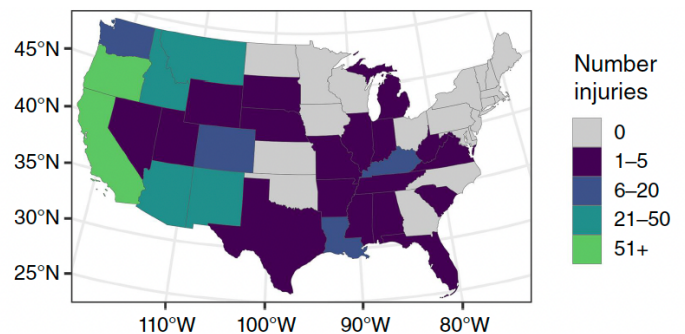
“This has implications for how agencies and organizations communicate risks,” says co-author Pietruszka: “Organizations have a responsibility to disclose specific risks to employees so they can make informed decisions. Our research is helping enable more thorough descriptions of the risks involved in wildland firefighting which we hope leads to fewer injuries.”

The findings highlight the value of pre-season planning strategies, including the use of tools like [potential operational delineations \(PODs\)](#). These tools identify locations for safer and more effective firefighting operations and where to consider targeted safety investments.

Looking ahead, this study represents the first step toward more extensive research about firefighter safety. The scientists and their collaborators are developing multiple follow-up studies, including a dedicated analysis of tree-strike injuries and a comprehensive review of firefighter fatalities dating back to 1910. They are also developing related quantitative risk assessment tools that can be easily used to improve decision making.

Management Considerations

- Geographic factors influence injury risk patterns in terms of frequency but not overall severity. Areas with extreme terrain and towering trees may require different approaches to safety planning such as identifying areas with fewer hazards and lower fire intensity.
- Injury data can be integrated with pre-season planning efforts such as Potential Operational Delineations (PODs) that identify safer firefighting locations and operational strategies.
- Many injuries result from environmental hazards rather than individual safety failures, suggesting that organizational-level risk tolerance decisions may be necessary to reduce injuries.



Geographic distribution of severe firefighter injuries, 2019–2023 by State. Most injuries occurred in western States, with California and Oregon showing the highest numbers.

Further Reading

Belval, E.J.; Pietruszka, B.M.; Viktora, A. 2025. [The price of doing business: Severe injuries in wildland firefighters in the United States by activity performed and hazard encountered](#). International Journal of Wildland Fire. 34: WF25038.

Contributors

[Erin Belval](#) is a research forester, and [Bradley Pietruszka](#) is a fire management specialist; both are with the Wildfire Risk Management Science Team at the Rocky Mountain Research Station.

[Alex Viktora](#) is a risk management specialist for the Forest Service Fire and Aviation Management Branch.

[Sylvia Kantor](#) and [Natalie Cooper](#) are the authors of this Science You Can Use.



[Rocky Mountain Research Station](#) is part of Forest Service Research and Development. While anchored in the geography of the West, our research is global in scale.

Our science improves lives and landscapes.