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Rocky Mountain Research Station

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Heads Up in a Dead Forest: Using the Snag Hazard Map to Support Safety and Strategic Planning for Fire Responders

Falling trees and tree fragments are one of the top five leading causes of fatalities for wildland fire responders. Wildfires—along with insect infestations, drought, disease, and other disturbances—have increased dead and dying trees in forests across the western United States.

In 2016, fire managers approached scientists with a question: Is it possible to create a map that could objectively predict what areas of a forest have the highest hazard from snags, or standing dead trees? To address this management need, Karin Riley and Kit O'Connor, Research Ecologists at the USDA Forest Service Rocky Mountain Research Station, partnered with the Forest Service's Risk Management Science Team and Oregon State University to create the Snag Hazard map.

"All fire managers know that an existing burn scar can be a strategic place to stop a fire," said O'Connor, who co-led the project. "But they also know that a scar can be an extremely dangerous place for fire responders due to the risk posed by dead and dying trees."

The Snag Hazard map is derived from TreeMap 2016, which is a national-level model that uses machine learning to match the Forest Service Forest Inventory and Analysis program's on-the-ground forest plot data to LANDFIRE maps at a 30 x 30 meter spatial resolution. The TreeMap dataset provides a list of predicted trees in a given area, including their species, diameter, height, and whether they are living or dead. The Snag Hazard map uses the modeled height and density of snags to provide a low, medium, high, or extreme snag hazard rating. The more snags present, and the taller those snags are, the higher the risk for injuries or fatalities.

"Hazard maps can help fire managers better plan and reduce the possibility of dangerous

Areas with high densities of snags—as seen here in the Shoshone National Forest in the wake of the Lava Mountain Fire—can pose safety risks to fire responders and incident management teams. USDA Forest Service photo by Kristen Honig.

situations," said Riley, who is the project lead for the Snag Hazard map. "Traditionally, the responsibility for safety in the field has been mainly placed on individual fire responders. Efforts like this represent a shift of safety issues to the strategic planning level."

In September of 2021, lightning strikes ignited three wildfires in Sequoia and Kings Canyon National Park (SEKI). While one fire was quickly contained, the Colony and Paradise fires grew considerably in the following week, eventually merging into the KNP Complex spanning approximately 18,000 acres. Steep slopes, rugged terrain, and existing dead trees presented serious challenges to fire responders. Snags were of particular concern, as two local fire responders had lost their lives due to falling trees just 3 years earlier.

In response to growing concerns, the Snag Hazard map was made available to incident management teams and National Park Service employees. Line officers and fire managers in SEKI utilized the Snag Hazard map to inform strategic planning, public outreach, and incident documentation. Additionally, the Snag Hazard map was used to illustrate where on the landscape snags posed the greatest threat to fire responders. No fatalities and no snag-related injuries were reported on the KNP Complex.

The Snag Hazard map is available on the Risk Management Assistance Dashboard, where fire managers, recreators, and other forest users can view projected snag hazards across the contiguous United States.

KEY MANAGEMENT CONSIDERATIONS

- The Snag Hazard map provides a spatial snag hazard rating (low, moderate, high, or extreme) at a 30 x 30 meter resolution across the continental United States. Hazard ratings are determined by the modeled median height and density of snags in a given area. To view the Snag Hazard map, navigate to the *Map Viewer* tab, open the *All Layers* panel in the *RMA Map Viewfinder*, and select Snag Hazard 2022.
- The Snag Hazard Map supports risk-informed decision-making. Wildland fire managers can utilize the snag hazard map to identify potentially dangerous conditions and direct fire responders away from high-risk areas.
- For the 2022 fire season, the Snag Hazard map is now updated annually with estimated snag hazard classifications for areas that have experienced wildfires that occurred after the 2016 TreeMap estimates.
- The Snag Hazard map is derived from TreeMap, and both applications use LANDFIRE maps as inputs. As a result, TreeMap and Snag Hazard maps are compatible with fire modeling outputs from software such as FlamMap, FARSITE, and FSim.

FURTHER READING

Riley, K.L.; O'Connor, C.D.; Dunn, C.J.; Haas, J.R.; Stratton, R.D.; Gannon, B. 2022. A national map of snag hazard to reduce risk to wildland fire responders. Forests. 13: 1160.

Riley, K.L.; Grenfell I.C.; Finney M.A.; Wiener, J.A. 2021. TreeMap, a tree-level model of conterminous U.S. Forests circa 2014 produced by imputation of FIA plot data. Nature Scientific Data. 8(11): 1–14. https://doi.org/10.1038/s41597-020-00782-x.

Riley, K.L.; Grenfell, I.C.; Shaw, J.D.; Finney, M.A. 2022. TreeMap 2016 dataset generates CONUS-wide maps of forest characteristics including live basal area, aboveground carbon, and number of trees per acre. Journal of Forestry. 1–26. https://doi.org/10.1093/jofore/fvac022.

PROJECT LEADS

Karin Riley is a research ecologist in the Fire, Fuel, and Smoke program at the Rocky Mountain Research Station. Her current research focuses on examining the relationship between climate and wildfire and using spatial planning to inform fire and landscape management options.

Kit O'Connor is a research ecologist in the Human Dimensions program at the Rocky Mountain Research Station. His current research focuses on wildfire risk planning, wildfire decision support, and integrating fire, insect disturbance, and changing climate into landscape planning and incident response.