California's Dixie Fire shows impact of legacy effects, prescribed burns

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The 2021 Dixie Fire burning on the night of August 25 near Taylorsville, California. Fire history largely determined how severely the wildfire burned, and low-severity fire treatments had the largest impact on reducing the worst effects of the fire, according to researchers. Credit: U.S. Forest Service

The 2021 Dixie Fire burned over nearly 1 million acres in California and cost $637 million to suppress, making it the largest and most expensive wildfire to contain in state history. Fire history largely determined how severely the wildfire burned, and low-severity fire treatments had the largest impact on reducing the worst effects of the fire, according to a Penn State-led research team.

"We're in extreme drought conditions over most of California," said Alan Taylor, professor of geography and ecology at Penn State and principal investigator on the project. "The Dixie Fire burned during the hottest summer in California on record and after two years with half the average precipitation and snowpack. The large amounts of fuels that had accumulated due to over a century of fire exclusion were primed to burn intensely due to these extremely dry conditions. The 2022 fire season may also be difficult in California. April 1 snowpack was only 38% of normal. In this study we wanted to see what factors help keep fire severity down when drought is extreme."

The researchers examined the Dixie Fire to see how fuel treatments and previous fires affect a wildfire burning under extreme conditions. They gathered Landsat 8 satellite imagery of the fire-damaged area taken immediately after the Dixie Fire and during the same time period in 2020 to create maps of the fire effects on vegetation. They used pixel-level median values from the satellite images and extensive on-the-ground assessments of fire damage to create a composite image for each year. The process allowed them to account for clouds and smoke still in the atmosphere after the fire and in 2020, which also saw a record-setting fire season. They compared the composite images to calculate the severity indices.

"We wanted to perform this analysis as soon as possible after the fire because we need to be learning lessons from megafires like the Dixie Fire as quickly as we can," said Lucas Haris, a former postdoctoral

researcher at Penn State now at the University of Vermont Rubenstein School of Environment and Natural Resources. "The multi-image approach that we took helped to ensure that smoke didn't influence the calculations because the perfect, smoke-free single image doesn't exist."

The remains of a forest after the 2021 Dixie Fire burned over the area. The fire burned over nearly 1 million acres in California, making it the largest fire to date in state history. Credit: U.S. Forest Service

The scientists used state and federal data to identify areas that had undergone mechanical thinning and burn treatments prior to the Dixie

Fire to see how past treatments and burn history affected fire severity. They reported their findings June 21 in the journal *Environmental Research Letters*.

The researchers found that areas that had burned at low to moderate severity in the past burned at low to moderate severity during the Dixie Fire. Areas that burned at high severity in the past, on the other hand, burned at high severity again. Tellingly, areas that burned at high severity within the past four decades were more likely to burn at high severity during the Dixie Fire than areas that had not experienced a fire in the last 120 years, according to the researchers. They attributed these findings to the landscape's ecological memory, or the legacy effects of past fires.

"Ecological memory is the idea that a particular landscape essentially has a memory of past events, whether that be a fire, logging, grazing or another type of disturbance," said Harris. "Those events shape the characteristics of a landscape in a way that has lasting impacts. These impacts can include changing tree species composition, the structure of the forest, understory plants and their composition and quantity, or, in the case of fire, the arrangement of fuels on the forest floor and the vertical structure of fuels. Basically, the forest has a memory of past events that manifest in the present day, and we saw this when examining the data from the Dixie Fire."

In a previous study in California's Klamath Mountains, the team found that they could predict the severity of future fires by looking at one variable: how did an area burn during the last fire? The current study provides insights into what will happen to more than nearly 1 million acres should another fire break out. The goal now is to prevent another severe wildfire like the Dixie Fire from occurring by providing officials with an assessment of the preventative tools available, and the best tool happens to be fire, according to Taylor.


BFD
BFD
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Firefighters at Lake Davis watch a scooper, a plane that can scoop up and dump water on a fire from the air. The Dixie Fire cost $637 million to suppress, making it the most expensive wildfire to contain in state history. Credit: U.S. Forest Service

The research team found that low-severity fire treatments in the form of prescribed and managed fires were more effective than mechanical thinning at limiting the severity of the Dixie Fire. Likewise, the combination of mechanical thinning and prescribed fire, which helps to clear flammable trimmings and debris left after thinning, was more effective than mechanical treatments alone.

"We work with a research ecologist at the Pacific Southwest Research Station named Frank Lake," Taylor said. "He is a Karuk tribal descendant and works with Native American communities on fire effects associated with traditional fire practices. They consider fire as medicine for the landscape. Fuel treatments using fire to fight fires is a necessary approach given the extent of fuel-rich forests in California and the western U.S."

The researchers recognized the challenges of communicating the benefits of having more managed and prescribed fires burning across the landscape, especially at a time when large wildfires are impacting ecology and public health in the form of smoke. But, they said, communities in the West had used fire on the landscape up until the 1920s, and they point to other areas of the nation like the Southeast where prescribed fire use is common.

"We know that it could work," Taylor said. "We know that people can coexist with fire."

More information: Alan H Taylor et al, Severity patterns of the 2021 Dixie Fire exemplify the need to increase low-severity fire treatments in California's forests, *Environmental Research Letters* (2022). DOI: 10.1088/1748-9326/ac7735

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