Forest carbon still plentiful post-wildfire after century of fire exclusion

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Researchers measure post-fire carbon emissions in Yosemite National Park. Forests in the park hold more carbon today than they did 120 years ago despite burning in a severe wildfire in 2013. Credit: Alan Taylor

Forests in Yosemite National Park hold more carbon today than they did

120 years ago despite burning in a severe wildfire in 2013, according to a Penn State-led team of researchers.

"Land vegetation across the globe absorbs about 30 percent of the carbon dioxide people create each year," said Alan Taylor, professor of geography and ecology at Penn State. "It's a big sponge in terms of carbon dioxide absorption, which helps offset some of the increases caused by fossil fuel consumption. There is a lot of interest in thinking about forests in particular as a way to help reduce the amount of atmospheric carbon dioxide."

Trees grow by absorbing and storing carbon through photosynthesis. Carbon makes up about half of a tree's mass, but amounts vary by species. The scientists wanted to find out how changes in fire activity affected carbon storage at Big Oak Flat, an old-growth forest in Yosemite National Park that had burned frequently for centuries but had not experienced a wildfire in the last 100 years due to federal policies mandating blanket fire suppression.

In 2002 the researchers measured the diameter of trees at Big Oak Flat and calculated how much carbon each tree held based on variables like size and species. They also cored trees to analyze the growth of rings and quantified deadwood on the forest floor. They used this data to reconstruct the forest and calculate how much carbon it stored in 1899 before fire suppression and during a century without wildfires, from 1899 to 2002.

"We compared our results to inventory data that the federal government had taken around 1911 to assess timber volume," said Taylor, who also holds an appointment in the Earth and Environmental Systems Institute. "Our method of reconstruction had the same statistical properties in terms of the abundance of trees as the inventory did, so it validated our tree ring approach. We were able to track what happened for that

100-year period, and then after the fifth-largest fire in California history burned over the area."

The researchers calculated how much carbon the forests in Yosemite National Park stored in 2002 and then after the 2013 Rim Fire. Credit: Alan Taylor

The researchers remeasured trees at the site after the 2013 Rim Fire, which burned more than 250,000 acres. They published their findings, which are among the first to calculate forest carbon over a 100-year period and after a wildfire, in a recent edition of the journal *Forest Ecology & Management*.

The scientists found that fire exclusion had allowed carbon storage to more than double in the park, and trees greater than three feet in diameter stored more than half of that carbon. The policy also allowed tons of surface fuels, like leaf litter and twigs, to pile up. Most of the carbon released during the 2013 wildfire came from these surface fuels, according to Taylor.

"Fire exclusion has probably allowed a lot of carbon to accumulate in the western United States," said Lucas Harris, a postdoctoral scholar in Penn State's Department of Geography. "But in the long term it's not a good ecological or carbon storage strategy because it greatly increases the risk of the forest burning up and killing all the trees."

The researchers also found that carbon storage across the research site was evenly distributed in the years before fire exclusion. The fire exclusion policy, however, encouraged the growth of less-fire-tolerant tree species that prefer shade and wetter conditions. These trees shifted the concentration of forest carbon to valley bottoms and areas with wetter soils. The Rim Fire burned less severely in these areas and reinforced the geographic shift in forest carbon storage.

"Thinking about carbon storage in terms of where it actually is at the landscape scale is meaningful if you want to manage for carbon storage going into the future," said Harris. "For a land manager looking at where they might want to use a prescribed fire to reduce surface fuels, or where they might want to go through and thin the forest to reduce fire hazard, having this spatial perspective can be really valuable."

Other study authors include former Penn Staters Andrew Scholl, Kent State University, and Amanda Young, University of Alaska; and Becky Estes, USDA Forest Service.

Provided by Pennsylvania State University

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