WILDFIRES:

A 'nuked' landscape and burning tree seeds

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Smoke from the Rim Fire glows orange while a hillside smolders in the Stanislaus National Forest in August 2013. Researchers are finding that climate change is increasing fire risk from California's high forests to its low scrublands. Photo courtesy of AP Images.

The Rim Fire blazed through the alpine forest of California's Sierra Nevada in 2013, growing into one of the largest and most expensive wildfires in the state's history. It roasted everything, killing an unprecedented number of trees and their seeds.

Now researchers suspect hotter fires and rising atmospheric temperatures might be permanently damaging similar forests.

The Rim Fire devoured more than 400 square miles, leaving up to 40 percent of the burn zone a barren wasteland of incinerated trees. A Forest Service official said at the time that the area looked "nuked."

Scientists worry that blazes like the Rim Fire represent the new normal. Rising temperatures have extended the fire season — 78 days longer since the 1970s, according to the Forest Service — and drought that might be exacerbated by climate change is turning the forest into a tinderbox.

Today, many researchers are racing to discover how this new fire regime is affecting California's diverse landscapes, from the highest subalpine forests to shrubby chaparral.

New findings suggest mid-elevation forests are struggling to recover. A study, currently being finalized for publication, of 2,500 plots of mid-elevation forest across 10 national forests found 43 percent of the area is not recovering five to 15 years after being burned.

Most of the data come from the Sierra Nevada, but the team also studied some forests along California's North Coast. The goal of the study, led by postdoctoral student Kevin Welch, was to develop a statistical model foresters can use to aid in replanting efforts.

"Ponderosas and firs don't re-sprout," Welch said of his findings. "The only trees that re-sprouted were hardwoods, and this has the potential to change the landscape over time."

Hugh Safford, an ecologist with the Forest Service's Pacific Southwest Region and co-author of the upcoming study, said he and other researchers have observed that fire is converting more and more tracts of forest into open, shrub-filled grasslands. Shrubs can handle less shade and tend to be very competitive species. They also tend to burn fast and hot.

Safford has been working in the Sierra Nevada for decades. Fire is natural and needed in mid-elevation pine, cedar and oak-filled forests, also called lower montane forests, he says. Fire breaks down organic matter into nutrients for soil, and fire clears out brush and shrubs, which improves water supply and increases the likelihood that larger trees will survive. Some species' seeds will not germinate unless touched by the intense heat of fire.

Lower montane forest in the Yosemite Valley. Photo by Jodie Wilson, courtesy of Wikipedia.

But hotter fires are now killing the seeds stored in the cones of firs, cedars and pine trees. Without that on-site seed repository, the trees must rely on birds, rodents or wind to bring seeds to the scorched landscape before new saplings can sprout.

"It's increasingly difficult for seeds to reach the interior of these large, dry patches," Safford said. "And then, even with regeneration, it's so dry that some of them are dying."

Historically, low-intensity fire has burned through these forests every eight to 40 years, devouring fuels near the ground but leaving the big trees intact. A different story is unfolding today.

"Fire regimes are changing because of the climate change component and our management decisions," Safford said. "Ninety years of fire suppression and logging, which removed the big trees that were more fire-resistant, and now the forests are filled in with a lot of densifying trees."

Their findings mirror that of other research, such as a **study** published in *Landscape Ecology* in 2013 which found that the return of pine and conifer forests in burned areas was uncertain.

Not all forest ecologists agree with these findings.

Chad Hanson, a research ecologist at the John Muir Project, part of the Berkeley, Calif.-based Earth Island Institute, said that according to his study of severely burned areas, also called snag forest habitat, conifers seem to be coming back just fine. He said five years is not long enough to accurately gauge regeneration. He also disputes that severe fire is increasing in the Sierra Nevada.

"Snag forest habitat created by high-intensity fire, especially large fires, that has biodiversity, that is comparable to old-growth forests," he said.

High-elevation forests at risk, too

It isn't just California's mid-elevation mixed-conifer forests that are grappling with possible ecological implications from more frequent and severe fires.

Mark Schwartz, a plant ecologist and director of the John Muir Institute of the Environment at the University of California, Davis, has been studying high-elevation forests in the Sierra Nevada for more than a decade. Forests above 9,000 feet or so are almost exclusively pine. The soil is thinner, there are less ground fuels to burn, and historically these forests, called subalpine, have burned every 50 to 200 years, he said.

Today, two abnormal things are affecting the health of these forests. First, fires are moving up mountain slopes more often. Although it's not clear why, Schwartz hypothesizes it could be caused by a mixture of earlier snowmelt and dry conditions. Firefighters, now battling more big blazes in mid-elevation forests, could also be playing a role by allowing fires to burn up into the high elevation, knowing that eventually they will run out of fuels and die out.

But climate change is also allowing more trees to grow in these high-elevation forests. And it's increasing the growth rates of high-elevation pines.

"If you have an increased density of trees at high elevations and more upslope fire, you can easily see transition from subalpine forests to something else," Schwartz said.

For folks monitoring ecosystems across California, a major question is how fire is going to affect the carbon stored naturally across the state, especially if forests shift from one type to another, or away from forests to shrubland.

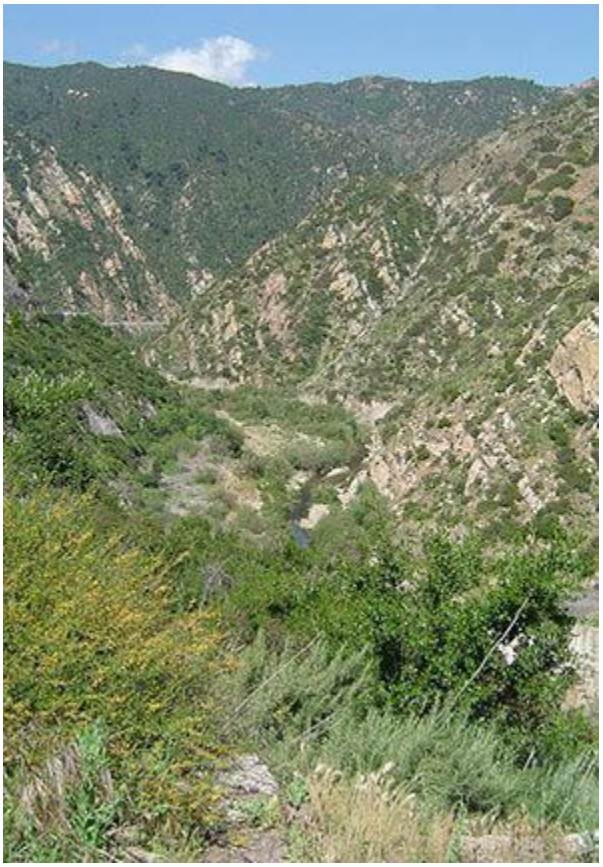
Forest carbon sequestration is one prong of A.B. 32, California's law to reduce greenhouse gas emissions 30 percent by 2030. Currently, one of the few ways to garner credits on California's cap-and-trade system is through forest projects.

"The big trees are the natural carbon storage vessels that we have naturally in California," said Nic Enstice, science coordinator for the Sierra Nevada Conservancy, a California state agency that provides state grants and support to a variety of groups doing research in the Sierra Nevada.

"Even if the forest grows back after fire, you're not going to see carbon stores on that landscape for 100 years at the levels that it was [before] that event."

Too much fire in the chaparral

Coming down from the mountains, scientists are also observing changes to chaparral ecosystems. Found in lower areas of California, these regions have fewer trees and more shrubby, grassy woodlands.



Chaparral in the Santa Monica Mountains. Photo courtesy of Wikipedia.

Many of the fires occurring in California this season have torched chaparral. The Sand Fire, now contained, burned 41,432 acres and destroyed three homes near Santa Clarita, north of Los Angeles.

The Soberanes Fire is still burning. Near the famed coastal city of Big Sur, the blaze has scorched more than 60,000 acres since igniting more than two weeks ago. The landscape is a mixture of chaparral, coastal sage, conifers, redwoods and evergreen trees. The rugged terrain makes fighting the blaze a challenge.

"There's no question that the longer-term drought and recent heat wave has played a role there," Safford said.

Chaparral-dense ecosystems burn infrequently. But when they do, the fire tends to be big and hot, with ecological benefits. Chaparral shrubs are fire-adapted and resprout from their roots. Yet when hit with fire too often, chaparral has trouble recovering, scientists say.

"Those strategies work best when you have fires every decade, not every two to three years," said Susan Harrison, a UC Davis professor of environmental science and policy. "In Southern California, we're seeing the conversion of shrubland to grassland dominated by exotic species."

Harrison and some colleagues are currently studying if warmer winter temperatures will undermine chaparral regeneration.

Manzanitas, for example, will regenerate after a fire, but it has evolved to do so in the spring. Spring, as the plants understand it, comes after a cold winter. If there is no cold winter, the shrubs may not get the hint, and they might not come back after a fire.