



# Forests of fatalities: after 70 million tree deaths, worst "still to come"

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INVERNESS -- Until recently, strolling through a California forest meant walking in dappled light along a path strewn with leaves or pine needles.

But across the state, once-towering pines have collapsed, their desiccated limbs sprawled across forest floors. Toppled oak and tanoak trees, their trunks bleeding, decomposing from the inside out, litter the ground.

Choked with the detritus of at least 70 million dead trees, vast tracts of the landscape have become a botanical emergency room, parched by drought, invaded by damaging insects and infected with a deadly organism that may have piggybacked its way to the state on rhododendron leaves.

In many communities of the central and southern Sierra Nevada range, "80 percent of trees are dead," said Ken Pimlott, the state's top forester as director of Cal Fire, the state forestry and fire-protection agency. "There will be no conifers [there] when this is done."

The catastrophic tree loss has taken out 66 million pines and other conifers and more than 5 million oak trees and tanoaks, which are relatives in the beech family. Nearly 60 million more water-starved trees are teetering. The dead and distressed woodlands represent a small fraction of the state's billions of trees. But the problem is acute because large concentrations of trees—hundreds of acres of forest—are being wiped out. And experts expect the situation to worsen.

Scientists say that until they learn more about the oak disease, or the drought eases, what is now a botanical calamity threatens to become an environmental disaster:

- Dead and dying trees are exceptionally flammable, amplifying an already severe wildfire threat after five years of drought.
- Treeless slopes foster soil erosion, perilous landslides and a loss of essential watersheds. More than 60 percent of the state's water originates in the hard-hit Sierra.
- Forests absorb carbon dioxide, a greenhouse gas, and long-term tree loss could set back the state's battle against climate change.
- When trees burn and decay, they release "black carbon," a highly destructive emission many thousand times more polluting than other greenhouse gases. A wildfire around Yosemite National Park in 2013 discharged as much carbon as 2.3 million cars emit in a year, state officials say.

The problem is playing out mostly along California's edges. Coast-hugging oaks are dying from Monterey County north to Humboldt County. Pines and other conifers, dried by drought and attacked by bark beetles, are failing along the state's eastern spine

(<https://drive.google.com/file/d/oBo7BADv7t15JUGl5dVl2a2wtOHc/view?usp=sharing>)

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"We've never experienced a change and impact at this scale," said Pimlott.

Recreational mountain communities such as scenic Shaver Lake northeast of Fresno and Bass Lake outside Yosemite National Park, are surrounded by brown, brittle pines. County officials around the state fret about possible loss of tourism income and even a decline in property values.

State leaders are paying attention. Gov. Jerry Brown has declared a state of emergency. More than 80 federal, state and local agencies, electric utilities and other organizations have formed the Tree Mortality Task Force

(<http://www.fire.ca.gov/treetaskforce/>), co-chaired by Pimlott, to combat the problem. Another group (<http://www.suddenoakdeath.org/>) is grappling with what has been called “sudden oak death.”

Some aspects of the problem are not new. Drought has ravaged the state before. Insects have been opportunistically attacking weakened trees for hundreds of years. Disease takes hold. Trees die.

But the current convergence of drought, bark beetles and oak disease is changing ecosystems enough that scientists cannot say when the tree population might be restored. In addition to the millions of oaks that have died since the mid-2000s, an unknown number may have the disease, and infected oaks can take two to five years to exhibit signs of trouble.

So far, the disease is confined to 15 of California’s 58 counties, their nursery products quarantined to help prevent further spread. Scientists believe sudden oak death, or *Phytophthora ramorum*, was brought to California on plants from commercial nurseries elsewhere.

The disease is a mostly water-borne mold that begins life on a host plant—largely the California bay laurel tree, but also rhododendrons and even rose bushes. Typically, microscopic spores splash from the leaves of the host onto nearby oaks and tanoaks, driven by rain and wind.

While the die-off of pines and other conifers is occurring on a scale unprecedented in recent times, those trees evolved along with invasive insects, and healthy ones have the capacity to fight off attacks. When the drought eventually ends, pines are likely to come back, experts say, but even that is not fully understood. Oak trees have no natural defense against the mold destroying them—it was identified in the state only about a decade ago—although not all infected oaks die. The question is whether, and how many, oaks can return.

Already researchers are seeing diseased oak stands replaced by chaparral and other fast-growing flora. Tanoaks, scientists say, bear the brunt of the epidemic and may not come back at all or, like the chestnut trees that once flourished in the United States, may ultimately become shrubs.

Diseased oaks were first observed in the state in 1995, in Marin and Santa Cruz counties. Much of the damage didn't show up until years later, and officials didn't recognize the potential for the current epidemic. That may have allowed sudden oak death to gain a stranglehold in the state.

Researchers reporting in the Proceedings of the National Academy of Sciences in May concluded, "Slowing the spread of *P. ramorum* is now not possible, and has been impossible for a number of years." The scientists cited 2002, when oak deaths exploded in the aftermath of torrential rains, as the last chance to eradicate the disease by removing dead and infected trees. Now, even an expenditure of \$100 million a year to address the problem would not be sufficient to stop the disease, the study (<https://drive.google.com/file/d/oBo7BADv7t15Jck9mTDNiakkyemc/view?usp=sharing>) concluded.

Brown asked the Legislature for \$150 million for such efforts. Lawmakers appropriated \$51 million for this fiscal year. Counties will get \$30 million of that.

Those funds are "a drop in the bucket," said Bob Kingman, assistant executive officer with the Sierra Nevada Conservancy, a state agency that manages the region hardest hit by pine loss. He guessed hundreds of millions of dollars might be needed.

"This is an emergency, long term," he said. "It's going to take an enormous effort, from the state and others, and that's just not happening now."

A handful of state agencies, county crews and public utilities are removing dead and diseased trees around power lines, roads, bridges and other infrastructure where they might pose a hazard to public safety. The U.S. Forest Service, which manages much of California's pine forest, has been cutting down dead trees, clearing debris from recreation sites and roads and taking other measures.

Cal Fire and other agencies are carting away trees and limbs in places where thousands of dead pines and oaks still stand near homes.

"We are literally one spark away from catastrophic fire in these tree mortality areas," Pimlott said.

Homeowners and pest control specialists are spraying or injecting oaks with a chemical concoction aimed at helping them fight infection, hoping to keep the disease at bay. That kind of labor-intensive work is not practical on a forest-wide scale, and aerial spraying of chemicals would likely be unacceptable and ineffective.

Now, the pathogen's spread is accelerating, despite California's drought, because many of the affected oaks are in coastal areas with damper climates. Researchers are documenting the advancing destruction and looking for ways to protect still-healthy portions of California's 32 million forested acres. There is an urgency to the work.

David Rizzo (<http://ucanr.edu/sites/rizzolab/>), a plant pathologist at UC Davis, is a coauthor of the sudden oak death study published in May. He and other scientists are rushing to better understand the disease and trees' response to it. As he has traveled to infected sites around the state, Rizzo has concluded that the oak disease will likely gain a wider foothold in the dense and contiguous tanoak forests of California's far north, where small outbreaks have been detected.

"That's several billion trees," Rizzo said. "We are still on track for a pretty massive epidemic. The unfortunate thing is that the worst is yet to come."

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