

## Bark beetles have devastated western forests, but that may not mean more severe fires

By Cally Carswell

**W**hen the evergreen trees turned red, it was hard not to worry. The die-offs started in Alaska about 20 years ago, and soon conifers were perishing en masse across western North America. Life drained from millions of hectares of forest so quickly it was as if they had been abruptly unplugged, like a Christmas tree before bedtime.

The killers: tiny insects called bark beetles. Many people worried that the dead, dry trees would give birth to huge, damaging wildfires. To prevent infernos, some U.S. lawmakers pushed expensive, controversial policies to aggressively log beetle-damaged trees. “We are battling a huge insect epidemic that is destroying our forests” and creating “prime real estate for forest fires,” warned then-Representative John Salazar, a Democrat from Colorado, on the floor of the U.S. House of Representatives in 2006. To some casual observers, the prediction seemed to come true as blazes such as the 2012 High Park Fire near Fort Collins, Colorado, set records for hectares burned and homes destroyed.

But that fire, like others, burned green forest as well as beetle-killed trees. And now, a growing body of research—including a study published last week—is challenging the notion that beetle-killed forests are more vulnerable to severe fires than forests that have escaped infestation. The findings are highlighting the complex causes of western wildfires and raising new questions about policies that promote the removal of insect-damaged trees to reduce fire risks. Contrary to popular belief, says forest ecologist Thomas Veblen of the University of Colorado (CU), Boulder, the science suggests that “healthy forests [can] include fire, and bark beetles, and lots of dead trees.”

**THE RECENT BARK BEETLE OUTBREAKS** aren't the first to grip North America. Some 15 major species of these insects, about equal in size and appearance to a fleck of mouse poop, kill trees in western forests. The beetles, which are native, attack mostly weak, old trees, boring in and cutting off



# Don't blame the beetles



the flow of nutrients. In the past, their populations boomed periodically, overwhelming patches of even healthy forest. But the recent epidemics seem different, researchers say. Beetles have devastated stands of ancient whitebark pine, for instance, which was not a common past target. And although historical data are scarce, the outbreaks appear to be unusually extensive and synchronized, with many species erupting simultaneously in all sorts of forests (see graphic, p. 156). The booms have been aided by warmer winters and summers, as well as tree-weakening drought, leading scientists to wonder if massive attacks could become a new normal. "With climate change, we're essentially seeing bark beetle outbreaks on steroids," says Brian Harvey, a forest ecologist at the University of Wisconsin (UW), Madison.

Among the most visible victims have been towering, lanky lodgepole pines (*Pinus contorta*), a common tree that defines many Rocky Mountain landscapes. Hillsides of mature lodgepoles faded from green to red to gray in just 3 or 4 years—the telltale sign of death by beetle. As the mountains flushed red, fears mounted that they would soon erupt in flames.

That perception is understandable, says ecologist Monica Turner of UW Madison. "It's normal for most of us to think that the more dead wood we have, the worse fires will be," she says. Campers, for instance, don't fuel bonfires with green trees still supple with water and sap—they use dead, dry wood.

Early qualitative studies did hypothesize that beetle-killed forests would ignite more easily and burn more fiercely. But as early as the 1990s, work led by Veblen suggested that a massive spruce beetle outbreak in Colorado in the 1940s hadn't had a major influence on subsequent fire frequency, extent, or severity.

Interest in better understanding the insect-fire connection grew, Turner says, as

the recent epidemics spread. One research target: lodgepole stands, where she and others began to tally up fuel characteristics and feed the data into fire behavior models. They hoped to learn whether beetle kill raises the risk of blazes developing into "ecologically severe" crown fires, which burn hotter and kill more trees than fires that crawl across the forest floor.

In a provocative 2011 study that modeled fire potential in forests in the Greater Yellowstone ecosystem, Turner was part of a team that found that during the "gray stage," when beetle-killed trees have lost their needles, the risk of crown fires actually decreases. That's because the fine fuels that help fire spread through the canopy, such as twigs and needles, were scarce. More

Bark beetles, including mountain pine beetles (above, left), have damaged trees throughout the west (opposite page), but their role in intensifying fires has been hard to pin down.

fact, fires in beetle-killed and unaffected forests may look the same, he says, "but the actual fire behavior could have been vastly different." Such details are important to officials who must decide how to spend hundreds of millions of dollars on fighting wildfires every year, and whether to risk lives to stop a blaze or let it burn.

**NAILING DOWN SUCH NUANCES** was difficult until recently, Turner says, because few researchers "had real fires to work in." But six fires in 2011, including the Salt and Saddle Complex fires in Idaho and Montana, respectively, offered Harvey, one of Turner's doctoral students, an ideal chance to study how mountain pine beetles influenced the ecological impact of fire. In the sweltering summer of 2012, he led field teams into the charred remains of lodge-

pole stands relatively untouched by beetles and those where the insects had killed up to 84% of the trees. Drenched in sweat and smudged with soot, they counted dead trees in dozens of plots, determining whether they had been killed by fire or beetles before the fire by looking under bark for the tunnels the bugs dig. The researchers also determined fire severity by measuring the depth of char on tree trunks, how many needles and small branches were consumed, and how much duff and topsoil had burned off the forest floor. And they evaluated recovery, counting each green seedling popping from the blackened soil in plots where most or all trees were dead.

Harvey's results, published online on 29 September in the *Proceedings of the National Academy of Sciences*, highlight

### **"We shouldn't let the bark beetles drive major management decisions."**

**Thomas Veblen**, University of Colorado, Boulder

surprisingly, their model suggested that even during the "red stage," when dead trees are clad in dry, easy-to-light needles, the risk of crown fires was no greater than in green forests.

But models are imperfect, and some researchers cautioned against drawing sweeping conclusions from them. The models couldn't accurately account for tree-to-tree differences in needle moisture and flammability in mixed stands of living and dead trees, for instance. Such complexity can influence important fire behaviors, such as how quickly it spreads, how frequently it "spots" (shooting embers that ignite new fires), and how difficult it is for firefighters to control, says Matt Jolly, a research ecologist with the U.S. Forest Service's Missoula Fire Sciences Laboratory in Montana. After the

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the sometimes counterintuitive dynamics between beetles and fire. In general, his group found that the insect-killed forests weren't more severely burned than greener stands. Other factors, including topography, wind, humidity, and air temperature, turned out to be more important in determining a fire's ecological severity.

That conclusion, based on real-world data and not models, is "a very important finding," says CU Boulder's Veblen, who was not involved in the study. It demonstrates that beetles didn't fundamentally change the impact that fire had on lodgepole forests: "They burn naturally at high severity, with or without beetles."

Harvey also saw hopeful signs of life, concluding that the prefire severity of a beetle outbreak didn't necessarily compromise the forests' capacity to regenerate. One key is a lodgepole adaptation called serotiny, in which resin seals and protects seeds within pinecones until wildfire melts the resin and releases the seeds. Beetle-killed trees can hold on to viable serotinous cones. "They've still got seeds locked up in the canopy," Harvey says.

Extreme fires can destroy the seeds, which are particularly vulnerable in red stage trees, where dead needles and branches make it more likely that whole treetops—cones, seeds, and all—will burn. But Harvey found that enough seeds survived in beetle-killed forests after severe fires to spur regrowth. Beetles didn't kill every tree, and "sometimes all you need are a few trees to get really high postfire seedling densities."

The recovery findings come with caveats, Harvey notes. They apply to just one forest type, lodgepole pine; in another study, he saw significantly lower postfire regrowth in beetle-killed forests dominated by Douglas fir, a nonserotinous species. And puzzles remain even in lodgepole forests. For instance, how long their cones protect seeds on dead trees isn't entirely understood, says Monique Rocca of Colorado State University, Fort Collins. This past summer, she did fieldwork similar to Harvey's in Colorado's High Park Fire scar and observed "large areas with very little regeneration," perhaps

due to the severity of the beetle kill or the time between the tree deaths and the fire.

Harvey's study also suggests beetle damage can influence fire behavior—lending credence to what firefighters in the United States and Canada have reported. On hot, dry, and windy days, for instance, he found that crown fires were more likely to burn dead trees down to pencil-like sticks. (In contrast, crown fires in green lodgepoles often consume only needles and twigs.) That behavior may have minimal ecological impact, but Jolly of the Missoula Fire Sciences Laboratory notes it can pose serious threats

and challenges to firefighters. Abundant dead wood also lends wildfires extra energy to create powerful and potentially dangerous air currents. One fire Harvey studied in a beetle-killed forest sucked in air with so much force that it toppled ponderosa pines more than 3 kilometers away, Jolly recalls. "We saw thousands of trees literally flattened."

**FOREST ECOLOGISTS SAY** there is still plenty to learn about fire-insect interactions, but the new findings strengthen the idea that beetles may receive too much blame for fire risks. The bigger challenge for forests, many researchers say, is the changing global climate and the ways in which it is simultaneously altering numerous ecological processes. A hotter climate is expected to increase drought and fire frequency, for instance, both of which could make it harder for seedlings to gain a foothold. "Really droughty conditions directly after [a fire] are probably going to be the most significant challenge for these forests," predicts fire ecologist Tania Schoennagel of CU Boulder.

And with heat and drought eclipsing beetles as major factors in fire and forest resilience, some researchers question periodic proposals to remove beetle-killed trees from significant swaths of forest. Earlier this year, for instance, U.S. officials cited improving forest health and reducing fire risks as their goals in designating 18 million hectares as priority areas for "treatment," which can include removing dead or threatened trees. (So far, however, specific plans aren't set.) Thinning can reduce fire risks around communities, roads, and in recreation areas by reducing available fuel, whether or not beetles have killed trees. But many fire ecologists argue that aggressively thinning dead wood in forests far from human use and infrastructure is unnecessary and unlikely to "improve" forest health or prevent climate-driven fires. The research, Veblen says, suggests "we shouldn't let the bark beetles drive major management decisions" throughout forests. ■

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## The beetles that won the west

Bark beetles have attacked some 17 million hectares of U.S. forest since 1996 and killed at least 5.2 million hectares of trees. The mountain pine beetle (*Dendroctonus ponderosae*), which often attacks lodgepole pines, is responsible for more than half of the damage.

