Beetles devastate forests in response to drought

by Melanie Lenart

If termites were devouring homes at the rate that beetles are killing southwestern trees, cities the size of Phoenix and Albuquerque would be crumbling under the attack.

More than 20 million Ponderosa pines died in Arizona and New Mexico following bug attacks between fall of 2002 and summer of 2003, noted Bobbe Fitzgibbon, an entomologist with the U.S. Forest Service's Forest Health Protection office in Flagstaff. Another 50 million piñon trees died in 2003, she added during a presentation to tribal land foresters.

Fitzgibbon makes her assessments based on extensive aerial surveys, where dry red needles serve as a telltale sign of mortality within the past year at the one-acre scale. A variety of bugs, mostly bark beetle species, are converting large tracts of southwestern forests from evergreen into ominous red.

The epidemic started in 2002 and worsened in 2003 throughout the West, with virtually every state west of the Rockies except Nevada suffering from the onslaught. And there's no sign that the pest outbreak will subside anytime soon—especially if the entrenched drought marches on and temperatures continue to climb.

The drought connection

Drought has a close association to an increase in bark beetle attacks, for a known physical reason. Trees typically defend themselves against beetles by "pitching them out" with their sap. Drier conditions mean less sap flow, however, so beetles find it easier to penetrate beneath the outer layer of bark during times of drought.

Bark beetle species include numerous species of ips, Douglas-fir beetle, spruce beetle, true fir beetles, round-headed pine beetle, mountain pine beetle, and western pine beetle. Together these beetles damaged about 87,000 acres in 2001, 627,000 acres in 2002, and 1.9 million acres in 2003 in Arizona (Figure A). Overall, the wave of peak insect kill appears to be moving north in time, according to Arizona data provided by Fitzgibbon.

"The ips beetles have been the most important in precipitating this latest outbreak," Fitzgibbon said. Ips beetles traditionally target smaller trees, but in this latest outbreak they are often striking at the tops of relatively large trees, where the bole tapers down.

Ips in Ponderosa forests accounted for 75 and 80 percent, respectively, of the acres damaged in 2001 and 2002. But the ratio dropped to about 37 percent in 2003, when piñon ips took over and attacked 1.1 million acres of Arizona piñon-juniper forest.

Another quarter of a million acres of spruce and aspen trees were defoliated in 2003 in the state by other bugs, such as the western spruce budworm and the spruce aphid. The damage continues to spiral upward in time (Figure A). In addition, drought alone appears to have killed trees on more than 65,000 acres in 2002 and 2003, the data show.

These figures showing millions of acres damaged compare to a previous high for Arizona of 490,000 acres damaged by bark beetles in 1957, Fitzgibbon said. The outbreak followed a devastatingly dry period for Arizona—to this day, 1955–56 retains the statewide record for driest water year.

Climate change impacts

In the Pinaleño Mountains of southern Arizona, similarly, the current insect outbreak among Ponderosa and piñon pines is "an order of magnitude larger and more severe" than the outbreak that occurred during the 1950s drought, noted entomologist Ann Lynch of the U.S. Forest Service's Research office in Flagstaff.

A half dozen different insect species are converging on Mount Graham and other peaks in the Pinaleños. Other southwestern high-elevation forests are succumbing to outbreaks of insect species that were previously innocuous or unknown to the region, such as the spruce aphid, formerly considered a maritime pest.

Why is more forest area being affected in this drought than during the 1950s drought? Lynch suspects the climbing temperatures of the past few decades help explain the difference.

"It's too hot, it's too dry, and there are too many bugs," as Lynch summed it up succinctly to the couple of hundred people attending her plenary session at a Sky Island biodiversity conference in Tucson in mid-May. "The drought is not sufficient to explain the extent of the devastation."

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Six-spine Ips Engraver, *Ips calligraphus*—not actual size.

Beetles, continued

As one example of climate change in action, Lynch focused on the McNary station at 7,000 feet in elevation in northern Arizona's White Mountains. Since 1940, the number of frost days has declined, with the year's frost-free period increasing from an average of 102 days to 147 days. Meanwhile, both minimum and midpoint temperatures for the year increased during this period.

"Much of the Rim country in Arizona was presumed to be beetle-proof," Lynch said. Not anymore. Bark beetles attacked more than half a million acres of Mogollon Rim forest managed by the White Mountain Apache and by Sitgreaves National Forest staff in 2002 and 2003, up from a total of 14,000 acres infested in 2001.

Temperatures from the 1990s on have established new highs for the 100-year plus instrumental record of temperature in the northern hemisphere, with 2002, 2003, and 1998 down as the three hottest years on record. The extra warmth increases the length of the growing—and beetle-breeding—season, while the drop in frost days decreases opportunities to kill off over-wintering broods.

A tendency toward earlier springs and longer growing seasons are among the predicted results of climate changes that are already occurring in the Southwest. Many tree species will face a change in their suitable range as a result of these and other impacts of climate change, including precipitation changes. The higher evaporation rates that accompany higher temperatures also are likely to increase drought frequency.

Ponderosa pine populations could decline in Arizona yet increase in New Mexico, suggested a 1997 study led by Robert S. Thompson of the U.S. Geological Survey. The study also predicted spruce, piñon pine, lodgepole- and Douglas-fir, and gambel oak would decline in the Southwest.

Beetles, and the insects attacking higher elevation spruce and fir forests, may be among the agents of change for this predicted conversion, along with fire.

Management issues

Along with climbing temperatures and drought, Lynch blamed the "overgrown" state of southwestern forests for the ongoing insect attacks. She and other entomologists agreed that reducing the density of the trees in a stand, known as thinning, can help prevent outbreaks.

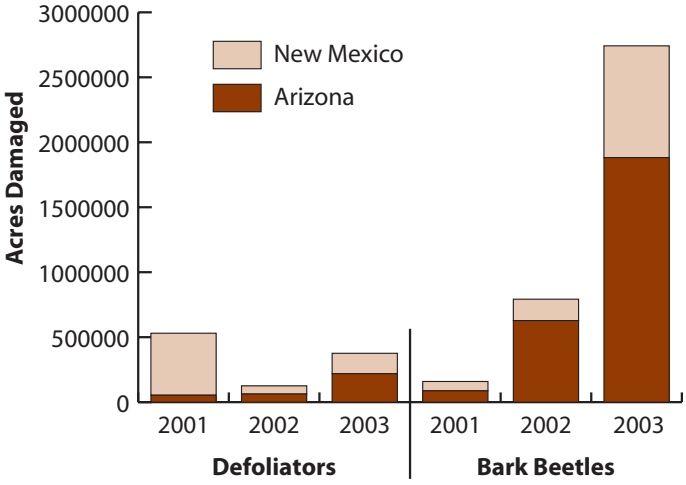

Figure A. Bark beetle attacks have been increasing in the Southwest, especially in Arizona. Bark beetles kill trees by attacking the cambium under the bark, girdling them so that they can no longer transport water to their needles. Defoliators eat the leaves and needles of trees—their attacks are not always fatal.

"I am a big proponent of thinning, thinning, and thinning. I don't care how you do it," Lynch proclaimed, indicating she supported the use of prescribed fires and cutting of some trees to reduce stand densities.

"You have to thin, and then it has to rain or snow," she added. If climate remains dry in the weeks or months following a thinning effort, the remaining trees in a thinned stand may be more vulnerable because of their increased exposure.

Victoria Wesley, a supervisory forester and entomologist for the San Carlos Apache Reservation, agreed that thinning out some of the trees potentially could save the rest. The 400,000 beetle-killed trees within the reservation's 111,000 acres of Ponderosa pine forest were mostly in "inoperable areas," where steep or rocky slopes prevent much management, she told University of Arizona CLIMAS researchers earlier this year.

"I think since we're not thinning those areas, the bark beetles are doing our jobs and going in and thinning," she said.

During an April outing at the reservation, she pointed to a section of green in an area that was otherwise reddened or left barren by bug kill: "That's an area where we thinned."

Jim Youtz, a supervisory forester and silviculturist working for the Bureau of Indian Affairs Fort Apache Agency in the White Mountains of northern Arizona, reported a similar observation.

"All of those big pockets of bark beetle outbreak were in unmanaged stands," he noted after observing a mortality map for the White Mountains shown in a presentation by Fitzgibbon. "Any area that had thinning in the last 10 years didn't have any significant mortality."

"In a way, we're losing trees where we need to lose them," Fitzgibbon agreed, alluding to attacks on dense stands of trees that have turned many Ponderosa forests into fire hazards and sites where drought and bugs are killing off trees that expanded into marginal areas during the wet period of the 1970s and 1980s.

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Beetles, continued

But Lynch worried that the beetles' approach to "thinning" tends to take out the large trees, such as old-growth Ponderosa, whereas forest managers and surface fires tend to thin out the smaller trees in a stand.

Even thinning by foresters can backfire if slash from the cut trees remains in the forest as a potential lure for beetles. For instance, the abandoned slash from thinning operations attracted the round-headed pine beetle to Tucson's Mount Lemmon in the fall of 2001, before the catastrophic wildfires of 2002 and 2003 struck, Fitzgibbon noted.

Similarly, using prescribed burns to thin stands can be risky in the unusually dense forests of this century, as New Mexico forest managers learned the hard way. A prescribed burn morphed into a wildfire and consumed about 47,000 acres of forest around Los Alamos in the summer of 2000.

Meanwhile, the wildfire risk is growing with the number of insect-infested trees on the landscape. The large patches of "red trees," along with the newly attacked trees trying to fend off bark beetle attacks with volatile compounds, feed the fires that can rage through the Southwest during dry months like May and June. Also, some of the dead trees that remain standing on the landscape could stoke fires decades from now, when they finally fall over to act as fuel on the forest floor.

As with catastrophic wildfires, there is little humans can do once beetles decide to consume a tree. Homeowners can water urban trees to prevent attacks, and even use pesticides to protect favorite trees, but these techniques remain too expensive to apply to large tracts of forests, Fitzgibbon said. Even thinning operations carry a price tag of many hundreds of dollars an acre.

That points to one big way forest wood differs from the wood found in and around homes. If bark beetles were devouring homes in Phoenix or Albuquerque, residents would be finding ways to resist the destruction. But the trees in the forest have to rely on their own chemicals to fight for their lives—and they're continuing to lose the battle on a large scale. There's no expectation for an end to the mortality anytime soon.

Melanie Lenart is a postdoctoral research associate with CLIMAS.

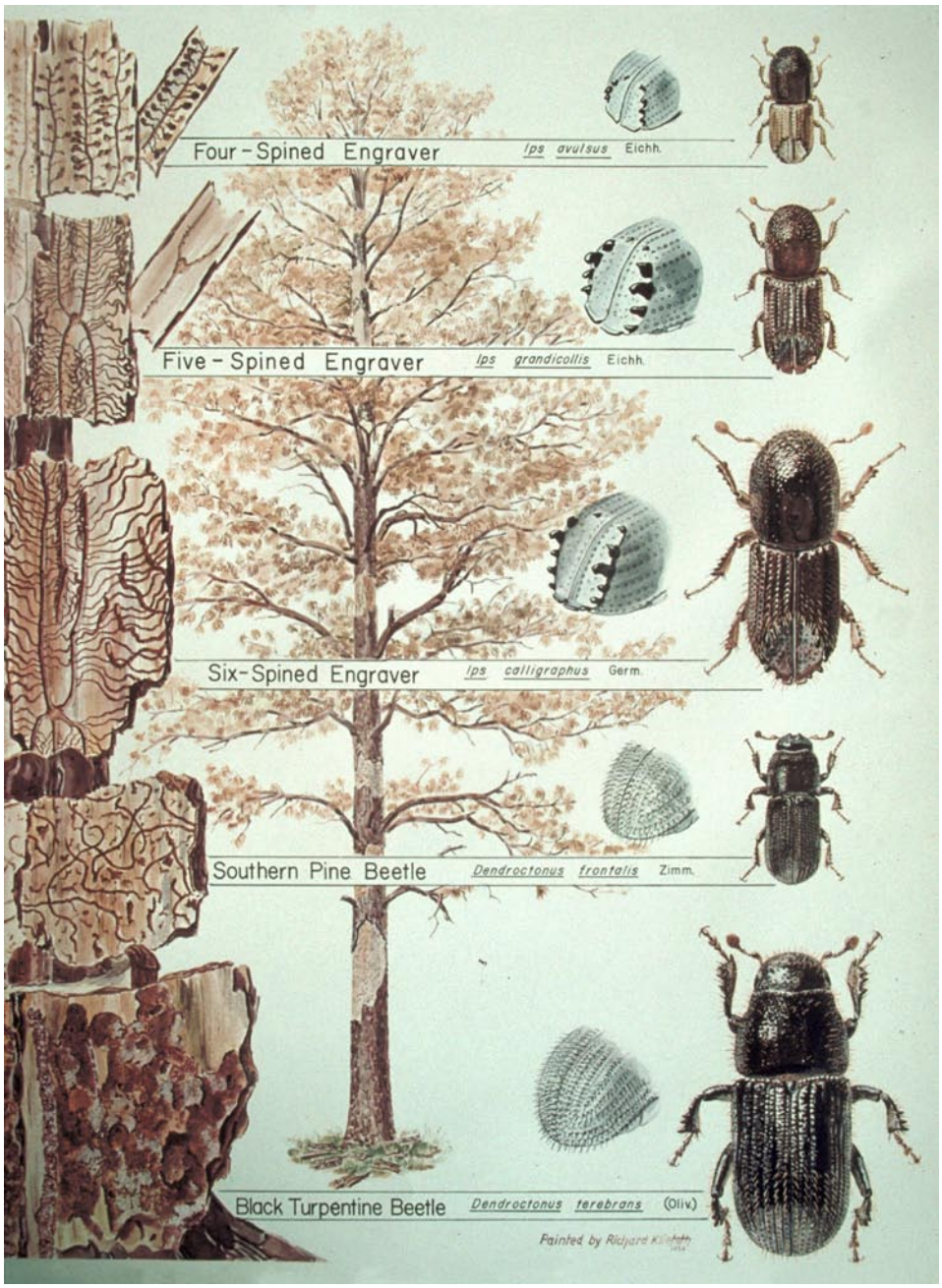

Figure B. Diagram of adults, gallery patterns, and attack sites of 5 bark beetle species (*Ips avulsus, Ips grandicollis, Ips calligraphus, Dendroctonus frontalis,* and *Dendroctonus terebrans*) The Ips beetles, typically about the size of a grain of rice, are the ones causing the most trouble in the Southwest in the recent onslaught on Ponderosa and piñon pines. Damage by *Dendoctonus* species, illustrated here by southern pine beetles and black turpentine beetles, are occurring at a much smaller scale. The images at left show the typical reproductive "galleries" created by the different beetle species under the bark. Image provided by Ronald F. Billings, Texas Forest Service, http://www.forestryimages.org.