Scientists Just Learning Why Forest Trees Die

by Marilyn Loser

2013 December 18

"It might seem surprising that, in 2013, we don't know how trees die," says Cally Carswell of High Country News. "We understand tree growth so well that we can decipher its code – tree rings – and reconstruct droughts thousands of years in the past. So why is tree mortality such a mystery?"

People tend to see forests as a stable, always-going-to-be-there entity, much like mountains.

Until recently, the question "Why do trees die?" didn't seem pressing. However, trees are dying at alarming rates near Alamosa in the Wolf Creek Pass area and in northern New Mexico. It's also true in other Colorado locations, the Northern Rockies, Alaska, and around the world.

Familiar tree species in our area – pinon, ponderosa, aspen, spruce, and juniper – are dying in record numbers.

It's obvious that drought and forest management practices have had a huge influence. 150 years of suppressing forest fires in conjunction with recent, intense droughts proved perfect conditions for raging forest fires triggered by lightning or other means.

Mix in various bark beetle infestations that attack trees weakened by drought leaving vast expanses of standing dry, dead timber and it seems the story is told.

But not so fast. "During the 1950s drought, tree death seemed less extensive, even though that drought was longer and drier than the more recent one," reports Dave Breshears, a University of Arizona professor and arid lands ecologist. What was different about this drought was temperature -- it was a degree or two hotter.

More than 90 percent of the pinon in the Los Alamos area of northern New Mexico succumbed to the drought of 2002-2003 while most of the scrubby junipers were still alive several years later, according to tree physiologist Nate McDowell of the U.S. Department of Energy in the Los Alamos area.

However, he noticed in 2013 that even junipers were dying in alarming numbers. In the past few decades, researchers also have noted a disturbing decrease in the number of aspen. It even has a name, Sudden Aspen Decline (SAD).

So what is happening? It turns out that drought is not just a problem of scarce precipitation. Surprisingly, to me, hot weather can also impose drought conditions on plants. "Minor temperature increases have an outsized effect on the amount of water the atmosphere can hold," reports Carswell. "When the

temperature goes up, the atmosphere gets a lot spongier. The relationship is exponential. Warm air sucks water more greedily from both plants and soil. If the water supply it's drawing on becomes depleted, the tension begins to strain a tree's water columns."

The way a tree drinks water can be likened to a child sucking a drink through a straw. If she sucks really hard at the end, the straw will collapse. The journal Nature printed an article by an international team of 24 plant scientists that examined trees worldwide.

The research showed that drought kills trees by effectively collapsing the straw-like suction that draws water out of the soil, up the living layer called the xylem below the bark and up and out into the leaves. The moisture difference between the wet roots and the sun-dried leaves drives the process through osmosis. However, if the roots dry out for a prolonged period, it causes "hydraulic failure." The tree's roots effectively suck air instead of water out of the dry soil.

They found that a decrease in water causes a permanent decrease in the ability of the trees to take up water once it again becomes available. Even a single summer of drought can kill off roots and decrease the tree's ability to take up water from the soil by 70 percent. The researchers concluded this probably accounts for most of the widespread aspen death aspen.

Meanwhile, back in the Los Alamos area, McDowell's research lead him to hypothesize that drought could kill trees either through thirst or starvation, and that owing to their different coping strategies, juniper would die of thirst while piñon would starve.

Juniper doesn't close it stomata (the tiny pores on its needles that regulate the tree's basic bodily function) as do many trees. Carswell explains, "Stomata allow trees to consume carbon dioxide and photosynthesize. They also let water escape." As explained earlier, if there's too little water in the soil, a tree's columns can collapse. When extremely stressed, juniper begins severing the water supply to entire limbs – reducing the amount of water the whole tree needs to survive. You often see dead, bark-free limbs on juniper.

To prevent this, many trees, such as pinon, close their stomata during droughts. Photosynthesis is to trees what cooking is to people. It's how they eat. McDowell conjectured that in trying to protect themselves from dying of thirst, piñons had starved to death instead.

"Trees're always a relief, after people." David Mitchell