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Rocky Mountain Research Station

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Beetle/Fire Double Whammy: Even Tough-as-Nails Lodgepole Pine May Struggle to Recover After Wildfires

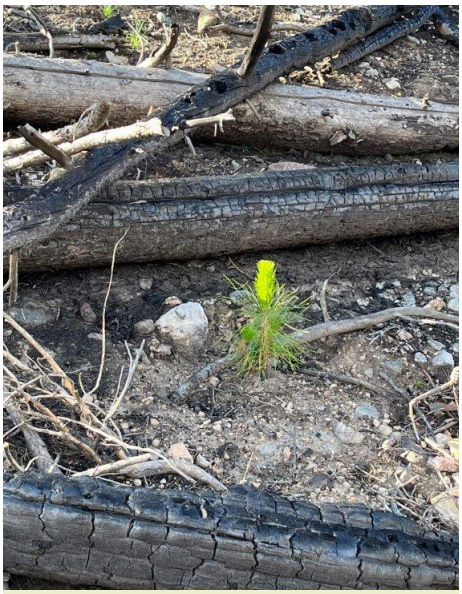
Lodgepole pine (*Pinus contorta* var. *latifolia*) has a reputation for indestructibility, but recent events in the Southern Rockies may have pushed even this stalwart species to the edge. Research by Rocky Mountain Research Station (RMRS) scientist Chuck Rhoades and colleagues shows that lodgepole forests burned by wildfires following mountain pine beetle outbreaks may not generate enough seedlings to return to pre-disturbance tree densities.

"Lodgepole pine is a stoic species that thrives on disturbance. Some folks might say it does a bit too well," says Rhoades. "It's a mistake, however, to assume these serotinous pines will always regenerate well on their own," he adds.

The species' claim to fame is that some of its cones are serotinous—that is, the cones remain closed until heated. This ability gives the species remarkable powers of regeneration after fire. However, the large wildfires of 2020 burned many lodgepole pine stands that had been killed by mountain pine beetle outbreaks in the 2000s.

This double disturbance raised the question: Are the seeds inside serotinous cones from beetle-killed lodgepole pines still viable—and thus available to regenerate stands after fire?

To answer this question, the team sampled cones from beetle-killed trees in eight unburned stands within or near four large wildfires in the Southern Rockies. The trees had been dead for about 15 years at the time of the fires, and the researchers estimated that the sampled cones ranged from 17 to 51 years old.



Lodgepole pine usually regenerates into well-stocked stands after wildfires from seeds released from cones that are opened by the heat of the fire. However, RMRS research shows that in lodgepole stands that have been dead for more than a decade prior to burning, such as those killed by mountain pine beetles, postfire regeneration may be limited by low numbers of viable seed. USDA photo by Chuck Rhoades.

Lodgepole pine trees drop about half of their cones within 6 years of being killed by bark beetles. This "bank" of cones in the soil may assist with pine regeneration if beetle-killed stands later burn. USDA photo by Timothy Fegel.

Compared to seeds from live or recently killed trees, seeds from these long-dead trees germinated about half as often. Germination varied across the study sites, ranging from 26 percent to 41 percent. Germination also declined with cone age, and 35 percent of the oldest cones produced no germinants at all. The team also tested germination of seeds in cones stored in the soil seedbank under snowpack. These seeds averaged 36 percent germination, which was comparable to seeds released from the canopy seedbank. Though this is good news, cones in the soil seedbank are susceptible to burning by surface and ground fires and predation by rodents.

For many lodgepole pine forests burned in the recent fires, postfire tree densities will meet or surpass acceptable stocking levels (i.e., 150 seedlings per acre). However, based on these RMRS findings, stands with high bark beetle mortality may not provide enough viable seed to reach the minimum density of seedlings needed for recovery. Thus, the double disturbance of bark beetle outbreaks and wildfire may translate into costly reforestation projects. As Rhoades cautions, "We should not assume that postfire regeneration of lodgepole pine will be adequate in beetle-killed stands. These changes may point to how climate change will alter these forests."

Key Findings/Management Implications

- Long-term seed viability may be a concern after compound disturbances.
- After a fire burns beetle-killed stands, it may be necessary to determine whether natural regeneration densities meet acceptable stocking levels and whether reforestation efforts may be warranted.
- Seeds stored in the soil seedbank under snowpack had equal or better chance of germinating as seeds stored in the canopy, but they are susceptible to surface fires and rodents.

Further Reading

Rhoades, Charles C.; Fegel, Timothy S.; Hubbard, Robert M.; Chambers, Marin E. 2022. Limited seed viability in long-dead serotinous lodgepole pine trees in the Southern Rockies, USA. Forest Ecology and Management. 526: 120565.

Rhoades, Charles C.; Hubbard, Robert M.; Elder, Kelly; Fornwalt, Paula J.; Schnackenberg, Elizabeth; Hood, Paul R.; Tinker, Daniel B. 2020. Tree regeneration and soil responses to management alternatives in beetle-infested lodgepole pine forests. Forest Ecology and Management. 468: 118182.

Rhoades, Charles C.; Hubbard, Robert M.; Hood, Paul R.; Starr, Banning J.; Tinker, Daniel B.; Elder, Kelly. 2020. Snagfall the first decade after severe bark beetle infestation of high elevation forests in Colorado, USA. Ecological Applications. 30(3): e02059.

Lead Scientist Bio

Chuck Rhoades is an RMRS research biogeochemist based in Fort Collins, CO. His work focuses on the biogeochemical linkages between terrestrial and aquatic ecosystems in managed and unmanaged areas.

The Rocky Mountain Research Station is one of seven units within USDA Forest Service Research & Development. RMRS maintains 14 field laboratories throughout a 12-state geography encompassing parts of the Great Basin, Southwest, Rocky Mountains, and the Great Plains. While anchored in the geography of the West, our research is global in scale. RMRS also administers and conducts research on 14 experimental forests, ranges and watersheds and maintains long-term research databases for these areas. Our science improves lives and landscapes. More information about Forest Service research in the Rocky Mountain Region can be found here: https://www.fs.usda.gov/research/rmrs.