Squirrels counter evolutionary impact of fire on lodgepole pine

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A red squirrel forages for lodgepole pine seeds in Yellowstone National Park. New research shows that squirrels counteract the evolutionary impact of fires on lodgepole pines. Credit: UW Photo

Reproductive response of lodgepole pine trees to fire in Yellowstone National Park is countered by the effects of squirrels eating pine seeds, two University of Wyoming researchers have documented.

That could explain the patchy recovery of Yellowstone's lodgepole forests since the massive fires of 1988, according to a paper published this week in the *Proceedings of the National Academy of Sciences* by Craig Benkman, professor in UW's Department of Zoology and Physiology, and recent UW Program in Ecology doctoral graduate Matt

Talluto.

And the counteracting impacts of fire and squirrels could provide valuable insights for land managers as fires are expected to become more frequent in the American West due to climate change, the researchers say.

"Changes to one of the inputs, squirrels and fire, can have pretty dramatic effects that cascade through the whole ecosystem," says Talluto, who, studied lodgepole forests for four years, including three summers in the field in Yellowstone. "Some big changes are expected in the coming decades in the way fire interacts with the ecosystem, and that could mean a change in the evolutionary dynamic. The responses might be more complex than we think."

Scientists long have known that lodgepole pine trees respond to fire by altering the production of pine cones. Instead of producing cones that open and release their seeds every year, trees that grow where fires are more common produce closed cones, known as serotinous cones. Those cones retain viable seeds for a decade or longer, until fires or other high temperatures melt the sealing resins and cause the seeds to fall from the cones. That results in faster, denser lodgepole regeneration when there are fires.

Lodgepole pine trees produce serotinous cones such as these in response to fires. The cones allow for more rapid tree generation after fires, but they're also targets for squirrels. (UW Photo)

Researchers have observed that response in Yellowstone lodgepoles since the 1988 fires, but the uneven nature of lodgepole recovery has been something of a mystery. A decade ago, Benkman raised the possibility that red squirrels, which live in lodgepole pine forests and eat pine seeds, are taking advantage of the concentrated production of serotinous pine cones and eating them, counteracting the evolutionary impact of fires favoring serotinous individuals. Talluto and Benkman's recent research has confirmed that hypothesis.

"We knew there was a correlation between squirrel populations and a lack of serotinous cone production, but we didn't know how that effect was happening," says Talluto, now a post-doctoral researcher at the University of Quebec in Rimouski. "Our work in the field has found that there's definitely a way for squirrels to cause evolutionary changes counter to what fire would promote, and our computer modeling has shown how this could happen over a long time in nature."

It is difficult to precisely compare the relative magnitude of the impacts

of fires and squirrels on lodgepole forests, but Talluto says the two evolutionary drivers are on about the same scale. Besides squirrels, no other factors have been identified that explain the spatial variation in serotinous vs. non-serotinous tree growth after fires.

The scientists say their research suggests that more widespread forest fires in the West won't necessarily result in a uniform evolutionary response by lodgepole pine. Determining the abundance of squirrel populations could help managers know whether to expect dense or sparse recovery of the trees.

Benkman and Talluto also say their findings confirm a growing consensus that evolutionary changes can happen quite quickly—and that those changes can dramatically affect entire ecosystems.

"When organisms like red squirrels interact strongly with dominant community members such as lodgepole pine, evolution can be rapid and affect the ecology of the whole community," Benkman says. "In this case, we have a very widespread system where this is very likely occurring."

More information: Conflicting selection from fire and seed predation drives fine-scaled phenotypic variation in a widespread North American conifer, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1400944111

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