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Science You Can Use *in 5 minutes*

Managing Fire for More Species: Landscape mosaics benefit plants and animals in Sierra Nevada forests

In the dry, fire-adapted forests of California's Sierra Nevada—where yellow pine, mixed conifer, and red fir historically burned on frequent, low-to-moderate severity cycles—restoring historical fire regimes has been a guiding principle for ecological management. But most contemporary forests in this region are far from that benchmark. Instead, these forests have been shaped by decades of fire suppression, and increasingly, by megafires at the opposite extreme.

New research suggests that restoring historical fire regimes doesn't fully achieve desired outcomes and points toward a more effective strategy—managing for forest heterogeneity.

"Restoring historical fire patterns will benefit most contemporary Sierra Nevada forests," explains Zach Steel, a research ecologist with the Forest Service Rocky Mountain Research Station, "but history is only part of the picture. History is an imperfect surrogate for ecological integrity. If in the process of getting fire back we lose a few more trees to fire than our historical targets would suggest, this study shows that's probably okay for ecological management."

Steel and colleagues from the Forest Service, Point Blue Conservation Science, and the University of California, Berkeley surveyed birds, plants, and bats across a wide range of fire histories in Yosemite National Park and the portion of Ansel Adams Wilderness in the Sierra National Forest. In these areas, managed wildfire has been used to reintroduce frequent fire to the landscape since the 1970s and 2003, respectively. These landscapes—

A pyrodiverse Sierra Nevada landscape showing the mosaic of conditions that support a high variety of plants and animals—from a mature intact forest at left to mixed-severity areas and small-moderate sized high-severity patches with standing snags at right. "Keep it messy," says research ecologist Zachary Steel. Forest Service photo by Zachary Steel.

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shaped by decades of repeated, managed ignitions—offered a rare opportunity to study ecological responses across a broad spectrum of fire severities, frequencies, and spatial patterns. This is something rarely possible in fire-suppressed forests or landscapes dominated by recent megafires.

Bird and plant species richness peaked in recently burned areas: birds in moderate fire severity areas and plants in lower severity fire areas. Bats were the exception, favoring landscapes with longer fire-return intervals and a mix of unburned mature forests and higher severity patches. Taken together, the three taxa showed the greatest species richness in areas with slightly more frequent and severe fire than historical targets would suggest. And across all three groups, species richness increased with pyrodiversity—the variation in the severity, frequency, and patch size of fire across the landscape. Managing for the mosaic, in other words, benefits many plant and animal species.

"This research has reinforced the southern Sierra National Forests' land management plan objective to reintroduce beneficial fire to forest ecosystems, either by managing unplanned ignitions or prescribed fire," said Marc Meyer, Southern Sierra Province Ecologist for the Forest Service Pacific Southwest Region. He notes that all three southern sierra national forests—the Inyo, Sequoia, and Sierra—have cited ecological benefits as one of several primary reasons for reintroducing low- to moderate-severity fire in their forest plans and burn projects. The research has also been well received at stakeholder presentations across the Eastern Sierra communities.

For managers navigating these decisions in the field, Steel is direct: "Worry less about losing a few trees to fire. Err on the side of getting more fire on the landscape than getting the perfect, low-severity, surface fuel-reducing treatment."

Sylvia Kantor is the author of this Science You Can Use.

Key Management Implications

- Historical fire regimes are a useful but imperfect guide to future management for ecological integrity. Direct plant and animal data, where available, can reveal management targets that historical estimates alone would miss.
- Species richness appears to peak under post-fire conditions slightly more frequent and severe than historical targets suggest, meaning managers and decision makers might be able to accept some imprecision in prescribed burns without sacrificing beneficial ecological outcomes.
- Managing for a mosaic of burn severities, fire frequencies, and patch sizes—while avoiding large high-severity patches—is likely to benefit birds, plants, and bats simultaneously, making pyrodiversity a broadly effective landscape-level strategy.
- Retaining patches of mature, infrequently burned forest within actively managed landscapes is important. Some bats and old-growth-dependent species depend on conditions that frequent fire alone won't provide.
- Managed wildfire, prescribed fire, cultural burning, and even low-to-moderate severity unplanned wildfires all contribute to the pyrodiverse conditions that this research links to higher biodiversity.

Further Reading

Steel, Zachary L.; Fogg, Alissa M.; Buzbee, Raphaela Floreani; [et al.].. 2025. Finding floral and faunal species richness optima among active fire regimes. Conservation Biology. 2025: e70079.

Steel, Zachary L.; Miller, Jesse E.D.; Ponisio, Lauren C.; [et al.]. . 2023. A roadmap for pyrodiversity science. Journal of Biogeography. 52 (2): 280–293.

Featured Scientists

Zachary L. Steel is a Research Scientist with the Forest Service Rocky Mountain Research Station.

Marc D. Meyer is a Southern Sierra Province Ecologist for the Forest Service Pacific Southwest.

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