CALIFORNIA FIRE SCIENCE CONSORTIUM

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Research Brief for Resource Managers

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Fire and fuel treatment effects on understory plant diversity in California mixed-conifer forests

Stevens, Jens T., Hugh D. Safford, Susan Harrison and Andrew M. Latimer. 2015. Forest disturbance accelerates thermophilization of understory plant communities. Journal of Ecology in press.
http://dx.doi.org/10.1111/1365-2745.12426

Changes in forest cover can have strong effects on the understory microclimate – if you've ever entered a forest clearing on a hot summer day you know this to be true. In mixed-conifer forests of California, changes in forest cover are most often caused by management activities such as fuel treatments, and by natural disturbances such as fire. Canopy disturbances have the potential to favor understory plant species that are more heat and drought tolerant, and so they might hasten changes in vegetation composition that are already underway due to climate change. A recent study by Stevens et al. looked at changes in understory composition and diversity two years after a combination of fuel treatments and wildfire, across 12 different sites in California.

The authors surveyed understory vegetation across a gradient of increasing canopy loss, ranging from unmanaged forest to fuel treatments, fuel treatments followed by low-moderate severity wildfire, and high-severity wildfire only. They grouped understory plant species into a northern group, which paleo-botanists suggest generally diversified in northern North America, and a southern group, which includes species that diversified in the sub-tropics and in California after the climate became drier 3-5 million years ago.

Management Implications

- Increasing forest canopy removal can push understory vegetation composition towards southern-origin species, and may accelerate vegetation shifts under climate change.
- Plant species diversity at the stand-scale appears to be greatest at moderate disturbance levels.
- Plant diversity in fuel treatments is strongly increased at the plot-scale, and slightly increased at the stand-scale, if wildfire is allowed to burn post-treatment.
- Non-native species abundance was low throughout, but was greatest following high-severity fire.

The southern group of species became more abundant in the understory following increasingly severe disturbances, relative to the northern group. Intriguingly, the authors found that the loss of northern species after disturbance was greater at wetter sites, suggesting that forests with more canopy cover prior to disturbance provide better micro-climate refuges for northern species, and may see greater species change after thinning or fire (Fig. 1). They suggest that drought stress in canopy gaps is likely contributing to these species shifts, based on their finding that species occurring in more disturbed areas had more drought-tolerant traits.

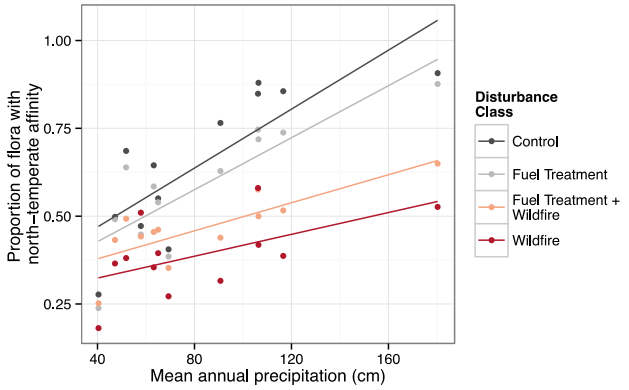

Figure 1: *Relative abundance of northern species increases with precipitation, but disturbance causes a greater proportional loss of northern species at wetter sites. Regression lines indicate increasing disturbance severity top to bottom.*

The authors also found that species diversity at the plot-level increased after fire, regardless of severity. Across many plots within a stand, however, there was greater species similarity among plots in high-severity stands, which had uniformly low canopy cover, than in low-to moderate-severity stands, which had more heterogeneous canopy cover. When these two estimates were combined, the authors showed that understory diversity at the stand-level was highest in intermediate disturbance stands, where fuel treatments were followed by wildfire (Fig. 2).

Based on these findings, the authors suggest that increasing canopy disturbance may lead to faster species shifts in response to a warming climate, by removing the buffering effect of forest canopy. However, they highlight that there is an important role for within-stand heterogeneity, as moderate-severity disturbances can create smaller openings that allow co-existence of plant species with different habitat requirements across small spatial scales.

The authors also suggest that allowing wildfire to burn through fuel treatments has important additional effects that are not achieved by fuel treatments alone, including further shifting the balance of species towards the southern group (especially in wetter forests), and further increasing overall stand diversity and heterogeneity.

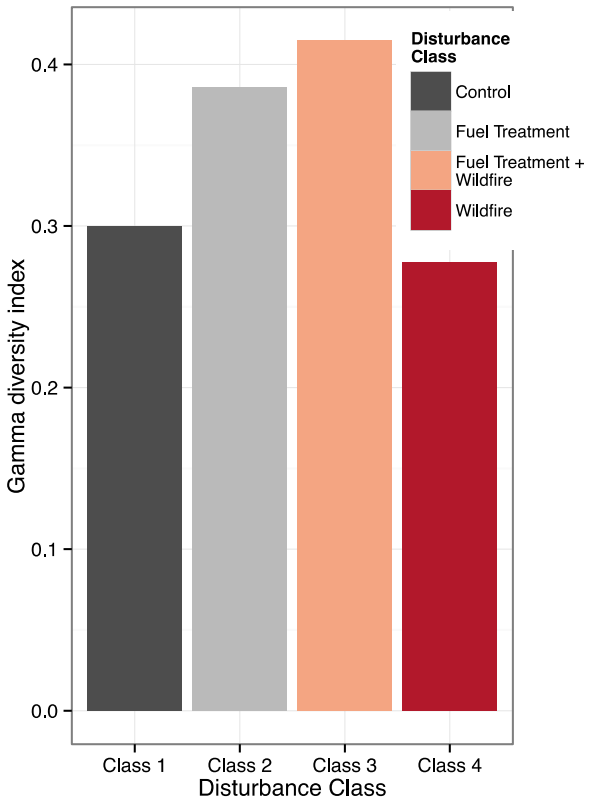

Figure 2: *Changes in stand-scale plant diversity*

Additional references for this topic:

De Frenne, P.; Rodríguez-Sánchez, F.; Coomes, et al. 2013. Microclimate moderates plant responses to macroclimate warming. PNAS 110(46): 18561-18565.

Harrison, S.; Grace, J.B. 2007. Biogeographic affinity helps explain productivity-richness relationships at regional and local scales. American Naturalist 170: S5-S15.

Stevens, J.T.; Safford, H.D.; Latimer, A.M. 2014. Wildfire-contingent effects of fuel treatments can promote ecological resilience in seasonally dry conifer forests. Canadian Journal of Forest Research 44(8): 843-854.