CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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Fire severity impacts on plant species richness

Miller, J. E. D. and H. Safford. 2020. Are plant community responses to wildfire contingent upon historical disturbance regimes? Global Ecology and Biogeography 29(10): 1621-1633.
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Management Implications

- Plant species often have characteristics that make them well suited to the predominant fire regimes of a given area. Thus, fire severities within the range of historical disturbance regimes are likely to maximize post-fire plant diversity.
- In forests where frequent, low-severity burns historically dominated, the return of low- or moderate-severity fire to the landscape often promotes increased levels of understory plant species richness. High levels of fire severity can reduce species richness.
- In contrast, plant species richness is more often maximized following high-severity fires in forests that were historically characterized by less-frequent, high-severity fires.
- In studies where thinning treatments were analyzed in conjunction with burn severity, sites with thinning followed by fire had the highest species richness.

Plants often have characteristics that make them well suited to the common type, frequency, and/or severity of disturbance in ecosystems where they occur. For instance, plant communities in forests with infrequent, high-severity fires often contain species with serotinous cones or whose germination is stimulated by smoke. Alternatively, plant species more typical of ecosystems with low-severity, frequent fires may have "fire resisting" traits such as thick bark. If disturbance regimes shift away from historically predominant disturbance regimes, the plant communities may no longer be well suited to the conditions under the new disturbance regime. This shift can have a negative impact on plant diversity.

Historical fire regimes in conifer forests of western North America ranged from frequent, low-severity fires to relatively rare, high-severity fires. In this region, forests once dominated by frequent, low severity fires are now experiencing larger, more severe fires due to the interacting effects of climate change and fire suppression that have increased forest density and fuel loads. In contrast, forests with historically less frequent and more severe fires have not experienced as much departure from historical fire regimes. Because plants in forests with formerly frequent, low-severity fires may not be well suited to survive or re-colonize after high-severity fires, the authors hypothesized that increasing degrees of departure from historical fire regimes would have a negative impact on understory plant diversity. To test this hypothesis, the authors reviewed studies from 34 sites across coniferous forests of western North America. In each of these studies, post-fire measurements of understory plant diversity were compared to pre-fire or unburned areas.

Figure 1: (A) In forests with historically frequent, low-severity burns, the return of low- to moderate-severity fire to the landscape often promotes increased levels of understory plant species richness, as in this area that burned at moderate severity in the Angora fire in the Tahoe Basin of the Sierra Nevada. **(B)** High severity fires in these systems can have a negative impact on understory plant species richness because plants that were adapted to the frequent, low severity fire regime may not be well suited to the conditions that occur following a high-severity fire. For example, a monoculture of dogbane dominated in the high severity areas of the Angora fire in the Tahoe Basin of the Sierra Nevada. *(Photo Credit: J. E. D. Miller)*

While the results were variable, plant species richness was maximized following high-severity fire in a higher proportion of studies from forests with historically rare, high-severity fires compared to forests with historically frequent, low-intensity fires. The authors identified three studies from forests that were historically dominated by less frequent, higher-severity burns. Two of these three studies found that species richness was maximized at with higher levels of fire severity, while the third study found that species richness was highest at low to moderate fire severity. Species richness responses were mixed in forests formerly dominated by frequent, low-intensity fires: 1) Species richness was maximized at low or moderate fire severity compared to high severity or unburned plots (3/8 studies); 2) Species richness was higher in burned versus unburned areas, but was not affected by varying fire severity (3/8 studies); 3) Species richness was maximized in areas with the highest fire severity (1/8 studies); or 4) Species richness responses varied among different types of plants (1/8 studies).

The authors also identified 21 studies that investigated species richness in unburned versus burned areas with a single level of fire severity. Most of these studies took place at sites that were formerly dominated by frequent, low-severity fires, and fire generally had a positive or neutral effect on species richness compared to unburned areas.

The authors concluded that historical disturbance regimes may play an important role in determining fire impacts on species richness, and that more research is needed to explicitly test these patterns across sites with varying degrees of departure from historical fire regimes. Additionally, plant species diversity was maximized on sites where thinning was used prior to fire. Thus, in forests that experienced frequent, low-severity fires, management treatments with application of thinning prior to prescribed fire will likely have the most positive impacts on species richness.

Suggestions for further reading:

Dodson, E. K., D. W. Peterson, and R. J. Harrod. 2008. Understory vegetation response to thinning and burning restoration treatments in dry conifer forests of the eastern Cascades, USA. Forest Ecology and Management 255 (8-9): 3130-3140.

Richter, C., M. Rejmánek, J. E. D. Miller, K. R. Welch, J. Weeks, and H. Safford. 2019. The species diversity x fire severity relationship is hump-shaped in semiarid yellow pine and mixed conifer forests. Ecosphere 10(10): e02882.