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Native fire regimes and landscape resilience

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Mechanisms for ensuring resilience must exist in order for large and complex ecosystems to persist across space and time in the face of often substantial disturbance and environmental fluctuation. Furthermore, resilience mechanisms must occur at spatio-temporal scales that can reinforce, by way of top-down control and bottom-up context, patterns and processes. Here, we examine the concept of landscape resilience to fire as a natural landscape-scale disturbance process, arguing that it applies to individual organisms, the patchiness of their arrangement in a landscape, and the spatio-temporal variability of that patchiness. We examine theoretical frameworks that can explain how organization and structure emerge on the landscape, including highly optimized tolerance, a mechanism that has been used to explain the resilience and robustness of complex systems. Fire ecology studies of forest and shrubland landscapes to date have focused on fire size distributions and how power law statistics appear to explain them. We review datasets from different fire environments to show the relative stability of power law assumptions. In addition, because fire sizes may not be the most informative indicator of inherent landscape resilience, we examine the relationship between distributions of other fire regime parameters (e.g., fire severity or frequency distributions), their variability or relative scale invariance, and why they may be useful measures of landscape resilience to disturbances. We conclude with an examination of “top-down” versus “bottom-up” controls on fire regimes, how these forcings might influence vegetation structure and composition associated with a given fire regime, and what we might learn from past ecosystem structure and resilience to create more adaptable future landscapes.