CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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What affects fire behavior more, climate or fuels?

Steel, Z. L., H. D. Safford, and J. H. Viers. 2015. The fire frequency-severity relationship and the legacy of fire suppression in California forests. Ecosphere 6(1):8. http://dx.doi.org/10.1890/ES14-00224.1

In an era of climate change and increasingly extreme fire weather events, some researchers and fire managers have suggested that weather conditions have become more important than fuels in driving fire behavior. Steel *et al.* examined the relationship between fuels and fire behavior by examining how fire suppression has affected fire severity in different forest ecosystems in California. The authors tested the hypothesis that fire behavior is limited by fuel availability in some California forests where climatic conditions during the fire season are nearly always conducive to burning and the primary limiting factor for fire ignition and spread is the presence of sufficient fuel. In fuel-limited ecosystems, fire suppression will result in increased fuels, leading to an increase in fire severity.

Steel *et al.* used two metrics - time since last fire (TSLF) and fire return interval (FRI) - as a surrogate for fuels accumulation resulting from fire suppression. They found that TSLF and FRI are strongly positively related to fire severity in yellow pine and mixed conifer forests, and to a lesser extent in mixed evergreen and big cone Douglas fir forests, demonstrating that fire severity in these forest types is still driven by fuels. On the other hand, Steel *et al.* found that TSLF and FRI were not related to fire severity in forest types (e.g., red fir and redwood) and bioregions (e.g., Klamath Mountains) where fire may be more limited by factors other than fuel loads, such as climatic conditions or ignition rates.

Management Implications

- Fire behavior in many California ecosystems, including mixed conifer and yellow pine forests, is strongly driven by fuels.
- Not all forest types and bioregions in California are fuel-limited. For example, climatic conditions, such as atmospheric moisture, limits fire behavior in redwood forests.
- In fuel-limited forest types, fuels management can still have meaningful effects on fire severity. However, managed wildland fire use may be the only way to accomplish this at meaningful scales.

Steel *et al.* conclude that it is important to understand the ecosystem context when examining the roles of fuels and other factors in influencing fire regimes. The concepts of "fuel-limited" and "climate-limited" patterns of fire effects and response in forest types of the western US is still a useful way to do this. For most California forest ecosystems, fuels are an important driver of fire behavior and management aimed at reducing fuel loads is well justified. However, given the scale of most fuel treatments, it seems evident that meaningfully restoring fire- and climate-resilient structure to fuel limited forests will only be accomplished through a major expansion in the managed use of wildland fire under moderate weather conditions.

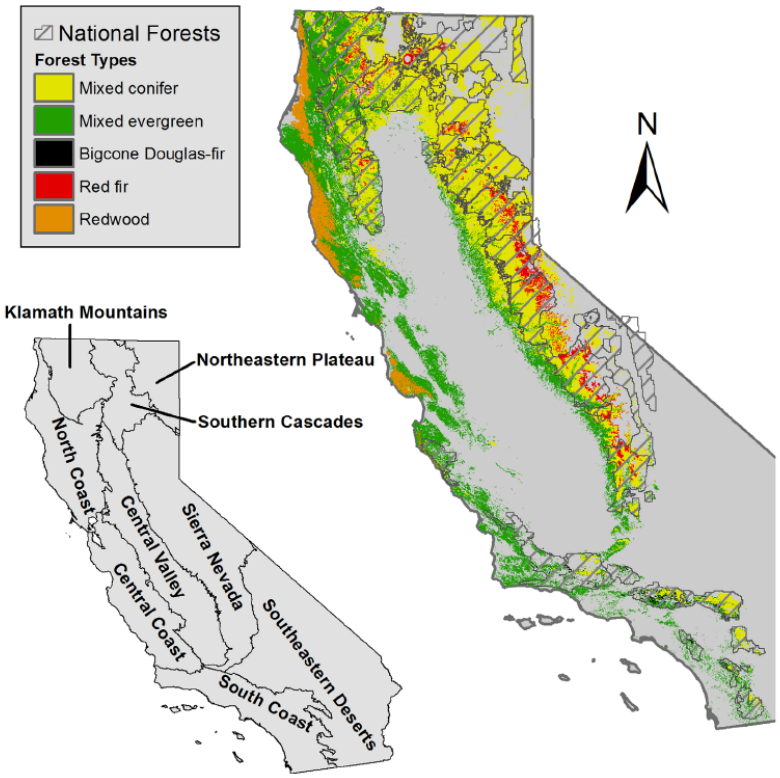

Fig. 1. Distribution of forest types across California and the bioregions used in this assessment (from Sugihara et al. 2006). Forest type legend order is from shortest to longest reference fire return interval (excluding human ignitions in the case of the redwood).

Correlation between fuel accumulation (FRI & TSLF) and severity for generalized forest types

"Fuel-limited" ***(Positive correlation)***	**"Climate-limited"** ***(Negative correlation)***
Yellow Pine* Mixed Conifer* Mixed Evergreen* Bigcone Douglas-Fir	Red Fir Redwood

**Especially robust correlation*

Further Readings:

Safford, H. D., and K. M. Van de Water. 2013. Using Fire Return Interval Departure (FRID) analysis to map spatial and temporal changes in fire frequency on National Forest lands in California. Research Paper PSW-RP-266. USDA Forest Service, Pacific Southwest Research Station, Albany, California, USA.

Sugihara, N. G., J.W. VanWagtendonk, K. E. Shaffer, J. Fites-Kaufman, and A. E. Thode. 2006. Fire in California's ecosystems. University of California Press, Berkeley, California, USA.