CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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Are historical fire regimes compatible with future climate? Implications for forest restoration

*Flatley, William T., and Peter Z. Fulé. 2016. Are historical fire regimes compatible with future climate? Implications for forest restoration. Ecosphere **7**(10). [DOI: 10.1002/ecs2.1471](https://doi.org/10.1002/ecs2.1471).*

Management Implications

- Prolonging the presence of mesic conifers under future climate regimes may require strict fire exclusion in the upper elevations.
- Managers may need to move target fire regime characteristics up in elevation, tracking the movement of communities or species as they respond to new climate conditions, as well as lengthen target fire return intervals.
- Under novel climate regimes, modeling may be useful in identifying target fire return intervals for maintenance of particular ecosystem services.

Restoration of historical fire regimes is often a management goal in fire-adapted forested systems. However, future climate-induced shifts in fire regimes and the distributions of fire adapted plant species could uncouple vegetation from the fire regimes for which they are adapted. The authors used a landscape simulation model to investigate how forest patterns will respond to future climate regimes if historical fire regimes are restored.

To assess how climate change will interact with fire to alter future forest conditions, a novel multimodel approach was employed. The forest growth model Climate-Forest Vegetation Simulator (C-FVS) was linked with the landscape simulation model LANDIS-II to simulate pinyon-juniper, ponderosa pine, mixed conifer, and spruce-fir forests within the Kaibab Plateau. Three climate regimes (no change, moderate change, and high change) and two fire regimes (no fire and fire restoration) were considered.

The authors evaluated the model response by comparing model outputs of composition and aboveground biomass with field data characterizing contemporary forest conditions and dendroecological reconstructions representing pre-fire exclusion conditions. The model effectively replicated forest growth rates, fire regimes, and successional processes on the Kaibab Plateau landscape.

In the absence of fire, the simulations projected extensive forest change under both the moderate (Figure 1) and high climate scenarios. The elevational displacement of vegetation projected under these scenarios is equivalent to what occurred on the Kaibab Plateau under the 3-5°C temperature increase experienced there during the Holocene, namely a conversion of alpine, mesic (moderate moisture) conifer forests to communities adapted to higher temperatures and more frequent fire disturbance. This would represent a substantial reduction in the diversity of forest habitats on the Kaibab Plateau.

Under the current climate scenario, fire restoration returned the vegetation to approximate historical conditions, but also resulted in an increased risk of large, high severity fire in untreated higher elevation forests due to fire spread from lower elevations.

Simulations involving the interacting effects of changing climate and fire restoration suggest that fire-driven vegetation shifts will likely be key to shaping the timing and rate of forest response to climate change. Mid-elevation fire led to high-severity upper elevation fire, which drove earlier conversion to lower elevation species, earlier declines in aboveground biomass, increased area of non-forest patches, and reduced species richness. Restoration of historical fire frequency in mid-low elevations facilitated a type change from ponderosa pine forest to grassland, and climate conditions in lower elevations shifted forest composition from ponderosa pine to pinyon pine and juniper, which could not persist under the restored fire regime.

Restoration of frequent fire forests and retention of communities that are vulnerable to fire may not be compatible with strict adherence to historic fire regime conditions.

Further reading:

Diggins, C., P.Z. Fulé,, J.P. Kaye, and W.W. Covington. 2010. Future climate affects management strategies for maintaining forest restoration treatments. International Journal of Wildland Fire ***19****:903-913. DOI:* [10.1071/WF09109](10.1071/WF09109).

Loudermilk, E.L., R.M. Scheller, P.J. Weisberg, J. Yang, T.E. Dilts, S.L. Karam, and C. Skinner. 2013. Carbon dynamics in the future forest: the importance of long-term successional legacy and climate-fire interactions. Global Change Biology ***19****: 3502-3515. DOI:* [10.1111/gcb.12310](10.1111/gcb.12310).

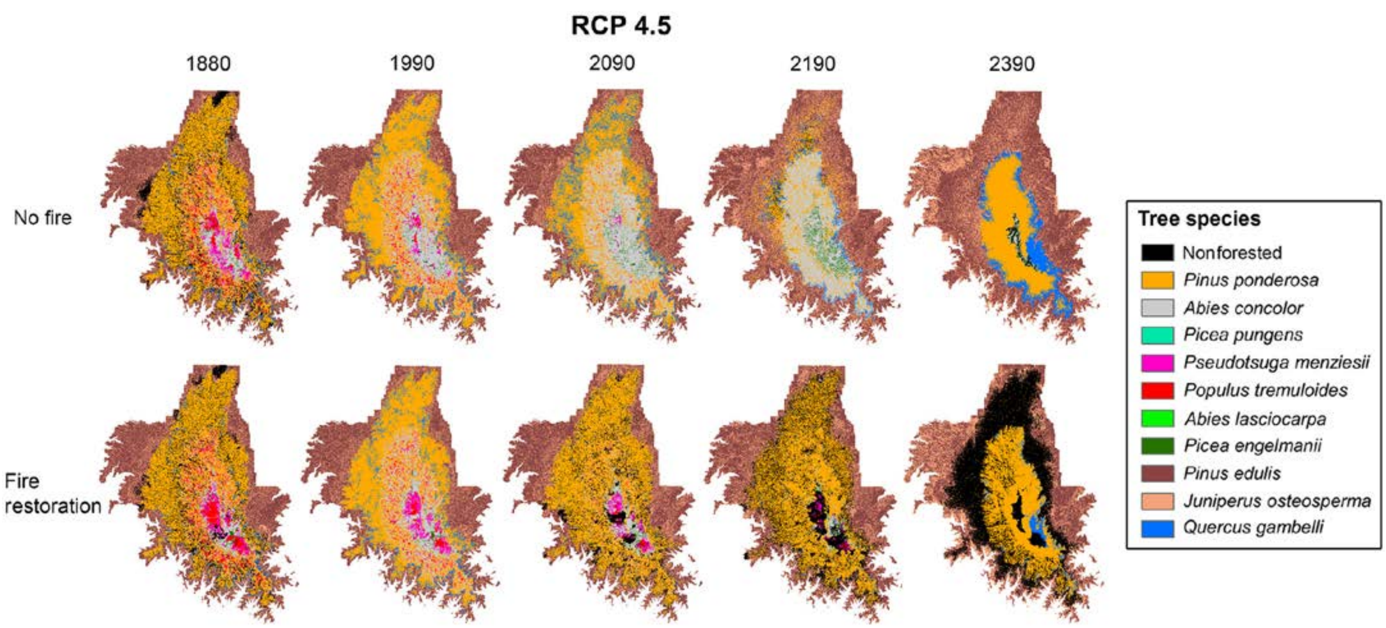

Figure 1. *Map of forest composition in the simulated Kaibab Plateau landscape under the RCP 4.5 climate change scenario. The maps are grouped according to the no-fire scenario (top row) and the fire restoration scenario (bottom row). Pixels are classified according to dominant species biomass. Maps are output from a single, representative model run.*