CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

Release:	Contact:	Phone:	Email:
June 2019	Marc Meyer	760-873-2447	marc.meyer@usda.gov

Sierra Nevada Fire Science Delivery Consortium | One Shields Avenue, Davis, CA 95616

Structure, diversity and health of Sierra Nevada red fir forests with reestablished fire regimes

Marc Meyer, Becky Estes, Amarina Wuenschel, Beverly Bulaon, Alexandra Stucy, Douglas Smith, and Anthony Caprio. 2019. Structure, diversity and health of Sierra Nevada red fir forests with reestablished fire regimes. International Journal of Wildland Fire 28, 386–396.
https://doi.org/10.1071/WF18114

The reestablishment of natural fire regimes may benefit forest ecosystems by restoring their fundamental structural, compositional, or functional characteristics. A 2019 study by Meyer and others showed that the reestablishment of natural fire regimes can be highly effective at restoring the structure and understory diversity of red fir forests but have little effect on the health of red fir under increasing moisture stress associated with drought and warming climate.

The authors compared twice-burned and unburned red fir stands in 22 separate, paired fires of Yosemite, Sequoia, and Kings Canyon National Parks and the Giant Sequoia National Monument. Fires in the twice-burned stands occurred between 2015 and the mid 1970's with unburned stands having no recorded fire as far back as 1908. They primarily sampled areas burned in wildfires that were managed for resource objectives but also sampled areas burned by prescribed fires or wildfires managed under full suppression strategies. The authors focused on the evaluation of key forest structural variables (such as stand density), understory diversity (species richness of tree regeneration, shrubs, and herbaceous plants), and functional attributes (such as red fir regeneration). They collected stand data during the latter half of the 2012-2016 drought in California to examine

Management Implications

- In upper montane landscapes with reestablished fire regimes, red fir stands had lower tree densities and canopy cover, restored spatial heterogeneity, and higher understory species richness than unburned stands.
- While reestablishing fire changed how the forest was structured, it did not change the impacts of drought and moisture stress; red fir crown loss ratings were primarily associated with topographic variables associated with increased moisture stress (i.e., lower elevations, south-facing slopes) and were similar between burned and unburned sites.
- Densities of large trees, large snags, red fir regeneration, and most surface fuels were similar between burned and unburned sites.

Wildland fire can restore and increase the adaptive capacity of Sierra Nevada red fir forests. *Image credit: Tony Caprio, NPS.*

whether prior burning buffered the health of red fir trees against drought, especially in drier (low elevation) sites.

Burned red fir plots were characterized by lower tree densities and canopy cover, restored spatial heterogeneity (such as less tree clustering at small spatial scales and a more even tree diameter distribution), and higher understory species richness (including tree regeneration, shrubs, and herbaceous plants) than unburned plots. Densities of large trees, large snags, and red fir regeneration were similar between burned and unburned sites. Surface fuels were generally similar between burned and unburned stands, although burned stands tended to have less coarse woody debris. Forest health indicators were similar between burned and unburned sites, and red fir crown loss ratings (an indicator of moisture stress and declining crown vigor) were primarily associated with topographic variables indicative of reduced soil moisture availability or increased tree moisture stress (such as lower elevations, south-facing slopes).

Although the reestablishment of natural fire regimes does not improve the health of red fir trees during exceptional drought events, the authors suggest it can restore red fir forest ecosystems and enhance adaptive capacity of upper montane forests in the Sierra Nevada under climate change. The authors observed that the repeated application of low to moderate severity fire can restore red fir forest structure and diversity, despite long-term fire exclusion and moderate fire return interval departure preceding fire reintroduction efforts.

Additional references for this topic:

Collins B.M., J.M. Lydersen, D.L. Fry, K. Wilkin, T. Moody, and S.L. Stephens. 2016. Variability in vegetation and surface fuels across mixed-conifer dominated landscapes with over 40 years of natural fire. Forest Ecology and Management 381:74-83.

Meyer, M.D., and M.P. North. 2019. Natural range of variation of red fir and subalpine forests in the Sierra Nevada bioregion. USDA Forest Service, Pacific Southwest Research Station General Technical Report PSW-GTR-263. (Albany, CA).

Miller C., and G.H. Aplet. 2016. Progress in wilderness fire science: embracing complexity. Journal of Forestry 114, 373–383.

van Mantgem P.J., A.C. Caprio, N.L. Stephenson, and A.J. Das. 2016. Does prescribed fire promote resistance to drought in low elevation forests of the Sierra Nevada, California, USA? Fire Ecology 12, 13–25.

Figure 2. Twice burned red fir stand in Yosemite National Park following the 1999 Lost Bear Bruno Fire and 1988 Horizon Fire, both wildfires managed for resource objectives, shows reduced densities of small diameter trees, increased spatial heterogeneity and understory diversity, and prevalence of large trees in the stand. Note the person wearing a white shirt located in the center background of the photo for scale. *Image credit: Marc Meyer, USFS.*