



## Research Brief for Resource Managers

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### Restoration actions should consider the composition of mixed conifer forest to increase resilience in fire-excluded stands

Stephens, S.L., J.T. Stevens, B.M. Collins, R.A. York, J.M. Lydersen. 2018. Historical and modern landscape forest structure in fir (*Abies*)-dominated mixed conifer forests in the northern Sierra Nevada, USA. *Fire Ecology* 14(2): 7. <https://doi.org/10.1186/s42408-018-0008-6>

In the Sierra Nevada most historical stand structure studies have focused on drier pine-dominated forests. This paper helps to fill a gap by contributing information on historical structure in more mesic forests with more moderate amounts of moisture.

Historical data are from field data collected at two sites on the Eldorado National Forest (ENF) in 1923 and 1936. The data were collected as part of the Forest Service timber inventory program. Historical data were compared to modern forest inventory analysis (FIA) data collected on the ENF 2001-2010 in forested habitats within the elevation range of the historic data.

Mean annual precipitation, mean April 1<sup>st</sup> snowpack, and mean annual climate water deficit were strong drivers of total tree density as well as small (6-12 in) and medium (12-24 in)-tree density. Density was high in rain-dominated regions with a low climatic water deficit. Large-tree density (>24 in) was driven by mean June climatic water deficit and slope. The highest densities of large trees were associated with lower June climatic water deficit. Total basal area was also tied to

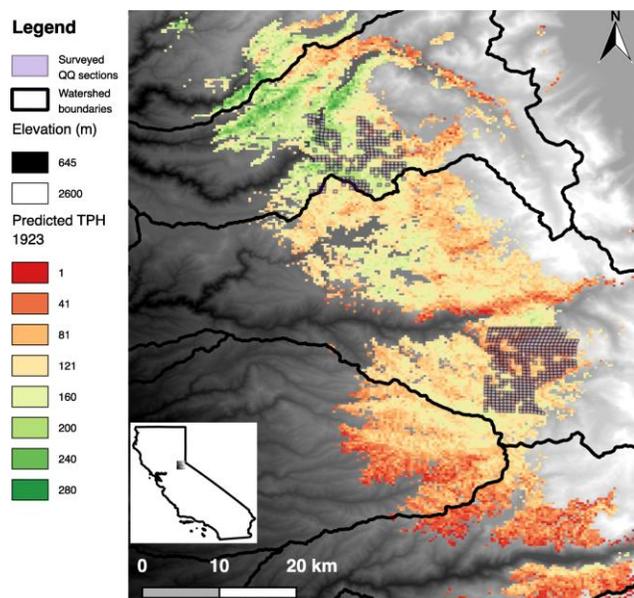
#### Management Implications

- The biophysical environment (largely driven by precipitation) had a pronounced influence on historical forest structure in fir-dominated forests.
- There has been a major structural shift in fir-dominated mixed conifer stands in the Sierra Nevada that has reduced the quality of habitat for the California spotted owl (CSO).
- Management actions (such as thinning and prescribed fire) that focus on recruiting large trees and reducing small trees in fir dominated forests could improve CSO habitat.
- Preferential removal of fir species may not align with restoring composition of fir-dominated mixed conifer forests.
- Restoration plans should differ depending on the type of mixed conifer forest in question (e.g. fir versus pine dominated).

climatic conditions, where high basal area was associated with rain dominated, NE aspects, with shallow slopes and low water deficit.

There has been a structural shift in fir-dominated mixed conifer forests in the Sierra Nevada. While basal area remains similar, small and medium trees have increased in density and large trees have decreased in density over about a 70 year period (the early

1900's to the early 2000's). The increases in small trees were most pronounced in rain-dominated areas where historical densities also tended to be higher. The loss of large trees was most pronounced in areas that historically had the highest large tree densities (low relative summer water deficit and shallow slopes); this is likely due to past timber harvests. This structural shift has likely reduced preferred nesting and roosting habitat for the California spotted owl.



**Figure 1:** Model predictions of landscape variation in tree density (trees/hectare, >6 in dbh) from historical data based on key biophysical variables. Historical timber surveys shown in purple. Study area shown in inset figure. Watershed boundaries are outlined in black from north to south: the Middle Fork American River, Rubicon River, South Fork American River, Cosumnes River, and Mokelumne River.

In the sampled stands, the historical ratio of fir to pine species was similar to modern conditions. Therefore, unlike many pine-dominated forests in the Sierra Nevada, the preferential removal of fir species may not meet the objective to restore species

composition in fir dominated mixed conifer stands.

Changes to fir-dominated mixed conifer forests in the Sierra Nevada were more subtle compared to pine-dominated areas. Forest restoration plans should account for differences in forest type in order to restore resilience and encourage adaptation in fire-excluded mixed conifer forests.

#### Further reading:

Collins, B.M., D.L. Fry, J.M. Lydersen, R. Everett, and S.L. Stephens. 2017. Impacts of different land management histories on forest change. *Ecological Applications* 27: 2475-2486.

Collins, B.M., J.M. Lydersen, R.G. Everett, D.L. Fry, and S.L. Stephens. 2015. Novel characterization of landscape-level variability in historical vegetation structure. *Ecological Applications* 25: 1167-1174.

Stephens, S.L., J.M. Lydersen, B.M. Collins, D.L. Fry, and M.D. Meyer. 2015. Historical and current landscape-scale ponderosa pine and mixed-conifer forest structure in the southern Sierra Nevada. *Ecosphere* 6(5)

Dolanc, C.R., H.D. Safford, S.Z. Dobrowksi, and J.H. Thorne. 2014. Twentieth century shifts in abundance and composition of vegetation types of the Sierra Nevada, CA, USA. *Applied Vegetation Science* 17: 442-455.

Dolanc, C.R., H.D. Safford, J.H. Thorne, and S.Z. Dobrowski. 2014. Changing forest structure across the landscape of the Sierra Nevada, CA, USA, since the 1930s. *Ecosphere* 5(8): Article 101