



## Research Brief for Resource Managers

**Release:**  
January 2015

**Contact:**  
Jon E. Keeley  
Marti Witter  
Liz van Mantgem

**Phone:**  
(559) 565-3170  
(805) 370-2333

**Email:**  
[jon\\_keeley@usgs.gov](mailto:jon_keeley@usgs.gov)  
[marti\\_witter@nps.gov](mailto:marti_witter@nps.gov)  
[evanmantgem@usgs.gov](mailto:evanmantgem@usgs.gov)

Central and Southern California Team, USGS Sequoia and Kings Canyon Field Station, Three Rivers, CA 93271

# Historical Fire-Climate Patterns in Sierra Nevada Foothills and Montane Landscapes

*Keeley, J.E. and A.D. Syphard. 2015. Different fire-climate relationships on forested and non-forested landscapes in the Sierra Nevada ecoregion. International Journal of Wildland Fire 24: 27-36. <http://dx.doi.org/10.1071/WF14102>*

Many western US forests have had accelerated fire activity (area burned) that is thought to be tied to global warming. In the Sierra Nevada of California the story is more complicated when considering the ecoregion from mountains to valley grasslands. These authors utilized annual fire data from the early 20<sup>th</sup> century to 2010 to evaluate historical changes in fires and the extent to which annual variations in climate were correlated with fires. They examined two data sources, the U.S. Forest Service lands, which mostly comprised mid to high elevation forests and Cal Fire data that included lower elevation state responsibility lands.

These two landscapes were consistent in that the peak of fire activity was in the 1920s with a subsequent decline in area burned (Fig. 4). However, in the later part of the 20<sup>th</sup> century they diverged as fire activity in the forests increased over the last few decades (Fig. 4a), consistent with other USFS forests in the western U.S. In contrast, the lower elevation Cal Fire lands showed relatively constant fire activity over the past 6 decades (Fig. 4b).

### Management Implications:

- Montane forests (USFS lands) have had increasing fire activity in recent decades but this is not the case for lower elevation foothills and valley (Cal Fire responsibility lands).
- For forests, years of higher fire activity are associated with warmer, drier springs and summers, but fires are not related to winter temperatures or precipitation. Temperature and precipitation in any season are not strongly correlated with high fire years in the foothills and valleys.
- The relationship between fire activity and climate variables is not static over time, as evidenced by the fact that for USFS lands, precipitation was more important in the first half of the century but spring and summer temperature was more critical to fire activity in the second half of the century.
- For the non-forested Cal Fire lands in this study, human land use patterns and the resulting vegetation shifts are probably more directly linked to fire activity than is climate.

These patterns in area burned do not appear to be driven by numbers of ignitions, which show a sharp decline in the past two decades (Fig. 5). Through the 1980's there was a steady increase in the number of fires for both landscapes, consistent with other studies that report correlations between population growth and numbers of ignitions. However, the cause of the sharp decline in fires over the past two decades is unknown. Factors accounting for the increase in fire area burned in recent years potentially include changing climates, fuel accumulation due to fire exclusion, and changes in fire suppression practices, in particular the switch in the 1960s from the '10 am policy' to one of 'constrain and contain.'

Analysis of historical fire-climate patterns found that:

- 1) Montane forests exhibited highly significant relationships between annual area burned and high

temperatures plus drought, whereas these parameters were not important determinants of fire activity in the foothills and valleys.

- 2) The fire-climate relationship in the forests was closely associated with high temperatures and drought in some seasons but not others; in recent decades, winter conditions did not play a significant role in determining fire activity but rather spring conditions were the most influential.
- 3) Historically the relationship between fire and climate on USFS lands has changed as spring and winter precipitation were the critical factors in the first half of the 20<sup>th</sup> century but in the last 50 years spring and summer temperature have been most critical.

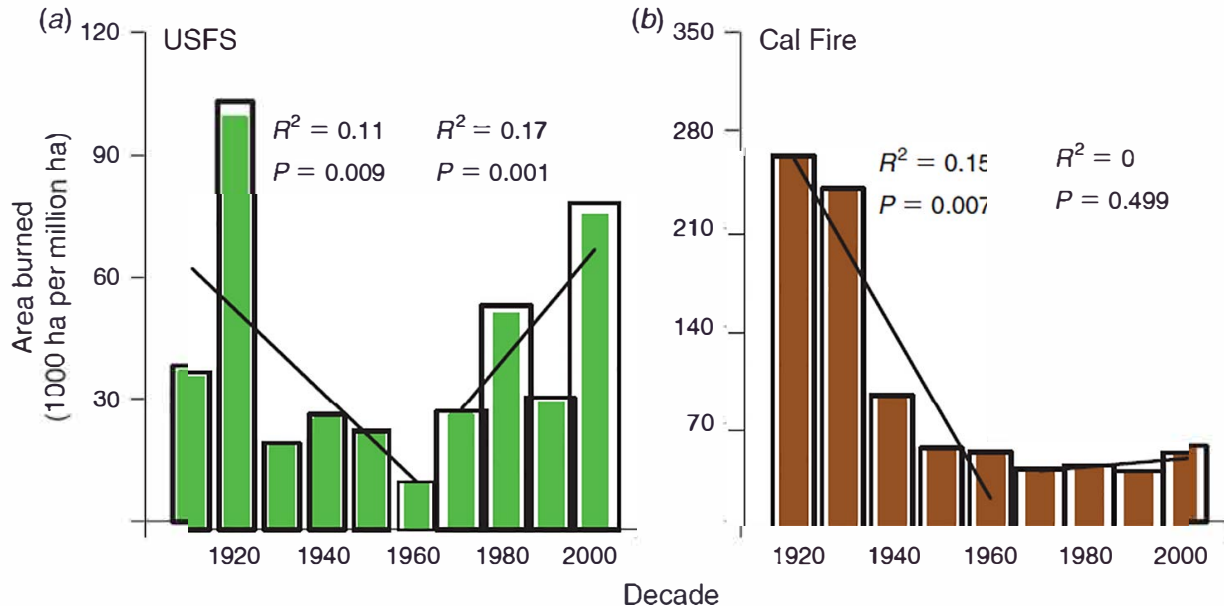
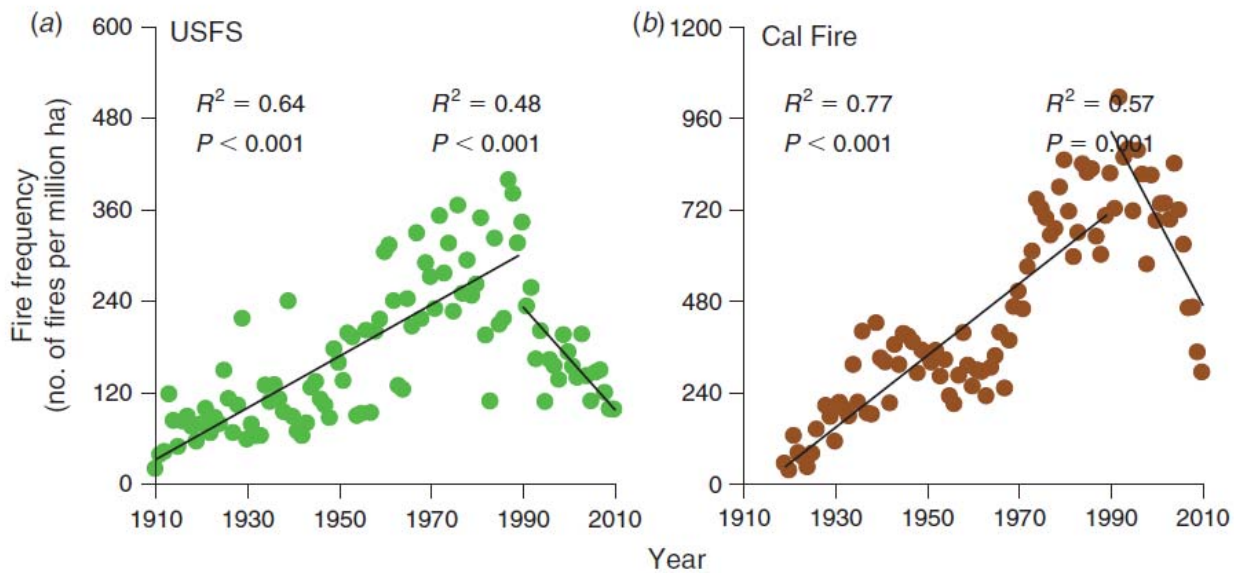


Fig. 4. (a) One hundred years of burning in the six US Forest Service (FS) forests of the Sierra Nevada (green bars) based on hectares protected. Because trends changed over time, regression lines are for decades 1910–50 and 1960–2000; and (b) 90 years of burning on lands protected by Cal Fire (brown bars) in Sierra Nevada counties with complete data for the years 1920–2009; regression lines are for decades 1920–50 and 1960–2000.



**Fig. 5.** Annual fire frequency for (a) US Forest Service (FS) data from 1910 to 2010; and (b) Cal Fire in counties with complete data for the years 1919–2010. Regression lines are for years 1910 or 1919 to 1989 and 1990 to 2010.