CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

Release:	Contact:	Phone:	Email:
September 2016	Jon E. Keeley	(559) 565-3170	*jon_keeley@usgs.gov*
	Marti Witter	(805) 370-2333	*marti_witter@nps.gov*
	Liz van Mantgem		*evanmantgem@usgs.gov*

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

Predicting Future Fire Regimes: Still a Long Way to Go

Keeley, J.E., and A. Syphard. 2016. Climate change and future fire regimes: examples from California. Geosciences 6:37. 14pp. doi:10.3390/geosciences6030037

It seems obvious that as temperatures rise with climate change, there will be more fires that burn more land. But in their recent review of climate change effects on future fire regimes, Jon Keeley and Alex Syphard conclude that "predicting future fire regimes is not rocket science; it is far more complicated than that."

Years of anomalously high area burned have been shown to be related to both drought and higher seasonal temperatures. These two climate variables affect fire either by reducing the *moisture content* of live and dead fuels or by precipitation increasing fuel *volumes* of herbaceous fuels in the year or two prior to fire. Variation in fuel structure across ecosystems plays a critical role in determining which is more important. This underlying variation in climate controls means that studies at large scales may not accurately capture fire-climate relationships.

Using historical analyses of annual burning in the different NOAA climate divisions of California, Keeley and Syphard show that fire-climate relationships are different among the major climate zones. In the Sierra Nevada there is a strong correlation with area burned and temperature (Fig. 1a) but in southern California there is no significant relationship (Fig. 1b). Further, in the Sierra Nevada, temperature is related to area burned only in spring and summer, not in fall and winter (Fig.1a).

Management Implications

- The relative importance of climate change varies across different ecosystems. Fire in montane forests has been affected by rising temperatures but lower elevation shrublands have not.
- Misleading forecasts of future fire regimes may occur if regional analyses of fire-climate relationships mix sub-regions with different climate drivers.
- Changes in seasonal temperatures are more important than annual means.
- Fire activity is ignitions-limited in southern California; ignitions management here is a potential fire management strategy.

These data illustrate several important points about the relationship between fire and increased temperatures in California:

1) seasonal temperatures are more important than annual means;
2) fire-climate analyses should be scaled appropriately to separate vegetation types such as montane forests, foothill woodlands and shrublands that respond to different climate signals;
3) not all parts of the landscape are equally sensitive to climate change; and
4) broad scale models may over-predict the total increase in fire activity in California.

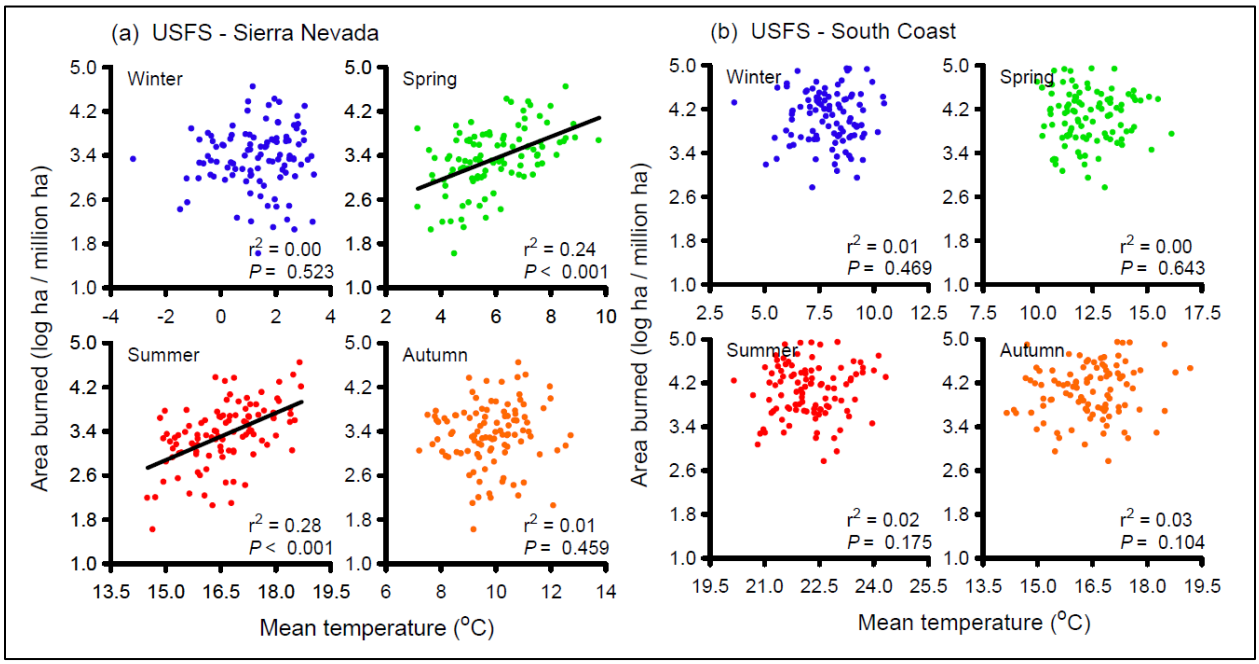

Figure 1. Seasonal mean temperature vs. annual area burned for USFS lands in two climate divisions,(**a**) Sierra Nevada and (**b**) South Coast

Other complications of climate change forecast models considered in the review include fire and drought; fire-climate interactions; vegetation trajectories and future fire regimes; population growth and future fires; and the effects of changing management tactics.

Drought is a key determinant of fire regimes and annual precipitation is the primary driver of drought variability. It is unclear how precipitation patterns will change in the future and whether future variability will exceed that of the past. What is certain is that increased temperatures increase evaporative water demand and therefore increase plant stress, with effects on plant mortality and altered fuel conditions.

Fire-climate interactions are not static, but can change over time. The best predictors of fire in the Sierra Nevada in the first half of 20th century was spring precipitation followed by winter precipitation. From 1960-2010 that changed to spring temperature followed by summer temperature. Past observations may not be adequate for future predictions.

V*egetation trajectories and future fire regimes.* As vegetation shifts occur with climate change, resulting fuels changes will feed back to fire regimes in complex ways that may be difficult to model.

Population Growth and Future Fires. Increases in human population and the contribution of human ignitions to fire regimes need to be separated from the effects of climate change. Urban sprawl exacerbates the magnitude of home losses and increases human ignitions. In southern California there is no evidence for a climate change temperature signal (Fig. 1b), instead catastrophic fires can occur in most years and are ignition limited.

Fire management tactics including suppression, prescribed burning or ignitions management all have the potential to improve outcomes from global change-altered fire regimes.