Hot, Dry, and in Flames: What Forces are Behind California's Wildfires?

Kate McWilliams

12/2/2019

Intro

Introduction Wildfires are important for the diversity and resiliency of California's ecosystems (Von Schaumburg, 2014). However, in recent decades, California has seen fires of unprecedented severity and frequency, garnering national attention (Abatzoglou and Williams, 2016). Between 1972 and 2018, the annual burned land-area in California increased by a magnitude of five times (Williams et al., 2019). The worst 10 wildfires in the State's history have occurred since 1991 (Serna et al., 2019). The costs of fighting these fires, in addition to the property damage and health effects caused by fires, is becoming increasingly difficult to cover (Delfino et al., 2009). California's climate, vegetation, and urban landscapes are highly diverse, meaning that the influences on fire activity are complex and vary spatially (Williams et al., 2019).This makes mitigation and anticipation more challenging. Jin et al. argue that a more in-depth understanding of how meteorology and fire is needed to improve predictions of how fire will change in the future and to anticipate management needs (Jin et al. 2014). California's worst fires occur in the Fall in coastal shrublands, when strong winds from offshore sweep downhill from a high-pressure area [Figures 1 & 2] (Jin et al., 2014). The Southern region is a microcosm for this effect with the San Antonio coastal range situated between the continental interior high desert of Southern Utah and the valley of San Bernardino County. These "downslope" winds are termed Santa Ana winds (Serna et al., 2019). This paper seeks to explore how large-scale anthropogenic impacts on the climate may influence fire events in Southern California, by analyzing temperature and precipitation data. "A thorough and nuanced understanding of how, when, and where anthropogenic climate change has or has not affected wildfire in California over the past several decades is critical to guide sustainable societal decisions ranging from where to develop housing to how limited resources can be optimized for landscape management" (Jin et al., 2014).

Heat, Dought, Wildfires: How does this domino-effect work?

Climate has a significant effect on California's seasonal wildfires. During the summer, when fires are most frequent in California, large burns result from the cumulative effects of a dry atmosphere and lack of rain (Jin et al., 2014, Westerling, 2011, Williams et al., 2019). It is a generally accepted theory that increasingly hotter and drier autumns are contributing to worse wildfire seasons. Though most research looks to forested regions that have plenty of vegetative mass to burn, a recent study by Jin et al. found that dry conditions also influence summer wildfires in non-forested regions of California. For example, sage scrub ecosystems in Southern California are dense with vegetation to fuel a fire. (Jin et al., 2014). As previously mentioned, the most devastating fires in Southern California occur in the Fall when Santa Ana winds from the northeast barrel down into the Los Angeles basin [Figure 2]. As the warm air descends, the winds heat up and drive out humidity. The strong, offshore Santa Anas exacerbate the fire risk in dry, pre-rain regions and blow sparks to spread fire (Serna et al., 2019, Jin et al., 2014).

If this trend is part of a regional climate pattern, what evidence shows that the fires are getting worse, and why are they getting worse? According to a study by Williams et al., warm-season days have warmed by an average of 1.4 °C from 1970 to present. This is part of a larger warming trend over the past century that contributes to a "atmospheric vapor pressure deficit" (Williams et al., 2019). This trend is consistent with the increased carbon emissions caused by humans.

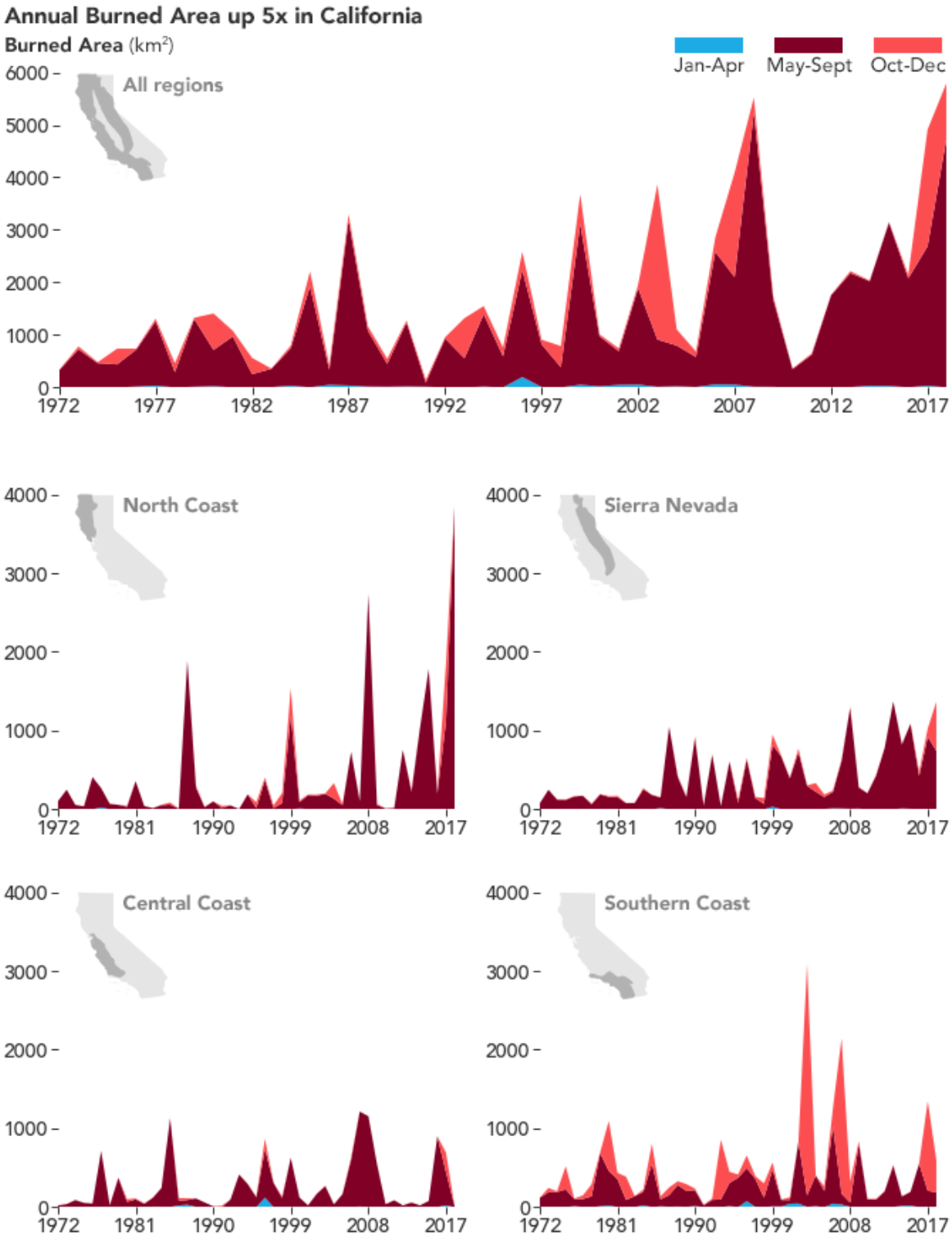

Figure 1: A graphic depiction of Santa Ana Winds descending into the valley. (Graphic: Joshua Stevens, NASA Earth Observatory)

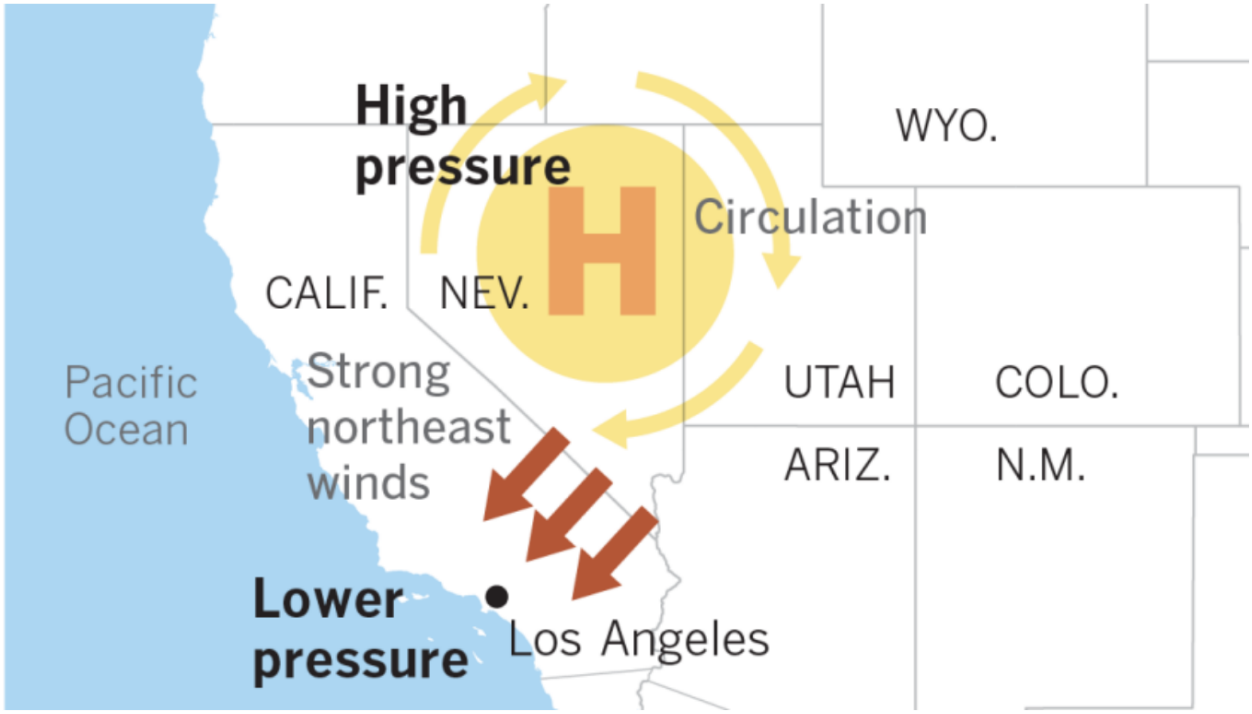

Figure 2: Santa Ana Winds from Continental Interior. (Photo Credit: Paul Duginski, LA Times)

Fires in the Anthropocene Era

Greenhouse gas emissions by humans and subsequent climate changes directly impact fire activity in North America, particularly in the forests of the Sierra Nevada and North Coast (Williams et al., 2019). These long-term trends in climate have great impacts on factors such as location, frequency, extent, and severity of wildfires(Westerling, 2011). Changes in climate are linked with 55% of observed increases in fuel aridity from 1979 to 2015 across western US forests (Abatzoglou and Williams, 2016). Other compounding factors include the human-facilitated invasion of non-native plant species. A growing expanse of Southern California's shrublands are being permanently replaced by invasive grasses, which do not have the same fire resistant qualities as native flora (Von Schaumburg 2014, Serna et al., 2019). In addition, State and local fire-fighting strategy tends to prioritize suppression of all fires, despite the fact that most Californian's have a sophisticated understanding of the ecological benefits of fire, especially those living in fire-prone areas (jin et al., 2014, McCaffery and Olsen, 2012). An undergrad thesis by D.M. Von Schaumburg points out that an increase in fire frequency in valleys and foothills parallels population growth and development in Southern California, likely due to the aforementioned factors. My case study seeks to answer the question, what role do trends in temperature and precipitation have in increased wildfires in Southern California?

Obtaining Climate Data on Southern California (Methodology)

A California Case Study

The City of Claremont is located at the foot of the San Antonio mountains in Southern California. The Meditterranean climate is characterized by mildly cool, rainy winters and hot, dry summers. Autumn brings Santa Ana winds over the San Antonio mountains and across an expanse that includes Claremont. I chose to examine temperature and precipitation data from Claremont as an indicator of temperature for the land area below Baldy. My goal was to see if increasing temperatures in Claremont, due to Santa Ana

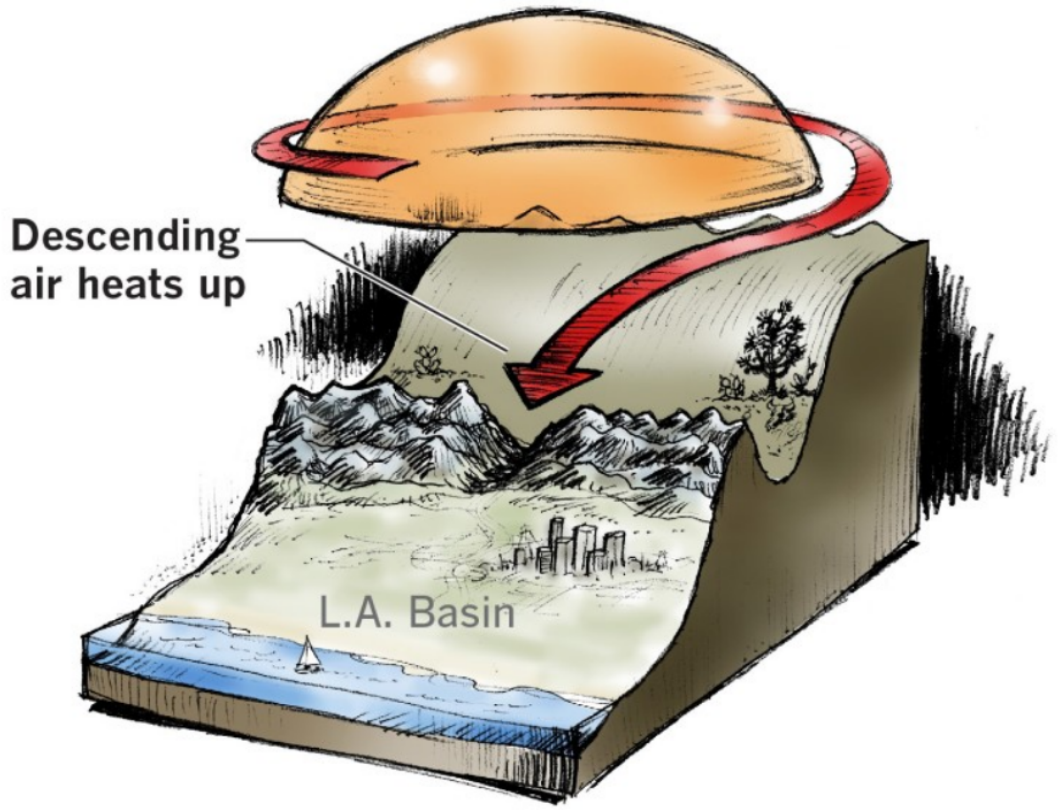

Figure 3: A graphic depiction of Santa Ana Winds descending into the valley. (Photo Credit: Paul Duginski, LA Times)

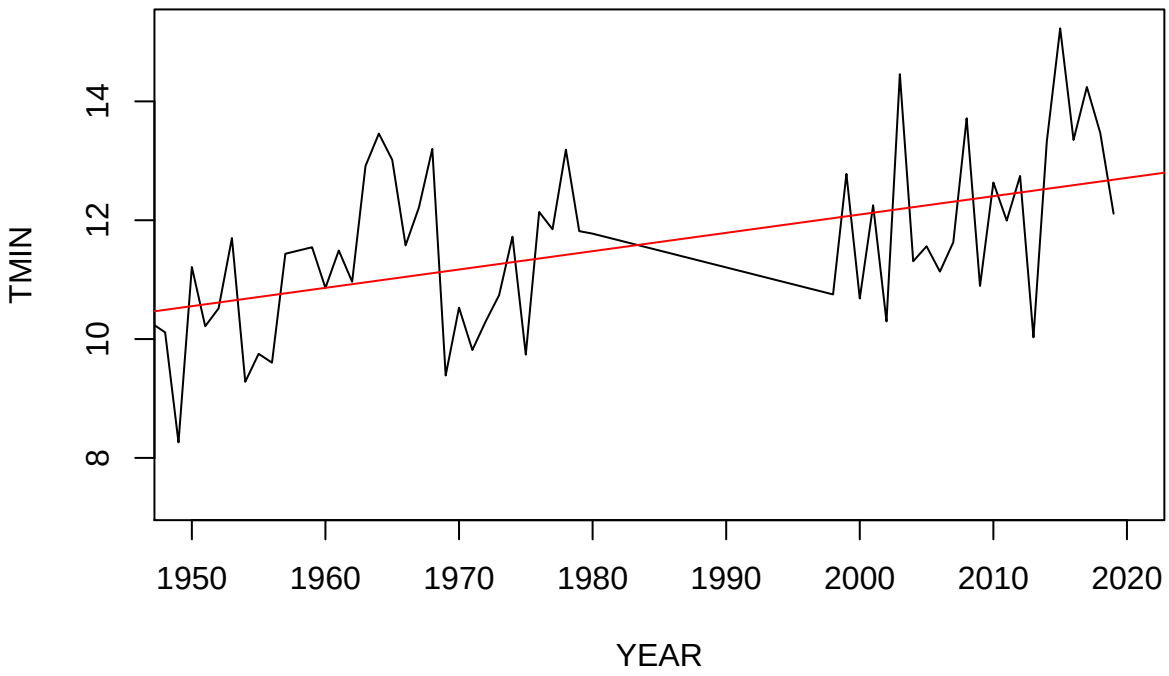

Figure 4: Minimum Temperature Average for October 1950-2019

winds, were correlated with increased fires around the region. I accessed the database on National Oceanic and Atmospheric Administration (NSSL [date unknown]) to collect temperature and precipitation data in Claremont. I chose the month of October because Autumn is the most high-risk time of year for fires after a long deficit of rain during the summer months.

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    0.00    0.00    0.00    1.24    0.00  276.10    9983
```

Results

The temperature data shows a drastically increasing average temperature for the month of October in Claremont over the past 70 years. This heat is most likely due to Santa Ana winds

The precipitation data shows a decrease in average rainfall for the month of October in Claremont from 1950 to 1980. There was no data from this weather station after 1980, however, the extended drought from in the trend continued to decrease .

Discussion

Compounding factors include: drought, decades of not allowing wildfires to burn brush. * In addition, wildfires alter the character of the ecosystems that support them (Westerling 2011). * “Wildlands are getting

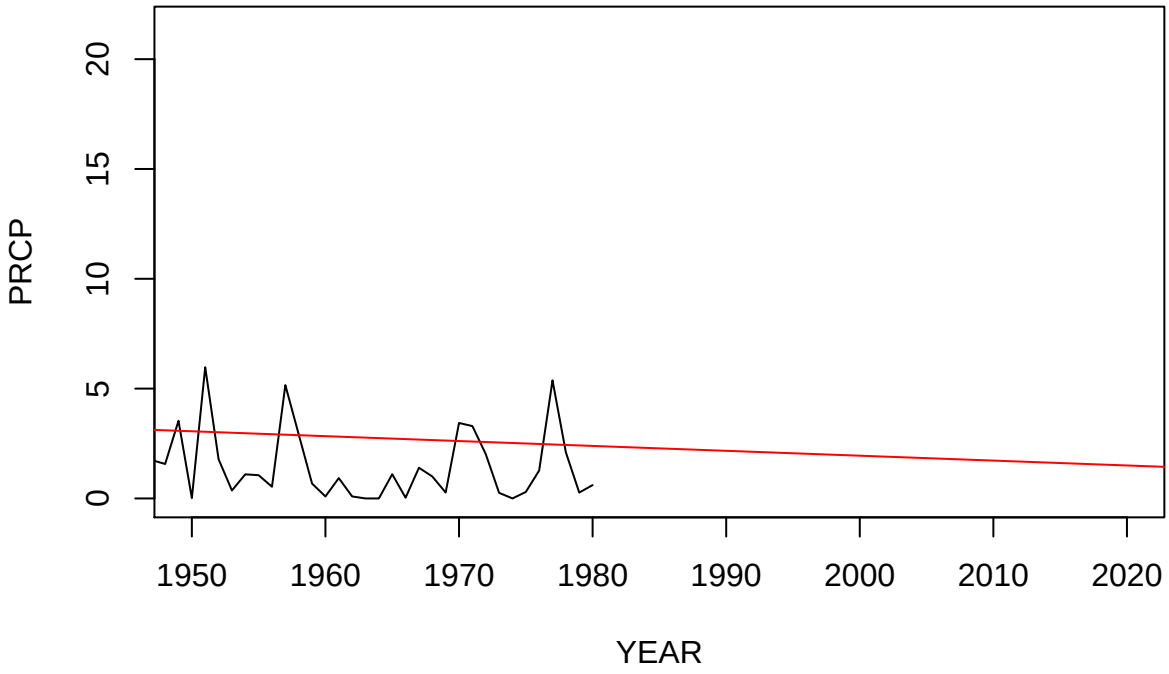

Figure 5: Average October Precipitation 1950-1980

burned too often, and then are stressed by drought, causing lasting changes to California's ecology that make the state even more at risk for wildfires." (times) * Who is it affecting? Wildlife and... rich people?

Conclusion

Sources

Abatzoglou J, Williams A. (2016). Impact of anthropogenic climate change on wildfire across western US forests. Proceedings of the National Academy of Sciences. 113 (42): 11770-11775.

Assembly Bill 1054. (2019). Chapter 79. California Legislature. Retrieved at: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200AB1054

Daily Summaries Station Details. 2019. NOAA National Centers for Environmental Information: State of the Climate. [cited 2019 Mar 11]. Available from: https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:USW00024157/detail

Davies I, Haugo R, Robertson J, Levin P. 2018. The unequal vulnerability of communities of color to wildfire. Proceedings of the National Academy of Sciences. 1-15.

Delfino, R.J., Brummel, S., Wu, J. 2009. The relationship of respiratory and cardiovascular hospital admissions to the southern California wildfires of 2003. Occupational and Environmental Medicine. vol 66:189-197.

Diffenbaugh, N., Swain, D., & Touma, D. (2015). Anthropogenic warming has increased drought risk in california. Proceedings of the National Academy of Sciences of the United States of America, 112(13), 3931-3936.

Jin, Y., Randerson, J., Faivre, N., Capps, S., Hall, A., & Goulden, M. (2014). Contrasting controls on wildland fires in southern california during periods with and without santa ana winds: Controls on southern california fires. Journal of Geophysical Research: Biogeosciences, 119(3), 432-450. doi:10.1002/2013JG002541

LaDochy, S., Medina, R., & Patzert, W. (2007). Recent california climate variability: Spatial and temporal patterns in temperature trends. Climate Research, 33(2), 159-169.

McCaffrey, S., Olsen, C., & United States. Forest Service. Northern Research Station. (2012). Research perspectives on the public and fire management : A synthesis of current social science on eight essential questions (General technical report nrs, 104). Newtown Square, PA: United States Department of Agriculture, Forest Service, Northern Research Station.

Serna, J., Lin II, R., Peltz, J. F. (2019). How do wildfires start and spread? Los Angeles Times.

Von Schaumburg, D. M. (2014). "A Study of Post-Fire Recovery in Invaded Coastal Sage Scrub at the Bernard Field Station." Scripps Senior Theses. 338. https://scholarship.claremont.edu/scripps_theses/338

Westerling, A., Bryant, B., Preisler, H., Holmes, T., Hidalgo, H., & Shrestha, S. (2011). Climate change and growth scenarios for california wildfire. Climatic Change, 109, 445-463.

Williams, A.P., Abatzoglou, J.T., Gershunov, A., Guzman-Morales, J., Bishop, D.A., Balch, J.K., & Lettenmaier, D.P. (2019). Observed impacts of anthropogenic climate change on wildfire in California. Earth's Future, 7, 892-910. https://doi.org/10.1029/2019EF001210