

# Drought and Forests in California

## Background

About one-third of California is covered in forests. From the redwoods of the northern coast to the oak woodlands of the foothills, California's diverse climate, soils, and geography support a wide range of forest ecosystems<sup>1</sup>. Most of these forests are adapted to periodic drought as a feature of the state's Mediterranean climate. However, warming trends, dense tree cover from fire suppression tactics, and the ongoing intense drought are threatening their stability, with especially pronounced impacts observed on the west side of the Sierra Nevada Range and in low to mid-elevation forests<sup>2</sup>.



## Significance of Snowpack

Snowpack in the Sierras has long served as a natural form of water storage, and the slow melting provided a stable water source for forests, keeping them hydrated into the summer months. Earlier snowmelt periods mean that the forests experience a longer dry season, leaving trees water-stressed and more vulnerable in the long-term. In 2015, April snowpack was at a mere 5% of average levels<sup>3</sup>, and it quickly fell to zero by May 28th<sup>4</sup>. This is the lowest measurement since instrumental recording began in 1950.

Coupled with higher air temperatures, which melt snowpack and increase evapotranspirative water demand, the drought is proving severely damaging for California's trees. Indeed, the combination can even be fatal for them.

When the trees are weakened by drought, they are often unable to produce enough defensive resin or pitch to counter bark beetle attacks.

According to estimates from the US Forest Service annual aerial surveys of tree health, about 3.3 million trees died in 2014, more than double the deaths in 2013<sup>6</sup>. In 2015 the number rose to 29 million<sup>7</sup>. These mortalities were primarily associated with drought and bark beetles.



Graphic: *Water in the West*, Stanford University; 2015 U.S. Drought Monitor map courtesy of NDMC-UNL

The US Drought monitor maps of July 2010-2015 illustrate the severity of drought, based on a wide variety of metrics including snowpack.



Image courtesy of USDA Forest Service Pacific Southwest Region Forest Health Protection Program

High levels of ponderosa pine mortality observed in the Southern Sierras during 2015 USFS aerial survey.

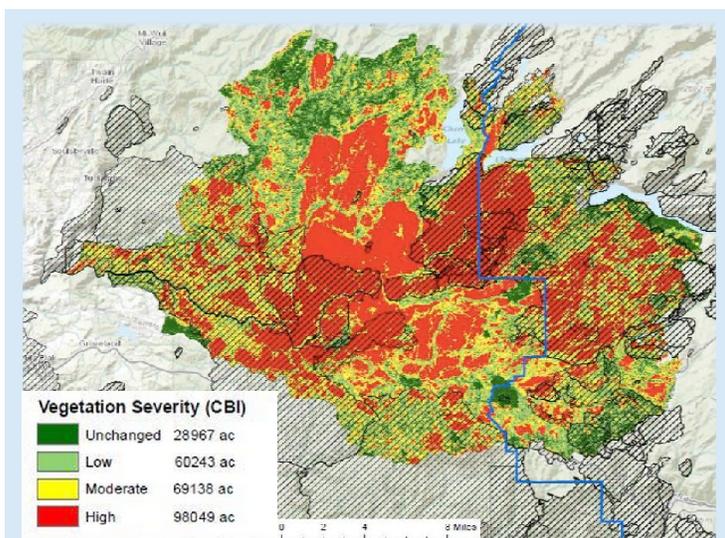
## Increased Tree Vulnerability

It is hard to attribute tree mortality to a single cause; it is often a combination of conditions and agents. Extreme drought can eventually kill trees directly through cavitation or carbon starvation, but what happens more often is that drought weakens trees and makes them more susceptible to woodboring pests. For example, the number of trees killed by bark beetles in California tends to jump after several years of inadequate precipitation<sup>5</sup>.

## Drought and Fire

Drought stress, exacerbated by warmer temperatures, is causing tree mortality and lowering the moisture content of forest fuels, increasing vulnerability to fire. Several studies have linked the recent increase in fire severity and length of the fire season to spring/summer temperatures and the percentage of the year that snowpack is present<sup>2</sup>. The Palmer Drought Severity Index (PDSI) and similar drought indicators have been utilized

successfully to predict wildland acres burned<sup>8</sup>. With this in mind, it is unsurprising that the 2007-09 drought included five of the largest wildfires in the state's recorded history in terms of acres burned<sup>9</sup>. The state's second- and third-biggest fires (third-biggest being the Rim Fire, shown below) occurred soon after, from 2012-2014.

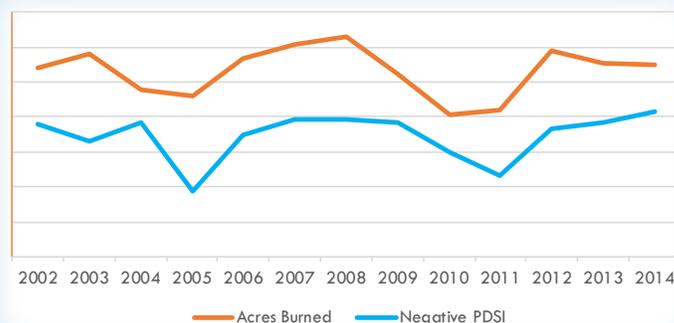


Map courtesy of Interagency Incident Information System InciWeb

Almost 40% of the area burned during the Rim Fire in Yosemite National park was classified as high severity<sup>10</sup>. In the 1980's, the average proportion of fires in the Sierra Nevada Range classified as high severity was only 20%<sup>11</sup>.

To further illustrate the influence of drought on fire, we graphed the number of wildland acres burned in California (this includes almost all forested land) and the PDSI from 2002-2014. The data was provided courtesy of National Interagency Fire Center and NOAA<sup>12, 13</sup>.

## Drought and Fire in CA - 2002-2014



Wildland acres burned vs. negative PDSI, indicating how drought increases fire spread. (Log transformation used for comparison; y-axis values omitted as they do not reflect actual values.)

## Land management and fire

Long-term fire suppression has led to changes in forest structure and build-up of surface fuels, which increases the potential for large, destructive fires. The density of young trees has risen while density of large trees has fallen by about 50% since the 1930s<sup>2</sup>. These young trees are already inherently more susceptible to fire, but they are also densely packed together and compete heavily for moisture, contributing to increased drought stress and likelihood of fire.

There have also been shifts in species composition, with fire suppression practices favoring shade-tolerant firs at the expense of pines, which are more fire resilient<sup>2</sup>. This degradation of forest quality only adds to water-stress from the drought, increasing fire risk.

Having more wildland-urban interfaces—human developments adjacent to forests—can also increase the frequency of ignitions and make fire harder to suppress.

### How can we protect forests during the drought?

- Selectively thinning in high-risk regions to promote species/age-class diversity and improve resiliency.
- Ensuring defensible space around forest homes: [www.readyforwildfire.org](http://www.readyforwildfire.org)
- Supporting the use of wood and other products of forest health projects, especially for green energy.
- Monitoring forest pest conditions and acting quickly to remove trees weakened from pests.

### What options and resources are available for forest land owners?

- Contact CAL FIRE, NRCS, Cooperative Extension, or Registered Foresters to develop a forest mgmt. plan.
- Seek financial assistance from local government, State Fire Safe Council, or Sierra Nevada Conservancy for forest health improvement projects.
- Forest Service forest health specialists: <http://www.fs.usda.gov/main/r5/communityforests>

1. <http://ucanr.edu/sites/forestry/files/78650.pdf>
2. [http://www.fs.fed.us/psw/publications/documents/psw\\_gtr237/psw\\_gtr237\\_023.pdf](http://www.fs.fed.us/psw/publications/documents/psw_gtr237/psw_gtr237_023.pdf)
3. <http://cdec.water.ca.gov/cgi-progs/snow/COURSES.o4>
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7. <http://www.fire.ca.gov/communications/downloads/>

8. <http://inciweb.nwcg.gov/incident/maps/3726/>
9. <http://www.sierranevada.ca.gov/our-work/docs/StateOfSierraForestsRptWeb.pdf>
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