Post-Drought Mortality in Sierra Nevada Mixed-Conifer Forests of California: Research and Extension

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Introduction

The epic California drought from 2012 to 2016 included historic dryness and warmth[1] resulting in record low snowpack across the Sierra Nevada[2]. This extended aridity generated progressive canopy water stress in approximately 888 million trees[3] that ultimately induced a massive wave of tree mortality. A key feature of this drought was the response of native bark beetle populations, particularly western pine beetle, leading to the worst ever insect-mediated mortality event recorded in the state[4].

[1]**Swain**, D. L. 2015. A tale of two California droughts: Lessons amidst record warmth and dryness in a region of complex physical and human geography. Geophysical Research Letters 42:9999-10003. [2]**Belmecheri**, S., et al. 2016. Multi-century evaluation of Sierra Nevada snowpack. Nature Climate Change 6:2–3. [3]**Asner**, G. P., et al. 2016. Progressive forest canopy water loss during the 2012–2015 California drought. Proceedings of the National Academy of Sciences 113:E249–E255. [4]**California** Forest Pest Council. 2016. 2015 California Forest Pest Conditions. USDA Forest Service, 21 p.

Aim

Establish drought-mortality (DX) sites along a latitudinal gradient in the Sierra Nevada, to:

1. **Summarize tree characteristics at each site**
2. **Explore patterns of tree mortality by species and diameter classes**
3. **Examine the rate and spread of bark beetles**

Ponderosa pine dominated DX site in Yosemite National Park Forest. Pine trees in background heavily impacted by mortality as seen by red crowns, indicating trees likely died in 2016

Location of all the DX monitoring sites on a north-south gradient in the Sierra Nevada

Methods

At a total of eight DX sites we established 29 to 36 fixed area circular plots using stratified random sampling.

Overstory tree (> 4" diameter-at-breast height (DBH) measurements included: species, status, DBH, damage causal agents. Bark beetle species that were considered mortality agents included: mountain pine beetle, western pine beetle and fir engraver. Understory trees (> 4 ft tall, < 4" DBH), shrub cover and fuel transects were also measured.

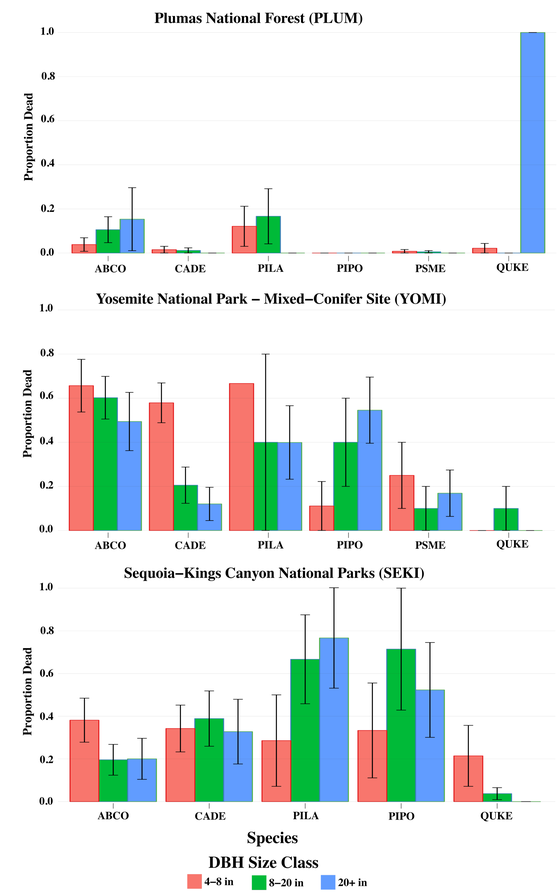
Tree species abbreviations: white fir (ABCO), Incense cedar (CADE), sugar pine (PILA), ponderosa pine (PIPO), Douglas-fir (PSME), black oak (QUKE).

Results

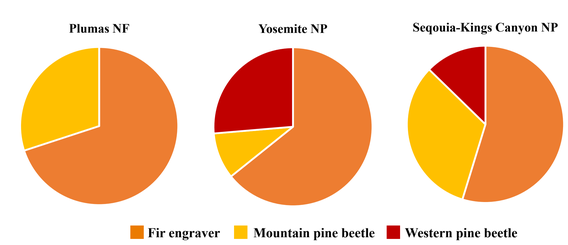
We report on three DX sites, located at northern, central and southern locations in the network. We summarize tree and site characteristics, proportion of live and dead trees, dead trees by size class and species; and proportion of attack by major bark beetle species.

Site characteristics and overstory summary for three DX sites

Site	No of Plots	Elevation (ft)	Slope (%)	Live (%)	Dead (%)	Dead (%)	Mean Density ± SE (trees ac^{-1})		Species Dominance (%)
					Beetles	*Unknown*	*Live*	*Dead*	
PLUM	29	4488-5118	3-53	97.5	1.7	0.8	343.7 ± 27.7	8.9 ± 3.0	PSME (37%), CADE (24%)
YOMI	37	4383-4948	6-66	66.1	18.6	15.3	81.5 ± 7.0	59.7 ± 7.2	CADE (30%), PSME (24%)
SEKI	29	5184-5961	19-102	66.2	16	17.8	16.5 ± 13.5	49.3 ± 9.0	ABCO (37%), CADE (28%)



Proportion of dead overstory trees for each species by size class



Proportion of attack by tree killing bark beetles at each DX site

- At DX sites tree mortality was lowest in at northern sites and highest at southern sites.
- Live tree dominance across the network is skewed towards shade tolerant species.
- Western pine beetle populations crashed in 2017, while fir engrave populations were increasing.
- In mixed conifer DX sites, fir engraver was the leading cause of recent bark beetle related tree mortality.

Extending Knowledge – Facilitating Conversation

On March 12 2018 we hosted a workshop for a diverse group of clientele. The workshop had 52 registrants and 45 attendees. Intended outcomes were:

1) Increase understanding of drought induced tree mortality and associated changes in the Sierra Nevada by sharing results of the drought mortality data collaborative.
2) Solicit input from partners and managers on useful data summary products.
3) Discuss ongoing collaboration on field data collection, interpretation and use.

Full site briefs, presentations and discussion notes available at:

http://ucanr.edu/treemortalitynetwork

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