Post-Drought Sierra Nevada Forests and how they vary with Management History and compare to Historical Forests

ECOLOGY PROGRAM *PACIFIC SOUTHWEST REGION * US FOREST SERVICE

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Following the 2012-2016 California drought, and the unprecedented tree mortality in the Sierra Nevada, forest managers have been left wondering what our future forests will look like. One statement commonly heard is that the drought mortality is "nature's way of balancing the system out and returning our forests to a more natural condition." While tree densities, which were inflated by years of fire suppression, are certainly reduced, it's important to understand the full suite of changes (e.g., in tree size, species and fuels) that have occurred in post-drought forests, many of which differ from historical conditions.

Project Overview

IN SHORT: We compared post-drought forests in treated (thinned and/or burned) stands versus untreated stands and relative to historical conditions.

GOAL: To evaluate how our common management practices influence forest resilience to drought and insect outbreaks. Study results will guide future treatments as we prepare for more prolonged, intense droughts as projected.

STATUS: The work showcased here is part of a larger project. Our first paper on how management history influenced tree mortality is also available: Restaino, C., Young, D., Estes, B., Gross, S., Wuenschel, A., Meyer, M., and Safford, H..2019. Forest structure and climate mediate drought-induced tree mortality in forests of the Sierra Nevada, USA. Ecological Applications 29(4):e01902. 10.1002/eap.1902 . Next, we are analyzing tree ring data to understand differences between drought survivors and dead trees, related to forest conditions.

Citation: Young, D., Meyer, M., Estes, B., Gross, S., Wuenschel, A., Restaino, C., and Safford, H. 2019. Forest recovery following extreme drought in California, USA: natural patterns and effects of pre-drought management. *Ecological Applications*. https://esajournals.onlinelibrary.wiley.com/doi/ epdf/10.1002/eap.2002

Study Background

QUESTIONS: What will our post-drought forests look like, based on residual and regenerating trees?

Post-drought, how do our current and future forests compare to historical forests, a forest restoration benchmark?

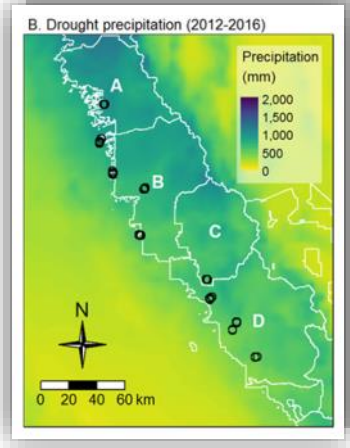
Did restoring forests alter their response to drought?

Historic conditions in a ponderosa pine stand circa 1917 (Sierra National Forest Photo HP03137).

We use historical forests (as described by their natural range of variation) as a benchmark in modern restoration, because those forests had high ecological function, Sierra Nevada species are adapted to them and they were very resilient to wildfire. We compared post-drought forests to historical forests to understand if the recent tree mortality event shifted forests closer or further from resilient conditions.

Additionally, the drought has offered an opportunity to evaluate common forest management practices. While one of the reasons we perform forest treatments like mechanical thinning and prescribed burning is to improve forest resilience to fire and other disturbances, we have little information on whether forest management shapes how forests respond to drought.

Field Measurements



Map showing monitoring sites across the central Sierra Nevada ranging from the Eldorado NF(A) to the Sierra NF (D). In 2017, we collected plot data at 10 paired (treated vs. untreated) sites in pine-dominated stands. At each site there were 16 plots. We measured tree data, fuels and seedlings and saplings at each 12.6 m radius plot.

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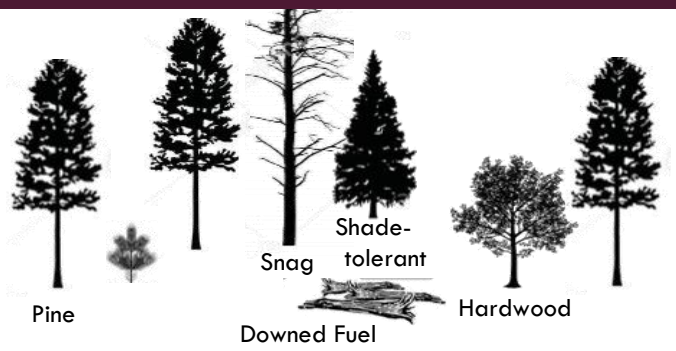
RESULTS

HISTORICAL FORESTS

Historic Sierra Nevada pine-dominated forests typically were more open, with fewer trees than modern-day forests. The few trees that were there were large and mostly pine. There wasn't much fuel on the forest floor because of the frequent fires that would come through about every 7 to 12 years. Those same fires also cleared out most of the smaller trees.



PRE-DROUGHT FORESTS

UNTREATED

Prior to the drought, fire suppression and early logging had wrought many changes in forests such as fewer large trees, infilling of small trees, a shift to more shade-tolerant species from pines and hardwoods (oaks) and increasing fuels on the forest floor.

TREATED

Through thinning and burning, managers had generally restored forests to historic conditions. They created more open stands, removed many of the small trees, particularly of shade-tolerant species (like white-fir and incense cedar) and reduced fuels.

POST-DROUGHT FORESTS

UNTREATED

After the drought, forests have fewer live trees and the biggest trees (mostly pines) have died; so shade-tolerant species are even more dominant. In most places, except those where the most trees died, live tree densities are still much higher than they were historically. And now, along with the high fuel loading on the ground, there are many standing snags. **Despite how many trees were killed in the drought, most untreated stands still require treatment to reduce shade-tolerant dominance, high tree and snag numbers and fuel loads.* Managed wildfires, where appropriate, may be the only way to reduce fuels across the expanse needed.**

***purple text = results interpretation**

TREATED

Treated forests have become even less dense than historical forests, but **there are enough saplings for the forest to recover, and reforestation will not be needed in most cases**. Here too, many of the largest trees and the pines were lost. The oaks though, are thriving and their increased presence **will likely confer future drought resilience and provide habitat for wildlife**. There are still relatively less shade-tolerant trees, **indicating treatment benefits persisted past severe mortality**. Like in untreated forests, there are many snags, which when they fall, **will accumulate into immense, far-reaching fuel loads leaving a legacy of recovering forests at risk to high-severity wildfire.**