CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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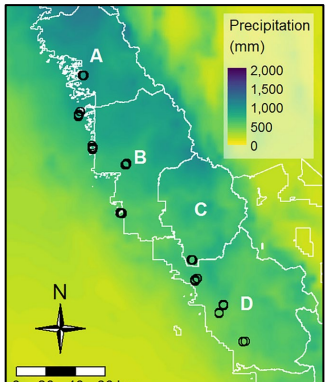
Forest recovery following extreme drought in California

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://doi.org/10.1002/eap.2002

Following the 2012-2016 California drought and unprecedented tree mortality in the Sierra Nevada, forest managers are wondering what our future forests will look like. While tree densities, 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 composition, and fuel loading) that have occurred in post-drought forests, many of which differ from historical conditions. This study compares post-drought forests to historical forests to understand if the recent tree mortality event shifted forests closer to or further from resilient conditions (see page 2).



Map showing monitoring sites and drought conditions across the central Sierra Nevada ranging from the Eldorado NF (A) to the Sierra NF (D).

Plot data was collected in 2017 at roughly 16 12.6 m radius plots at 10 paired (treated vs. untreated) sites in pine-dominated stands across the central Sierra Nevada. Data included information on fuels, individual trees, and regeneration.

The drought has also offered an opportunity to evaluate common forest management practices. While forest treatments like mechanical thinning and prescribed burning are often used to improve forest resilience to fire and other disturbances, this study adds information on how forest management may affect forest response to drought.

Management Implications

Untreated forests

- Untreated forests still require treatment to reduce shade-tolerant dominance, high tree and snag numbers, and fuel loads.
- Prescribed fires and wildfires managed for resource objectives may be the only way to reduce fuels across the expanse needed.

Treated forests

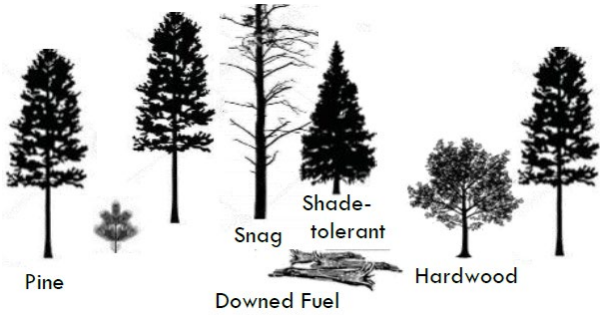
- There are enough saplings for the forest to recover and reforestation will not be needed in most cases.
- Increased oak presence will likely bring future drought resilience and provide habitat for wildlife.
- Low numbers of shade-tolerant trees indicate treatment benefits persisted past severe mortality.
- High numbers of snags leave recovering forests at risk to high-severity wildfire.

Suggestions for further reading:

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.

Historical Forests

Historical 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. Fuels were minimal and sparse because frequent surface fires occurred about every 7 to 12 years. Those fires cleared out most of the smaller trees, especially shade tolerant species like white fir and incense cedar.



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 historical conditions. They created more open stands, removed many of the small trees, particularly of shade-tolerant species, and reduced fuels.

Post-drought Forests

Untreated

After the drought, forests have fewer live trees and the biggest trees (mostly pines) have died; shade-tolerant species are even more dominant. In most places, except where the most trees died, live tree densities are still much higher than they were historically, particularly in smaller size classes. Along with the high fuel loading on the ground, there are many standing snags. Most untreated stands still require treatment to reduce shade-tolerant dominance, high tree and snag numbers, and fuel loads.

Treated

Treated forests are even less dense than historical forests, but there are enough saplings for the forest to recover. Many of the largest trees and pines were lost, but oaks are thriving, and their increased presence will likely provide for future drought resilience and provide habitat for wildlife. There are still relatively fewer shade-tolerant trees, indicating treatment benefits persisted past severe mortality. Like in untreated forests, there are many snags, which will leave recovering forests at risk to high-severity wildfire.