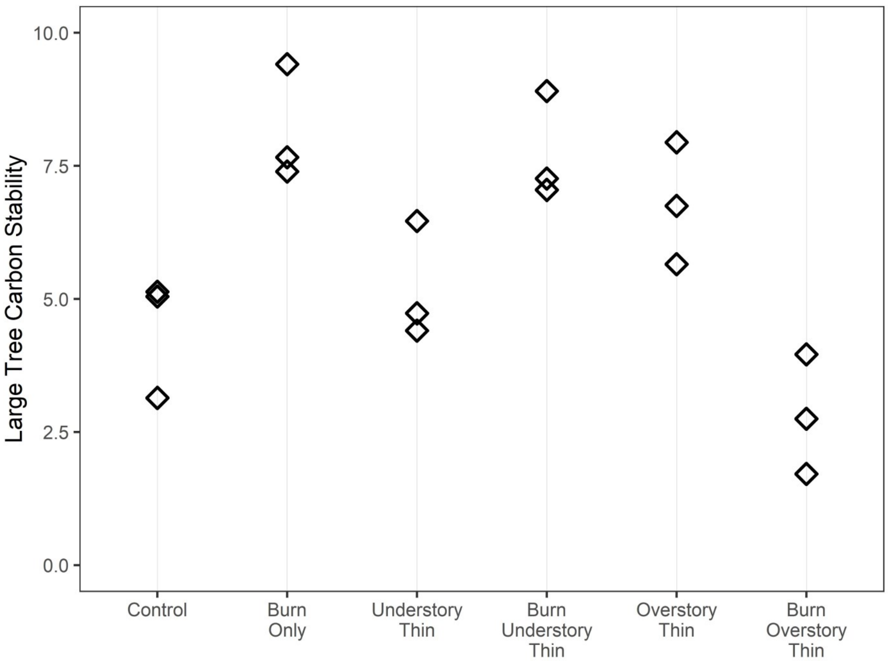
Earth Systems Ecology Lab



Temporal carbon stability of live trees (> 75 cm DBH) during the drought period. Treatments are ordered left to right by decreasing treatment intensity.

Non-stationary climate and forest carbon debt

Changes in prevailing climate and natural disturbance regimes are altering the carbon carrying capacity of fire-prone forests. While forest restoration techniques can stabilize carbon against high-severity wildfire, the efficacy of these treatments to mitigate carbon loss during drought is unresolved. The sensitivity of forest carbon to ongoing climate change will determine the carbon costs of maintaining forest resistance to high-severity wildfire. We utilized a long-term experiment that manipulated stand densities and surface fuel loads to quantify the effects of the 2012-15 California drought on the distribution of carbon as a function of treatment intensity and to quantify the effects of a second-entry prescribed fire on carbon dynamics.

We found that carbon stability and tree survival during the drought varied by treatment, but the relationship was non-linear. During the drought period, all treatments experienced a redistribution of live tree carbon into the dead tree and surface fuel carbon pools. We also found that the increase in drought-related fuel inputs influenced the carbon dynamics of the second-entry burn, increasing emissions in two of the three burn treatments when compared to the initial burn. The increases in emissions were largely driven by higher consumption of the dead tree and surface fuel pools. However, the second-entry burn consumed a portion of drought-related carbon debt, returning surface fuels back to pre-drought levels. Our results demonstrate that forest restoration techniques can increase carbon stability under extreme drought events but are unlikely to make forests completely resilient to non-stationary climate. Managing fire will be necessary to mitigate the risk of catastrophic wildfire, but the redistribution of carbon associated with non-stationary climate will increase the carbon cost of subsequent management.

Management Implications

Non-stationary climate is decreasing the carbon carrying capacity of frequent-fire forests

Drought-induced mortality increases the carbon debt of frequent-fire forests

Managing fuel inputs is necessary to prevent "mass fire" , but drought effects will increase the carbon cost of management

Prescribed fire can successfully deal with drought-related fuel inputs

Publication:

Goodwin, MJ, MP North, HSJ Zald, MD Hurteau, 2020. Changing climate reallocates the carbon debt of frequent-fire forests. Global Change Biology. doi: 10.1111/gcb.15318.

Funded by: California Department of Forestry and Fire Protection as part of the California Climate Investments Program grant no: 8GG14803

Contact Information

Matthew Hurteau: mhurteau@unm.edu

Marissa Goodwin: mjgoodwin@unm.edu

www.hurteaulab.org