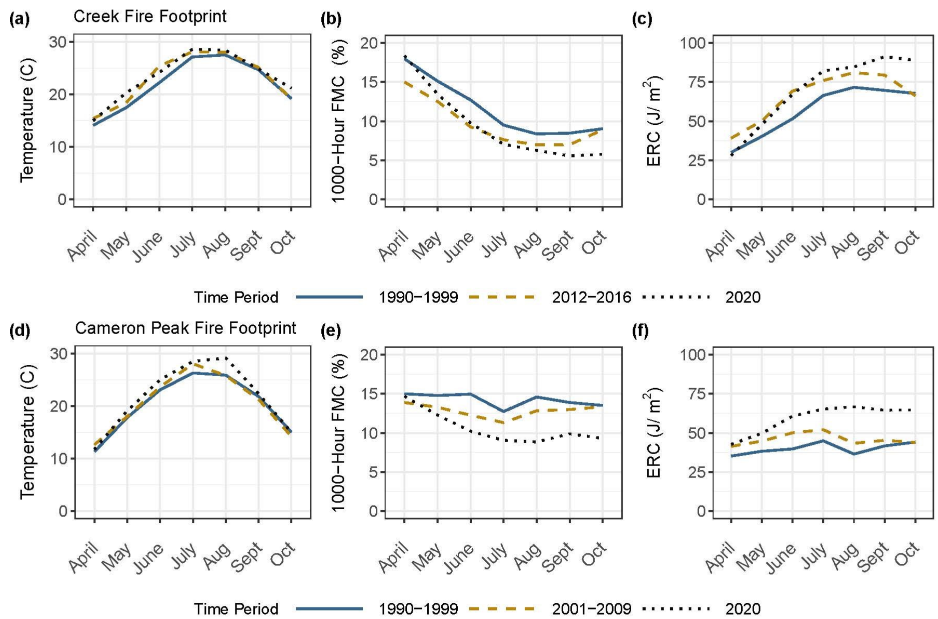
Earth Systems Ecology Lab



Average monthly temperature maximums (C), average 1000-hr fuel moisture content (FMC), and average energy release component (ERC) for the footprints of the Creek Fire (a-c) and Cameron Peak Fire (d-f). Time series for each site include 1990–1999, 2012–2016 or 2001–2009 (the respective drought period for each site) and 2020.

Tree mortality and fuel aridity increase potential energy release during wildfire

The proportion of fuel that is available to burn during wildfire is a function of fuel moisture content (FMC), which controls the amount of time and energy needed to vaporize fuel moisture before the ignition of a fuel particle can occur. Numerous studies show that rising temperatures are decreasing FMC in both live trees and dead fuels with corresponding increases in wildfire activity and area burned. Climate change is also increasing the likelihood of drought events and insect outbreaks which has resulted in widespread tree mortality in many forest ecosystems. Because dead fuels are inherently drier than live trees, tree mortality coupled with rising temperatures can substantially increase fuel availability and the amount of energy that can be released when wildfire occurs.

Here we used temperature and fuel moisture data to examine changes in FMC over the past three decades. Additionally, we calculated changes in potential energy release for two forests that experienced substantial drought and insect mortality and were subsequently burned by wildfires in 2020 (the Creek Fire in CA and the Cameron Peak Fire in CO). We found that tree mortality transitioned substantial amounts of biomass from live to dead fuel pools in both of these forests. Coupled with climate-driven decreases in dead FMC, this resulted in increases in fuel availability and the amount of stored energy available for release in the areas where the Creek and Cameron Peak Fires occurred. Our results demonstrate that fires that occur where there is a surplus of standing dead trees and downed logs (1000-hr fuels) may release substantial amounts of energy in the form of heat. Because heat energy release drives fuel ignition and wildfire spread, the combined effects of climate-driven tree mortality and fuel aridity likely play a role in the unprecedented fire behavior that has characterized modern wildfires.

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Management Implications

Tree mortality transitions biomass from live to dead fuel pools

Climate change is decreasing the fuel moisture content of dead fuels, which increases fuel availability

Increasing dead biomass combined with decreasing fuel moisture increases the amount of energy stored in the forest that can be released during wildfire

Energy release from combustion can contribute to a fire becoming plume-dominated

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Contact Information

Matthew Hurteau: mhurteau@unm.edu

Marissa Goodwin: mjgoodwin@unm.edu

www.hurteaulab.org