An unstoppable force: 21st-century wildfires cause a subalpine forest landscape to change fundamentally, regardless of suppression

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Background/questions/methods

Subalpine conifer forests of Greater Yellowstone were characterized historically by large stand-replacing fires that occur under extreme weather, are not limited by fuels, account for most area burned, and are generally not suppressible. Projections suggest 21st-century warming could initiate astonishing increases in the frequency and size of large fires, which may erode forest resilience. Fire managers can suppress smaller fires when conditions are not extreme, but whether fire suppression might alter future fire and forest patterns remains unresolved. We used a process-based forest model, iLand, to ask: *How might fire suppression influence 21st-century patterns of burning and forest resilience in subalpine forests of Greater Yellowstone?* We simulated a ~45,000-ha forest landscape in Grand Teton National Park from 1989-2100 with a scenario in which all fires were suppressed when burning conditions were not extreme and another scenario where all fires could burn. We compared cumulative area burned, percent forested area, forest age, and tree species composition. We expected area burned to increase during the 21st century, causing forested area to decline as tree regeneration failed after short-interval fire or within large burned patches. We also expected suppression to modestly slow the increase in cumulative area burned and reduce forest loss.

Results/conclusions

Fire activity increased slowly during the early-21st century; only 10% of cumulative area burned occurred from 1989-2055. After 2055, a climate threshold was crossed and area burned increased nonlinearly. Burning patterns did not differ between suppression and non-suppression scenarios. Percent forested area was inversely related to cumulative area burned. In 1989, 90% of the landscape was forested, and forested area remained high until ~2055 when the rate of burning accelerated. Forested area then declined rapidly and only 20% of the landscape remained forested in 2100. Lodgepole pine forests declined more frequently than spruce-fir, which occupy cooler-wetter locations at higher elevations. Lodgepole pine dominated 74% of forested stands in 1989 but only 49% in 2100, while spruce-fir dominance increased from 14% to 27% of stands during the same period. Forest age also declined, as expected. In 1989, 50% of the forest was young (< 40 years old). By 2100, 94% of remaining forest was young. Statistical climate-fire models for subalpine forests of Greater Yellowstone project substantial increases in fire activity. Our results indicate that fire suppression does little to alter these trajectories and that 21st-century fire may cause subalpine forest landscapes to change fundamentally.