2020 Colorado wildfires: tree germination 1-year post-fire

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Introduction: The 2020 Colorado wildfire season resulted in nearly 600,000 ac of burned forest across Colorado and Wyoming in multiple forest types. Information on early post-fire regeneration is useful for managers as they strategically plan reforestation efforts. This information is particularly important due to uncertainties around post-fire forest recovery across the western USA, particularly in an era of changing climate (Stevens-Rumann et al., 2018). Additionally, some of the higher-elevation forests burned by these 2020 Colorado wildfires (e.g., lodgepole pine and spruce-fir forests) experienced compound disturbances, such as mountain pine and spruce beetle mortality followed by the 2020 wildfires. Understanding initial germination and regeneration dynamics is crucial for strategizing short- and long-term forest recovery related activities, such as reforestation and erosion mitigation.

Figure 1 (right): A photo of a high severity burn area in the2020 Cameron Peak Fire.

We measured tree regeneration 1-year following fire in 108 plots in four 2020 wildfires (Calwood, Cameron Peak, East Troublesome, and Mullen Fires) that burned in Colorado and Wyoming and across four forest types (ponderosa pine, mixed conifer, lodgepole pine, and spruce-fir) to gain an initial understanding of immediate post-fire forest recovery, and to understand differences in initial forest recovery across forest types to identify if shifts in vegetation may be occurring.

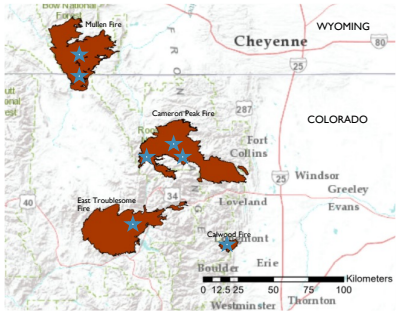


Figure 2: Map of four 2020 Colorad0 wildfires (red polygons) with approximate study sites (blue stars) in Colorado and Wyoming.

Methods: Field sites were selected based on accessible terrain (i.e., within 1.5 mi of roads, no deep stream crossings, and on slopes <40% grade) within fire perimeters. Low-moderate and high severity burn areas were initially identified using BAER soil burn severity layers in Spring 2021. We also performed field verification for severity types, and high severity burn areas were classified as 100% overstory mortality where no surviving trees were within 100 m proximity. We measured tree regeneration, understory vegetation recovery, and other variables in 108 plots. Plots are based on the Colorado Forest Restoration Institute "mothership" protocol, which includes a full botanical survey within a 1/10th ac area. Tree germination was surveyed in three 1/100th ac subplots within the larger 1/10th ac plot at plot center (depicted in green (Figure 3), and along the north and east transects.

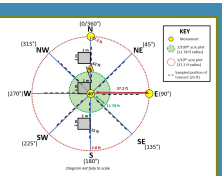
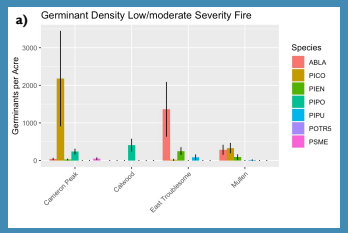
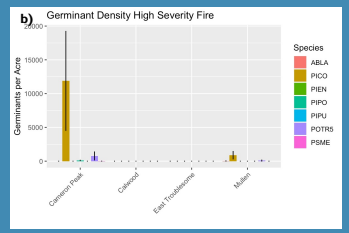


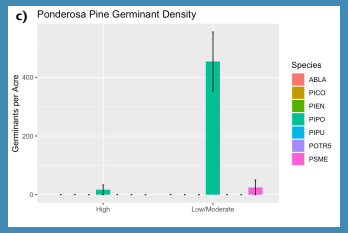
Figure 3: Depiction of CFRI "mothership" monitoring plot. Seedlings are measured in three 1/100th ac plots within the 1/10th ac plot.

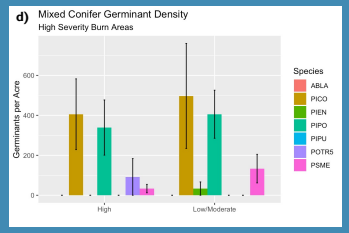
Figure 4 (right): CFRI post-fire monitoring crew, 2020 Cameron Peak Fire in a high severity burn area

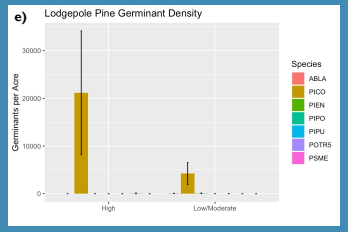
Figure 5: Figures (a-f) illustrating tree germination per acre following the 2020 Colorado wildfires by species; a) germination averaged across low-moderate severity burn plots by wildfire, b) germination averaged across high-severity burn plots by wildfire, and germination averaged by severity for four forest types across all fires for c) ponderosa pine, d) mixed conifer, e) lodgepole pine, and f) spruce-fir.

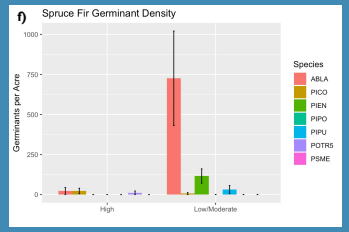












Discussion: Our preliminary findings indicate that tree germination is occurring in low-moderate severity burn areas by multiple tree species, but in high severity burn areas, only two fires (Cameron Peak and Mullen) saw germination, which was dominated by lodgepole pine. Germination was highly variable across wildfires and forests types.

In ponderosa pine forests types, low-moderate severity burn areas had ~400 germinants per acre, whereas high severity burn areas had only ~25 germinant per acre. Mixed conifer forest types were dominated by lodgepole and ponderosa pine across both severity types and regeneration of Douglas-fir and aspen had >25 germinants/ac in high severity burn areas, whereas in low-moderate severity burn areas, Douglas-fir and Engelmann spruce were present. Lodgepole pine forests were dominated by lodgepole pine germination, with much higher rates of germination in high severity burn areas (>20,000 germinants/ac) than in low-moderate severity burn areas (<5000 germinants/ac). Additionally, germination by lodgepole was highly variable, with some plots having little to no germination and others having >30,000 germinants/ac. In spruce-fir forests, germination of subalpine fir, lodgepole, and aspen were occurring in high-severity burn areas, but at low rates (<25 germinants/ac), while in low-moderate severity burn areas, germination was dominated by subalpine fir (~740 germinants/ac), with lower rates of germination of Engelmann spruce (~125 germinants/ac), blue spruce (~25 germinants/ac), and lodgepole pine (<25 germinants/ac).

Continued monitoring of germination and establishment rates into the future will be important to inform recovery activities, as these tree species will continue to produce germinants in future years, and germinants will also experience high rates of mortality.

Figure 5 (right): Photo of a lodgepole pine germinant in a high severity burn area in the 2020 Mullen Fire, CO.

Next Steps:

- Include other variables such as aspect, elevation, slope, topography, moisture stress, understory vegetation, fine and coarse wood, etc. in analysis,
- Share results with managers who are performing reforestation activities on these fires,
- Continue to monitor these plots 2-, 3-, 5-, 10- years post-fire if funding is available.

Literature cited:

Stevens-Rumann, C.S., Kemp, K.B., Higuera, P.E., Harvey, B.J., Rother, M.T., Donato, D.C., Morgan, P. and Veblen, T.T., 2018. Evidence for declining forest resilience to wildfires under climate change. *Ecology letters*, *21*(2), pp.243-252.

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