ABSTRACT

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Age alone is not enough: Multiple drivers control postfire stand development in Rocky Mountain conifers

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Background/Question/Methods:

High-severity, infrequent fires in subalpine and montane forests shape landscape mosaics of stand age and structure for decades to centuries. As fire activity increases, understanding factors that foster convergence or divergence in structure and function (tree density, size, and productivity) among postfire stands is increasingly important for anticipating future landscape patterns. We used a process-based forest landscape and disturbance model (iLand) to ask: *How do initial postfire tree density, climate drivers, and soil characteristics interact to influence among-stand variation in development of same-aged forest stands and how does the relative influence of drivers vary among species?* We parameterized iLand for four widespread conifer species [lodgepole pine (*Pinus contorta* var. l*atifolia*), Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), Engelmann spruce (*Picea engelmannii*), and subalpine fir (*Abies lasiocarpa*)]. Simulations were initialized with field data from stands regenerating from stand-replacing fires in Greater Yellowstone (Wyoming, USA) that spanned a wide range of stem densities and elevations. Stand development was simulated for 300 years under current climate without further disturbance. We expected differences in initial tree density to dominate lodgepole pine stand development and differences in climate and soils to dominate stand development in the other conifers.

Results/Conclusions:

Simulations of stand development using iLand performed well. For example, simulated age-specific stem densities, basal areas, tree heights, tree diameters, and stand-level means fell within observed ranges for lodgepole pine and Douglas-fir, and among-stand variation persisted over time. Early variation among lodgepole pine stands (n=70) was driven primarily by initial density (33–343,794 stems ha^{-1}). However, climate was the key driver of among-stand variation in basal area after 100 years and density after 250 years. Over 275 years, stand density coefficient of variation (CV) declined from 96% to 25% (mean 945 stems ha^{-1} at year 300) and basal area CV from 67% to 19% (mean 28.41 m^2 ha^{-1}). Variation among Douglas-fir stands (n=38) was also driven by initial density (14-13,653 stems ha^{-1}), but soils eventually became the dominant driver of basal area variability and among-stand variation was more persistent. Over 275 years, stand density CV declined from 82% to 36% (mean 240 stems ha^{-1}) and basal area CV from 58% to 42% (mean 15.78 m^2 ha^{-1}). Heterogeneity across forest landscapes affects wildlife habitat, ecosystem processes (e.g., nutrient cycling), and susceptibility to future disturbances (e.g., insect outbreaks). Understanding factors that determine postfire stand variability is increasingly important as historical drivers change.