Spatial and temporal reconstruction of twentieth-century growth trends in a naturally-seeded pine forest
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Abstract (Summary)
This research uncovered growth trends from 1920 to 1990 in a stand of south-western ponderosa pine (Pinus ponderosa Dougl. ex Laws. var. scopulorum), and investigated the role of climate and competition in shaping the observed trends. I focused on a 800 x 400-m permanent plot maintained by the U.S. Forest Service since 1920 near Flagstaff, Arizona. Temporal growth trends were quantified by size class using a mixed linear model applied to forest inventories, repeated at 10-year intervals. Tree density and stand basal area increased from 1920 to 1990, but growth rates of individual trees declined regardless of size class. Growth of large pines, whose density increased slightly, declined more than that of small pines, whose density almost tripled. I argued that competition for resources reduced growth rates of large trees more than those of small trees.

Geostatistical analyses showed that, from 1920 to 1990, stem size was spatially autocorrelated over distances no greater than 30 m, a measure of average patch diameter. Tree density increased by increasing the number of pine groups rather than their horizontal dimension. Increased tree crowding corresponded to lower average, variance, and spatial dependence of individual growth rates. Since growth variation was less related to inter-tree distance at higher tree densities, density-dependent limitation of tree growth did not necessarily correspond to distance-dependent growth rates.

No significant trend from 1910 to 1990 was found in climatic variables computed from daily meteorological records. Dendroclimatic analyses showed that climate-tree growth relations had not significantly changed over the twentieth century. Annual growth of both large and small pines was positively related to winter snowfall and to July monsoon rainfall. Periodic basal area increment obtained from dendrochronological data revealed that forest inventories over-estimated growth rates, especially for small pines. On the other hand, tree-ring chronologies developed using different standardization options showed different temporal trends. Repeated forest inventories quantified growth of individual trees and of the entire stand, but integrated bark and wood increment. Dendrochronological data had superior temporal resolution and accuracy, but their limited spatial coverage hindered representation of growth trends for the entire stand.

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