

Fire Exclusion Linked to Increased Forest Density in a New Mexico Piñon-Juniper Savanna Landscape

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Piñon-juniper (PJ) ecosystems cover approximately 30 million ha in the western United States (West 1999). High variability in species assemblages and structure exists across this large geographic range, driven in part by varying climate. Among the three functional PJ types (persistent PJ woodlands, PJ savannas, and PJ shrublands), the least is known about ecosystem processes and vegetation dynamics in PJ ecosystems containing a substantial grass component - PJ savannas (Romme et al. 2009). The best supported model for fire regimes in PJ is one of infrequent, high-severity fire (e.g., Floyd et al. 2004). However, it is logical that: (1) the grass component of PJ savannas could support frequent, low-severity fire, and (2) exclusion of frequent fire is a plausible mechanism for the observed increases in PJ tree density in PJ savannas. To assess these hypotheses I used dendroecological methods to reconstruct the history of fire, forest age structure, and composition on a ~ 30,000 ha PJ-dominated mesa landscape (Rowe Mesa, New Mexico), located at the PJ (two-needle pinyon (*Pinus edulis*)-Rocky Mountain juniper (*Juniperus scopulorum*), grassland, ponderosa pine (*Pinus ponderosa*) (PIPO) ecotone (Margolis 2014). At seven sites located on a 7-km grid I collected fire scars, aged trees, and measured forest composition and density. I cross-dated 112 fire-scarred trees (8% juniper, 17% pinyon, and 74% ponderosa) containing 630 fire scars that burned during 87 unique fire years (1547-1899). Fires recorded synchronously at multiple sites (spreading fires) occurred every 7.8 years on

average. Fires recorded at over half of the sites (wide-spread fires) occurred every 23.7 years on average. Evidence of high-severity fire (e.g., even-aged stands or groups of fire-killed snags or logs) was not observed. Instead, multi-decadal variability in tree establishment was negatively correlated with fire frequency (i.e., frequent fire reduced tree establishment). Peak PJ establishment was synchronous with the collapse of the frequent fire regime and dry conditions in the late 19th century. I conclude that frequent, low-severity fires burning grass fuels historically maintained low tree densities across what was a PJ-PIPO savanna landscape. Further, late 19th century fire exclusion associated with the removal of fine fuels from intensive livestock grazing was the primary driver of current high tree densities on Rowe Mesa dominated by PJ species (mean density = 881 live trees ha⁻¹, 94 percent of which were < 130 years old and likely would not have been present when the frequent fire regime was active). Wildlife species that favor a more open, grassy environment would not be favored by the documented changes, whereas other species that prefer a dense woodland environment could benefit from the changes.

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