ABSTRACT OF DISSERTATION

FIRE, CLIMATE, AND FOREST STRUCTURE IN PONDEROSA PINE FORESTS OF THE BLACK HILLS

A prevailing model for historical conditions in ponderosa pine forests is that frequent surface fires maintained open, low-density forest stands composted primarily of old, large trees. However, this model may not apply uniformly to ponderosa pine forests in the Black Hills of southwestern South Dakota and northeastern Wyoming. Infrequent, extensive stand-replacing fires also may have occurred and apparently resulted in large landscapes of dense, even-aged forest. I examined this alternative model for the Black Hills using fire-scar and tree-age data. Fire chronologies from over 1000 trees collected at over 50 locations span the past four to six centuries. Compared to other ponderosa pine forests in the southwest US or southern Rocky Mountains, these communities burned less frequently. Surface fire frequency varied from an average of every 10 to 13 years at lower elevation sites on the ponderosa pine - northern Great Plains prairie ecotone to as much as 30 to 33 years at higher elevations. Mid-elevation interior sites at Jewel Cave National Monument burned on average every 20 to 26 years. Fires largely ceased in all areas shortly after Euro-American settlement began in the 1870s. Pre-settlement age structure documents very pulsed patterns of tree establishment, with the most abundant cohort occurring from 1770 to 1805. Cohorts established during wet periods in the northern Great Plains. Extended wet conditions likely promoted abundant tree regeneration, fast growth, and longer periods between surface fires that would have permitted more trees to reach canopy status, therefore becoming more “fireproof” during later surface fires. The absence of fire was likely more critical to structuring the current forest than any potential

variation in fire behavior. The late 1700s cohort also followed an extended drought from1756 to 1761, and tree mortality caused by moisture stress may have contributed to stand opening. Patchy crown mortality from fire coupled with other disturbances undoubtedly contributed to stand opening before pulses of climatically driven seedling establishment. Mortality and regeneration were likely completely uncoupled processes and even-aged structure is not definitive evidence of stand-replacing fires in ponderosa pine forests. However, abundant fire scars indicate that surface fires were ubiquitous across the Black Hills landscape. Thus, the prevailing historical model of frequent surface fires promoting and maintaining mostly open forest stands is largely supported by the tree-ring evidence, although the Black Hills had a greater range of variability in fire behavior than ponderosa pine forests of other regions as documented by historic descriptions of the forest at settlement.

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