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Scaling laws and fire-size distributions in historical low-severity fire regimes

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Low-severity fires are recorded by fire-scarred trees. These records can provide temporal depth for reconstructing fire history because one tree may record dozens of separate fires over time, thereby providing adequate sample size for estimating fire frequency. Estimates of actual fire perimeters from these point-based records are uncertain, however, because fire boundaries can only be located approximately. We examined two modeling approaches for indirectly estimating fire-size distributions without attempting to establish individual fire perimeters. The slope and intercept of the interval-area function, a power-law relationship between sample area and mean fire-free intervals for that area, provide surrogates for the moments of a fire-size distribution, given a distribution of fire-free intervals. Analogously, by deconstructing variograms that use a binary distance measure (Sorensen's index) for the similarity of the time-series of fires recorded by pairs of recorder trees, we provide estimates of modal fire size. We link both variograms and interval-area functions to fire size distributions by simulating fire size distributions on neutral landscapes with and without right-censoring to represent topographic controls on maximum fire size. From parameters of the two functions produced by simulations we can back-estimate means and variances of fire sizes on real landscapes. We compare these estimates to those from indicator Kriging (at different thresholds between 0 and 1) on the real landscapes. This scale-based modeling provides a robust alternative to empirical and heuristic methods and a means to extrapolate estimates of fire-size distributions to unsampled landscapes.