



Multi-scale synthesis of historical fire regimes along the south-central US prairie-forest border

[Molly V. Rooney and Michael C. Stambaugh. Fire Ecology, 15:26; 2019](#)

In this study, researchers synthesized the findings from a growing network of tree-ring based fire-scar studies in the prairie-forest transition zone of the south-central US to increase the understanding of historical fire regimes of the region. Tree-ring based fire history reconstructions offer insights into long-term ecosystem changes and associated human influences, and a recent increase of high-severity fires in the region has led to heightened interest in better understanding the past, to manage current and future ecosystems. The findings from three new site-level fire-scar data sets, and those from 10 previously published similar studies (13 total fire history study sites) were compared, and the regional fire regime characteristics of frequency, severity, extent, and seasonality were synthesized and reported.

The 13 study sites were located across Oklahoma (n=10) and Texas (n=3) along the north-south oriented prairie-forest ecotone between the eastern deciduous forest and Great Plains. Study sites were located within the Cross Timbers, Blackland Prairie, and Oak-Hickory

MANAGEMENT IMPLICATIONS

- Historical fire regimes at locations across the prairie-forest border were dominated by frequent, low-severity, dormant-season fires.
- These data provide important context for policies, planning, and management of forests and grasslands.

ecoregions, which support a matrix of forests, woodlands, savannas, and prairies. Here, prairies are typically found on flatter portions of the landscape, which transition into forests in areas of increased topographical relief, lower soil fertility, and riparian zones. Due to site and environmental factors, trees are mostly short and of poor form with low economic value, which has led to this region retaining one of the most extensive uncut forests in the United States, and thus a unique opportunity to document long-term fire regime characteristics through tree-ring and fire-scar analyses.

To reconstruct the historical fire regimes, basal cross-sections were removed from live and dead trees at all 13 study sites. The number of trees sampled

[2010](#) for more on this) were used to assign the year, and when possible, the season, of occurrence for all fire scars identified.

Site-level (~1 km²) fire-regime characteristics were compared among all 13 study sites, and then synthesized to describe these characteristics at the regional (~140,000 km²) scale. Fire frequency was calculated via 'fire intervals.' This metric refers to the number of years between fire scars on a tree, or at the region-level, when considering all 13 sites. Fire severity was estimated from the percentage of trees recording at a site which were scarred per fire year, and fire seasonality was determined based on fire scar position within the annual growth ring and classified as being in the earlywood, latewood, or dormant. A fire extent index (FEI) was calculated to evaluate the regional extent of fire years, determined as the product of the number of sites recording fire (0 to 13) and the average percentage of trees fire-scarred. For both the site- and region-levels, fire frequency, severity, and seasonality were summarized for the entire time periods included in the tree-ring record, and also three sub-periods corresponding to prevailing patterns of land uses and occupying culture: pre Euro-American Settlement (EAS), post-EAS, and recent use.

In all, fire-scar data from 595 trees from 13 study sites, showed that historically, fire was generally frequent and largely of low-severity (see Fig. 3 from the study below). The maximum time span recorded at any site was from 1636 to 2010 (374



Post oak (*Quercus stellata*) trees of short stature and poor form grow to old age in the Cross Timbers ecoregion. Photo taken at the Wichita Mountains National Wildlife Refuge in southwest Oklahoma.

at each study site ranged from 34 to 69 trees; 11 of the sites included samples only from post oak (*Quercus stellata*), one site included samples only from shortleaf pine (*Pinus echinata*), and one site contained samples from multiple species (post oak, Shumard oak (*Q. shumardii*), blackjack oak (*Q. marilandica*), and black hickory (*Carya texana*)). Standard dendrochronology techniques (see [Speer](#)

Historical fire regimes along the prairie-forest border

years; Cache Creek study site in the Wichita Mountains National Wildlife Refuge), with a common period of 1770 to 2002 (232 years) provided by all 13 sites. During the common time period, 223 fire events (222 fire intervals) were detected, with an average of 61 different fire events detected per site. During this time period, fire interval length ranged from 1 to 66 years, with a mean fire interval (mfi) of 5.1 yr across all sites. The shortest mfi was detected at the Tallgrass Prairie Preserve (northern-most site, 2.2 yr) and the longest at Purvis Creek State Park in east Texas (second southern-most site, 8.1 yr). During the pre-EAS time period, the mfi for all sites was 5.2 yr; 6.8 yr during the EAS time period; and, 5.1 yr during the recent use time period (only six of the 13 sites were included in this calculation). Changes in fire frequency through time were not consistent across all sites. For example, the four northern-most study sites exhibited increased fire frequency post-EAS, while the group of six sites to the south showed less frequent fire, and the three southern-most sites (all in Texas) showed mixed results (two

increased, one decreased in frequency).

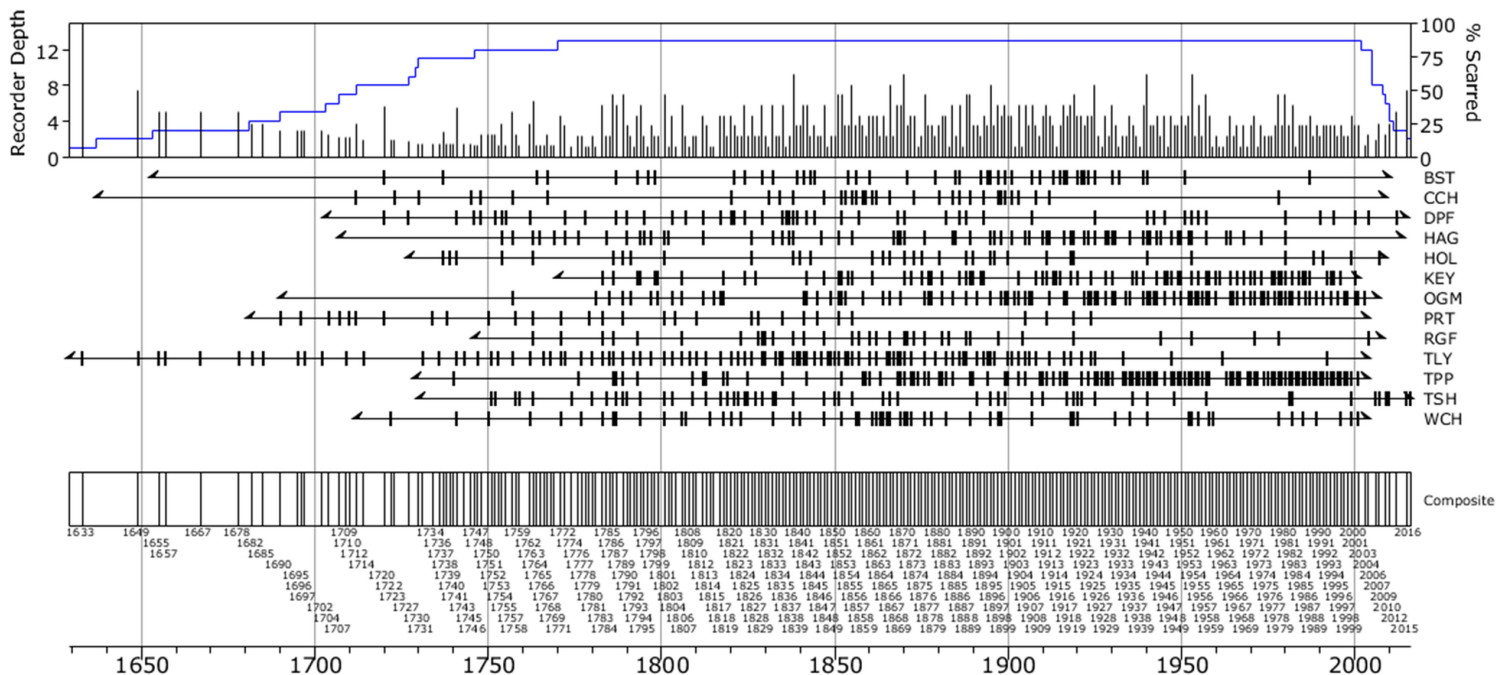
At the region-level, fire events were two to seven times more frequent than at the site-level. The region-level mfi was of 1.04 yr (range: 1-2 yr) and only 10 years showed no fire detected from 1770 to 2002. In the pre-EAS time period, the region-level mfi was 1.08 yr, compared to 1.0 during the post-EAS period.

Most fires were calculated to be low-severity. During the entire time period, and post-EAS, the majority of fires scarred between 1 and 5% of the trees recording; while during the pre-EAS and recent use periods, the majority of fires scarred 6 to 10%. For the time period common among all sites (1770-2002), FEI trended upward until about 1850, after which it stabilized and then began to decline between 1910 and 1920. All sites were dominated by dormant-season fires (ranging from 58 to 97% dormant at all sites). The predominance of dormant season fires suggest that lightning has not historically been an important fire ignition source, as lightning occurs primarily during the summer growing season.

In conclusion, the results from this study show that frequent fire has a long and important role in the ecology of the prairies, woodlands, and forests of the prairie-forest border. Fire frequency generally increased following EAS, while severity decreased, likely related to fragmentation of fuels and land-use changes (likely related to livestock grazing). The findings in this study show that interactions between humans, vegetation, and fire have varied with human population levels and culture. The unique long-term data presented in this study has fire management implications to the conservation of wildlife, range and grazing management, controlling the expansion of eastern redcedar (*Juniperus virginiana*), and wildfire risk management.

FOR FURTHER READING

[Speer, J. H. 2010. Fundamentals of Tree-Ring Research. University of Arizona Press, Tucson, Arizona, USA.](#)



Fire-scar records of 13 oak woodlands sites across the south-central US during the period 1636 to 2015 C.E. Horizontal lines represent the period of record of each site (i.e., all trees combined) with fire event years shown as bold vertical tick marks. Site codes (right) correspond to Table 1 in the publication. Years at bottom represent the occurrence of fires across the study region. Top panel shows the number of sites represented through time (i.e., recorder depth, blue line) and the percentage of sites recording fire (percent scarred, vertical bars).

