NEW DATA HIGHLIGHTS ROLE OF FREQUENT, WIDESPREAD SURFACE FIRES IN LAKE STATES PINE FORESTS

Historical fire characteristics in the Lake States are commonly defined by a single metric - fire rotation intervals (a spatial-temporal metric) - which are often determined using Euro settlement-era General Land Office (GLO) data. A closer look suggests GLO data cannot detect surface fires which were the primary disturbance agent in the region driving forest dynamics. These findings call into question the ways we view historical disturbance, but also current management practices.

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In the Great Lakes Region (GLR) fire rotation, or the number of years it takes to burn an area equivalent to the area of interest, is an extensively used metric calculated with Euro-settlement era General Land Office (GLO) records. However, fire rotation and GLO records are best suited for understanding high-severity fires. Techniques used to reconstruct fire history vary by the nature of evidence left behind. Frequency metrics, like mean fire return interval (MFRI) are most appropriate in frequent fire systems with low levels of tree mortality, whereas area-based estimates, like fire rotation interval, are most appropriate where higher-severity fires leave few surviving trees and subsequent even-aged stands occur.

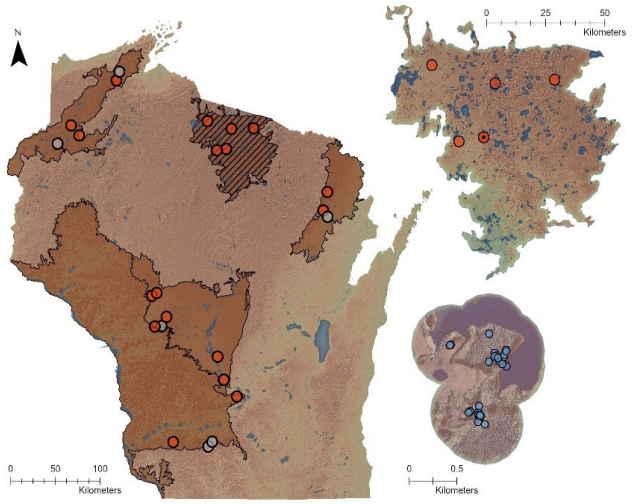
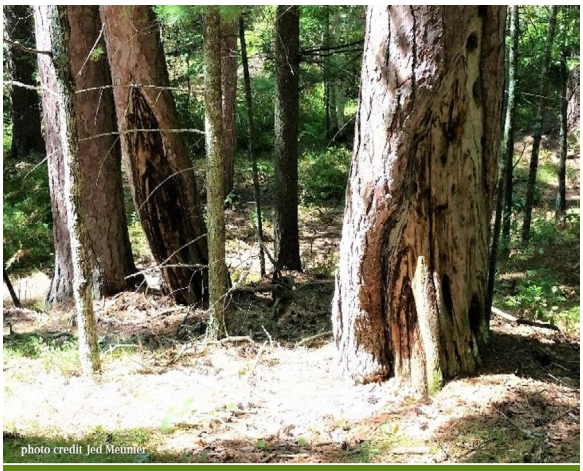


Figure 1. Fire history study sites spanning WI evaluated at regional (1000s km^2), landscape (10s km^2), and site (1s km^2) scale. Photo (in upper right) is of fire scarred red pine in old growth site.



MANAGEMENT IMPLICATIONS

1. GLO data described sites (e.g., composition, density) reasonably well, but not scale or frequency of fires.

2. Low-severity fires were frequent (every 9 years on average) and widespread (858–2,564 km^2 per year) across WI (> 60 times assumed historical averages of ca. 40 km^2).

3. Regionally significant fire years (1000s km^2) occurred every 10 years and were associated with moderate drought.

4. Lake States red pine forests lack heterogeneity that would have been common with frequent, low-severity fires and this phenomena is likely much more widespread than once appreciated. Management needs to attempt to build greater heterogeneity across these forests.

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A growing body of evidence suggests that low-severity fires were more important in great lakes systems than previously believed and in need of greater evaluation.

To evaluate fire rotation methods generally and GLO data specifically for describing fire regimes, researchers compared tree-ring and GLO data across 26 different sites (34 stands). GLO data was in many ways well aligned with tree-ring data; pines were almost always noted in survey points closest to research plots, density estimates were similar in most cases, and the fire years recorded by surveyors were detected with tree-ring methods as well. This research also determined that GLO fire records do not provide good data for low-severity fires, especially within the commonly used 15-year detection windows used for calculating fire rotation. Within this 15-year window multiple fires were detected at all fire history sites while none of the GLO sites nearest our tree-ring fire history sites noted fire. Fire rotation intervals ranged from 11 (NE Sands) to 34 (N. Highlands) years across ecological landscapes. Notably, High-severity rotation intervals calculated with GLO data (Schulte and Mladenoff 2005) were 65 and 98 times longer in these same landscapes.

High-severity fire regimes are typically found in cold, wet environments where ignition and conditions conducive to burning (e.g., extreme drought) occur infrequently and large patches of high-severity fire, which comprise most of the area burned, drive landscape dynamics. Alternatively, moderately wet climates are most fire prone due to greater fuel production but also periodic dry spells for burning, promoting frequent low- to moderate-severity fires. This research found an increasing role of drought with larger fire years (Fig. 2). Some regionally significant fire years were also pronounced droughts (e.g., 1697, 1736, 1800 etc.), including 1736 one of the most extreme droughts in > 400 years. More commonly however, fires occurred under moderately dry conditions which in turn occurred more regularly than extreme drought and could have helped moderate severe fire effects.

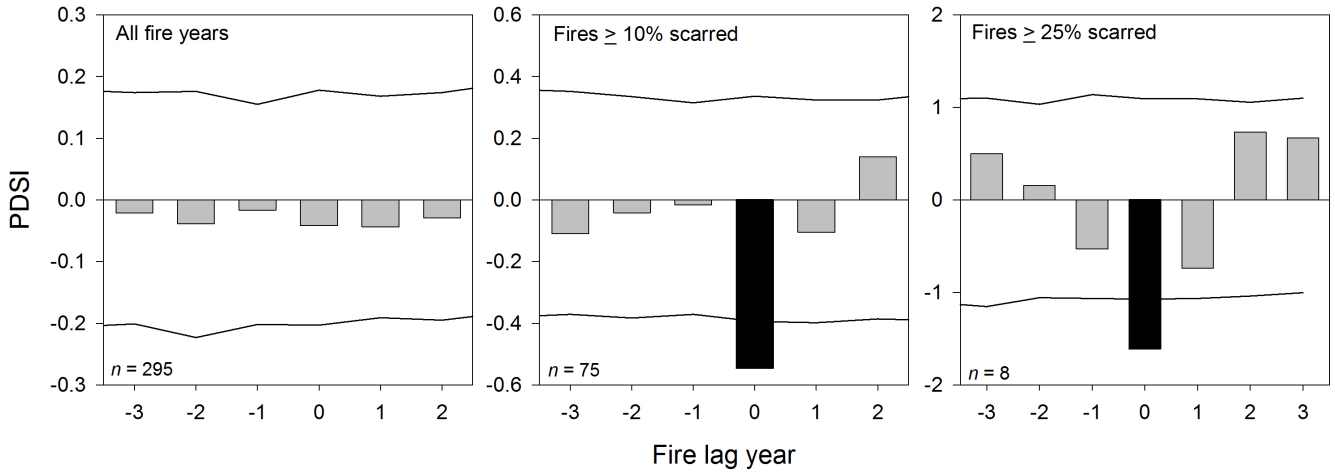

Figure 2. Average Palmer Drought Severity Index (PDSI) across Wisconsin for years prior and subsequent to fire event years (year 0) for all fires and those with > 10%, and > 25% average rate of scarring across all ecological landscapes. Positive PDSI values indicate wet conditions, negative values represent dry conditions; note changing scale of y-axes. Solid bars indicate PDSI values outside of a 99% confidence interval (95% CI depicted by lines).

Reduction of forest compositional and structural diversity is a widespread problem with increasing evidence that fire created heterogeneity critical for maintaining species diversity and ecosystem resilience. This new research suggests that historically fire was not only frequent and important at stand scales but was regionally significant across different landscapes. It suggests that we may need to scale up the use of fire across landscapes to meet the magnitude of the problem – a nearly universal increase in forest homogeneity.

Meunier, J., Shea, M. 2020. Applying the usual rules to an unusual ecological situation: fire rotation in Great Lakes pine forests. Forest Ecology and Management, 472 https://doi.org/10.1016/j.foreco.2020.118246.

Schulte, L.A., Mladenoff, D.J., 2005. Severe wind and fire regimes in northern forests: historical variability at the regional scale. Ecology 86, 431–445. https://www.fs.usda.gov/treesearch/pubs/25599