Reanalysis of the Fire History in *Pinus resinosa* stands of the Mississippi Headwaters, Itasca State Park, Minnesota

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Objectives

The objectives of this research were to reconstruct historical fire frequency, evaluate the accuracy of a fire history study previously conducted in Itasca State Park (Frissell, 1973), and evaluate the relationship between climate and fire in north-central Minnesota. This project was preformed as a portion of the North American Dendroecological Fieldweek (NADEF) which took place July 4-10, 2004.

Study Site

The study site (*Figure 1*) is located in the north central portion of Minnesota on the shores of Lake Itasca at 47º13'1.2" N latitude and 95º12'0.0" W longitude. The area consists of approximately 32,000 acres of land and over 100 individual lakes. Three sampling locations (Peace Pipe Vista, Preachers Grove, and White Pine Ridge) were selected which were representative of those sampled in the previous study by Frissell (1973). These sites are in a mixed pine and hardwood stand dominate by *Pinus resinosa, Pinus banksiana,* and *Pinus strobus,* between 140-150 meters above sea level. Peace Pipe Vista (*Image 1*) and Preachers Grove (*Image 2*) are located approximately 1km apart along the East Arm of the lake. White Pine Ridge (*Image 3*) is located on the West Arm of the lake.

Figure 1: Study Site


Image 1: Peace Pipe Vista


Image 2: Preachers Grove


Image 3: White Pine Ridge

Methods

Complete cross-sections were cut with a chain saw (*Image 4*) from stumps, snags, and downed logs (Arno and Sneck, 1977). Local declining trees were cored to establish reference chronologies that would facilitate the dating of the fire scars. The cross-sections and cores were taken to the laboratory and sanded (*Image 5*) using progressively finer grit sandpaper (120, 220, 320, and 400) until the cellular structure of the wood was visible at 10X magnification (*Image 6*). All tree rings were crossdated to their exact year of formation (Stokes and Smiley, 1996) and all fire scars embedded within the rings were recorded. Interannual fire-scar positions (dormant season (*Image 7*), early-earlywood (*Image 8*), middle-earlywood, late-earlywood, latewood (*Image 9*)) were also recorded to determine seasonal variability of fire occurrence (Baisan and Swetnam, 1990; Grissino-Mayer and Swetnam, 1993). The data was then entered into FHX2 software for the final statistical and graphical analyses (Grissino-Mayer, 2001). The program was used to compute measures of central tendency such as, mean fire interval (MFI), median fire interval, and Weibull median interval (WMI). Additionally, superposed epoch analysis was preformed to determine the link between climate and fire in our sites. Master dating chronologies were created once all tree rings had been measured.


Image 4: Sample acquisition


Image 5: Sample preparation


Image 6: Sample analysis


Image 7: Dormant Scar


Image 8: Early-earlywood Scar


Image 9: Latewood Scar

Results

Each of the studies, NADEF (2004) and Frissell (1973), recorded total intervals (total number of fire years - 1) of 17 for the period of time analyzed. The calculated mean fire intervals for the NADEF (2004) and Frissell (1973) studies were nearly equivalent at 12yrs and 11yrs respectively. Also, the Weibull mean intervals (median (50th percentile) of the Weibull distribution) were very similar at 9.9 for Frissell (1973) and 9.23 for NADEF (2004). The discrepancy in the maximum interval between fires is related to the years of fire exclusion near the end of each study (*Table 1*). The establishment of *P. resinosa* cohorts during this study occurred predominately in the early portion of the 18th century. Additional establishment pulses occurred following years where a portion of Itasca State Park was affected by fire (*Figure 2*). The superposed epoch analysis (SEA) illustrates numerous connections between fire and climate. There is a positive southern oscillation index the year prior to fire. This positive index affects the winter temperature and precipitation in Minnesota. Additionally, the SEA shows there is a positive relationship between palmer drought severity index (PDSI) and fire years at Itasca State Park (*Figure 3*).

Site	Intervals	MFI	WMI	Maximum	Minimum
NADEF (2004)	17.0	12.0	9.23	46.0	1.0
Frissell (1973)	17.0	11.0	9.9	26.0	2.0

Table 1: Fire Statistics for NADEF and Frissell.

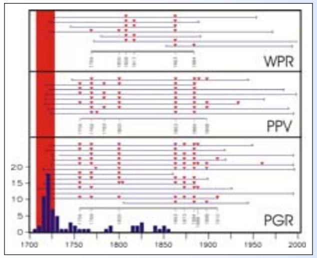

Figure 2: Fire Dates and Establishment Dates.

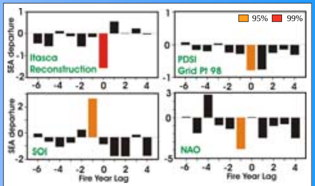

Figure 3: Superposed Epoch Analysis.

Conclusions and Discussion

Although the data for the fire history reconstruction was very similar, the cross-dating of samples showed that the dates from Frissell (1973) where incorrectly estimated in some instances (*Figure 4*). Because ring-counting is based on a series of rings without cross-dating the samples between the site, numerous errors in the sample dates as well as the fire dates occurred. Although, there is no error in the accuracy of the dated rings in this study, various fire scars proved problematic when assigning seasonality. Numerous dormant season scars where found throughout the study which caused difficulty in determining the year of scar formation. Because of this problem, dormant season scars could be imprecise by ± 1 year. The SEA analysis shows that the climatic variations which occur in Minnesota effect fire intensity. Local short-term drought creates short-term lag fuels which are associated with the low intensity surface fires which are typical in *P. resinosa* stands. Long-term droughts, which are commonly regional, create heavier fuel loads. This heavier accumulation of flammable materials creates a more intense and complete burn throughout the area surrounding Lake Itasca. In conclusion, this study showed that fire history reconstructions based on ring counts are inaccurate because of the lack of cross-dating the samples. Although the dating of the Frissell (1973) study was in error there were comparable fire statistics between the two studies. Additionally, the SEA shows that varying regional climatic effects create differing fire climates in north central Minnesota.

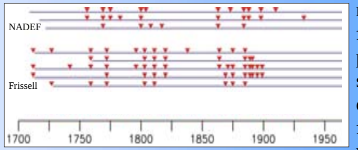

Figure 4: Comparison of fire dates.

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