How past land-use has affected tree growth development and climate sensitivity in Rice County, Minnesota area

Emmie Peters

Advisor: Professor Anthony D' Amato

Introduction

The Big Woods once covered over 8000 km² of Minnesota and Wisconsin, but now only small remnants remain (Frelich 2002). Given the importance of these forests to regional biodiversity and forest-derived goods, there is a great need to better understand their development and potential sensitivity to climate variability. Rice County, Minnesota is home to the Nerstrand Big Woods State Park, as well as several other fragments of this forest type making it an ideal place to study the relationship between the present vegetation and its land use history and past climate.

Methods

Study Design

Five plots (Figure 1), 400 m² in size, were established on original Big Woods remnants with varying amounts of human disturbances. Cores were taken of all trees with a diameter of 10 cm or above at breast height (4.5 feet), along with species and the DBH being recorded. Cores were taken within a one-month time frame to minimize amount of additional growth that occurred between each plot. Trees less than 10 cm were counted and species were identified.

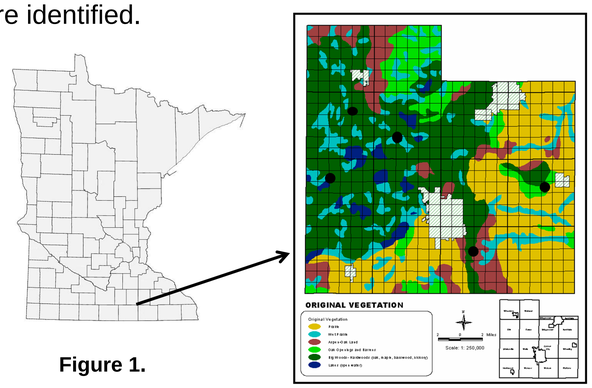


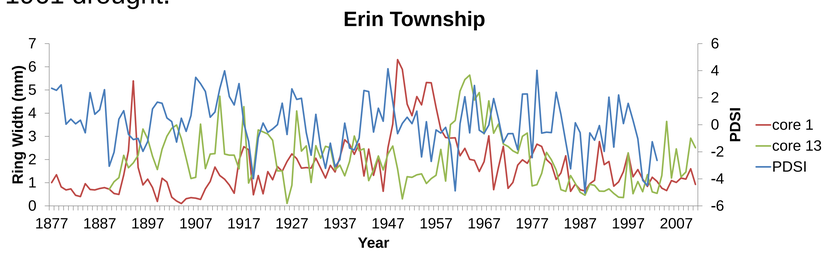
Figure 1.

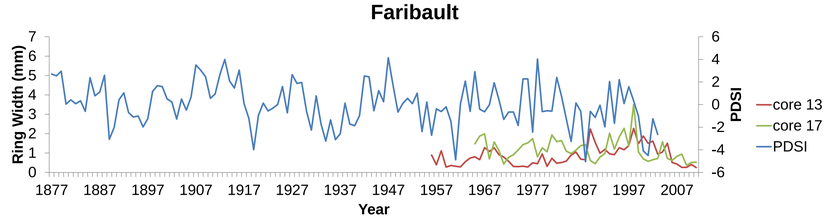
Analysis

After the cores from each plot were obtained, they were prepared for analysis by being mounted, labeled, and sanded to a flat polish. All cores were then dated based on ring counts and the two oldest cores from each site were measured using a Velmex sliding scale micrometer.

Results: Climate Sensitivity

- Several drought events occurred in the study region over the past 134 years: 1889, 1919, 1961,1988, and 2000.
- Reduced radial growth at these sites was reflected in these events, particularly on the Shieldsville Township plot during the 1961 drought.





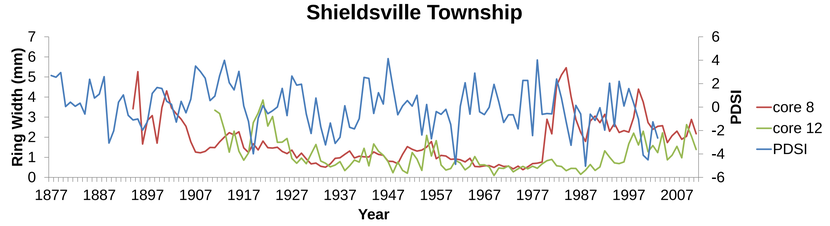


Figure 2. Relationships between tree ring widths for two cores at each site and Palmer Drought Severity Index (PDSI). Positive PDSI values indicate wetter than average years, whereas negative values indicate drier years.

Results: Release Events

- Patterns of growth and release indicate that several sites experienced canopy disturbance in the 1980s, potentially due to management and drought impacts.
- Recruitment on the sites corresponds with when these and several other canopy disturbance events were recorded in the tree rings from these areas (Figure 3).

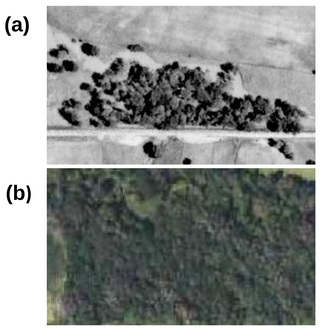


Figure 3. (a) Plot located at Forest Township in 1950. (b) Same site in 2010.

Results: Recruitment

- Maximum over-story tree age across sites ranged from 47 to 134 years.
- Patterns in recruitment reflected past natural and human disturbance (Figure 3), with peaks occurring in 1910-1920, 1960, and 1970 (Figure 4).
- These more recent peaks coincided with different degrees of tree harvesting in these stands.

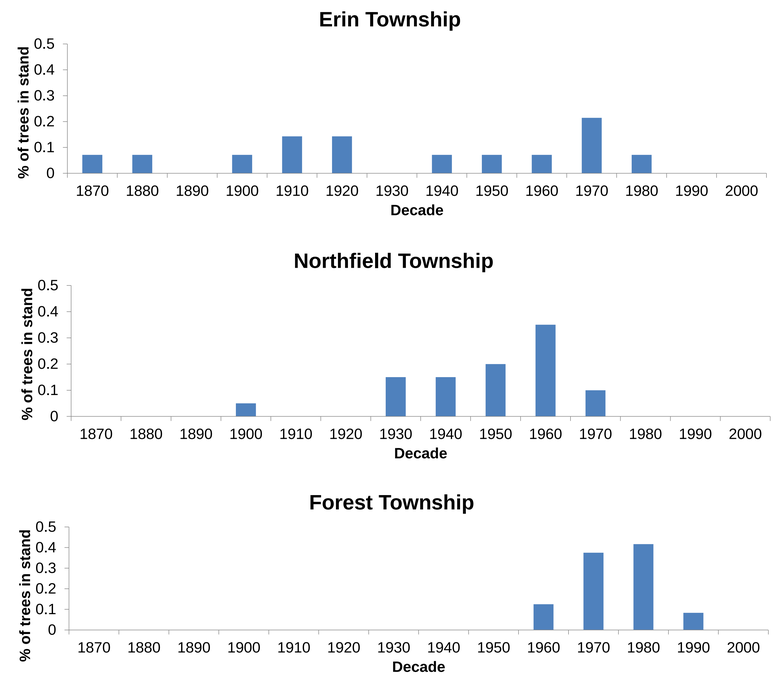


Figure 4. Age structure of Big Woods forests based on dating increment cores collected from these areas.

Conclusions

- Development of these forests has strongly been influenced by past land-use, natural disturbances, and drought.
- Given the sensitivity of the canopy tree growth to past drought events and their isolated nature, these forests may be particularly vulnerable to future climate change.
- Future management of these areas should focus on maximizing resilience to future climate and disturbance-related stressors.

References

Frelich, Lee E. Forest Dynamics and Disturbance Regimes: Studies from Temperate Evergreen-deciduous Forests. New York: Cambridge UP, 2002. Print.

Acknowlegdements

I would like to thank Mike Reinikainen for assisting in the analyses of the data along with all members of the Silviculture and Applied Forest Ecology Lab in the Department of Forest Resources at the University of Minnesota.