Comparison of Annual Red Pine (Pinus resinosa) Growth and Climate Variability

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Introduction

Understanding climate variations is challenging because instrumental climate records are relatively short and may not capture the full range of climatic variability within a region. Dendrochronology (tree-ring analysis) offers a tool for investigating past climates by comparing tree ring widths with regional climate variations (Fritts 1976).

I used tree-ring widths collected at Cloquet Forestry Center in N. Minnesota (Figure 1) to investigate the relationship between growth and climate in an effort to evaluate the utility of these trees to serve as a climate proxy. The trees were collected from an old growth stand called Camp 8 (CME). Climate records at the Cloquet Forestry Center in Cloquet, Minnesota only date back to 1894, however tree ring data gathered from Red Pine (*Pinus resinosa*) in the area extends a record back to 1726, greatly extending our potential understanding of climate variability

Significant correlations between growth and climate have previously been used to make inferences about summer climate in the Boundary Waters Canoe Area Wilderness (BWCAW) which found ring widths are most strongly related to June/July rainfall (Kipfmueller et al. 2010).

Methods

Skeleton plotting techniques were used to identify marker years in common between individual trees to assign exact calendar dates to each annual ring. Ring widths were measured to the nearest 0.001 mm and checked for dating errors using COFECHA, a computer program that statistically checks the measured series to ensure dating is precise (Grissino-Mayer 2001).

The correctly dated measurements were then detrended to remove age-related growth using ARSTAN, by fitting a cubic spline to each series (66% of segment length), dividing the measurements by its curve fit, and averaging all series together for each year to create a tree-ring index. The tree-ring index is a dimensionless index where variations are related to year-to-year changes in the external environment rather than the annual biological growth trends.

Results

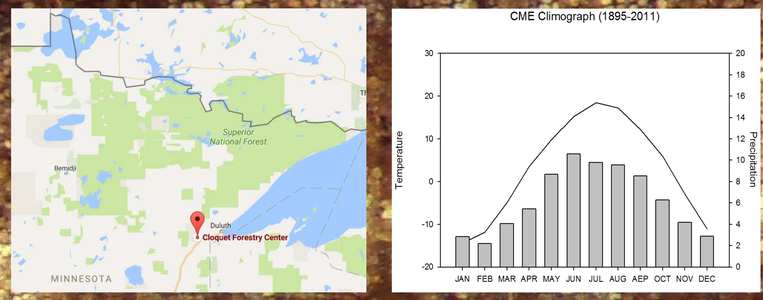


Figure 1. Location of Cloquet Forestry Center (left Map data © 2016 Google) and climate patterns at Cloquet, MN (right Data from United States Historical Climatology Network)

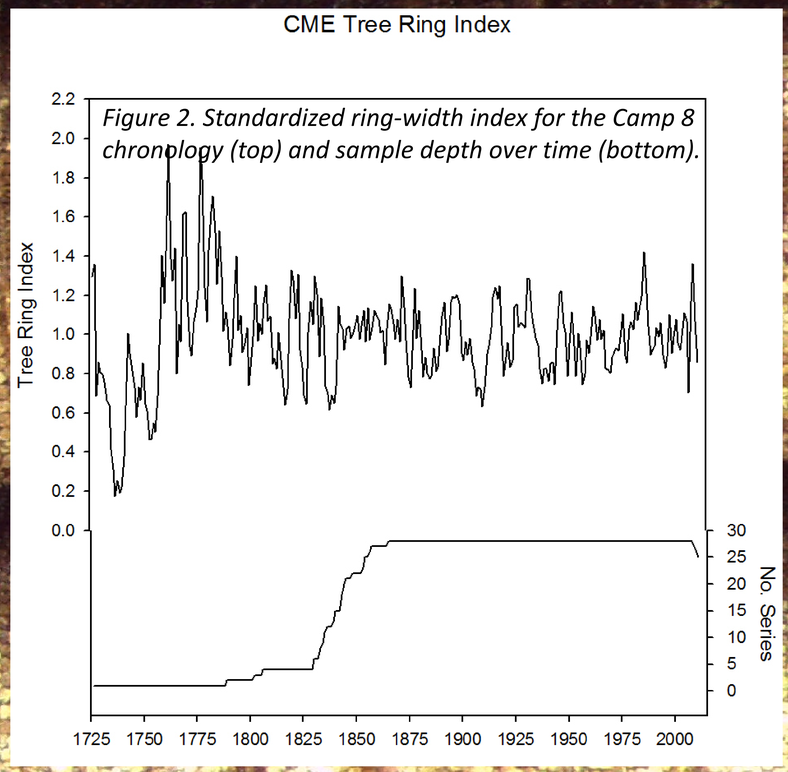
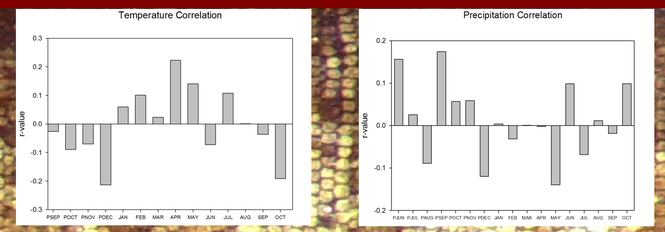


Figure 2. Standardized ring-width index for the Camp 8 chronology (top) and sample depth over time (bottom).



Figures 3 (left) and 4 (right). Growth-climate relationships in the Camp 8 (CME) stand illustrating relatively weak relationships.

Conclusion

Though the Standardized Tree Ring Index (Figure 2) showed considerable interannual variation, relative changes in growth were only weakly related to monthly climate variables (Figures 3&4). Only Temperature from the previous December, and April of the current year had weak correlations with tree ring widths.

These trees are growing in a managed stand of red pine and the difference between growth-climate patterns here compared with red pine elsewhere may be due to a masking of climate influences. Differences in competition due perhaps to stand thinning activities may have led to a stronger response in the ring-widths than climate patterns. In a way, the influence of climate patterns may be masked by management activities.

References/Acknowledgements

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Monthly average temperature and precipitation data was gathered from the Cloquet Forestry Station through the United States Historical Climatology Network (USHCN).

This project was made possible by the Undergraduate Research Opportunities Program (UROP)