

Development of a Tree-Ring Chronology from Eastern Red Cedar (*Juniperus virginiana*, L.) for the Upper Mississippi River Valley

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ABSTRACT

Dendrochronology is the science that uses tree-rings dated to their exact year of formation to analyze temporal and spatial patterns of processes in the physical and cultural sciences. There currently is no published record for tree-ring studies using Eastern Red Cedar in the Upper Mississippi River Valley in Wisconsin. Therefore, this study develops a chronology from tree-rings using Eastern Red Cedar (*Juniperus virginiana*, L.). The objectives of this study were to collect samples from both live and dead trees and to create a tree-ring chronology based on standard dendrochronological methods including skeleton plotting and cross-dating. Creating a master chronology makes this study significant because it adds to the knowledge of tree-rings for western Wisconsin and has the potential to be used for further work in dendroclimatology to assess past climate change for the Upper Mississippi River Valley.

INTRODUCTION

Dendrochronology is the science that uses tree-rings dated to their exact year of formation to analyze temporal and spatial patterns of processes in the physical and cultural sciences (Grissino-Mayer, 2007). Andrew Ellicott Douglas is single-handedly credited for creating the science of dendrochronology in the early 1900s with his studies on the Giant Sequoias in California and pines in Arizona (McGraw, 2000). Dendrochronology is made possible by the fact that in many trees the annual rings visible in the cross-section, rather than being uniform in width, show varying widths as a response to variations in environmental factors such as climate (Stokes and Smiley, 1996). Tree-rings are very useful for many reasons. First, they put the present in proper historical context. Secondly, they enhance our knowledge of current environmental processes and conditions. Finally, they can help to improve understanding of possible future environmental issues (University of Arizona Laboratory Tree-Ring Research, 2005).

By examining the International Tree-Ring Data Bank website, there are very few tree-ring chronologies for Wisconsin and there currently is no published record for tree-ring studies using Eastern Red Cedar in the Upper Mississippi River Valley in Wisconsin (Grissino-Mayer and Fritts, 1997; National Climatic Data Center, 2007). There have been a number of published studies conducted in the states of Oklahoma (Butler and Walsh, 1988), Missouri (Guyette et al., 1980; Batek et al., 1999), and Virginia (Larson, 1997; Copenheaver et al., 2005). These studies have used Eastern Red Cedars to determine the dendrochronological potential of *Juniperus virginiana*, to develop climatic reconstructions, and to establish 19th century vegetation and fire regimes. In addition, Woodhouse and Brown (2001) used Eastern red cedar in their study of Great Plains drought.

The primary objectives of this project were to gather samples from both live and dead Eastern Red Cedar trees and to then create a master chronology for Eastern Red Cedar in the Upper Mississippi River Valley. The cross-dating index of Eastern Red Cedar is a 2, which the International Tree-Ring Data Bank indicates is a species that can be cross-dated across a region, and is significant for establishing a long-term chronology (National Climatic Data Center, 2007). Therefore, this is an excellent tree specimen to use for the proposed study. Standard dendrochronology methods were practiced by collecting cores in the field and preparing the samples by mounting and sanding in the laboratory (Phipps, 1985; Stokes and Smiley, 1996). All wood samples were skeleton plotted and then cross-dated between the live and dead trees. A tentative master chronology was produced from the skeleton plot of an approximate 235-year-old dead snag and a composite plot from 24 live trees.

METHODS

Two field sites were used in the study. Both of the field sites, Beck and Welch, are owned by the Mississippi Valley Conservancy. They are bluff top sites located above the city of La Crosse in La Crosse County, Wisconsin.

Cores from 24 live trees and two cross-sections from dead trees were collected from the Mississippi Valley Conservancy properties in late fall 2007 and early spring 2008 (Figure 1).



Figure 1. Coring a live eastern red cedar at the Beck Site.

Standard dendrochronology methods were practiced in the field (Phipps, 1985; Stokes and Smiley, 1996). The trees that were selected for the study appeared to be stressed and are, therefore, more useful because they should have growth rings that respond well to climate fluctuations (Fritts, 1991). Trees that have a more complacent growth are not as beneficial for dendrochronological purposes. An increment borer, a precision tool designed to remove a small core from a live tree without harming it, was used to extract two 5-mm-sized cores from each live tree (Phipps, 1985; Stokes and Smiley, 1996). Two dead tree samples, one of which dated at approximately 235 years, were collected from the Beck Site by cutting cross-sections using a hand saw (Figure 2).



Figure 2. Cross-section from 235-year-old dead snag collected at the Beck Site.

In the laboratory, the cores were allowed to dry and then were mounted on standard tree ring core mounts (Phipps, 1985). Once mounted the cores were prepared for analysis by sanding so that the individual tree-rings were more easily visible using four different grits of sand paper (150, 220, 320 and 400) on a belt sander. Additional hand-sanding with 400 grit paper further enhanced the ability to distinguish individual tree rings. After the cores were sanded individual rings were examined under a microscope and decades were marked on the cores to determine the number of years of growth for each tree. The same procedures were used for the dead tree cross-section samples. The process of dating each of the cores is accomplished by producing skeleton plots on graph paper. The cores from live trees and cross-sections from the dead samples were all skeleton plotted and then cross-dated between the samples from live trees and also the dead tree samples (Stokes and Smiley, 1996).

Skeleton plotting is the process of marking a tree's ring width variation on graph paper strips (Phipps, 1985). Rings are usually compared with each other within a decade. Only the narrower rings are plotted with a line on graph paper. A weight is assigned to each narrow ring ranging between 1 and 10. Very narrow rings have values of 7 to 9. Narrow rings are assigned weights of 4 to 6. Slightly narrow rings get weights of 1 to 3. Only extremely narrow rings are given a weight of 10. A composite skeleton plot for the cores from the live trees was produced after the skeleton plots for the individual core samples were completed (Figure 3). A single skeleton plot was created for the 235-year-old cross-section sample from a dead tree (Figure 4).

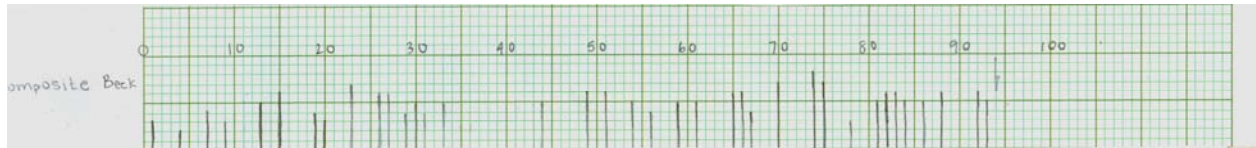


Figure 3. Composite skeleton plot compiled from individual skeleton plots for the 24 live trees.

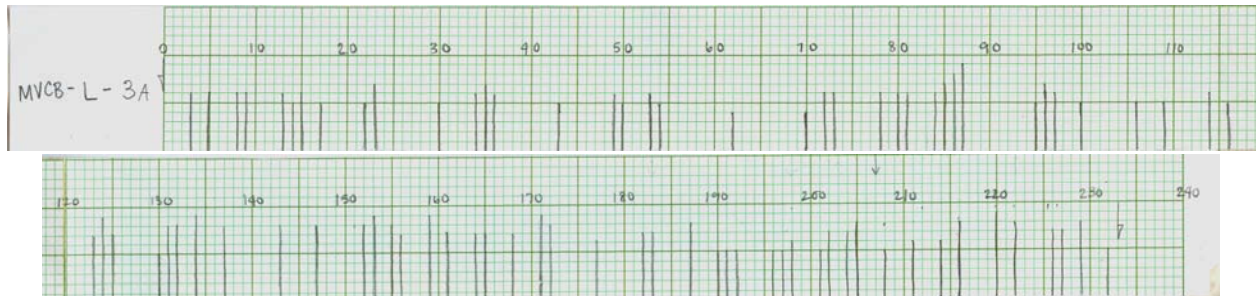


Figure 4. Skeleton plots for the first 120 years (top) and last 115 years (bottom) of the 235-year-old dead snag from the Beck Site.

The skeleton plots for all of the samples were cross-dated between the live and dead trees. Cross-dating is the method of matching ring-growth characteristics across many samples from an area of similar environmental conditions and it permits identification of exact year of formation for each ring (Phipps, 1985).

RESULTS AND DISCUSSION

A total of 48 cores and 3 cross-sections were collected for the study from two field sites. The trees sampled were found to have a wide range in age differences. The oldest dead sample was a snag that is approximately 235 years old. On average, most of the living trees were between 40 and 60 years old.

So far, a probable match has been made between the composite plot from the cores of the live trees and the skeleton plot of the cross-section from the 235-year-old dead tree using the cross-dating method. The composite skeleton plot of the core samples from live trees was matched to the single skeleton-plot of 235-year-old dead snag (Figure 5). All of the cross-dated samples have been used to compile a tentative master chronology for Eastern Red Cedars in the Upper Mississippi River Valley that is not presented in this paper.

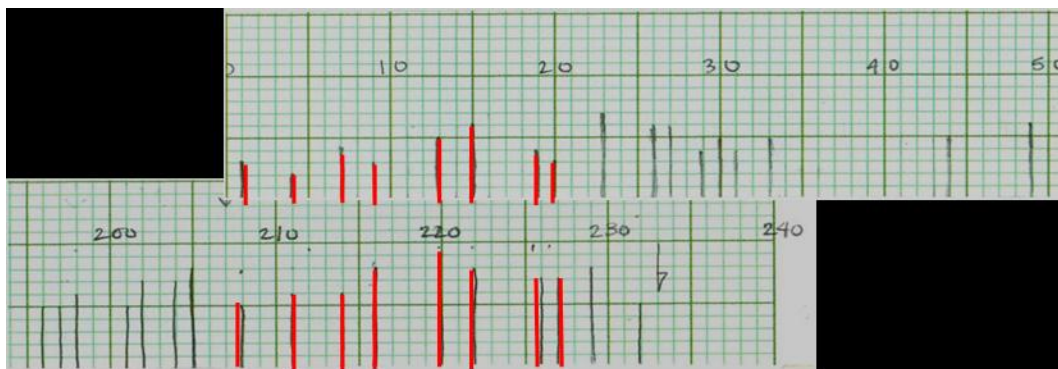


Figure 5. Probable match for the composite skeleton plot from the 24 live tree core samples (top) and the skeleton plot of the 235-year-old dead tree cross section (bottom). The matching years from each skeleton plot are highlighted in red.

At this point there is a tentative match in the skeleton plots, but more samples that confirm this match would improve the chronology. With additional work the results from this research project have the potential to be used for further work in dendroclimatology to assess past climate change for the Upper Mississippi River Valley (Fritts, 1991).

LIMITATIONS

Field work for this study was limited by the onset of winter and constrained the number of wood samples collected. More samples need to be collected, especially from dead trees to produce a more precise, and perhaps longer, chronology. Several live or dead tree samples that would better tie together the skeleton plots created in this study are needed to provide a more definitive match. At this point there is a slight match in the skeleton plots, but more samples that confirm this match would improve the chronology.

ACKNOWLEDGEMENTS

The assistance of Melinda Froehlich, Judy Hafemann, and Dr. Dean Wilder is greatly appreciated for their help collecting in the field and in the laboratory. I would also like to thank the Mississippi Valley Conservancy for the use of their land in this study. This research was funded by the UW-L Undergraduate Research Grants Program.

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