

A Dendrochronological Analysis of White Spruce in Prairie Shelterbelt Systems: Aaron Ivey Farm



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Mount Allison Dendrochronology Lab

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Abstract

As a part of the Agricultural Greenhouse Gases Program, which seeks to determine the carbon sequestration capabilities of shelterbelt trees and their response to climate and climate change, the Mount Allison Dendrochronology Lab conducted a tree-ring analysis on white spruce across latitudinal and longitudinal gradients in Saskatchewan. Using dendrochronological cross-dating techniques and climate analysis, patterns in tree growth were revealed and a relationship to climate variables was established. At the Ivey property, white spruce samples were collected from twenty trees, and the oldest samples were 59 years old.

Introduction

The Mount Allison Dendrochronology Lab is currently involved in the Agricultural Greenhouse Gases Program, in conjunction with the University of Saskatchewan, which is investigating the capability of shelterbelt trees to store carbon. The carbon storage capability of these trees will inform their ability to off-set carbon emissions and potentially act as carbon credits. The objective of the larger project is to determine the current and future capacity of carbon sequestration in these shelterbelt trees.

In the summer of 2012, samples for this project were collected across most of Saskatchewan. These samples were used for three separate studies which used dendrochronological (tree-ring) analysis, with the intention of investigating whether the sensitivity of the trees (in this study, white spruce, *Picea glauca*) to major climate factors changed depending on their location. In order to do so, the ages and growth patterns of white spruce at each site were determined, and their sensitivity to climate factors was compared to those established at other sites. As a landowner, and therefore a stakeholder in this project, we would like to provide you with the results of our findings on your property.

Site Information

MAD Lab Site Code: 12NL200

Date: May 8th, 2012

Site Name: Ivey League

Site Contact Info: Aaron Ivey

Latitude: 51°07'29.6"

Longitude: 103°38'36.3"

UTM: 0594928 5664586

UTM Zone: 13U

MASL (m above sea level): 679m

Satellites: 8

Species Common Name: White Spruce

MAD Lab Species Code: 200

Methods

The MAD Lab sampled twenty white spruce trees, using a 5.1 mm increment borer to take two core samples from each tree at approximately breast height. These samples were stored in plastic straws and taken back to the Mount Allison Dendrochronology Lab in Sackville, New Brunswick, for analysis. The diameter at breast height and the total height were also measured

for each tree. The samples were glued onto slotted mounting boards and labeled with the appropriate site code. The samples were sanded with progressively finer sandpaper (60 to 600 grit) and then buffed in order to reveal the cell structure and tree-rings. The annual growth rings were measured under a microscope using a Velmex staging system with a precision of 0.001 mm. The measurements from each core created a growth pattern which could then be matched against the other cores from that site, in order to create a standardized chronology which would demonstrate the overall tree-growth patterns through time.

In order to determine the environmental factors influencing the tree’s growth, annual tree-ring measurements were compared to historical climate data from the Kelliher, SK weather station, using the program DendroClim. The program provides statistical correlations which allow us to identify which climate variables influence the growth of the trees at each site.

Results and Discussion

The oldest samples were determined to be 59 years old at breast height. This suggests they were planted in the early 1950s, which is in agreement with the database provided from the Prairie Farm Rehabilitation Association, which indicates that white spruce were planted here between 1945-1952. The tallest tree was 19.03 m high, and the widest tree had a diameter of 46.5 cm (see Table 1). The average ring-width measurement was determined to be 2.75 mm (see Figure 1 for the standardized growth of the tree over time). The climate data from the Kelliher station indicated that current June temperature and current June precipitation were the strongest climate variables affecting the tree growth (see Figures 2 and 3).

Table 1: Diameter and heights of trees sampled at the Ivey property.

Sample ID	DBH (cm)	Total Height (m)
12NL201	46.5	17.03
12NL202	39.0	16.63
12NL203	27.0	17.03
12NL204	37.5	16.63
12NL205	38.2	17.43
12NL206	28.5	17.43
12NL207	33.0	18.63
12NL208	41.5	18.83
12NL209	40.3	19.03
12NL210	31.3	17.53
12NL211	35.0	17.23
12NL212	37.6	18.43
12NL213	32.7	18.13
12NL214	41.1	18.23
12NL215	29.2	17.43

12NL216	29.5	17.73
12NL217	32.0	17.53
12NL218	29.7	17.23
12NL219	29.6	17.83
12NL220	39.4	17.63

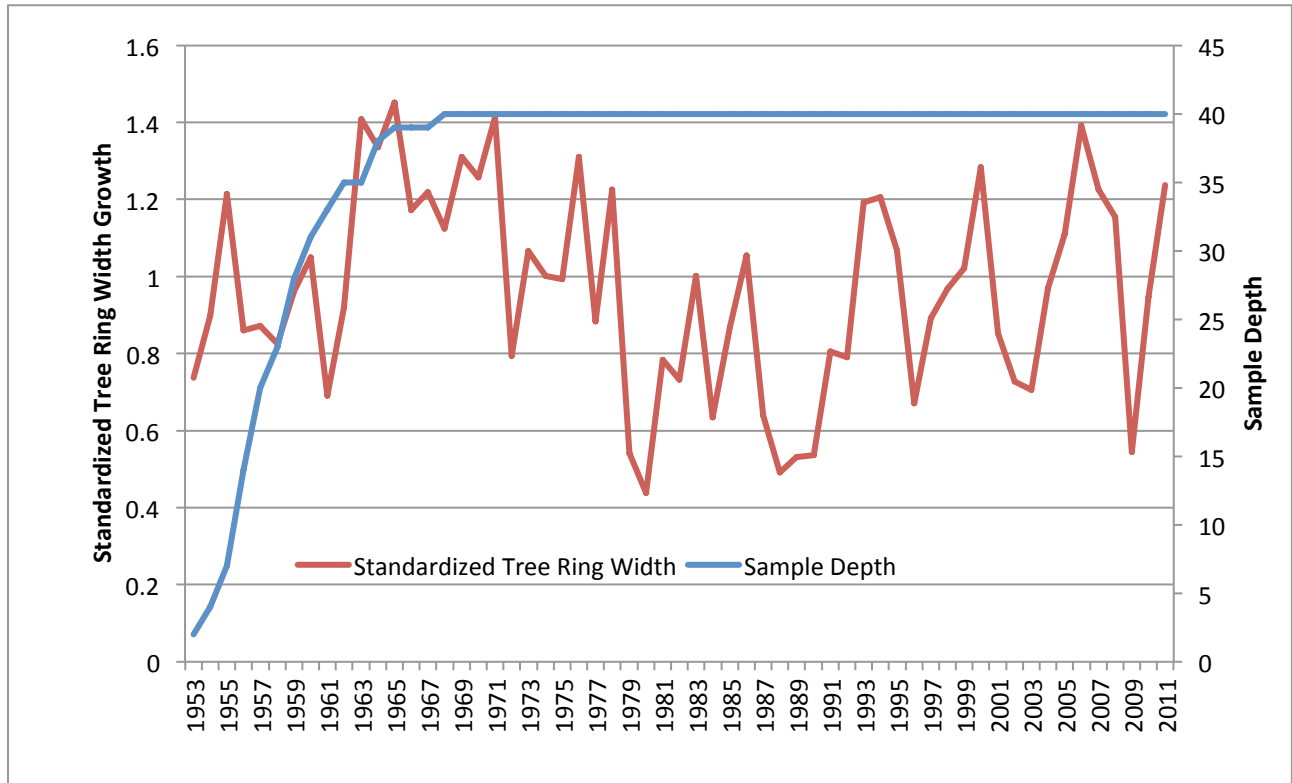


Figure 1: Master chronology for white spruce at the Ivey property. Standardized measurements of 1 indicate an average year of growth (in this case, 2.75 mm), while any value above or below one indicate a year of above or below average growth. Sample depth is the number of samples averaged to produce the ring measurement for that year.

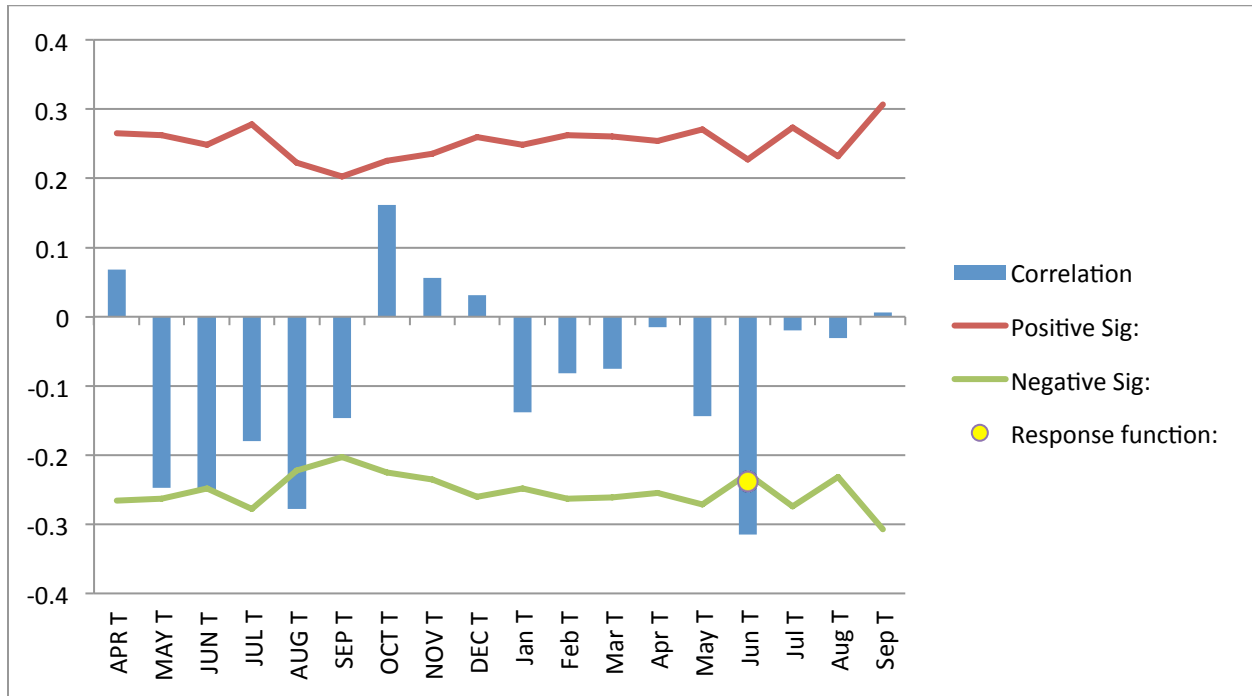


Figure 2: Results of the climate analysis comparing annual tree-ring growth to historical temperature variables from Kelliher, SK. The bars represent the degrees of correlation between the tree growth and the climate variable. The places where the bars cross the linear threshold are considered significantly correlated, marked by the response function circle. The uppercase letters (ie. APR) label the previous years' variables.

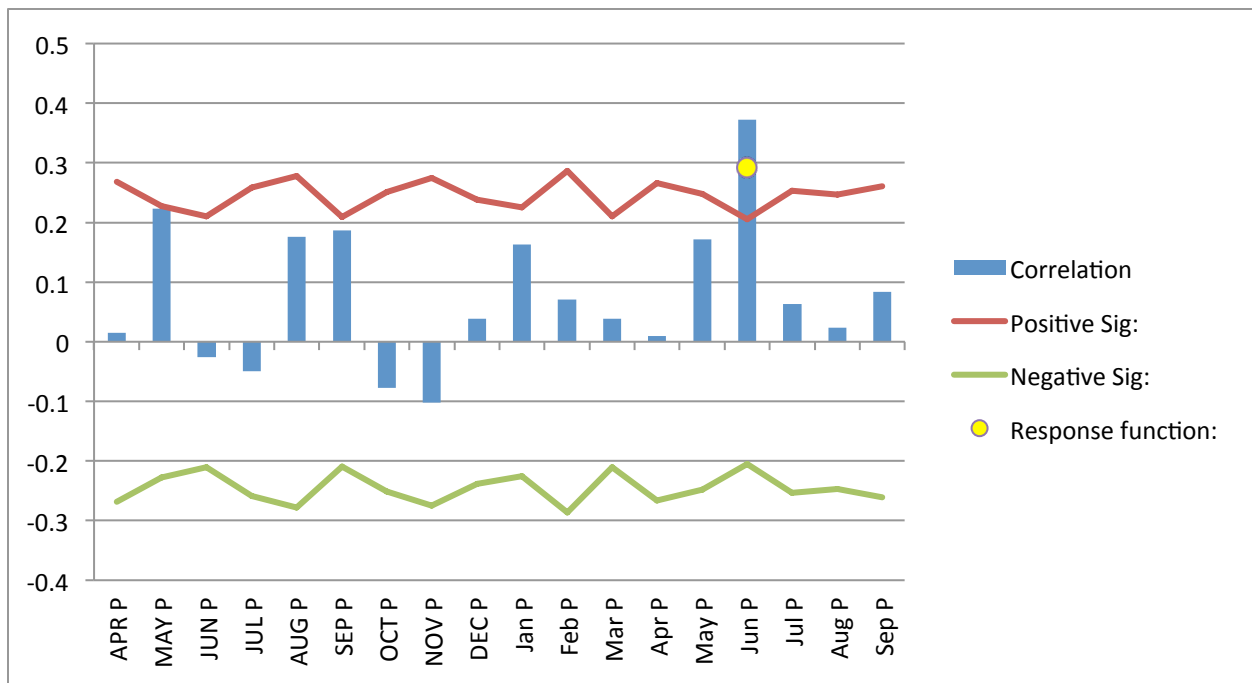


Figure 3: Results of the climate analysis comparing annual tree-ring growth to historical precipitation variables from Kelliher, SK.

Conclusion

The results of this analysis give a strong indication of the important climate variables in eastern-central Saskatchewan. The importance of current June precipitation in influencing tree-growth seems to increase as sites are further north, and this site fits with the trend, as it displays a significance which is higher than more southerly sites, but remains lower than some more northern sites. The data used from this site will be used in future studies, which will attempt to determine future growth trends and the amount of carbon sequestered by white spruce to determine its potential and viability in carbon sequestration.

This research was conducted at the Mount Allison Dendrochronology Lab in Sackville, New Brunswick, and funded through the Agricultural Greenhouse Gases Program and NSERC-USRA (Jennings). Any questions regarding the findings of this report should be directed to:

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