

A Dendrochronological Analysis of White Spruce in Prairie Shelterbelt Systems: Assie's 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 Assie’s Farm, white spruce samples were collected from twenty trees, and the oldest samples were 65 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: 12HL200

Date: May 5th, 2012

Site Name: Assie's Farm

Site Contact Info: Gerald and Irene Assie

Latitude: 52°41'50.17"

Longitude: 104°53'05.88"

UTM: 0507773 5838602

UTM Zone: 13U

MASL (m above sea level): 549m

Satellites: 10

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. These 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 weather stations located in Pilger (for temperature) and Melfort (for precipitation), 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 65 years old at breast height. This suggests they were planted in the early 1940s, which is in agreement with the database provided from the Prairie Farm Rehabilitation Association, which indicates that white spruce were planted here in 1943. The tallest tree was 19.03 m high, and was also the widest tree, with a diameter of 43.2 cm (see Table 1). The average ring-width measurement was determined to be 2.24 mm (see Figure 1 for the standardized growth of the tree over time). The climate data from the Pilger and Melfort stations indicated that the previous year’s September, October, and December precipitation and the current year’s June precipitation were the strongest climate variables affecting the tree growth, while temperature was not a significant factor (see Figures 2 and 3).

Table 1: Diameters and heights of trees sampled at Assie's Farm.

Sample ID	DBH (cm)	Total Height (m)
12HL201	31.0	15.23
12HL202	27.6	15.63
12HL203	28.6	14.83
12HL204	31.1	16.23
12HL205	35.5	17.73
12HL206	26.5	13.83
12HL207	31.1	17.03
12HL208	29.4	17.03
12HL209	37.0	17.43
12HL210	28.0	15.43
12HL211	35.5	18.43
12HL212	25.1	17.43

12HL213	28.7	17.23
12HL214	33.4	17.43
12HL215	35.3	17.03
12HL216	31.2	18.83
12HL217	29.3	16.23
12HL218	31.1	16.13
12HL219	33.1	16.03
12HL220	43.2	19.03

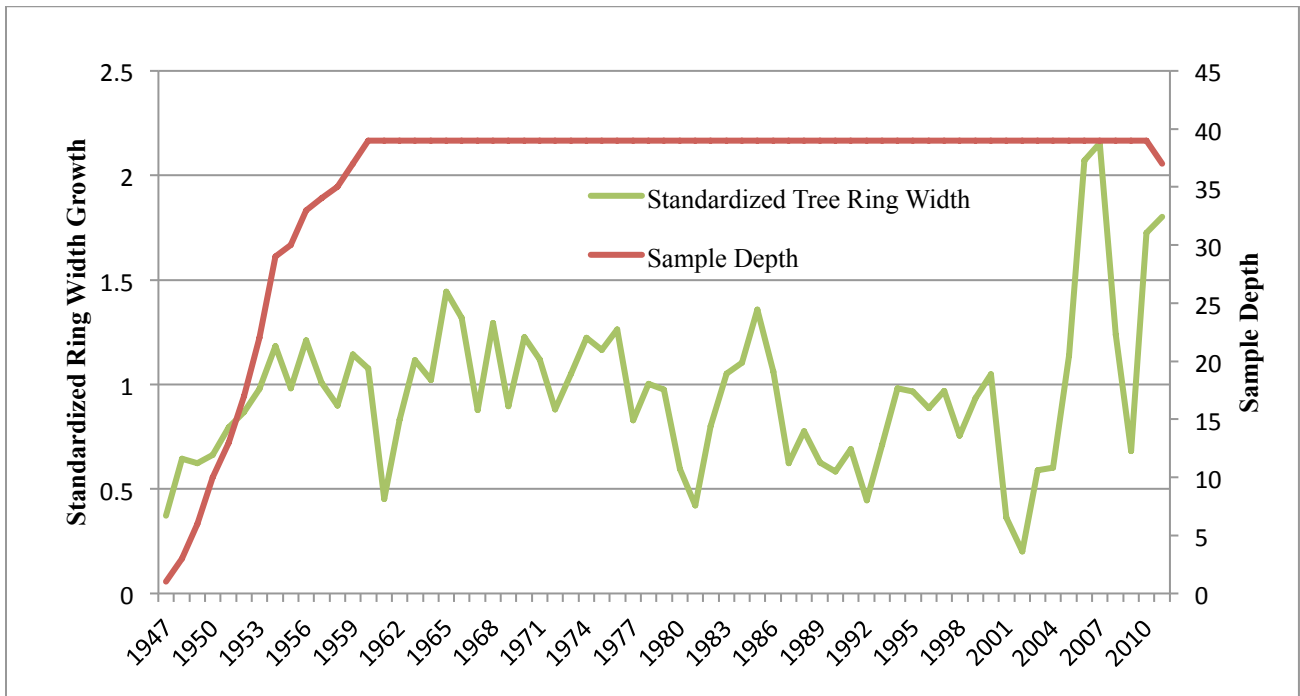


Figure 1: Master chronology for white spruce at the Assie’s property. Standardized measurements of 1 indicate an average year of growth (in this case, 2.24 mm), while any value above or below one indicate a year of above or below average growth. Sample depth is the number of samples averaged to produce the ring measurement for that year.

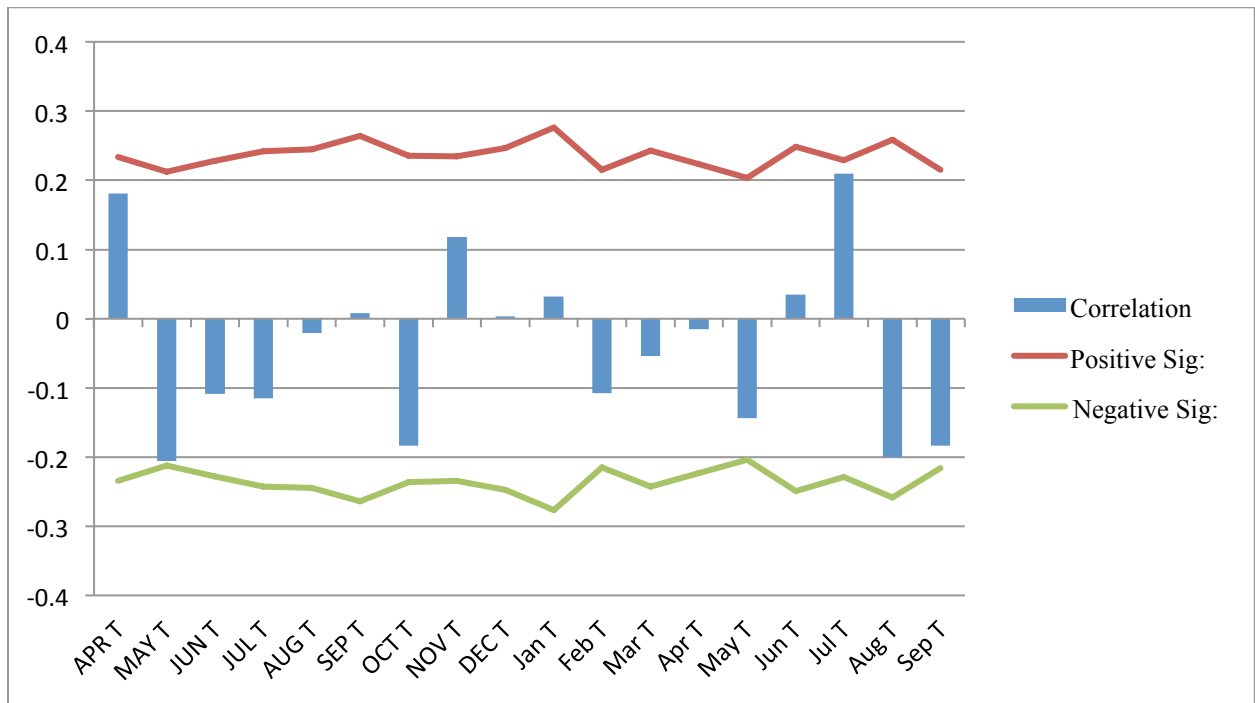


Figure 2: Results of the climate analysis comparing annual tree-ring growth to historical temperature variables from Pilger, SK. The bars represent the degrees of correlation between the tree growth and the climate variable with anything surpassing the linear thresholds being considered significantly correlated. The uppercase letters (ie. APR) label the previous years' variables.

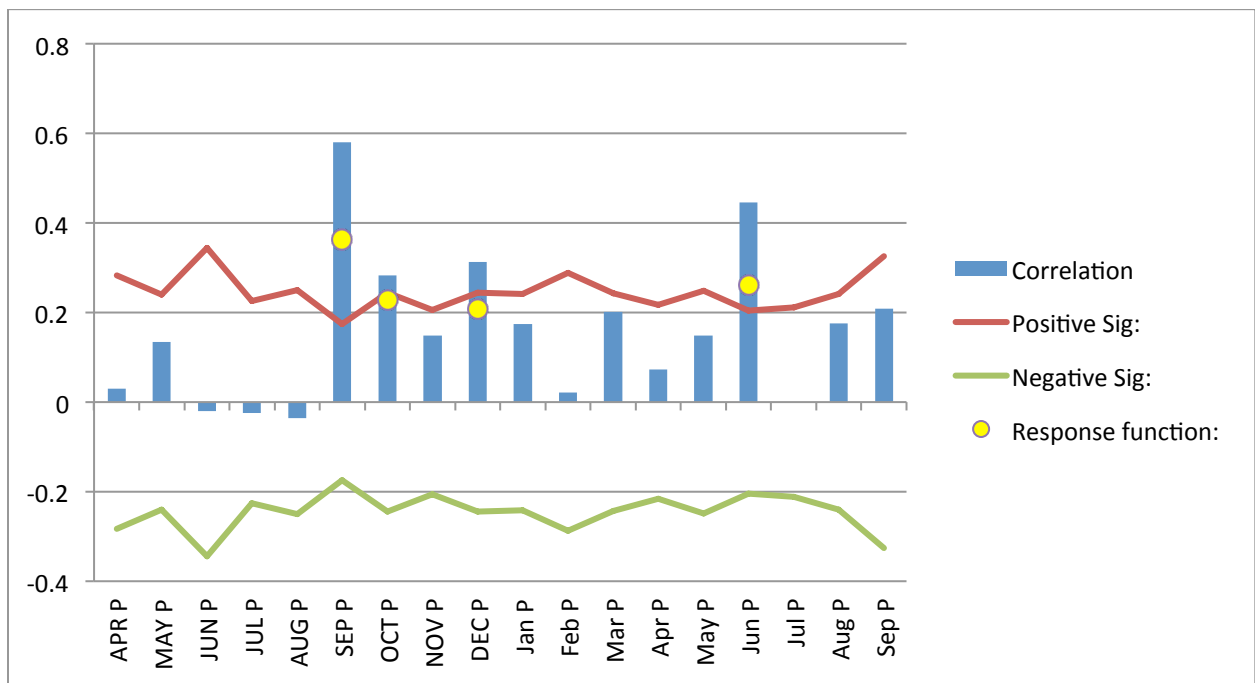


Figure 3: Results of the climate analysis comparing annual tree-ring growth to historical precipitation variables from Melfort, SK.

Conclusion

The results of this analysis give a strong indication of the important climate variables in northeastern Saskatchewan. For example, the importance of current June precipitation in influencing tree-growth seems to decrease in trees found further south, and this site fits with the trend, as it shows a strong correlation for June precipitation not found in more southerly sites. Likewise, the previous year's September precipitation becomes more significant in northerly sites, a trend supported by the data from this site. 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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