

A Dendrochronological Analysis of White Spruce in Prairie Shelterbelt Systems: James Robertson 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 Robertson property, white spruce samples were collected from 20 trees, and the oldest samples were 37 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: 12LL200

Date: May 7th, 2012

Site Name: Double Rainbow

Site Contact Info: James Robertson

Latitude: N 49°23'29.3"

Longitude: W 103°22'09.3"

UTM: 0618301 5472249

UTM Zone: 13U

MASL (m above sea level): n/a

Satellites: 10

Species Common Name: White Spruce

MAD Lab Species Code: 200

Methods

The MAD Lab sampled 20 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 into 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 Estevan 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 37 years old at breast height. This suggests they were planted around 1970, which is in agreement with the database provided from the Prairie Farm Rehabilitation Association, which indicates that white spruce were planted here in 1967. The tallest tree measured was 12.03 m high, and was also the widest tree measured, with a diameter of 44.2 cm (see Table 1). The average ring-width measurement was determined to be 3.25 mm (see Figure 1 for the standardized growth of the tree over time). The climate data from the Estevan station indicated that previous November temperature (negative) and precipitation (positive) were the strongest climate variables affecting the tree growth (see Figures 2 and 3).

Table 1: Diameter at breast height and heights of trees sampled at the Robertson property.

	DBH (cm)	Total Height (m)
12LL201	24.4	10.43
12LL202	25.4	10.03
12LL203	24.5	9.23
12LL204	32.8	9.43
12LL205	26.2	10.03
12LL206	15.3	6.73
12LL207	28.0	10.43
12LL208	26.7	10.23
12LL209	18.2	9.03
12LL210	19.7	9.43
12LL211	19.5	9.43
12LL212	24.5	8.83
12LL213	18.3	9.63
12LL214	25.8	10.23
12LL215	28.5	10.83
12LL216	26.2	10.13
12LL217	23.7	11.03

12LL218	30.4	10.43
12LL219	31.9	11.43
12LL220	44.2	12.03

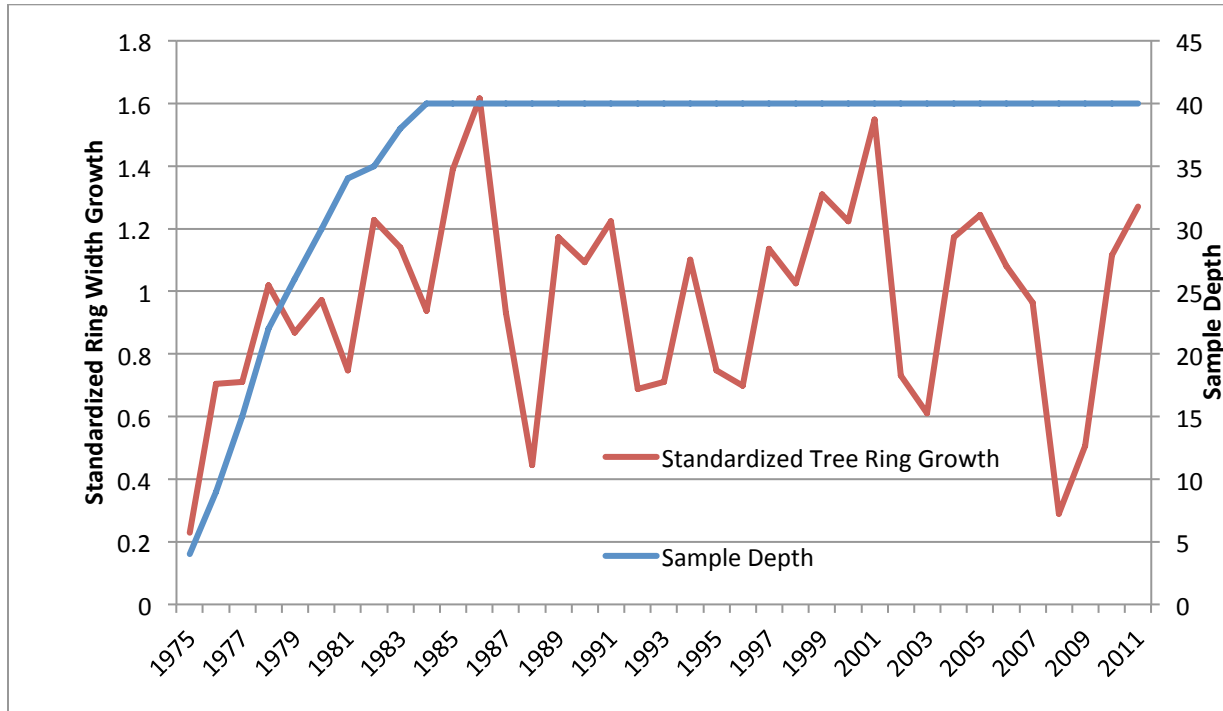


Figure 1: Master chronology for white spruce at the Robertson property. Standardized measurements of 1 indicate an average year of growth (in this case, 3.25 mm), while any value above or below one indicate a year of above or below average growth. Sample depth is the number of samples averaged to produce the ring measurement for that year.

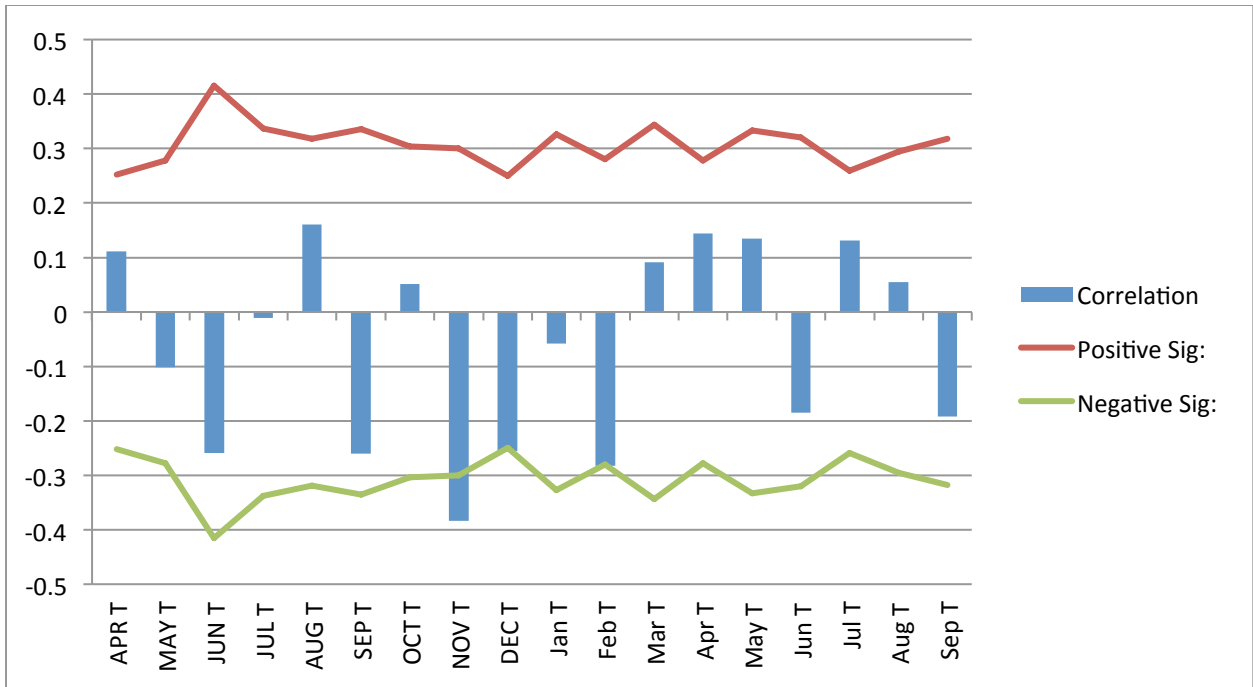


Figure 2: Results of the climate analysis comparing annual tree-ring growth to historical temperature variables from Estevan, SK. The bars represent the degrees of correlation between the tree growth and the climate variable. The places where the bars cross the linear threshold are considered significantly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

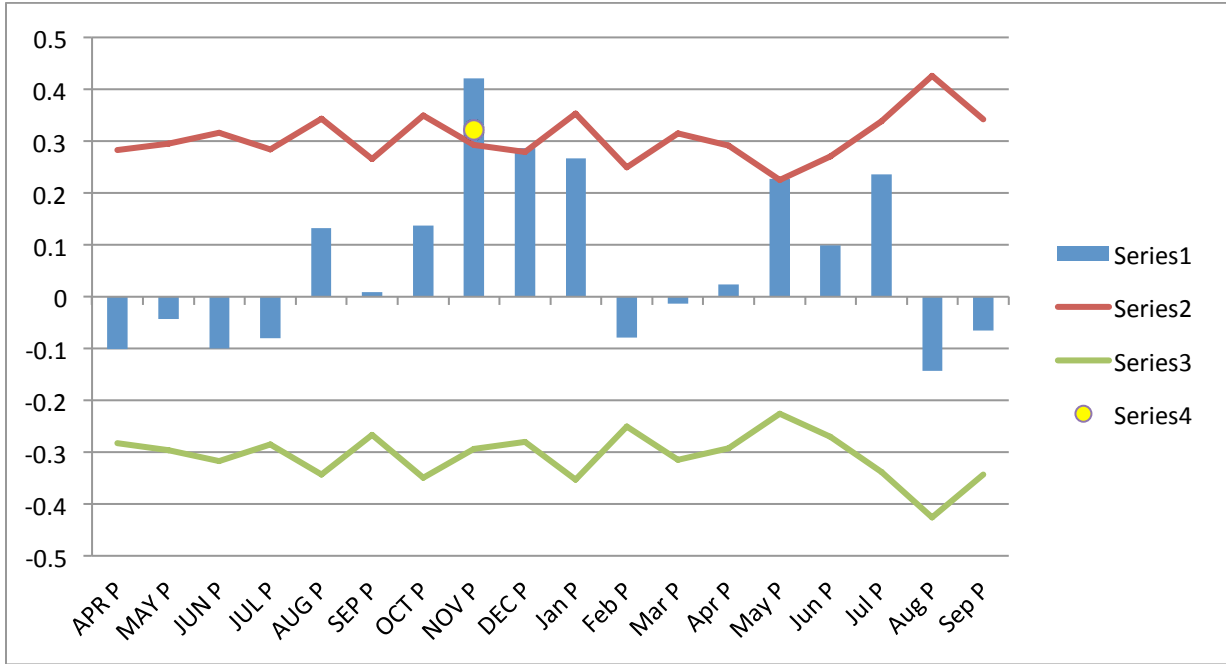


Figure 3: Results of the climate analysis comparing annual tree-ring growth to historical precipitation variables from Estevan, SK.

Conclusion

The results of this analysis give a strong indication of the important climate variables in south-east Saskatchewan. For example, the importance of certain factors, such as previous September precipitation or previous May precipitation, in influencing tree-growth decreases in the more southerly areas of the province, and do not register as significant for this site, despite being quite important at other, more northerly, 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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