A Dendrochronological Analysis of White Spruce in Prairie Shelterbelt Systems: Ed Pideryhora Farm

Cecilia Jennings, Jason Maillet, Emily Hogan, Mariana Trindade and Colin P. Laroque

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Mount Allison University, Department of Geography and the Environment

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 Pideryhora property, white spruce samples were collected from 20 trees, and the oldest samples were 64 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) 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:12OL200

Date: May 9th, 2012

Site Name: Pid's Palace

Site Contact Info: Ed Pidperyhora

Latitude: N 51°43'54.9"

Longitude: W 103°50'38.4"

UTM: 0579845 5731868

UTM Zone: 13U

MASL (m above sea level): 568 m

Satellites: 7

Precision: ± 18m

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 Kelliher 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 64 years old at breast height. This suggests they were planted before 1947. The tallest tree sampled was 23.63 m high, and the widest tree had a diameter of 54.1 cm (see Table 1). The average ring-width measurement was determined to be 2.9 mm (see Figure 1 for the standardized growth of the tree over time). The climate data from the Kelliher station indicated that precipitation from the previous September, as well as current year's January precipitation (which would provide snowpack and act as a source of water later in the season), May precipitation and June precipitation were the strongest climate variables positively affecting the tree growth, while temperature did not seem to be a significant factor (see Figures 2 and 3). Current year's June temperature was a strong factor, but did not pass the statistical correlation tests to be counted as significant.

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

	DBH (cm)	Total Height (m)
12OL201	50.8	21.63
12OL202	37.2	21.83
12OL203	47.2	22.43
12OL204	35.7	8.83
12OL205	44.3	19.63
12OL206	39.3	17.03
12OL207	39.3	13.43
12OL208	42.2	21.63
12OL209	37.6	21.63
12OL210	42.5	22.23
12OL211	30.9	17.03
12OL212	36.5	21.03
12OL213	40.0	19.43
12OL214	34.5	19.03
12OL215	48.5	21.13

12OL216	38.1	19.23
12OL217	54.1	22.83
12OL218	34.3	8.23
12OL219	48.5	22.83
12OL220	39.8	23.63

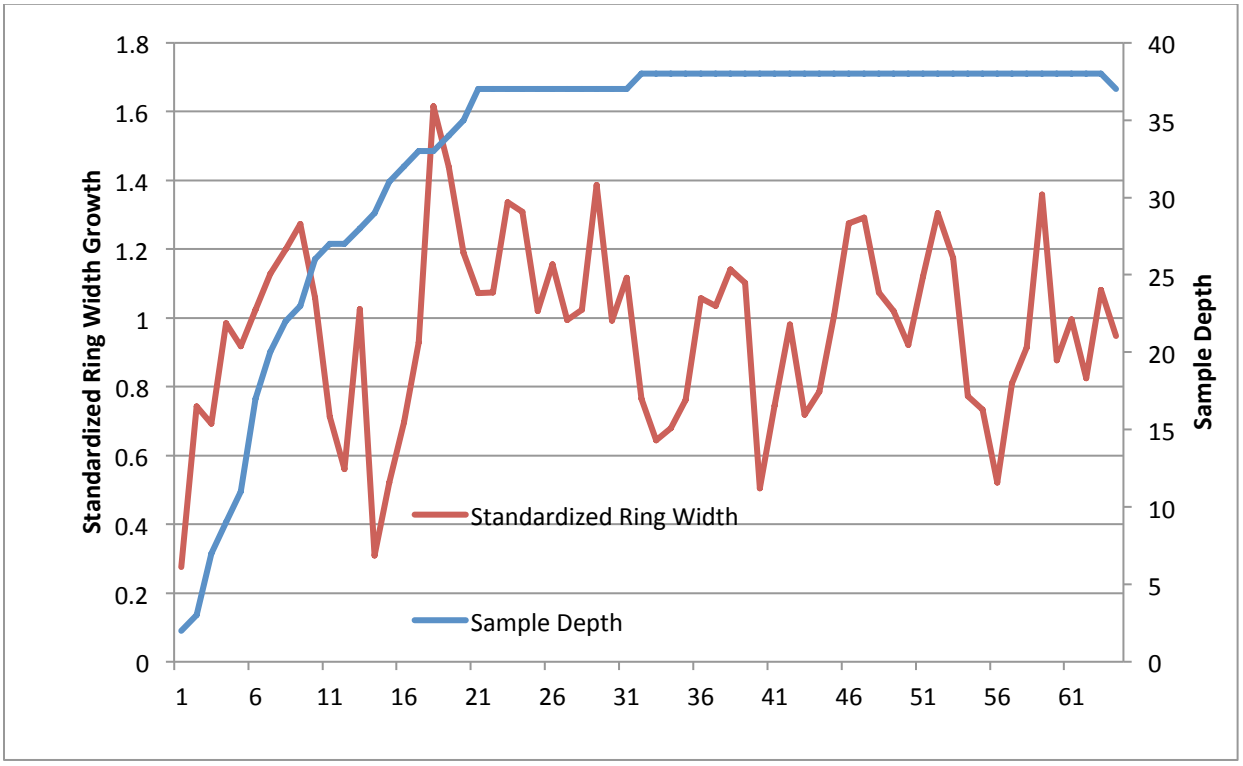

Figure 1: Master chronology for white spruce at the Pideryhora property. Standardized measurements of 1 indicate an average year of growth (in this case, 2.9 mm), while any value above or below one indicate a year of above or below average growth. Sample depth is the number of samples averaged to produce the ring measurement for that year.

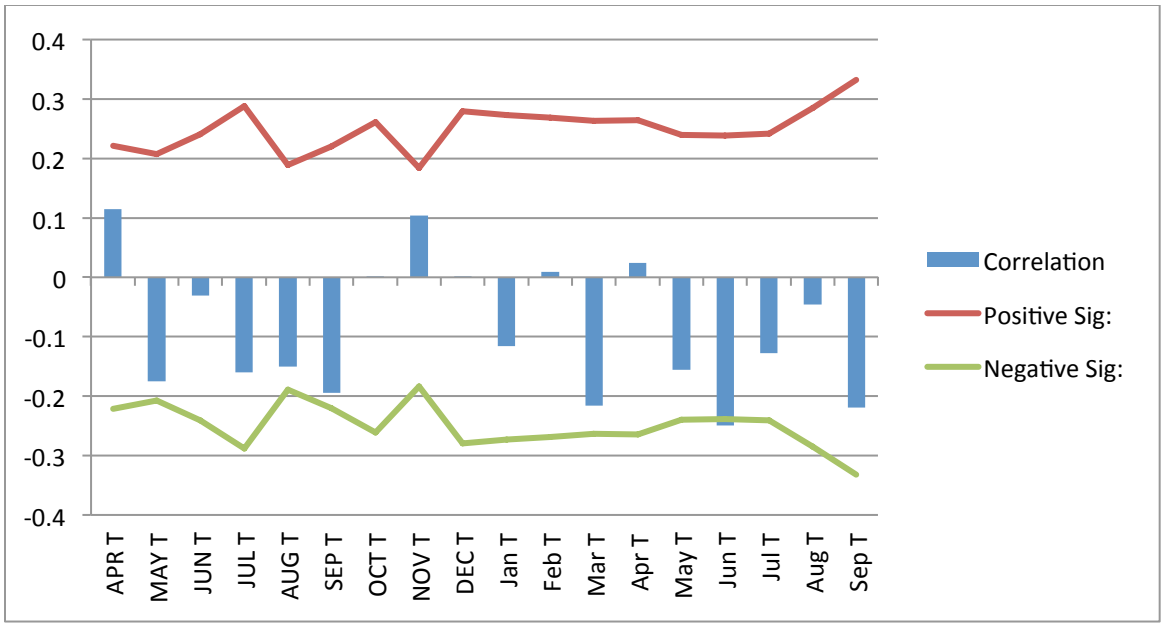

Figure 2: Results of the climate analysis comparing annual tree-ring growth to historical temperature variables from Kelliher, SK. The bars represent the degrees of correlation between the tree growth and the climate variable. The places where the bars cross the linear threshold are considered significantly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

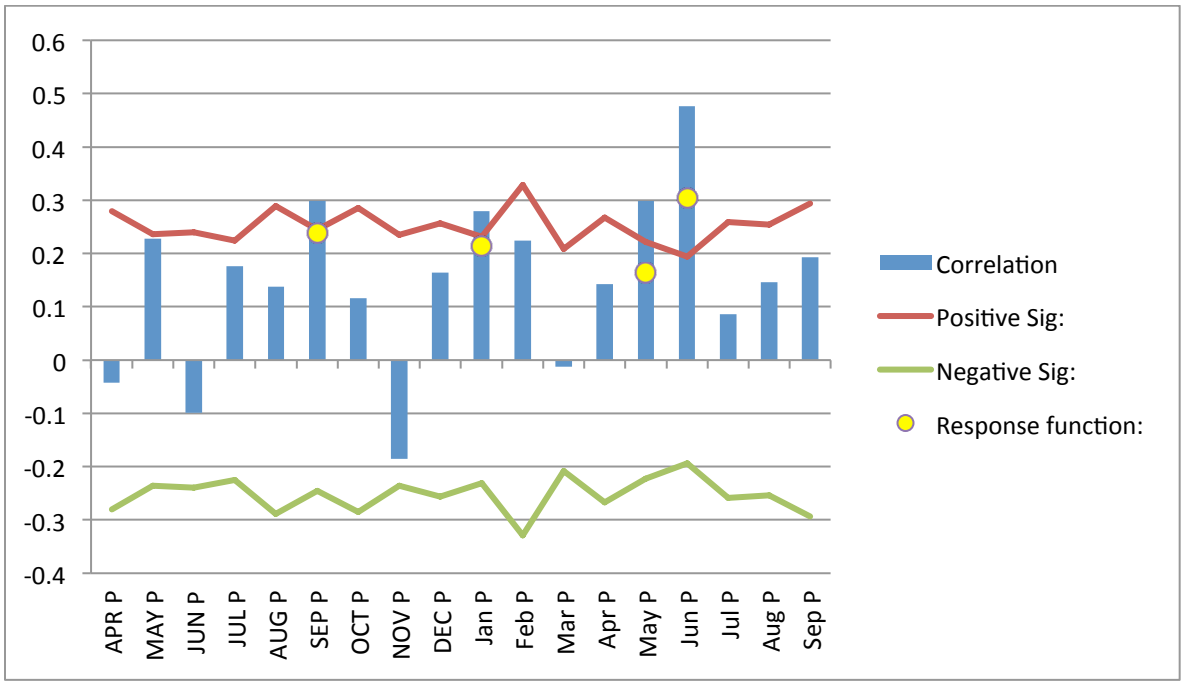

Figure 3: Results of the climate analysis comparing annual tree-ring growth to historical precipitation variables from Kelliher, SK.

Conclusion

The results of this analysis give a strong indication of the important climate variables in eastern central Saskatchewan. For example, the importance of current May and June precipitation in influencing tree-growth seems to increase as sites are further north, and this site fits with the trend, as May and June precipitation acts as a stronger influence here than in sites found further south. 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:

Dr. Colin Laroque
Professor, MAD Lab Director
University of Saskatchewan
Department of Soil Science
Room 5C10, Agriculture Building
51 Campus Drive,
Saskatoon, SK
S7N 5A8
Phone: 306-966-2493
Fax: 306-966-6881
E-mail: colin.laroque@usask.ca