

# **A Dendrochronological Analysis of White Spruce in Prairie Shelterbelt Systems: Joan and Arlee Kerluke Farm**



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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 Kerluke's property, white spruce samples were collected from 20 trees, with the oldest samples being 67 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:** 12GL200

**Date:** May 4<sup>th</sup>, 2012

**Site Name:** Spoon Slaughter

**Site Contact Info:** Joan & Arlee Kerluke

**Latitude:** N 51°57'40.8"

**Longitude:** W 103°47'58"

**UTM:** 0582487 5757419

**UTM Zone:** 13U

**MASL (m above sea level):** 543m

**Satellites:** 9

**Precision:** ± 6m

**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 (located approximately 80 km away from the site), 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 67 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 1941. The tallest tree sampled was 19.83 m, and was also the widest tree, with a diameter of 58.0 cm (see Table 1). The average ring-width measurement was determined to be 2.82 mm (see Figure 1 for the standardized growth of the tree over time).

The climate data from the Kelliher station indicated that the previous year’s August temperature and precipitation, and current year’s June precipitation were the strongest climate variables affecting the tree growth (see Figures 2 and 3). The previous year’s August temperature had a negative correlation, which means that high temperatures create minimal growth, while previous August and current June precipitation had a positive correlation.

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

	<b>DBH (cm)</b>	<b>Height (m)</b>	<b>Total Height (m)</b>
12GL201	58.0	18.2	19.83
12GL202	45.5	17.4	19.03
12GL203	43.4	13.8	15.43
12GL204	45.5	16.4	18.03
12GL205	53.7	16	17.63
12GL206	37.7	15.8	17.43
12GL207	40.0	17.8	19.43
12GL208	39.5	16.8	18.43
12GL209	29.0	13.2	14.83
12GL210	33.0	14.6	16.23
12GL211	48.2	18	19.63
12GL212	30.0	15.8	17.43

12GL213	48	17.6	19.23
12GL214	51.4	16.6	18.23
12GL215	43.0	9	10.63
12GL216	22.5	10.4	12.03
12GL217	26.0	9.5	11.13
12GL218	29.0	13	14.63
12GL219	25.1	15.4	17.03
12GL220	30.2	13.2	14.83

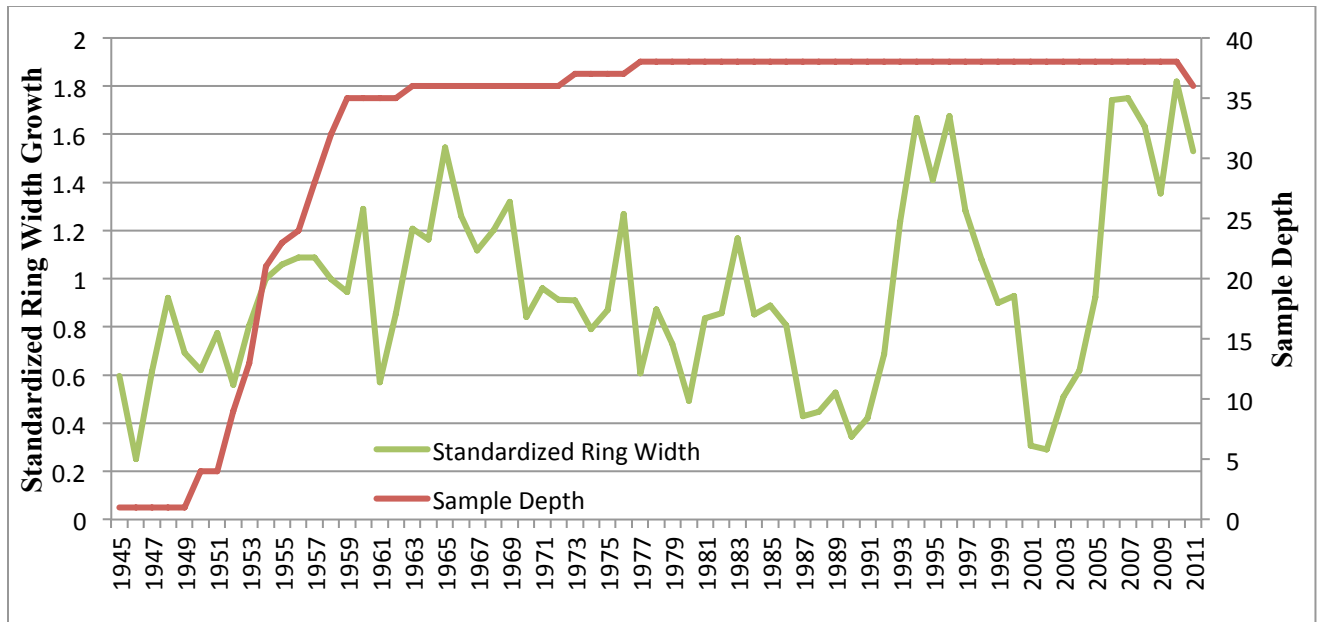


Figure 1: Master chronology for white spruce at the Kerluke property. Standardized measurements of 1 indicate an average year of growth (in this case, 2.82 mm), while any value above or below one indicate a year of above or below average growth. Sample depth is the number of samples averaged to produce the ring measurement for that year.

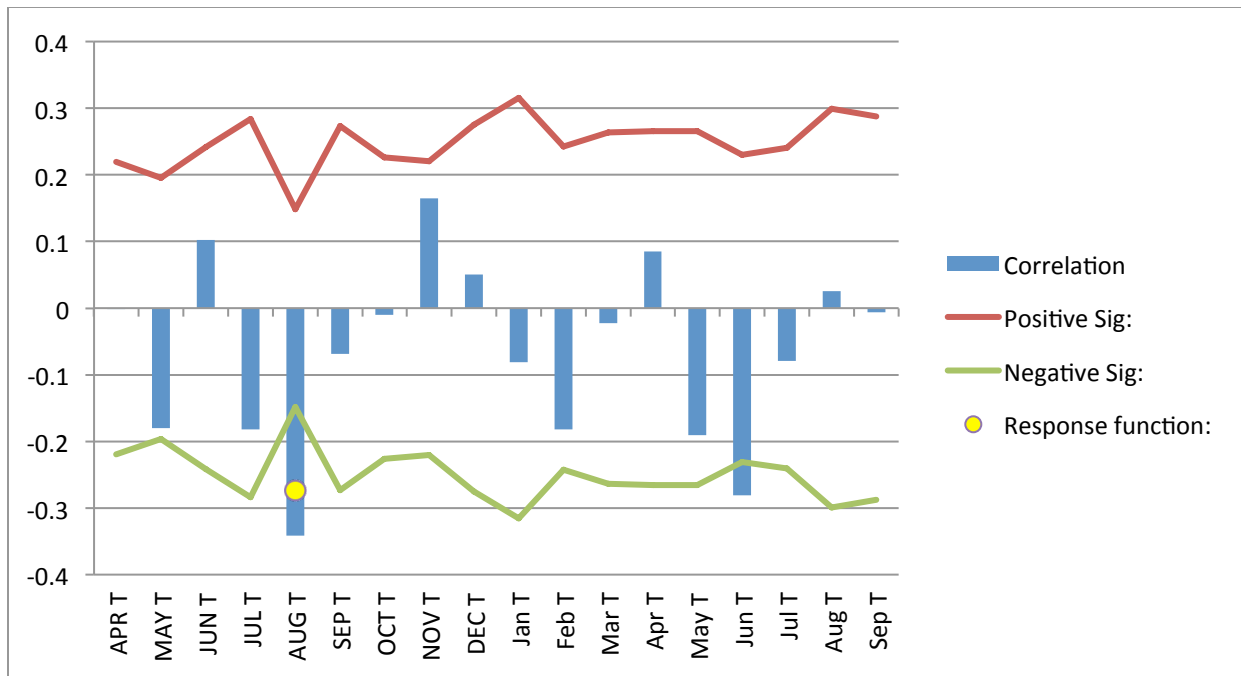


Figure 2: Results of the climate analysis comparing annual tree-ring growth to historical temperature variables from Kelliher, SK. The bars represent the degrees of correlation between the tree growth and the climate variable. The places where the bars cross the linear threshold are considered significantly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

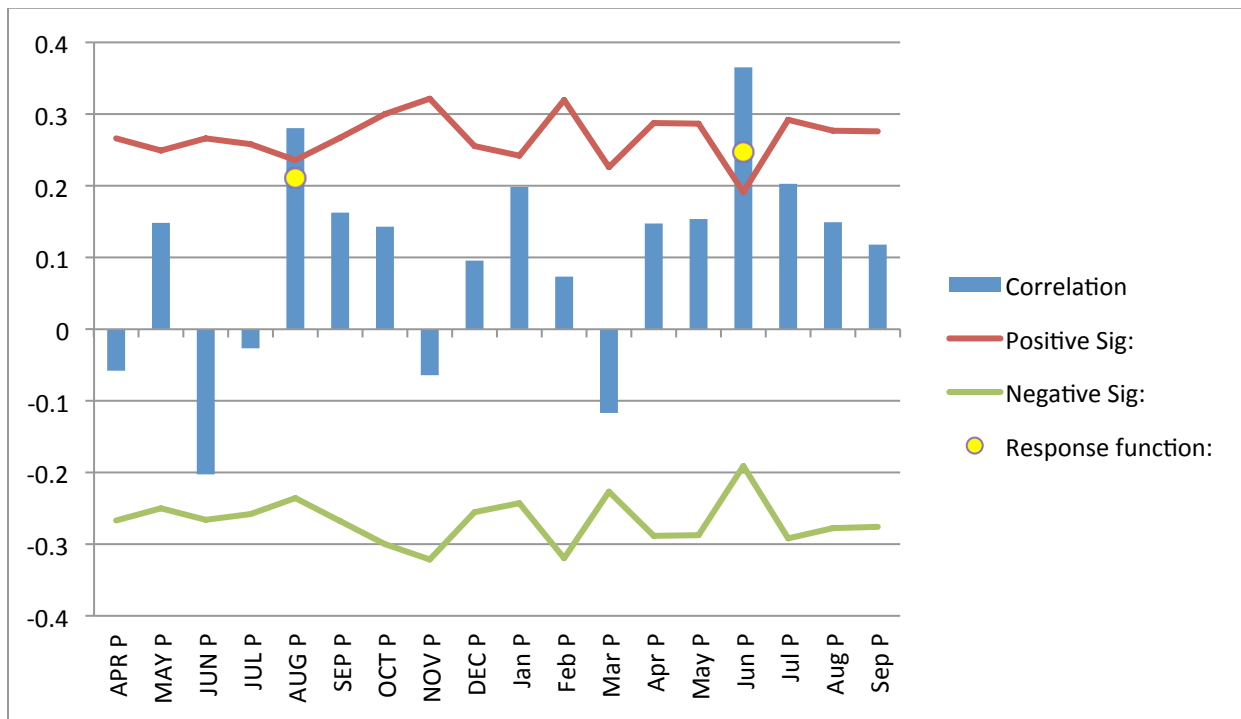


Figure 3: Results of the climate analysis comparing annual tree-ring growth to historical precipitation variables from Kelliher, SK.

## **Conclusion**

The results of this analysis give a strong indication of the important climate variables in north-east Saskatchewan. For example, the importance of current year's June precipitation in influencing tree-growth seems to increase as sites are further north, and this site fits with the trend, as June precipitation shows a significant correlation not found in sites 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:

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