A Dendrochronological Analysis of White Spruce in Prairie Shelterbelt Systems: Fairway Farms

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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 Fairway Farms, white spruce and green ash samples were collected from a total of forty trees. The oldest samples for both white spruce and green ash were 66 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 tree species to major climate factors changed depending on their location. In this case, samples were used for two studies, focused on white spruce (*Picea glauca*) and green ash (*Fraxinus pennsylvanica*). In order to do so, the ages and growth patterns of the trees 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:12ML000

Date: May 8th, 2012

Site Name: Fairway Farms

Site Contact Info: Terry and Marilyn Manson

Latitude: N 49°50'18.7"

Longitude: W 103°25'52.3"

UTM: 0612815 5521863

UTM Zone: 13U

MASL (m above sea level): 610m

Satellites: 4

Precision: ±14m

Species Common Name: White Spruce

MAD Lab Species Code: 200

Species Common Name: Green Ash

MAD Lab Species Code: M00

Methods

The MAD Lab sampled 20 white spruce and 20 green ash 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 Yellow Grass, 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 white spruce samples were determined to be 66 years old at breast height. This suggests they were planted in the mid-1940s, which is in agreement with the database provided from the Prairie Farm Rehabilitation Association, which indicates that white spruce were planted here in 1944. The tallest white spruce sampled was 16.43 m high, and the widest spruce had a diameter of 39.2 cm (see Table 1). The tallest green ash sampled was 11.83 m, and the widest green ash had a diameter of 45.6 cm (see Table 2). The average ring-width measurement was determined to be 1.81 mm for white spruce (see Figure 1 for the standardized growth of the tree over time) and 1.83 mm for green ash (see Figure 2).

The climate data from the Yellow Grass station indicated that, for white spruce, previous year's August temperature (negative), previous November temperature (positive), and current April temperature (positive), along with previous August precipitation (positive) were the strongest climate variables affecting the tree growth (see Figures 3 and 4). For green ash, the strongest climate variables were the previous year's May (negative) and October (positive) temperature and current year's January temperature (negative), as well as May and June precipitation from the previous year (positive) (see Figures 5 and 6).

Table 1: Diameter at breast height and heights for white spruce sampled at Fairway Farms.

	DBH (cm)	Total Height (m)
12ML201	21.5	12.83
12ML202	28.3	13.03

12ML203	26.7	16.43
12ML204	27.5	16.23
12ML205	27.8	13.23
12ML206	39.2	16.23
12ML207	30.1	15.03
12ML208	24.2	10.83
12ML209	31.5	14.83
12ML210	25.0	12.93
12ML211	22.5	13.83
12ML212	26.3	11.13
12ML213	22.4	13.43
12ML214	24.7	12.83
12ML215	23.6	13.23
12ML216	21.4	14.03
12ML217	28.3	14.03
12ML218	30.7	16.03
12ML219	17.7	11.03
12ML220	28.6	10.83

Table 2: Diameter at breast height and heights for green ash sampled at Fairway Farms.

	DBH (cm)	**Total Height (m)**
12MLM01	35.4	8.83
12MLM02	19.8	7.93
12MLM03	36.2	8.43
12MLM04	29.1	8.83
12MLM05	26.4	10.03
12MLM06	31.8	7.03
12MLM07	40.8	10.63
12MLM08	17.5	7.13
12MLM09	16.7	8.23
12MLM10	37.5	11.83
12MLM11	22.0	11.23
12MLM12	19.7	10.83
12MLM13	31.1	7.83
12MLM14	26.1	9.03
12MLM15	45.6	10.23
12MLM16	30.3	10.13
12MLM17	270	6.23
12MLM18	23.9	8.23

12MLM19	20.1	9.93
12MLM20	26.5	8.43

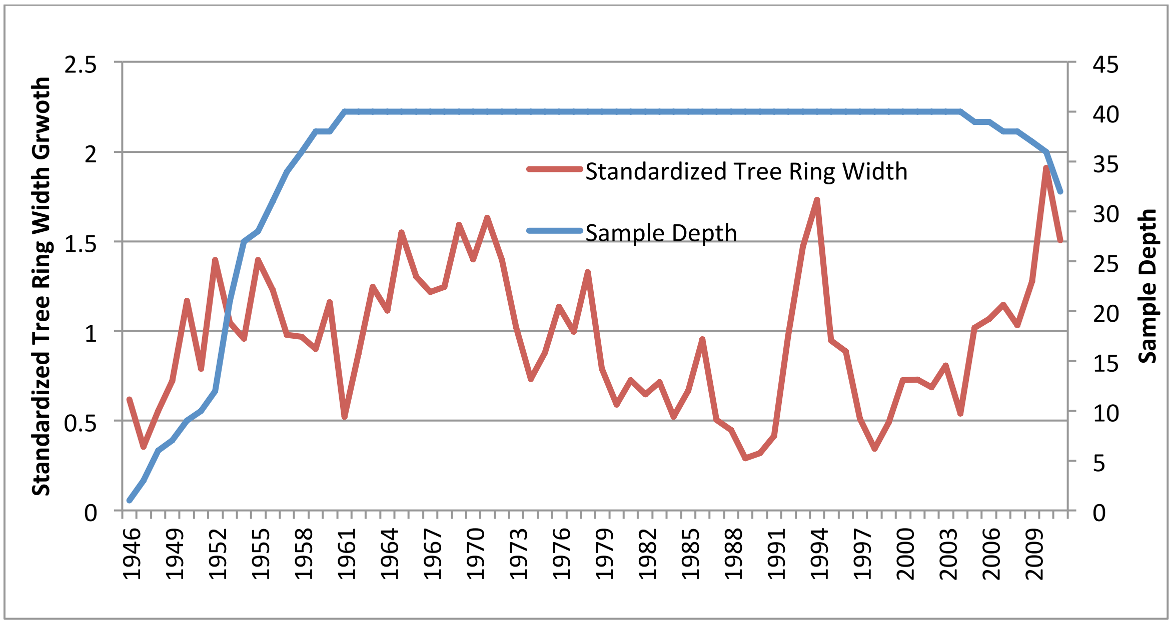

Figure 1: Master chronology for white spruce at Fairway Farms. Standardized measurements of 1 indicate an average year of growth (in this case, 1.81 mm), while any value above or below one indicate a year of above or below average growth. Sample depth is the number of samples averaged to produce the ring measurement for that year.

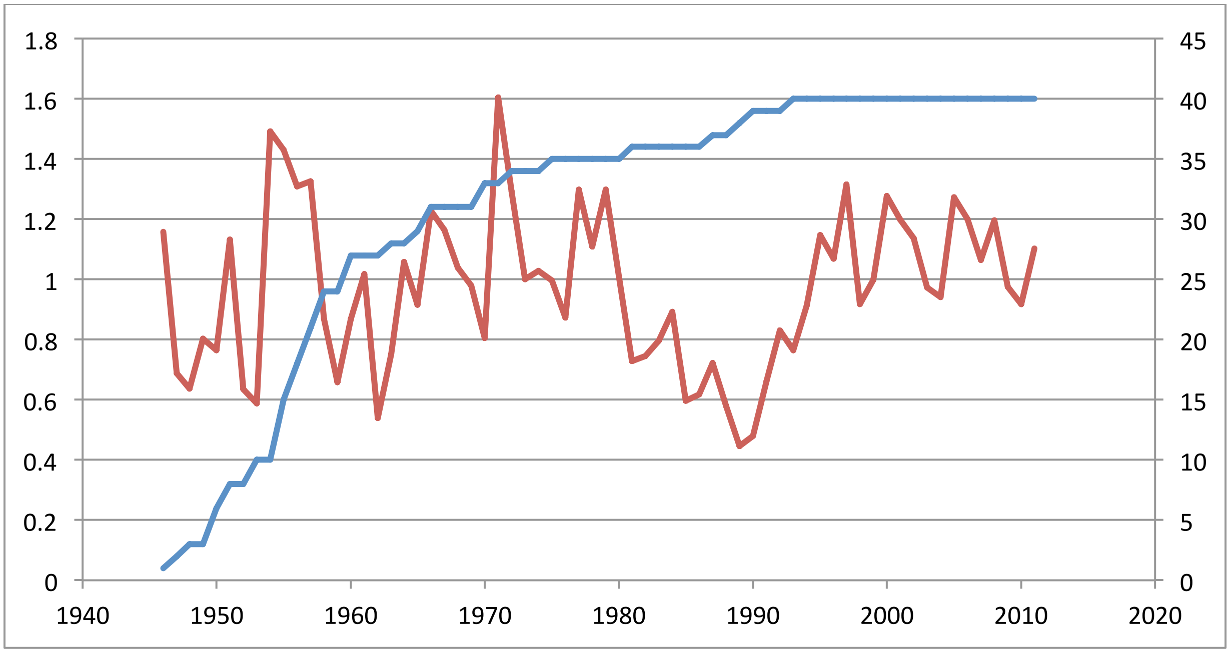

Figure 2: Master chronology for green ash at Fairway Farms. Standardized measurements of 1 indicate an average year of growth (in this case, 1.83 mm), while any value above or below one indicate a year of above or below average growth. Sample depth is the number of samples averaged to produce the ring measurement for that year.

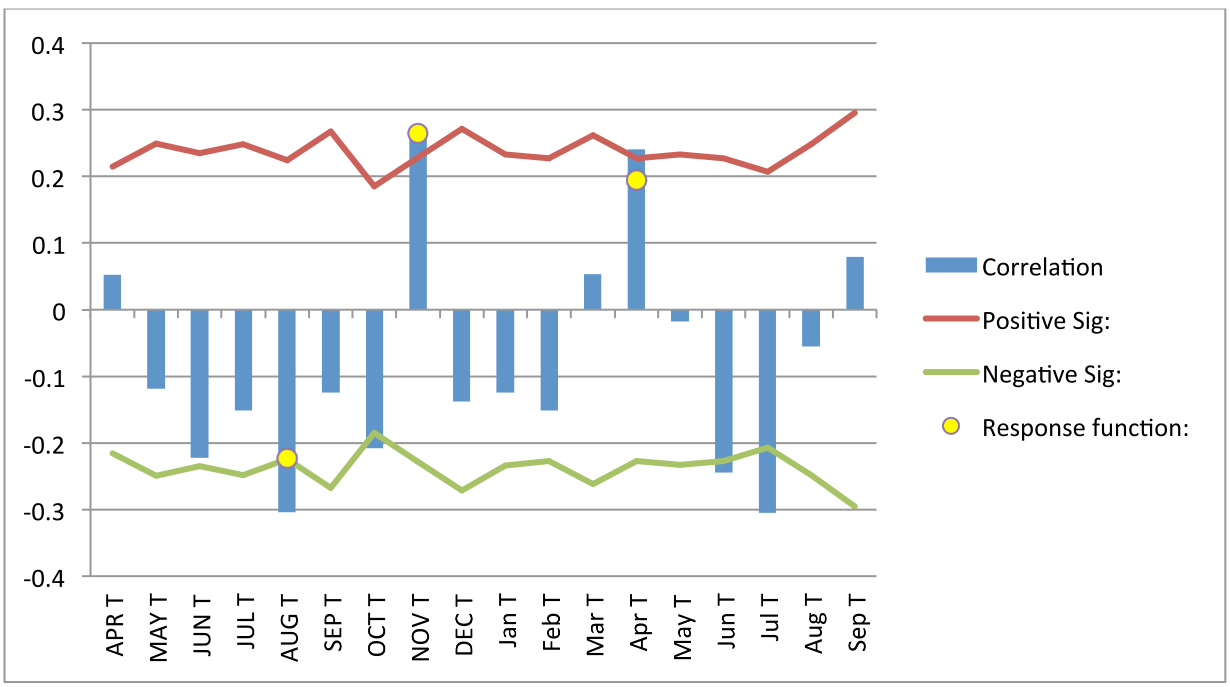

Figure 3: Results of the climate analysis comparing annual white spruce tree-ring growth to historical temperature variables from Yellow Grass, SK. The bars represent the degrees of correlation between the tree growth and the climate variable. The places where the bars cross the linear threshold are considered significantly correlated, marked by the response function circle. The uppercase letters (ie. APR) label the previous years' variables.

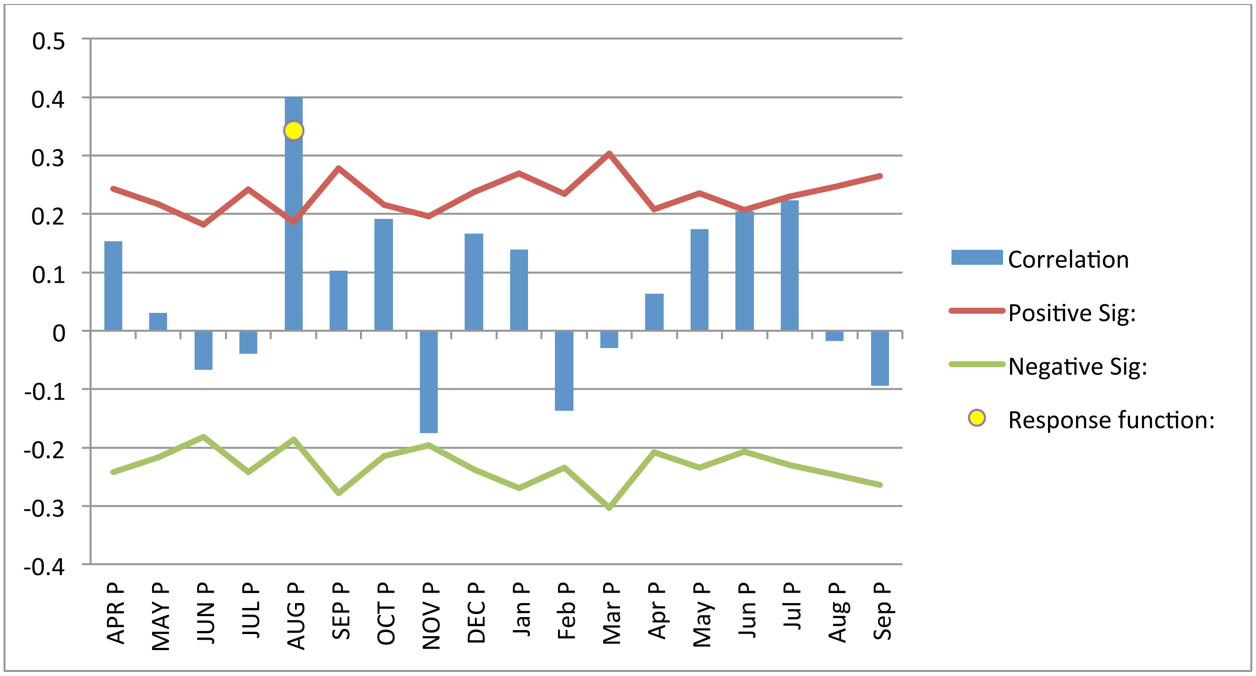

Figure 4: Results of the climate analysis comparing annual white spruce tree-ring growth to historical precipitation variables from Yellow Grass, SK.

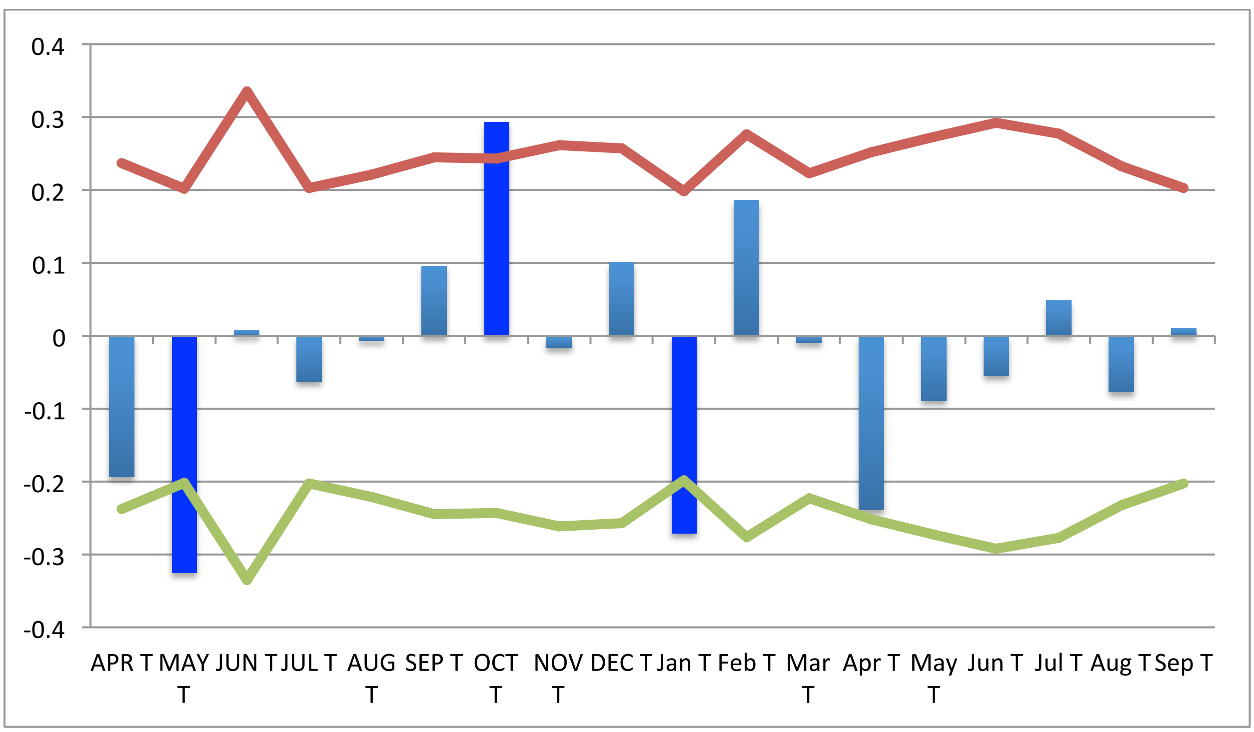

Figure 5: Results of the climate analysis comparing annual green ash tree-ring growth to historical temperature variables from Yellow Grass, SK.

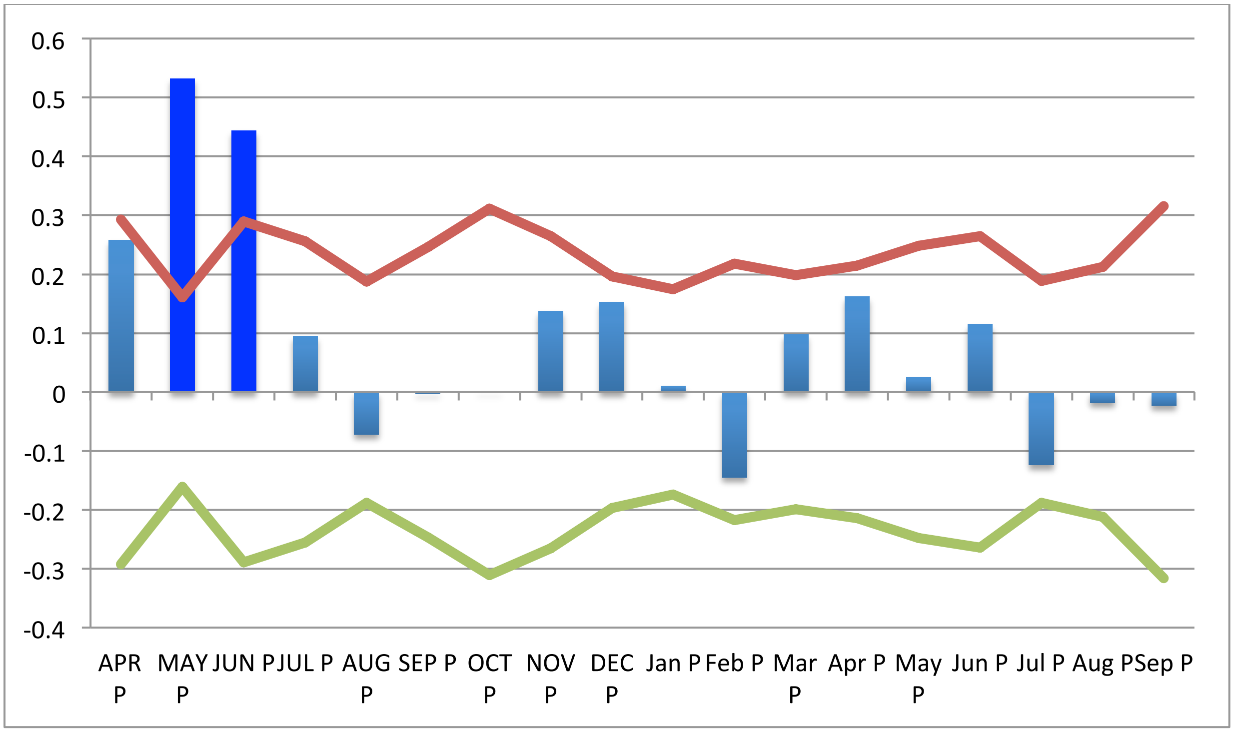

Figure 6: Results of the climate analysis comparing annual green ash tree-ring growth to historical precipitation variables from Yellow Grass, SK.

Conclusion

The results of this analysis give a strong indication of the important climate variables in central south-east Saskatchewan. For example, the importance of current April temperature in influencing white spruce tree-growth is significant in this part of Saskatchewan, but is less significant (even negatively correlating in some areas) in the rest of the province. For green ash, the significance of the previous May's precipitation increases in areas further north, a trend which fits with the results of this site's data. 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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