A Dendrochronological Analysis of White Spruce and Green Ash in Prairie Shelterbelt Systems: Michel Cummings 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 and green ash trees 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 Cumming's property, white spruce and green ash samples were collected from 20 trees per species. The oldest white spruce samples were 62 years old, while the oldest green ash sample was 75 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 case, studies investigated both green ash, *Fraxinus pennsylvanica* and 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 and green ash 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:12QL000

Date: May 10th, 2012

Site Name: Chez Michel

Site Contact Info: Michel Cummings

Latitude: N 50°34'17.1"

Longitude: W 104°03'46.9"

UTM: 0566352 5602590

UTM Zone: 13U

MASL (m above sea level): 683

Satellites: 9

Species Common Name: Green Ash

MAD Lab Species Code: M00

Species Common Name: White Spruce

MAD Lab Species Code: 200

Methods

The MAD Lab sampled 20 trees of each species, 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 Indian Head 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 62 years old at breast height. This suggests they were planted around 1949, while the green ash (oldest was 75 years old) was planted around 1936. The tallest white spruce sampled was 19.91 m high, and the widest tree had a diameter of 50.7 cm (see Table 1). The tallest green ash measured 11.5 m, and the largest diameter was 33.9 cm (Table 2). The average ring-width measurement was determined to be 2.54 mm for white spruce (see Figure 1 for the standardized growth of the tree over time) and 1.26 mm for green ash (see Figure 2).

Table 1: Diameter at breast height (DBH) and heights of white spruce sampled at the Cummings' property.

	DBH (cm)	**Total height (m)**
12QL201	50.7	18.71
12QL202	26.0	18.51
12QL203	29.8	16.91
12QL204	47.8	17.71
12QL205	37.7	16.91
12QL206	35.7	16.71
12QL207	40.9	16.91
12QL208	33.1	18.71

12QL209	37.8	18.51
12QL210	32.7	17.51
12QL211	27.6	16.11
12QL212	41.0	18.71
12QL213	38.1	19.11
12QL214	34.4	19.11
12QL215	49.5	19.91
12QL216	34.3	18.91
12QL217	36.8	18.71
12QL218	37.3	19.31
12QL219	34.5	18.71
12QL220	39.7	18.31

Table 2: Diameter at breast height (DBH) and heights of green ash sampled at the Cummings' property.

	DBH (cm)	**Total height (m)**
12QLM01	33.9	8.71
12QLM02	25.5	11.51
12QLM03	19.3	7.71
12QLM04	22.6	8.11
12QLM05	22.5	9.11
12QLM06	26.3	9.11
12QLM07	19.4	8.51
12QLM08	25.1	8.71
12QLM09	21.4	9.11
12QLM10	22.5	9.91
12QLM11	26.4	9.11
12QLM12	20.2	6.71
12QLM13	15.0	6.71
12QLM14	23.3	9.11
12QLM15	20.5	9.91
12QLM16	22.3	7.71
12QLM17	23.6	9.51
12QLM18	22.7	9.71
12QLM19	24.4	8.31
12QLM20	30.0	8.31

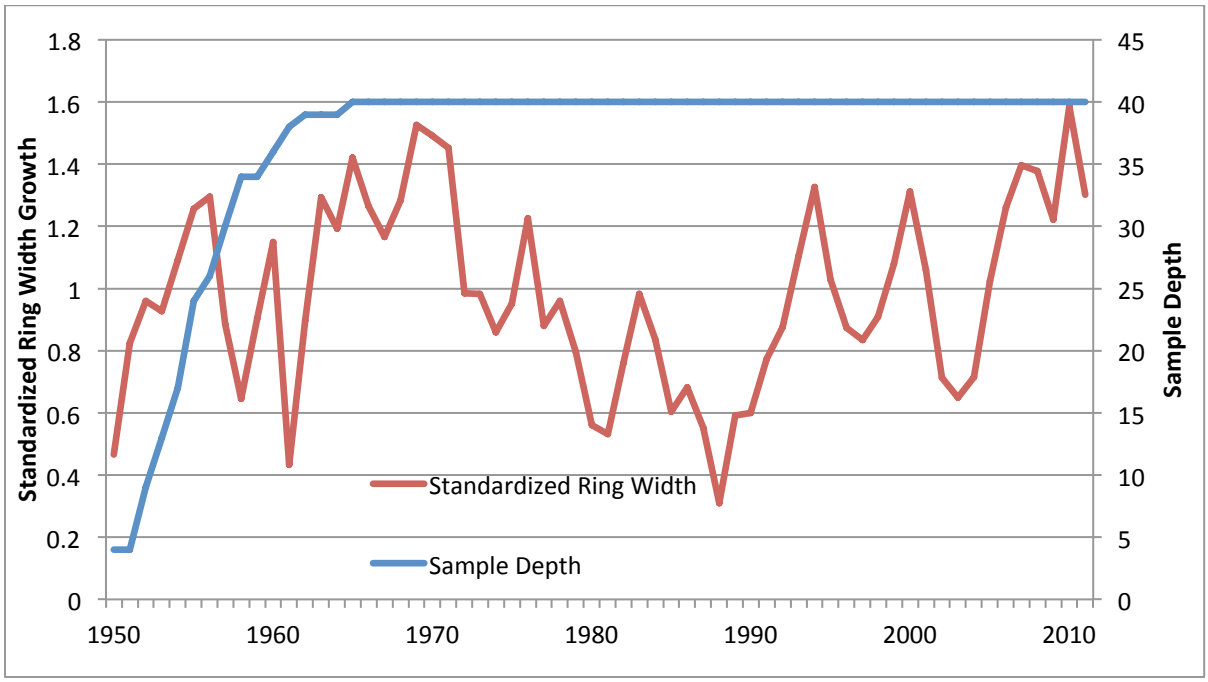

Figure 1: Master chronology for white spruce at the Cummings property. Standardized measurements of 1 indicate an average year of growth (in this case, 2.54 mm), while any value above or below one indicate a year of above or below average growth. Sample depth (right axis) is the number of samples averaged to produce the mean ring measurement for that year.

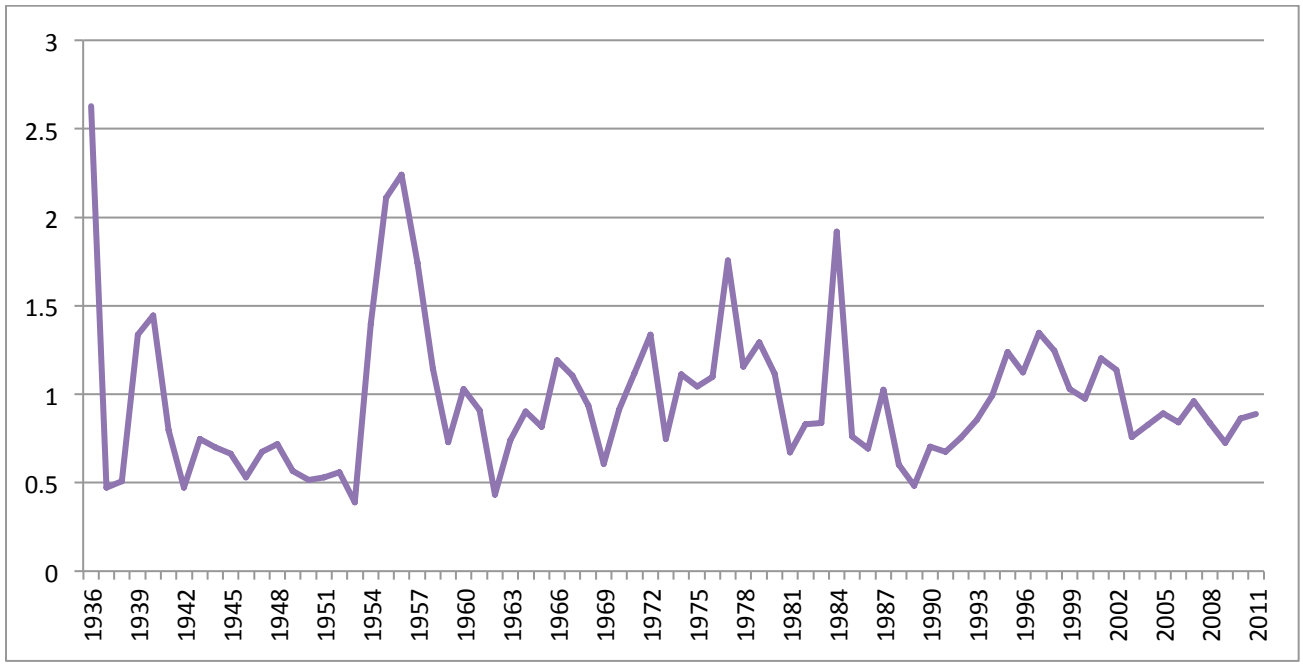

Figure 2: Master chronology for green ash at the Cummings property. Standardized measurements of 1 indicate an average year of growth (in this case, 1.26 mm), while any value above or below one indicate a year of above or below average growth.

The climate data from the Indian Head station indicated that past year's November temperature (positive) and the precipitation of the current June were the strongest climate variables affecting the growth of the white spruce (see Figures 3 and 4). The strongest climate variables affecting green ash growth were previous year`s May temperature (negative), and past May and June precipitation (positive) (see Figures 5 and 6).

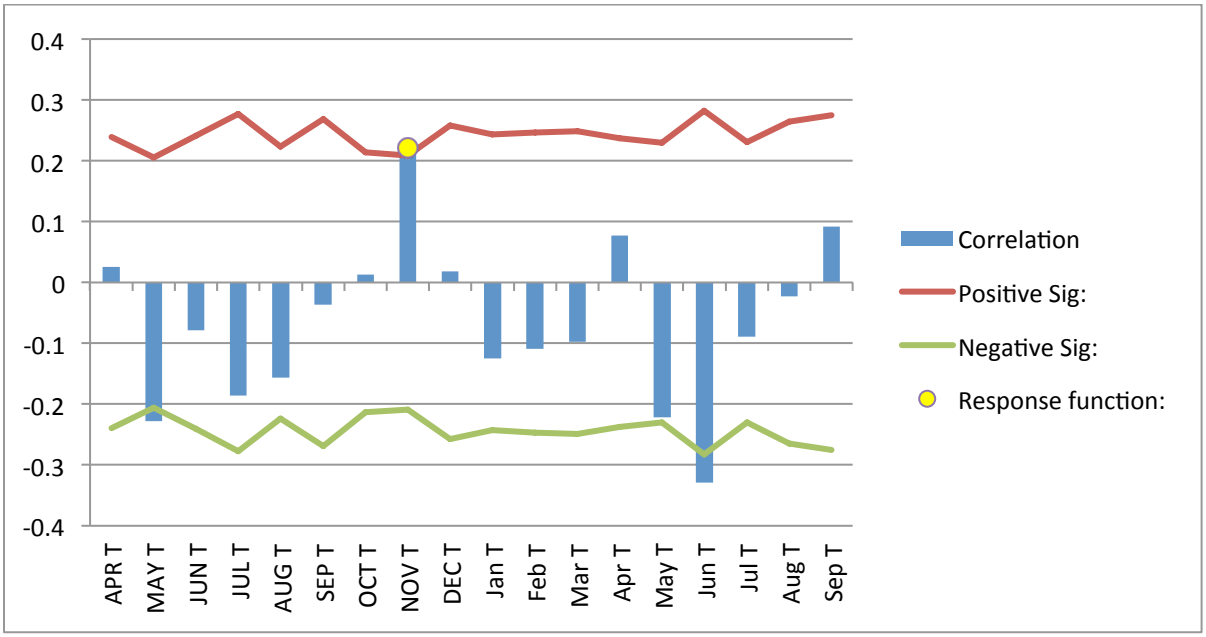

Figure 3: Results of the climate analysis comparing annual white spruce tree-ring growth to historical temperature variables from Indian Head, SK. The bars represent the degrees of correlation between the tree growth and the climate variable. The places where the bars cross the linear threshold are considered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

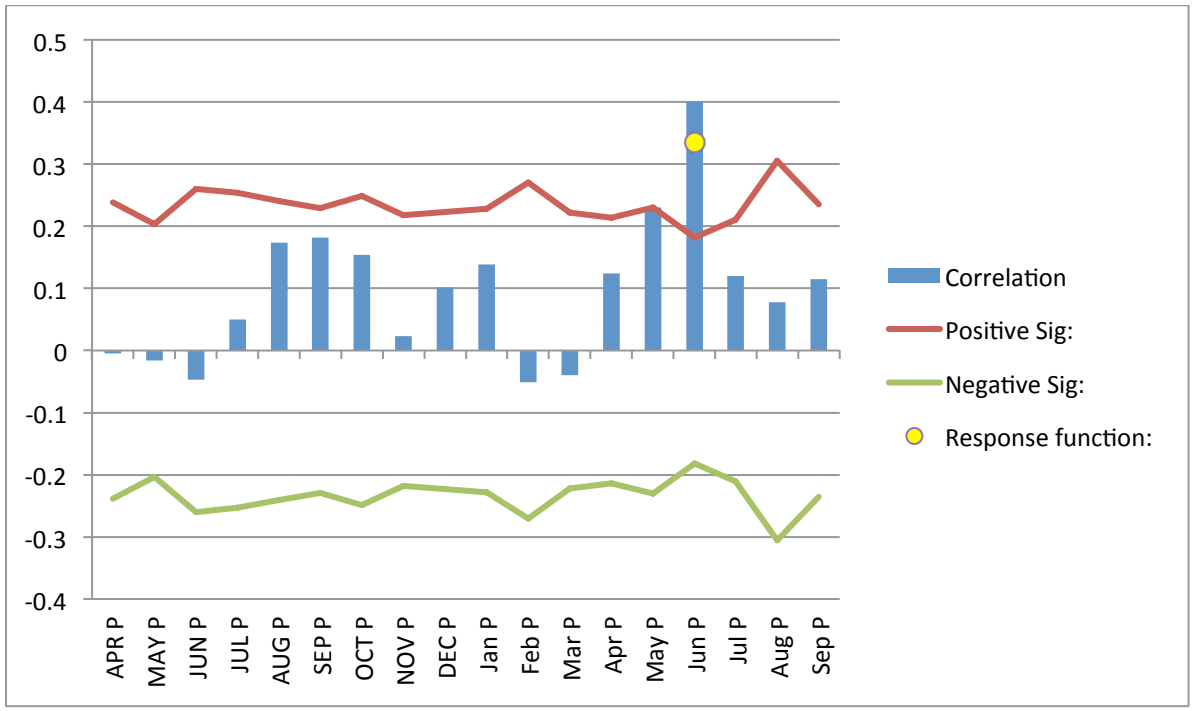

Figure 4: Results of the climate analysis comparing annual white spruce tree-ring growth to historical precipitation variables from Indian Head, SK.

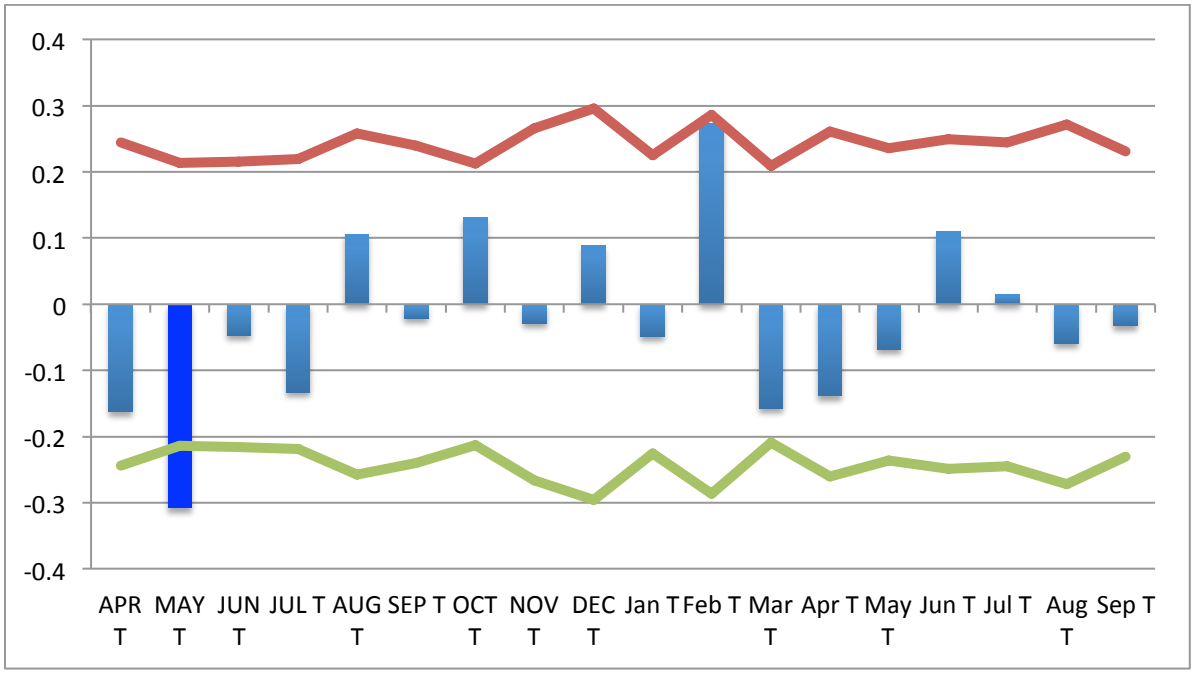

Figure 5: Results of the climate analysis comparing annual green ash tree-ring growth to historical precipitation variables from Indian Head, SK. The darker bars indicate significant response correlations.

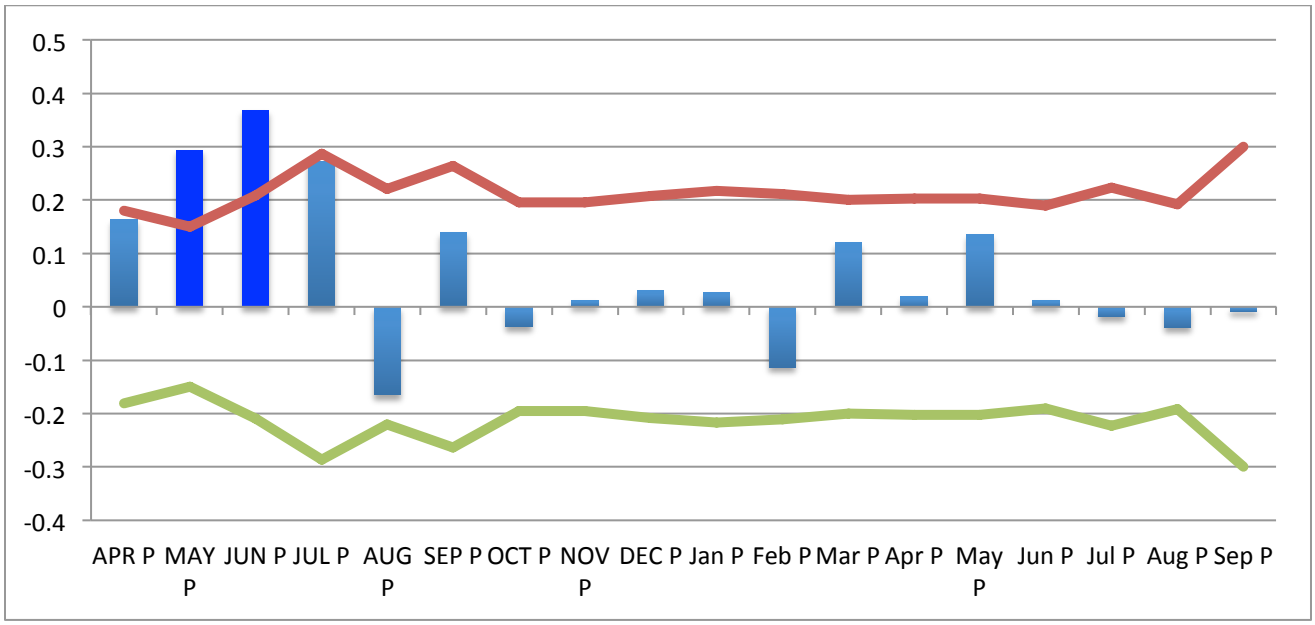

Figure 6: Results of the climate analysis comparing annual spruce tree-ring growth to historical precipitation variables from Indian Head, SK.

Conclusion

The results of this analysis give a strong indication of the important climate variables in central eastern Saskatchewan. For example, the importance of current June precipitation in influencing tree-growth for white spruce seems to change from positive (more precipitation results in more growth) to negative (more precipitation results in less growth) as sites are further north and this site fits with the trend, as June precipitation is negatively correlated to growth, but not as strongly as some sites further north. 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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