Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BA (Concordia University, 2016)

“Dendrochronological Reconstruction of Precipitation Trends to 1591 AD in the Sooke Watershed, Vancouver Island, British Columbia”

Department of Geography

Friday, May 15, 2020
1:00 P.M.
Conducted Remotely

Supervisory Committee:
Dr. Dan Smith, Department of Geography, University of Victoria (Supervisor)
Dr. Johannes Feddema, Department of Geography, UVic (Member)
Dr. Elizabeth Campbell, Pacific Forestry Centre, Canadian Forest Service (Outside Member)
Dr. Tobi Gardner, Integrated Water Services, Capital Regional District (Outside Member)

External Examiner:
Dr. Brian Starzomski, School of Environmental Studies, UVic

Chair of Oral Examination:
Dr. Barbara Sawicki, Department of Mechanical Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

By 2050, mean annual temperature on Vancouver Island, British Columbia (BC) is expected to rise by 1.5°C and summer precipitation is expected to decrease 14% above pre-industrial levels. The purpose of this thesis was to extend the Sooke Watershed precipitation record by developing proxy records from annual Douglas-fir tree rings, with the goal of being able to provide information about the historical range of variation that could assist future water management decisions. Robust dendrohydrological relationships were established to extend the instrumental record of precipitation back to the year 1591.

To provide geographic context for the hydrologic history in the Sooke Watershed, I examined Douglas-fir climate-radial growth relationships across western Canada to three monthly climate variables: precipitation, average temperature, and Hargreaves Climatic Moisture Deficit (CMD). Ten study sites were chosen to represent a gradient of climate conditions where Douglas-fir grows in Alberta and British Columbia. In order to explore how growth sensitivities varied over time, long- and short-term climate-growth relationships at these study sites were analyzed and compared to those established for the Sooke Watershed. A short-term analysis of the radial growth of Douglas-fir trees in the Sooke Watershed revealed the presence of a negative climate-growth relationship to June and July temperature starting in 1990. Further, the radial growth of Douglas-fir trees at all sample sites was moisture limited, whereby they exhibited strong positive growing season correlations to precipitation and negative correlations to CMD. Lastly, lagged negative effects of August and September precipitation and CMD were present and related to the annual growth increments. These results signify that: the rise in air temperature in recent decades is limiting the radial growth of Douglas-fir trees in the Sooke Watershed; annual variation in ring-width increments is regulated by to the amount of precipitation that falls near the end of the prior growing season; and, moisture availability in the spring of the current year of growth plays an important role in determining the annual increment of radial growth. Collectively, the results suggest that the radial growth of Douglas-fir trees within the Sooke Watershed are sensitive to interannual climate fluctuations and future growth is likely to be altered by changes in temperature and precipitation regimes.

These climate-growth relationships justified the development of a May-June-July precipitation reconstruction for the Sooke Watershed. Using a novel detrending method, an Ensemble
Empirical Mode Decomposition, I created a model that explained 28% of the precipitation variance. Results from the dendrohydrological analyses extend the understanding of the water supply area May-June-July precipitation record to 1591. The reconstruction revealed four major summer drought episodes that exceeded severity during the instrumental record; 1594-1596, 1898-1899, 1796-1777, and 1662-1665. Four extreme summer pluvial episodes were also observed from 1793-1794, 1920-1921, 1689-1690, and 1946-1647. The findings of the research provide information about historical summer precipitation trends within the Sooke Watershed – the primary water supply area to Greater Victoria. Notably, the research places summer drought and pluvial events recorded within the instrumental record into a much longer context, permitting an understanding of natural frequency and duration of hydrological events in the Sooke Watershed.