CLIMATE-FIRE-VEGETATION INTERACTIONS IN THE CARIBOO FORESTS: A DENDROCHRONOLOGICAL ANALYSIS

Dr. L.D. Daniels
Department of Geography
University of British Columbia

Dr. E. Watson
Department of Geography
University of Western Ontario

EXECUTIVE SUMMARY

Dendrochronological techniques yield high-quality data for reconstructing historical change in forests and quantifying temporal aspects of disturbance regimes. In this study, we used annual-resolution tree-ring data to investigate:

(1) the influences of year-to-year climate variation on tree growth and fire occurrence, and
(2) the impacts of fire on forest structure and dynamics in the Cariboo region of British Columbia.

We developed 14 new ring-width chronologies, six for Douglas-fir and eight for lodgepole pine. The chronologies were used to crossdate age and fire scar samples and to test for climate-tree growth relationships. Chronologies for both species were positively correlated with Williams Lake precipitation, indicating that wet (dry) summers result in wide (narrow) annual rings. The Douglas-fir chronologies were selected for climatic reconstruction since they were longer, exhibited more inter-annual variation, and had a stronger common signal between trees than the lodgepole pine chronologies. The Douglas-fir ring-width chronology from site 6 was combined with a ponderosa pine late-wood chronology from Chasm (provided by E. Watson) in a statistical model that we used to reconstruct precipitation in our study area from c. 1630 to 1995.

Crossdating of 136 samples yielded 280 fire-scar dates ranging from 1575 to 1988. At the plot spatial scale, fire intervals ranged from two to 59 years, with median intervals of 13 to 22 years. Fire intervals doubled when we considered only fires that scarred at least two recorder trees per plot, indicating that severe fires burned less frequently than low-severity fires.

Fire was a primary determinant of stand structure and dynamics in the Douglas-fire – lodgepole pine forests of the Cariboo region. The mixed fire regime includes both low-severity stand-maintaining fires and less frequent stand-replacing fires. Evidence of stand-maintaining fires included uneven age-structures, low density of veteran trees, Douglas-fir with up to eight fire scars, and lodgepole pine with multiple fire scars. Discrete cohorts of trees with fast initial growth rates indicated stand-replacing fires. In eight of the nine study plots, cohorts of trees established following fires that burned in the late 1800s or early 1900s. Post-fire stand development processes such as crown closure, inter-tree competition and self-thinning were evident in the radial growth suppressions and releases of individual trees.

For forests with mixed fire regimes that include stand maintaining and stand-replacing fires, it is difficult to quantify the impacts of fire suppression and to determine whether current stand differ from historic stands. Nevertheless, the current fire-free interval exceeded the median fire return interval at all plots and the maximum interval at all but two plots. Weak correlations suggested that long fire intervals may explain the density of canopy and subcanopy trees observed in some plots, but additional data are needed to draw meaningful conclusions. The radial growth rates of contemporary saplings are much lower that the initial growth rates of subcanopy and canopy trees. Slow sapling growth may be due to competition from overstory trees and low light availability, implying that current stand structures are different from historical conditions.

We used our fire scar records, precipitation reconstruction, and El Niño-Southern Oscillation (ENSO) indices to test for climatic influences on fire occurrence between 1700 and 1970. Links between El Niño-Southern Oscillation, interannual variation in climate, and fire in the Carbioo region were consistent with climate-fire relationships in other dry forests in North and South America. Fire occurrence was related to droughts that last three to five years and correspond with the onset of strong La Niña events. Fires commonly burned in the second year of a drought, following desiccation of fine and coarse fuels. Years of above average precipitation preceded fire years and likely contributed to build up of understory vegetation and fine fuels. Future research will test for climate-driven changes in the fire regime over periods of decades to centuries and attempt to differentiate between the influences of climate and human impacts on the Cariboo fire regime.

The links between climate and fire are regionally important given the current mountain pine beetle outbreak in British Columbia. This research suggests that risk of catastrophic fire in the Cariboo forests will be greatest if a strong La Niña event coincides with peak fuel accumulations resulting from the current outbreak. In 2002, we experienced a moderate El Niño event; La Niña events typically follow El Niños by three to five years.

KEY WORDS: Cariboo region, climate reconstruction, dendrochronology, disturbance regime, Douglas-fir, dry forests, El Niño, fire history, fire return interval, inter-annual climate variation, La Niña, lodgepole pine, stand dynamics, ring-width chronologies

RESEARCH CONTRIBUTIONS

A. Final Report: (available on request: daniels@geog.ubc.ca)

Daniels, L.D. and E. Watson. 2003. Climate-Fire-Vegetation Interactions in the Cariboo Forests: A Dendrochronological Analysis. Report to Forest Innovation and Investment – Forest Research Program, Vancouver BC, April 2003. 56pp.

Daniels, L.D. 2003. Tree-Ring Analysis of the Fire Regime of the Cariboo Forest, British Columbia. Power point presentation, http://www.geog.ubc.ca/~daniels/Cariboo.ppt

B. Conference Presentations:

Daniels, L.D. 2003. *Fire history in the Cariboo region of British Columbia, Canada*. Annual Meeting of the Association of American Geographers, New Orleans, March 2003.

Stan, A., L.D. Daniels, and J. Dobry. 2002. *Dendroclimatic analysis of Douglas-fir in the Cariboo region of British Columbia.* Poster presented at Dendrochronology, Environmental Change and Human History, Quebec City, August 2002.2002-3.

C. Upcoming Conferences, Workshops and Meetings

Meeting with D. Conly (Lignum Ltd) and K. Iverson (Iverson and MacKenzie Biological Consultanting Ltd.) to review research results and applications, 100 Mile House, BC, May 6, 2003

Invited presentation at *Managing our Dry Forests and Grasslands Workshop*, Federation of British Columbia Naturalists, Kamloops BC, May 8, 2003

Presentation during a Special Session on *Natural disturbances and their ecological impact during the Holocene*, Canadian Association of Geographers Annual Meeting, Victoria, BC, May 27-31, 2003

Workshop with representatives from University of Victoria, BC Ministry of Forests and CFS-Pacific Forestry Centre to discuss disturbance regime research and management implications, Victoria, BC May 29 (Date to be confirmed)

D. Manuscripts in Preparation

Daniels, L.D., E. Watson, A. Stan, J. Dobry, M. Feller and K. Klinka. (In prep) Dendroclimatic analysis of Douglas-fire and lodgepole pine in the Cariboo region of British Columbia. To be submitted to *Tree-Ring Research,* June 2003.

Daniels, L.D. (In prep) Climate-Fire Interactions and Forest Dynamics in the Cariboo region of British Columbia To be submitted to *Canadian Journal of Forest Research*, May 2003.

Daniels, L.D. (In prep) Reading Between the Lines: Dendrochronology Basics for Forest Ecologists Studying Natural Disturbance Regimes. To be submitted for publication as a *BC Ministry of Forests Research Extension Note*, May 2003

E. Contributions to the International Tree-Ring Databank

Daniels, L.D., J. Dobry, M. Feller and K. Klinka. (In Prep). Thirteen new chronologies, 6 Douglas-fir and seven lodgepole pine from central British Columbia. To be submitted to the International Tree-Ring Databank, NOAA, Boulder Colorado, June 2003

For further information, contact Dr. Lori Daniels, Department of Geography, University of British Columbia, daniels@geog.ubc.ca