DENDROCLIMATOLOGY OF EASTERN WHITE CEDAR (*THUJA OCCIDENTALIS* L.) AT LAKE HÉBÉCOURT, QUÉBEC

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Objectives

The objective of this study was to evaluate the dendroclimatic potential of eastern white cedar at Lake Hébécourt in northwestern Québec. We did this by conducting response function analyses with ring-width chronologies developed from trees representing different growth conditions.

Material and methods

On five islands in Lake Hébécourt, a total of 41 white cedar trees were sampled, which represented the following three growth conditions: i) 12 shoreline trees that are inundated at least during periods of high water levels (shore), ii) 16 relatively small and twisted trees rooted within cracks in cliff faces and growing about 2 m above the maximum water level (cliffs), and iii) 13 trees located in the interior of the forest more than 2 m above the lake and growing on relatively deep soil (forest interior). Using an increment borer, one to three cores were taken from each tree, glued on wooden supports, and then sanded. The samples were crossdated using pointer years, that is years where ring widths were much larger or smaller than the average. Tree-ring widths were measured and crossdating was verified statistically with the program COFECHA. The measurement series were detrended by negative exponential functions and chronologies were developed separately for each of the three sites with the program ARSTAN.

The relationship between the residual chronologies (i.e., ring-width indices) and climate was analyzed for 1920 to 2001 by calculating response functions using the program RESPO. Regional monthly mean temperature and monthly sum of precipitation from June of the year preceding growth to September of the year of growth were used in the analysis as explanatory variables. The climate series were calculated by Tardif and Bergeron (1997) that used data from eight weather stations in the area of Lake Hébécourt to better approximate the regional climate.

Finally, we compared the results of our dendroclimatic analysis to those published for nearby Lake Duparquet (Archambault and Bergeron 1992, Tardif and Bergeron 1997).

Results

Maximum tree age diminished from the cliffs to the forest interior from 400 years (cliffs) to 230 years (shore) and about 100 years (forest interior), respectively. Mean ring width of trees from within the forest (0.79 mm) was distinctly larger than at the shore (0.57 mm) or on the cliffs (0.48 mm). Mean sensitivity was around 0.2 and varied little among the sites. This relatively complacent ring-width pattern is also expressed by the low number of pointer years. Small ring widths were detected for 1920, 1921, 1981, and 1982, whereas large tree rings were formed in 1968 and 1992.

The climate variables used in the response function analysis explained about 20% of the variation in the ring-width data. Generally, the shore and cliff chronologies had similar growth responses to temperature and precipitation, whereas that of the forest interior differed somewhat. Growth at the shore was negatively related to the late summer temperatures (August and September) of the current year but positively influenced by precipitation in November of the preceding year and particularly by precipitation in June of the current year. Tree growth on the cliffs was negatively related to September temperatures during the year of the tree-ring formation, whereas no significant response function was found with the precipitation variables. In the forest interior, summer temperatures (July and August) were negatively associated with growth in the following year.

Comparison of the three chronologies of Lake Hébécourt with those developed at Lake Duparquet revealed a close similarity between them, the strongest correlation being observed with that of the cliff faces.

Conclusion

The dendroclimatological potential of a species is related to its sensitivity to climate and to age of the trees. The results of our study furnish evidence that the potential of eastern white cedar depends largely on the site conditions. Within the forest, the trees are mostly very young and their growth seems not to be very sensitive to either temperature or precipitation. Trees growing on the cliff faces and at the shore, however, attain much higher ages - probably because they are more protected from fire, the major natural disturbance in the area – and their radial increment is somewhat more sensitive to climate. Since the periodic flooding of the shoreline trees might affect their growth response to climate, particularly to precipitation, we suggest that eastern white cedar growing on cliffs serve best for climatic reconstructions.

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References

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