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Frontline Express
Canadian Forest Service – Great Lakes Forestry Centre

Revealing the Past Secrets of Trees via Stem Analysis

INTRODUCTION

Trees are in essence, factories that convert sunlight, nutrients, water and carbon dioxide to oxygen and carbohydrates through photosynthesis. Carbohydrates provide the tree with an internal source of chemical energy, which is used to manufacture new leaves, branches and roots, and also to produce a new layer of wood (xylem), which is permanently encased within the trunk of the tree (see Figure 1).

Examination and measurement of these layers enables forest researchers to study intrinsic patterns of tree growth and development and to determine the effect of factors such as, commercial thinning, insect defoliation, atmospheric pollution, and increased temperature associated with climate change.

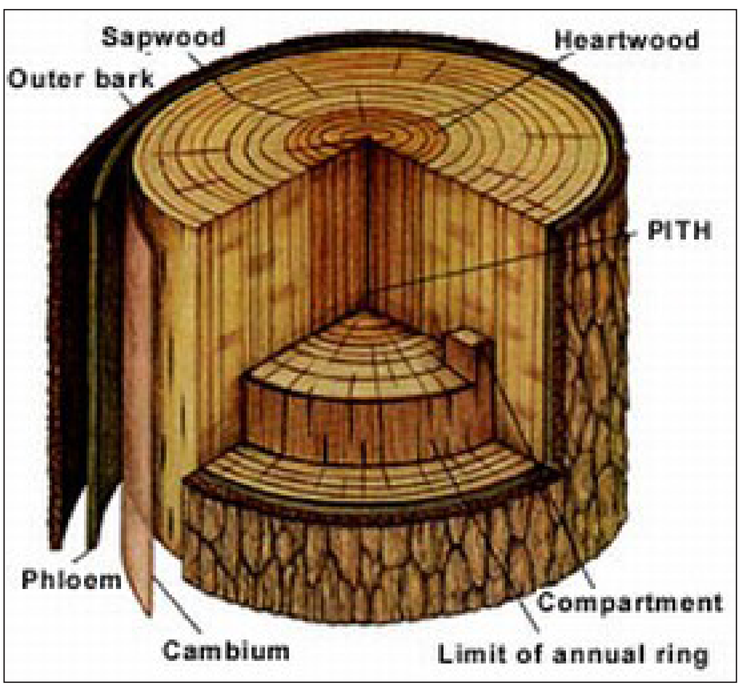

Figure 1. Internal structure of a pine tree. Photo from: Umea Plant Science Centre at http://www.upsc.se/aericsson.htm

METHODS

To study these annual growth layers in detail, a tree must be cut down and cross-sectional samples removed at various points along the trunk. The width of the annual rings are then measured on each cross-section using a computer imaging system (see Figure 2).

To reconstruct the growth record of trees via stem analysis, the development of complex mathematical formulas and associated software is required. For example, the calculation of annual diameter, height and volume growth requires a knowledge of the geometry of conical solids. Fortunately, researchers within the CFS Fibre Centre, have developed innovative software to simplify these computations.

RESULTS

By examining the relationship between the effects of factors such as thinning, fertilization, tree improvement and climatic change, researchers can detect and delineate the consequences of these influences on tree growth and development.

Figure 2. Laboratory processing - computer image system: forest mensurationist using a scanner and associated digital display to measure annual ring widths from a cross-sectional sample obtained from a jack pine tree.

For example, Figure 3 illustrates the difference in the annual growth layer profiles between two jack pine trees: one within a thinned stand and the other in an adjacent unthinned stand.

The thinning occurred in 1971 at an approximate age of 11 years. At time of sampling (spring 2001), the two trees were were 41 years of age, and situated within the dominant crown class of their respective stands. The growth layer profiles indicate that both trees were approximately of equal size in 1971 with similar pre-treatment developmental patterns.

However, the difference between the trees increased with time as shown by the rapid increase in annual ring widths of the tree within the thinned stand. Although both trees exhibited a gradual tip-to-stump reduction in annual ring widths, the decline was much more rapid for the tree within the unthinned stand. Furthermore, a substantial reduction in annual ring width occurred at a height of approximately 7.5 m when the control tree was 17 yr of age. This may be due to competition with neighbouring trees.

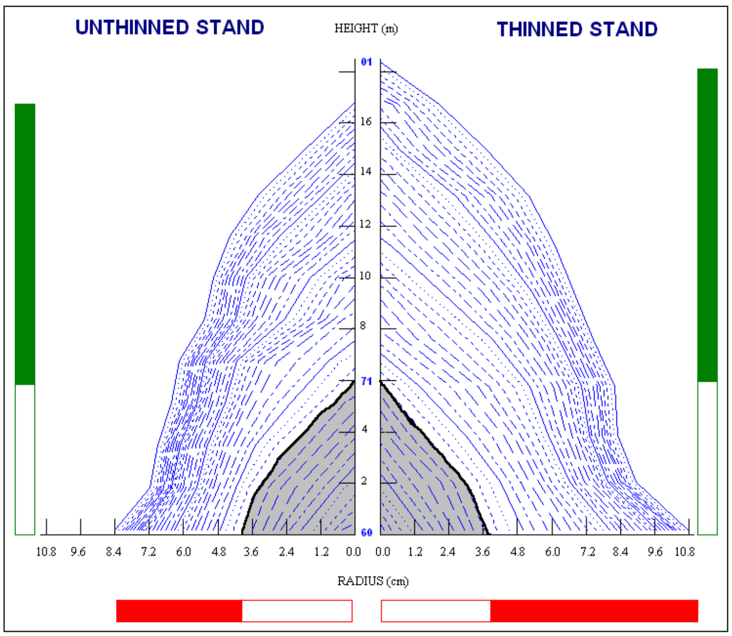

Figure 3. Cross-sectional view of the annual growth layer laid down each year of the tree's life (1960-2001). The profile on the left-hand side is derived from a tree selected within the unthinned stand whereas the profile on the right-hand side is derived from a tree selected within the thinned stand. The grey shaded area denotes the developmental patterns during the pre-treatment period (1960-1971). The horizontal red solid bar illustrates diameter growth since 1971 whereas the vertical green solid bar illustrates the height growth since 1971. Note, 60, 71 and 01 denote calendar years 1960, 1971 and 2001, respectively.

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CONCLUSIONS

Stem analysis allows researchers to reconstruct the entire growth history of a tree. Results from stem analysis allow forest managers to improve their sustainable management practices and provide the foundation for the development of evidence-based forest policies, which will ultimately result in increased forest productivity and more valuable forest products.

SOURCES OF RELEVANT INFORMATION

Newton, P.F. 2003. Stem analysis program for coniferous forest tree species. Computers in Electronics in Agriculture 39:61-66.

Newton, P.F. 2004. A stem analysis computational algorithm for estimating volume growth and its empirical evaluation under various sampling strategies. Computers in Electronics in Agriculture 44:21-31.

