# Branch Models to Predict the Effect of Common Silvicultural Treatments on Pinus Banksiana Visual Lumber Downgrade by Knots

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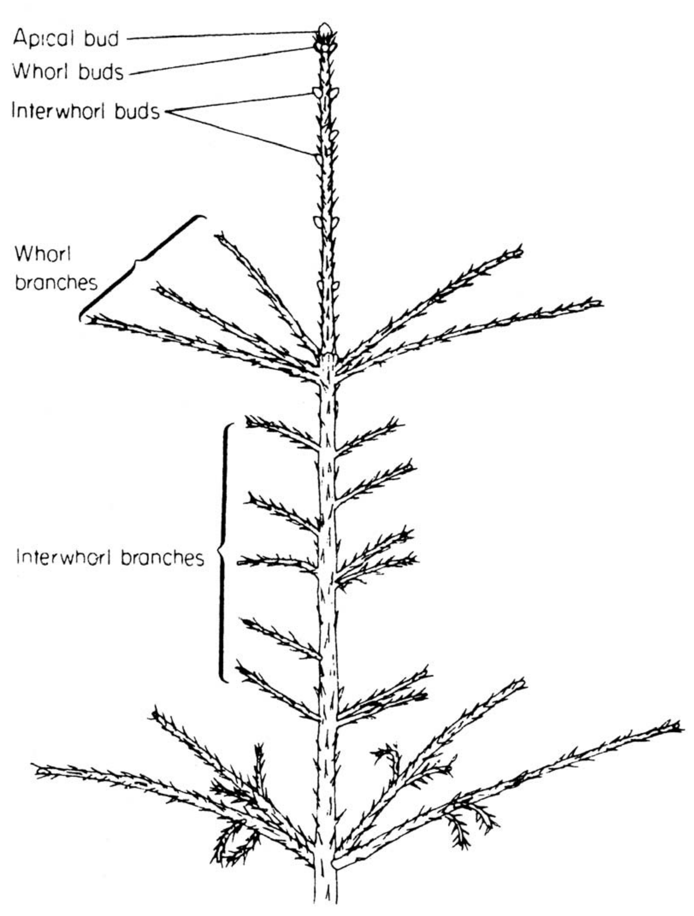
Chaire en productivité forestière

Short supply of sawlogs in Eastern Canada is in part due to decreasing availability of species traditionally used for that purpose. Among species left, Jack pine (*Pinus Banksiana* Lamb.) is the second fastest-growing conifer during the first 20 years in its native range and represents more than 20% of softwood volume in Canada. In return, spacing in softwood plantation in the last decade has been decreased without considering the impacts on wood quality. For Jack pine, the most important feature of wood quality is knot size, which is correlated to lumber strength and stiffness. Indeed, knots have been reported as the main lumber downgrading defect, being inversely proportional to stand density. Recently, functional-structural models have been used in conjunction with a wood quality module to assess the effects of management choices on the growth of Scots pine. One of these models, PipeQual, has been calibrated for Jack pine, and preliminary validation has shown very little bias for height and diameter growth. The ultimate step is to predict the size of individual branches through empirical models. To calibrate these models, height, diameter, insertion angle, and state of every branch were measured on nearly a hundred sampled trees distributed in Eastern Canada. Simulated trees will be virtually sawn by Optitek© using common sawmill settings and sawing patterns. Coordinates of each piece coming out will be coupled with the branch models to define knots found on each face. Lumber will then be visually graded where size, position and quality of the knots are considered. Silvicultural scenario simulations will be carried out to find the optimal silvicultural treatments that yield the highest volume production with the best lumber quality.

*The originality of this study is to bind forest growth modeling and wood quality sawing simulation in order to find the optimal silvicultural treatments that yield the highest volume production with the best lumber quality*

**Fig. 1.** Nodal Vs internodal




*Cochrane, 1978*

## Methods

Looking for a broad geographic extent in eastern Canada, naturally regenerated and planted Jack pine stands were sampled in four sites: Petawawa Research Forest (Ontario), SmurfitStone freehold (Quebec), and Eel River (New-Brunswick) and Tracadie Range (New-Brunswick). Almost all stands were even-aged pure stands of natural and plantation origin, aged from 21 to 79 years old. On the 24 sites, between 2 and 10 trees per site were sampled, for a total of 96 trees. All trees (trees measurable with a diametric tape, i.e. over 1.1 cm) were sequentially numbered, the species, state (dead/alive) has been noted and DBH measured. Where permanent sample plots (PSP) were not available, core or disc was also collected at DBH on all those trees to determine their age. Distribution of DBH was then divided into three equal classes, and one sample tree per class was selected. Before sample trees were to be felled, total height, height to live crown base, and crown shape and size, i.e. maximum crown radius in the 8 cardinal points, were measured. Both height measurements were made with a Vertex hypsometer. The sample trees were selected to represent the DBH range found in the stand. The closest competitors were then identified and their distance and azimuth from sample tree were measured. Total height, height to live crown base, and crown shape and size, i.e. maximum crown radius in the 8 cardinal points, were measured on both the sample trees and their competitors. Once felled, height to live crown base, defined as the lowest live nodal whorl (containing at least one live branch, i.e. supporting needles) not separated by more than one dead whorl, was remeasured more precisely. The height of every whorl was recorded and identified as nodal or internodal. Nodal branches bear at the top of each growing season length increment, while internodal branches are generally smaller branches along the internode (Fig. 1). Branch measurements included state (dead/alive), basal diameter (outside butt swell), and insertion angle in addition to stem diameter and azimuth for the nodal branches. The azimuth was measured by the clockwise distance (5 mm precision) from magnetic North. Azimuth was then transformed to clockwise degrees from geographic North. From the field data, a series of variables were computed, such as the number of branches per annual shoot (total, nodal, internodal), whorl number from base (total, nodal, internodal), and annual shoot length.

## Preliminary Results

Three key variables of the branches affect wood quality via knotiness: the **number of branches**, their **size** and their **insertion angle**. The number of branches depends greatly on the growing conditions that are reflected by the annual shoot length. The results obtained from the analysis of the number of branches per annual shoot in combination with the annual shoot length are shown in figure 2. It shows that the higher the number of branches per annual shoot the higher the proportion of long annual shoots (higher deciles), and inversely. The growth of branches are highly affected by competition. It holds true with the Jack pines sampled, as a general trend of decreasing total branch basal area per tree with increasing stand density is observed (Fig. 3). Branches have the tendency to flatten out after the first few years of growth. Thus, branch insertion angle decreases with age because of the weight it supports all its life, both its own biomass and the precipitations . Our data show that branch mean insertion angle decreases with relative height from more than 84° to 62° (Fig. 4).

**Fig. 2.** Relative frequency of the annual shoot length deciles in combination with the number of branches per annual shoot for *Pinus banksiana*

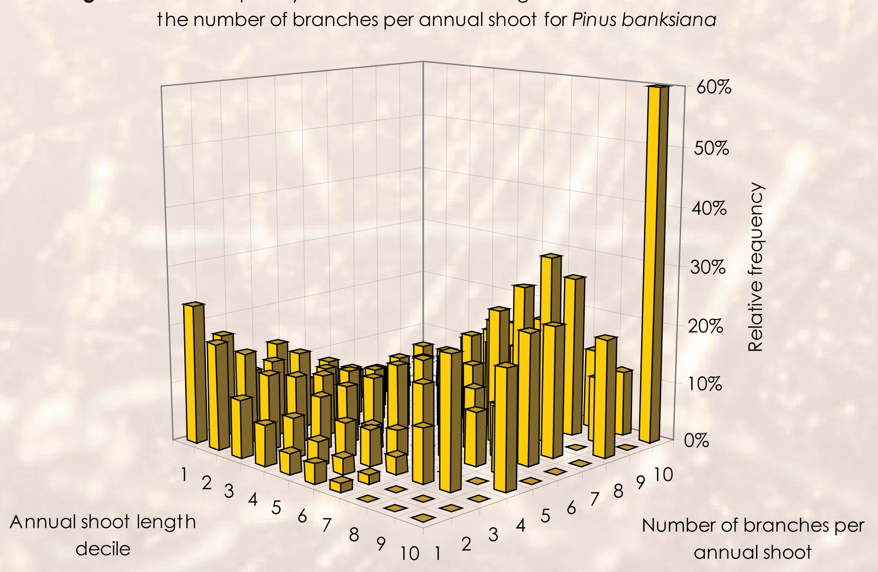



**Fig. 2.** Branch basal area per tree in function of stand density for Pinus banksiana

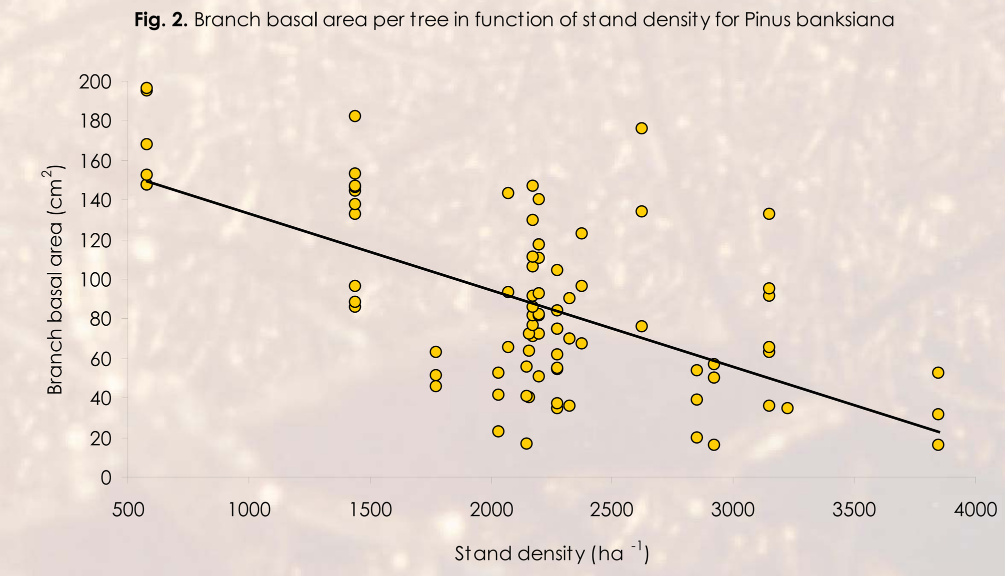



**Fig. 4.** Branch mean insertion angle in function of relative height for *Pinus banksiana*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