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Canadian Forest Service

CANADIAN WOOD FIBRE CENTRE

Fibre Facts nº 31

Assisted migration of white spruce within the eastern Canadian range has a limited effect on lumber quality.

Photo: I. Duchesne

With climate change, assisted migration is often considered a forest management tool to ensure that plantations are established with seedlings that are best adapted to future climates. Provinces have therefore developed rules for seed transfer along climatic gradients; however, the resulting effects on wood properties and lumber quality at rotation age remain unknown. To evaluate the effect of seed provenance and plantation sites on lumber quality at rotation age, trees from two white spruce legacy provenance trial sites (established during the mid-1960s) were harvested, processed, and tested.

Results show that assisted migration of white spruce within the eastern Canadian range has a limited effect on lumber quality. But because the average volume per stem at the southern site (Petawawa, Ontario) was twice that of the northern site (Baskatong, Québec), breeding and silviculture strategies should aim to maximize stem volume production at northern sites for efficient carbon sequestration and wood production.

Canada

From natural forest to second-growth plantations: a changing fibre supply

In past decades, major investments in breeding programs and intensified plantation silviculture have accelerated tree growth rates and shortened harvest rotations. Consequently, this has changed the fibre quality compared with past slow-growing unmanaged forests.

Climate change is now increasing fibre supply uncertainty due to the risks of pest and wildfire tree mortality and more frequent climatic anomalies that impact growth. Despite rising mean temperatures in the boreal forest, it remains unclear whether growth will sufficiently increase to counterbalance the negative impacts of climate change.

Although adaptive forest management measures are applied (including the northbound migration of southern seed lots within a species' distribution), answers are needed on how assisted migration affects wood properties and lumber product quality. Those effects remain poorly documented in genetic selection and breeding programs for northern conifers.

Canadian Wood Fibre Centre researchers, in collaboration with the Laurentian Forestry Centre, used translocation experiments (provenance trials) from the Canadian Forest Service's early breeding programs to study wood properties and full-size lumber product quality at rotation age, when moving seed sources into different climatic and environmental conditions. Six white spruce provenances that were planted in two provenance trial sites in Baskatong, Quebec, and Petawawa, Ontario, were selected to represent the eastern Canada geoclimatic range of the species (from west to east: Thunder Bay, Ontario, to Edmundston, New Brunswick) (**Figure 1**).

From these provenance trial sites, 108 trees were harvested. The stems were manually measured and bucked to maximize the production of 3.6-m (12-ft) logs that were sawn into lumber (**Figure 2 and 3**).The lumber was kiln dried, visually graded, and tested through static bending to determine stiffness and strength.

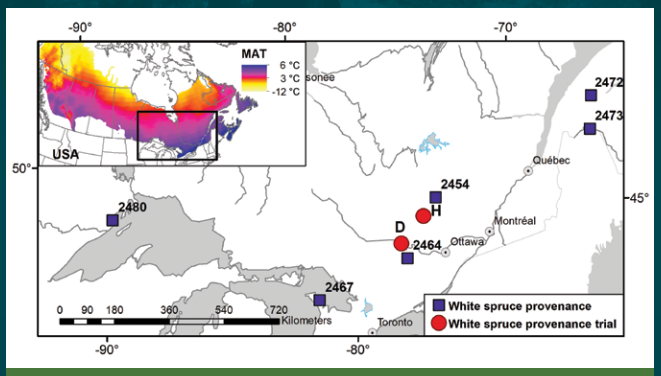

Figure 1. White spruce provenances included in the lumber quality study (blue squares) and location of the studied trials Baskatong (H) and Petawawa (D) (red circles). In the inset map, the study area is marked with black box, with mean annual temperature (MAT) from 1950 through 1980 superimposed on the range-wide distribution of white spruce in Canada.

Figure 2. Measurement of tree stems prior to bucking in the wood yard at the Duchesnay School of Forestry (Photo: I. Duchesne).

Figure 3. Conversion of logs to lumber using a portable sawmill (Photo: I. Duchesne).

Key Findings

In the southernmost site of Petawawa, trees had greater height (> 3 m) and diameter (46 mm larger at breast height) growth compared with trees from the Baskatong site. This led to significantly more volume accumulation, emphasizing that productivity level and planting site conditions are essential drivers for growth performance regardless of the provenance (**Figure 4**).

Lumber mechanical properties were not affected by assisted migration. Despite faster growth among trees in the Petawawa provenance trial site, lumber stiffness (modulus of elasticity) and lumber strength (modulus of rupture) were very similar at both sites. There was no obvious geoclimatic gradient between the six contrasted provenances for these structural properties; however, within-provenance variation was high (**Figure 4**).

Analysis showed that competition, site, and provenance have a significant influence on tree height and volume. This indicates that performance and adaptation of seed sources are affected by more complex patterns than translocation alone. More genetic testing is needed in comparative plantations to identify best performing planting stock.

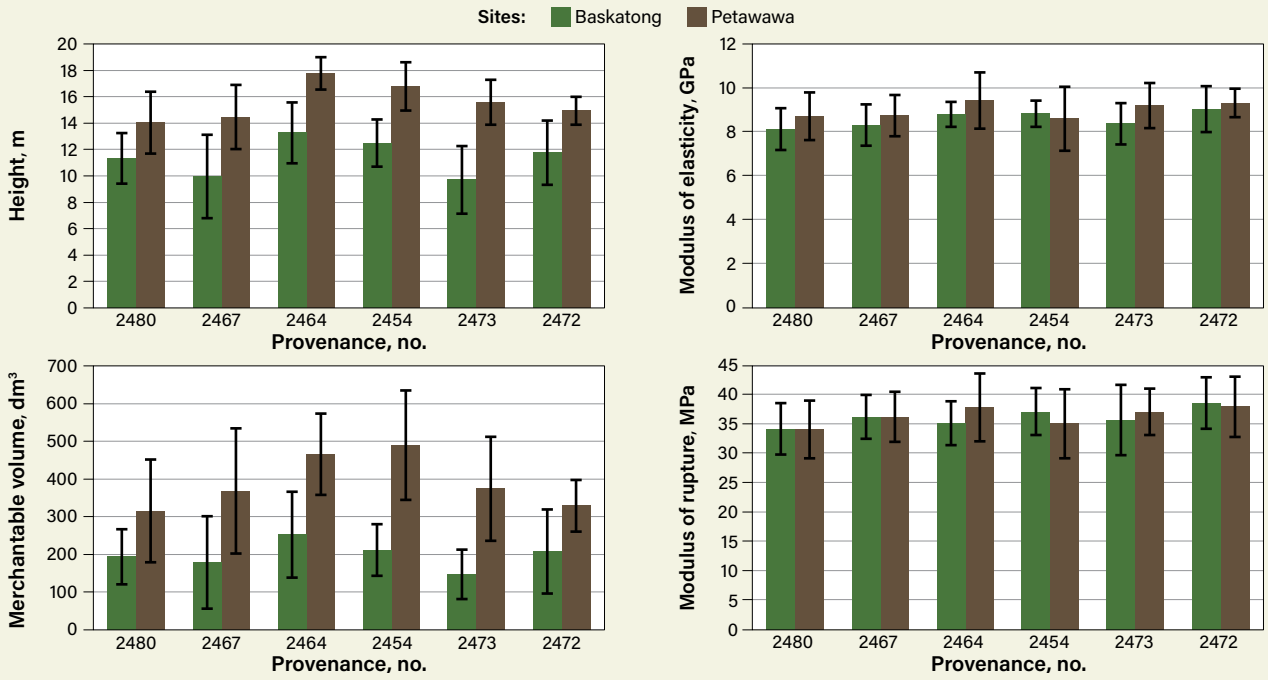

Figure 4. Mean height, merchantable stem volume, lumber stiffness (modulus of elasticity), and strength (modulus of rupture) as a function of provenance and site. Provenances are ordered from west to east.

Main Considerations

The results from this study show that moving provenances within the eastern Canadian range of the species had a relatively limited impact on lumber quality. Despite a temperature increase of 2 °C since the establishment of the plantation during the 1960s, the lower productivity in the northern site led to a low percentage of high-dimensional lumber (2 in × 6 in) in overall production. Based on these findings, assisted migration and forest management strategies should primarily focus on maximizing volume productivity, as well as selecting productive plantation sites and well-adapted trees. In addition, tree breeding programs should aim to minimize the decrease in wood stiffness resulting from increased productivity and decreased rotation cycles.

In both provenance trials, more than 86% of the fast-growing plantation lumber yielded a mean visual grade of No. 2 and better. However, the machine stress-rated (MSR) grade potential and percentage of lumber that met the bending stiffness design values for visual grades were generally low (12%–26%). Because the visual grading system was developed based on trees from unmanaged forests, plantation-grown lumber should preferably be machine stress-rated to ensure its fitness for structural applications in buildings.

Photo: I. Duchesne

Collaborators:

FPInnovations

Duchesnay
ÉCOLE DE FORESTERIE

For more information (reference):

Duchesne I, Lenz PRN, Girardin MP, Isabel N. Translocating seed sources to new geoclimatic environments has limited effect on lumber quality of eastern Canadian white spruce. Canadian Journal of Forest Research. 2022; 52(12):1553–1565. https://doi.org/10.1139/cjfr-2022-0075

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