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CWFC Facts 012

Canadian Wood Fibre Centre

Fibre Facts

Can wood properties be predicted from tree morphological traits in plantation-grown white spruce?

With the increasing worldwide demand for high-value forest products, we need to adjust our methods and strategies to respond to this demand and extract higher value from our wood resources. For instance, the wood quality of felled timber is largely unknown because this information is not included in our forest inventories. In order to have a meaningful impact on the Canadian forest industry, we need a better understanding of the interrelationship between silviculture, tree physiology, and wood quality, and the latter must be integrated into forest inventories.

It is in this context that there is a growing interest in predicting wood quality using remote sensing techniques to enhance the forest inventory for operational planning. LiDAR (Light Detection And Ranging) is one of the techniques that have the potential to significantly contribute to the improvement of forest inventory and management. Today, attributes such as tree height and crown width can be assessed more precisely and more cost-effectively by remote sensing-based approaches than by field measurements alone.

The Canadian Wood Fibre Centre (CWFC) of Natural Resources Canada, together with FPInnovations, explored the correlations between wood traits and tree morphology from plantation-grown white spruce to determine whether wood quality could be accurately predicted from stem and crown morphological traits. With adequate knowledge of this relationship, it could be possible in the future, using forest inventories produced through remote sensing techniques, to provide wood quality estimates in addition to traditional volume and dimension estimates.

A CWFC research team analyzed 495 even-aged white spruce trees from a 30-year-old plantation in the Mauricie region, Quebec. This plantation was chosen to minimize competition effects that arise from heterogeneous age or spacing structures often found in natural stands.

This study had three main objectives, namely to:

- examine the relationship between wood quality traits and crown morphological traits that are typically available through remote sensing and other large-scale forest inventory techniques;
- investigate more generally how much variation in wood traits can be explained by general tree morphology; and
- determine which morphological traits are best suited for predicting a specific wood quality trait.

In order to respond to these objectives, a total of 10 wood traits and 19 morphological traits were investigated. Tree morphology traits were assessed using inventory ladders. The number of branches, their diameter and the trunk diameter were measured at four selected whorls on the living crown. Wood traits were assessed from wood increment cores collected at breast height and analyzed with SilviScan® at FPInnovations in Vancouver. This technology provides high-resolution data for traits related to wood anatomy and wood mechanics.

The analysis of results revealed solid relationships between morphological traits and wood quality in plantation-grown white spruce. The most important tree morphological variables for the prediction of wood traits were tree height, crown width, and trunk diameters, especially diameter at breast height. The ability of morphology traits to predict wood traits differed widely among the latter. On average, morphology traits could predict about 29% of variation existing in all wood traits taken together. Wood traits related to cell micro-structure, such as fibre wall thickness,

WOOD TRAITS	MORPHOLOGICAL TRAITS
1. fibre coarseness	1. tree height
2. tangential cell diameter	2. height of the live crown
3. radial cell diameter	3. crown width
4. fibre wall thickness	4. diameter at breast height (DBH)
5. wood density	5. taper coefficient
6. mean annual increments	6. total number of whorls
7. latewood proportion	7. whorl height from ground (3)
8. longitudinal modulus of elasticity (MOE)	8. diameter at whorl (1)
9. angle of cellulose microfibrils (MFA)	9. diameter at whorl (2)
10. cellulose crystallite width	10. total number of branches
	11. branch no. 1–4
	12. branch diameter 1–4
	13. total surface of knots at branch base

were only weakly correlated, whereas wood traits related to increment growth, such as annual ring width or fibre diameter, showed a strong correlation to tree morphology.

Even moderate correlations between wood quality and tree morphology have the potential to enable us to classify standing timber based on morphological measurements, provided by LiDAR, for example. Further research in natural forests, as opposed to the even-aged plantation used in this study, will help confirm the scope of applicability of the reported results. The research team expects some bigger variations in wood and morphology traits when considering trees from different plantation densities, various stand layers and different ages. However it needs to be shown whether more variation may increase the accuracy of prediction models.

The results of the present study are encouraging for the inclusion of wood quality traits in future inventories. The presented analyses could guide the choice of wood traits to improve inventory techniques aiming to optimize the forest product value chain.

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