NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

Prediction of Wood Stiffness in White Spruce

Development and validation of models for **wood stiffness** for use in the **Mixedwood Growth Model**

Derek Sattler and Jim Stewart

Canadian Wood Fibre Centre
Working together to optimize wood fibre value – creating forest sector solutions with FPInnovations

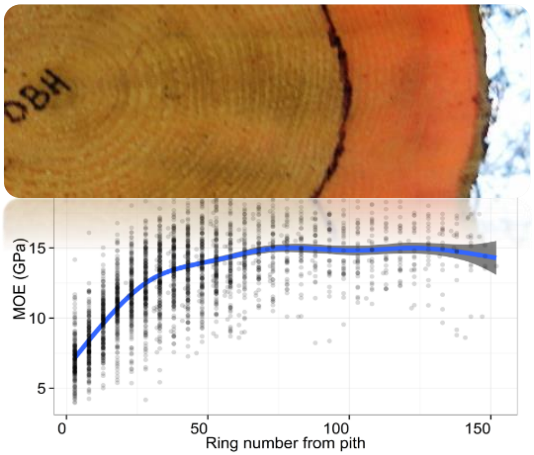
RESEARCH GROWING INTO PRACTICE

Natural Resources Canada | Ressources naturelles Canada

Canada

Objective

- Develop a model for the prediction of **pith to bark** wood stiffness for **White Spruce** within the **Boreal Plains Ecozone**



Why?

Enhanced Forest Management

Maximising the return on investment

Integrated market demands

- Pull supply mode
- Value added products

Feedback

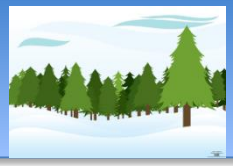
- Wood properties demanded by markets

Market demands

Push supply mode

Forest Management

- Volume based objectives
- Wood quality based objectives

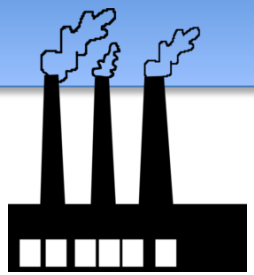


Investments

- Silvicultural treatments, etc.

Product Transformation

- Solid wood products
- Pulp and paper
- Bioenergy



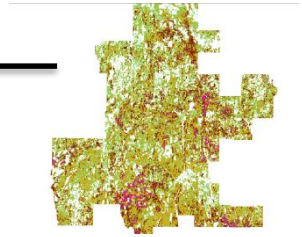
Markets

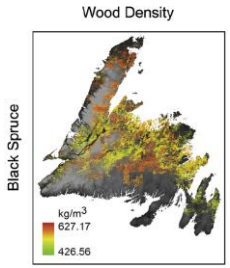
Return on investments

Enhanced Forest Management

Maximising the return on investment

Lessard et al. 2014.





Growth model

Strategic level

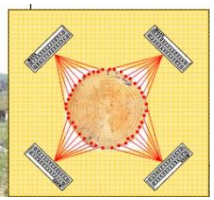
- Enhanced forest inventory (volume + wood properties)
- **Growth and yield simulators**

Enhanced Forest Management

- Volume based objectives
- **Wood quality based objectives**

Operational level

- Tools for measurement of wood properties in the field (CT-scanner, Hitman)
- **Growth and yield simulators**



Growth model

Enhanced Forest Management

Maximising the return on investment

Lessard et al. 2014.

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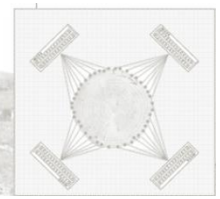
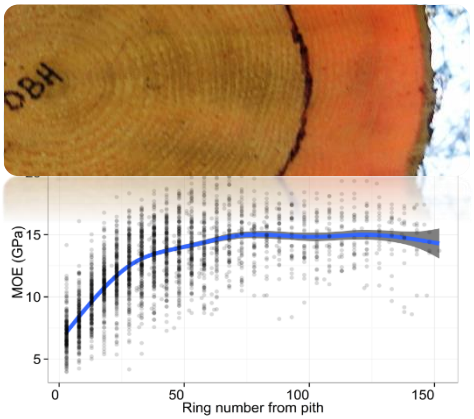


Growth model

- Example: **B.C. Tree and Stand Simulator (TASS III)**

Wood Property Models for Growth and Yield Simulators

Wood property model



Wood Property: $f(Cambial\ age)$

Growth and Yield Simulator

Wood Property Models for Growth and Yield Simulators

Canadian Wood Fibre Centre

- Ring density
  - Lodgepole pine – *Sattler et al. (in press)* and *Peng and Stewart 2013;* White Spruce (in progress)
- Micro-fibril angle
  - Lodgepole pine – *Wang and Stewart 2012*
- Wood Stiffness (*MoE*)
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Wood Stiffness in White Spruce

- Key attribute for structural lumber

Increased efficiency
Optimization of processing time

Sawlogs

High MOE

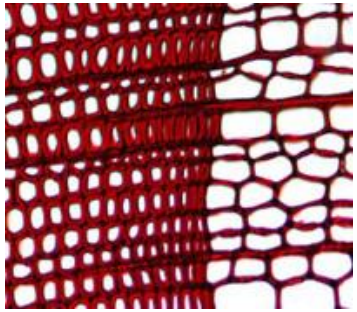
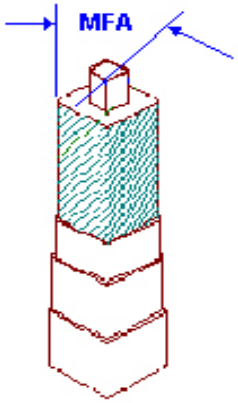
Low MOE

Lumber grade

Edlund et al. (2006)

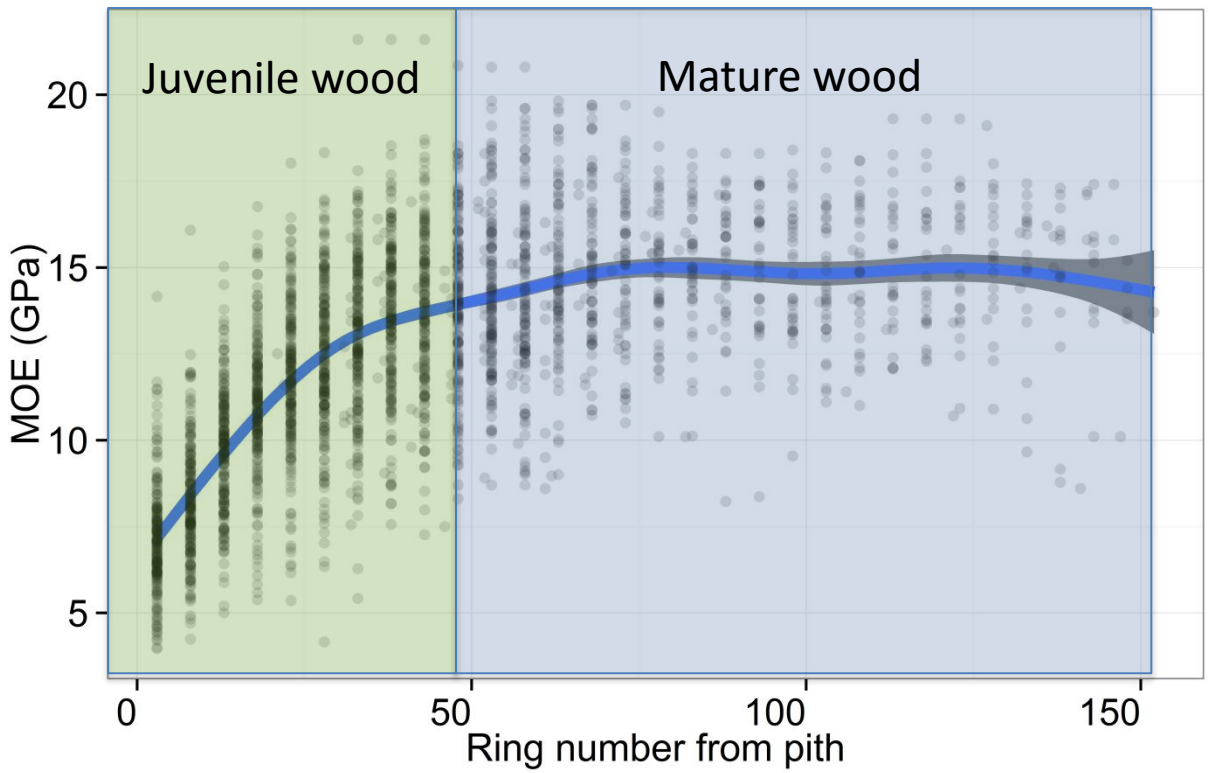
Wood Stiffness in White Spruce

- Anatomical level $f(Microfibril\ angle + cell\ specific\ gravity)$

  - Wood Stiffness =  + 

Wood Stiffness in White Spruce

- Ring-level: $f(Cambial\ age + growth\ rate)$



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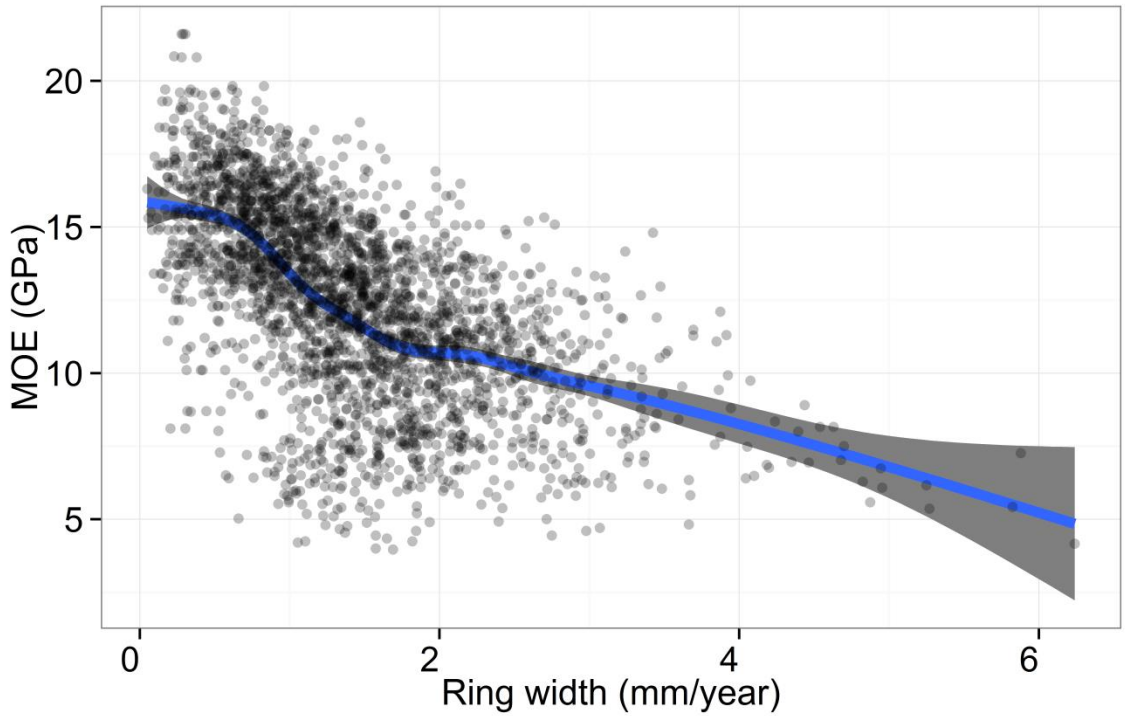


Silvicultural treatments

→ Growth rate

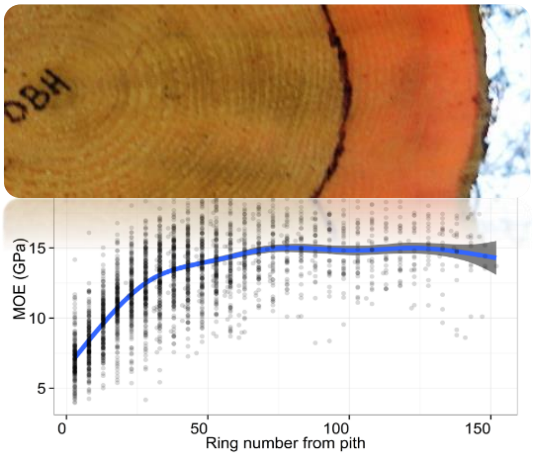
→ Wood quality objectives

Location effects?

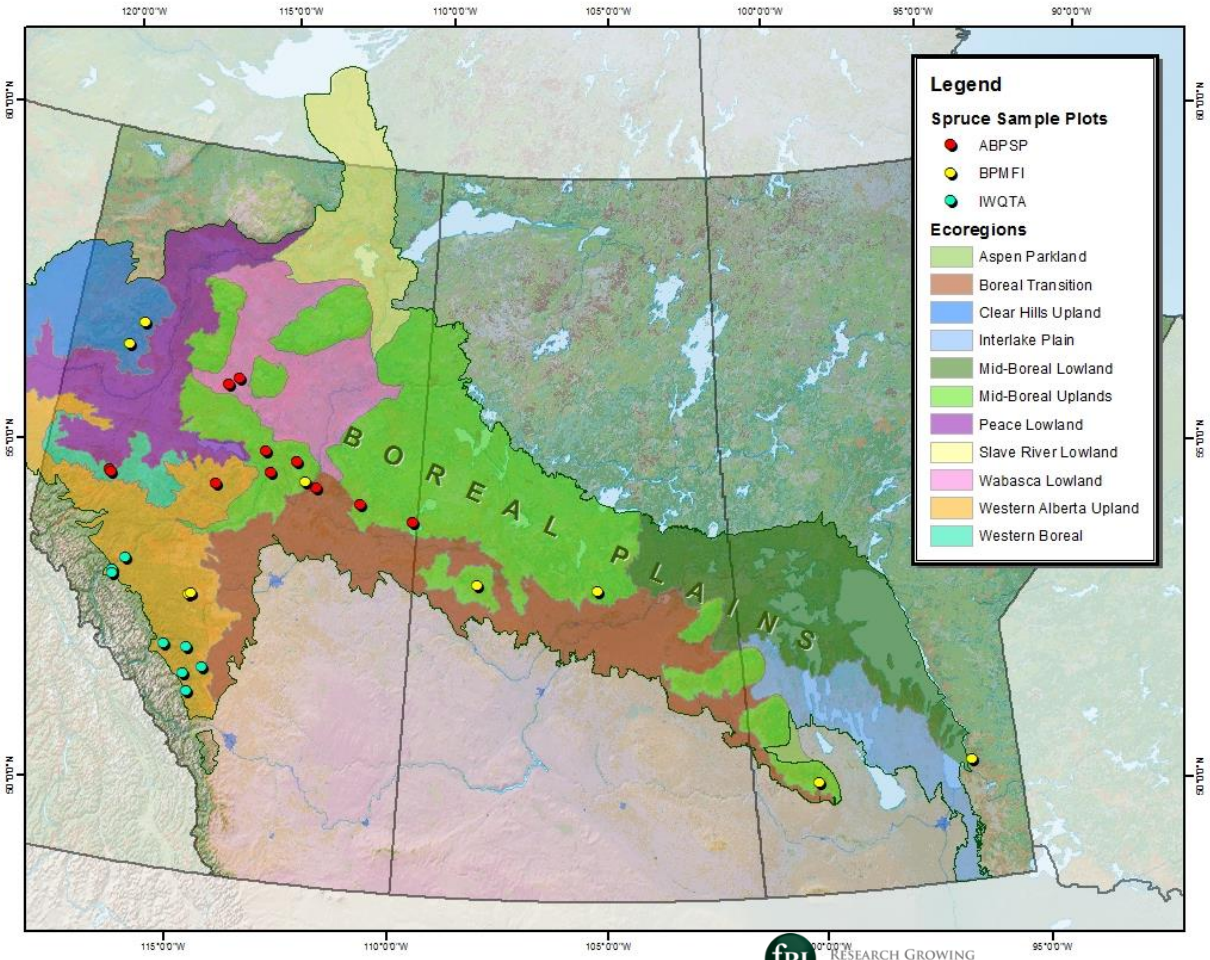
Climate effects?

Objective

- Develop a model for the prediction of **pith to bark** wood stiffness for White Spruce for use in the **Boreal Plains Ecozone**



Models for Stiffness for the Boreal Plains Ecozone



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RESEARCH GROWING INTO PRACTICE

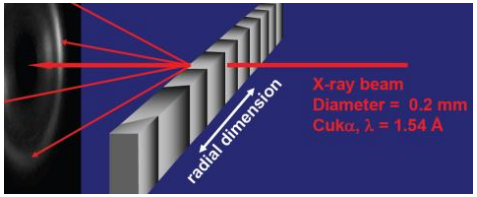
Validation of Existing Model

- **Model/Parameters**: Wood stiffness from **static bending**

Static bending

< 20%

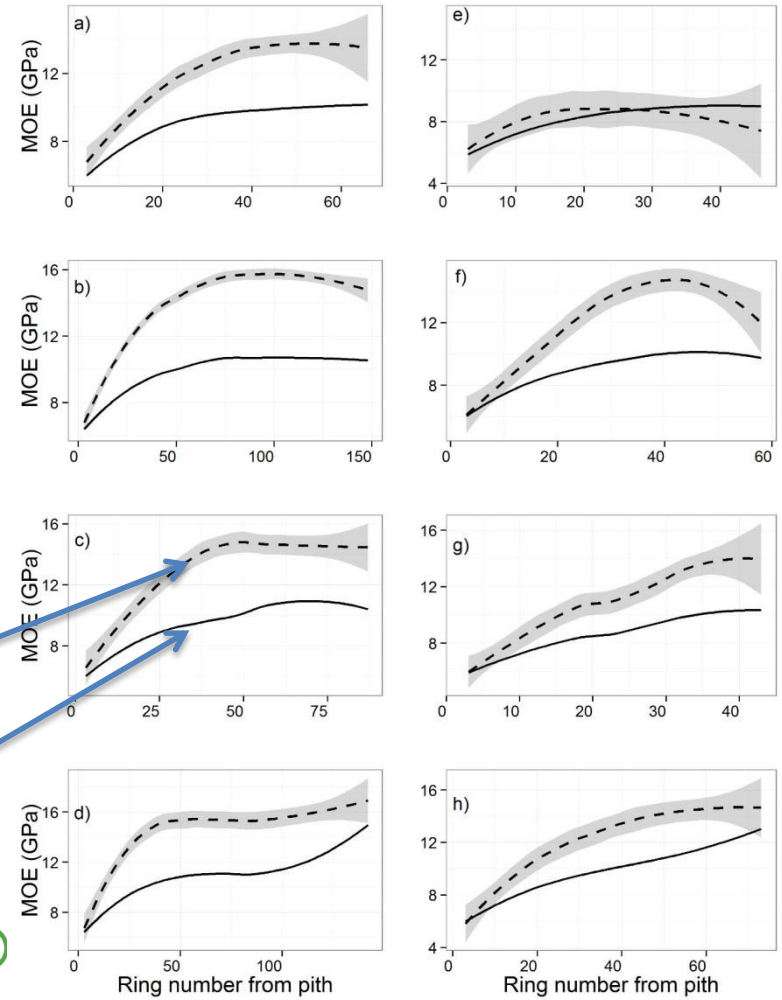
- **Validation data**: Wood stiffness via **Silviscan-3**



Validation of Existing Model

- Under-estimated
- Measurement bias?

Boreal Plains Test Locations



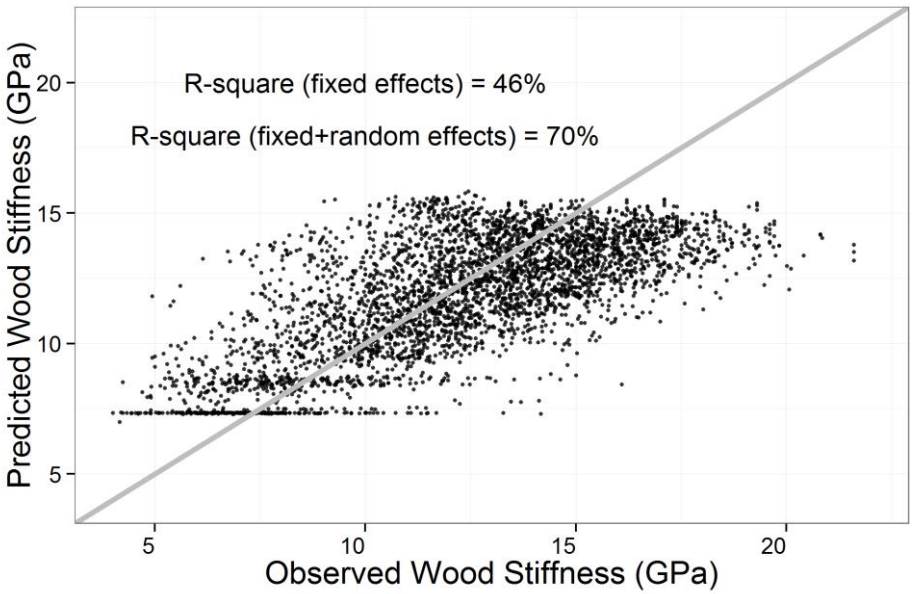
Observed MOE_{ss}

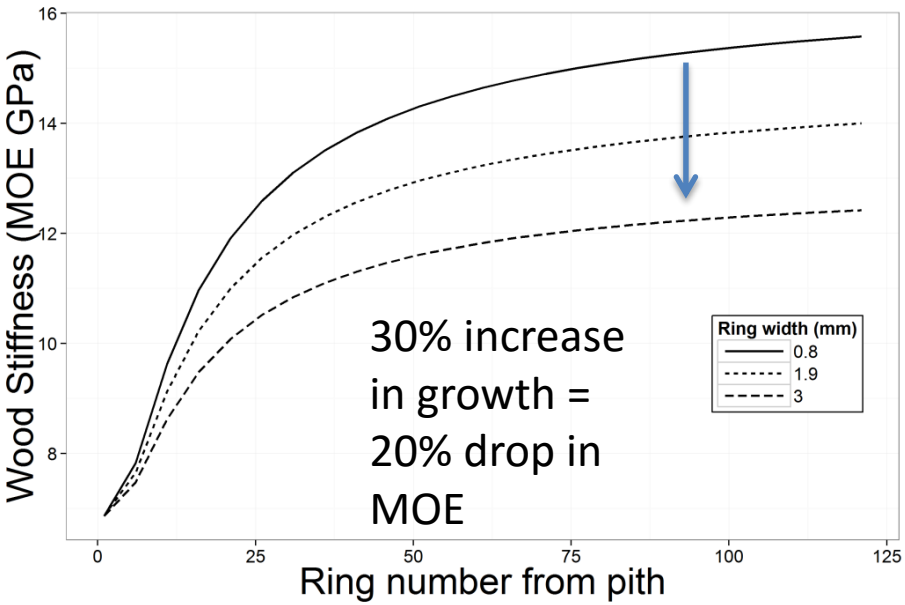
Predicted MOE

New Model for Wood Stiffness

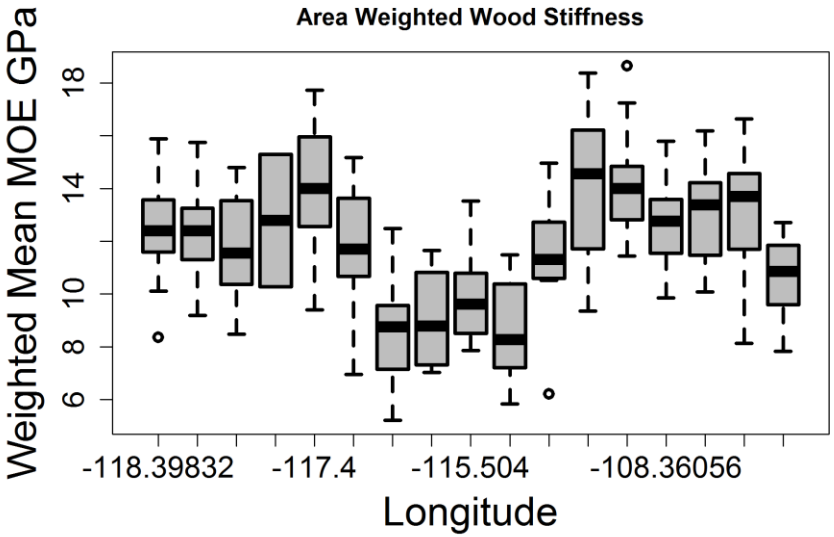
- New Model (v1.0): ✓ ✓

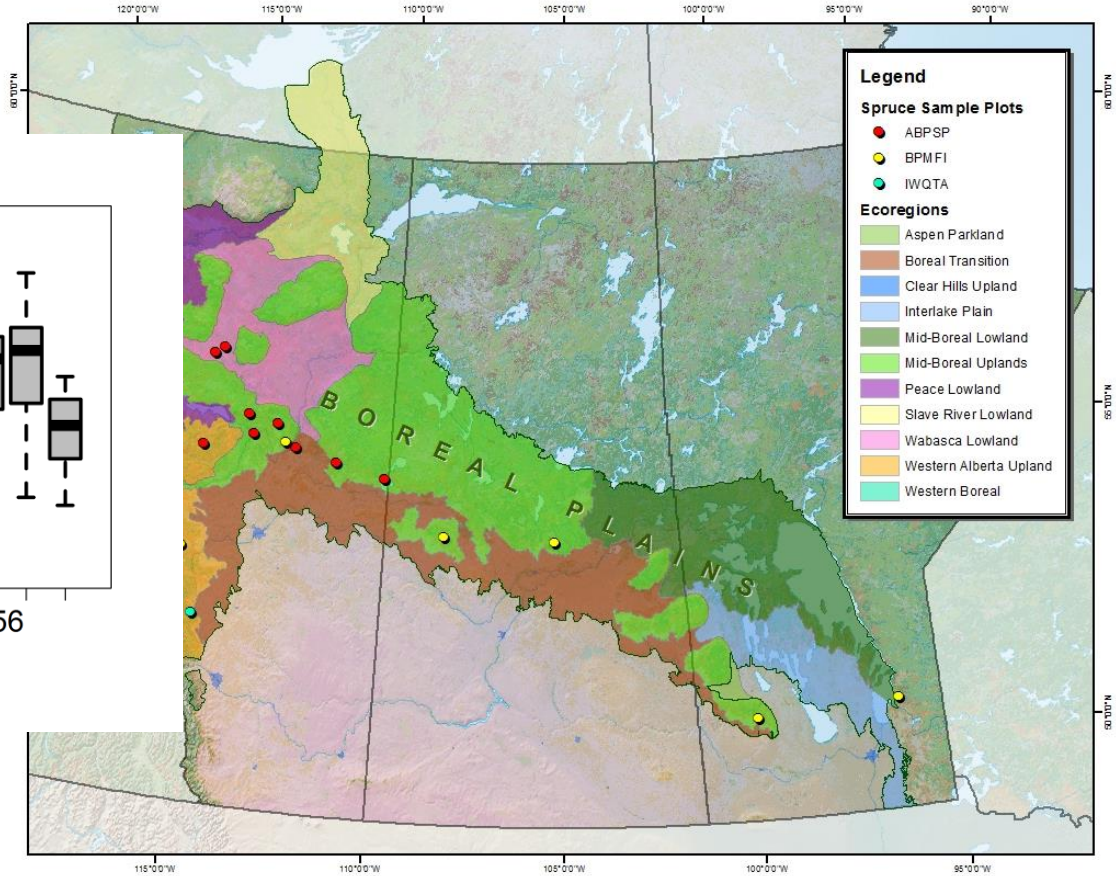
$$MoE_i = f(Cambial\ Age + Growth\ rate)$$





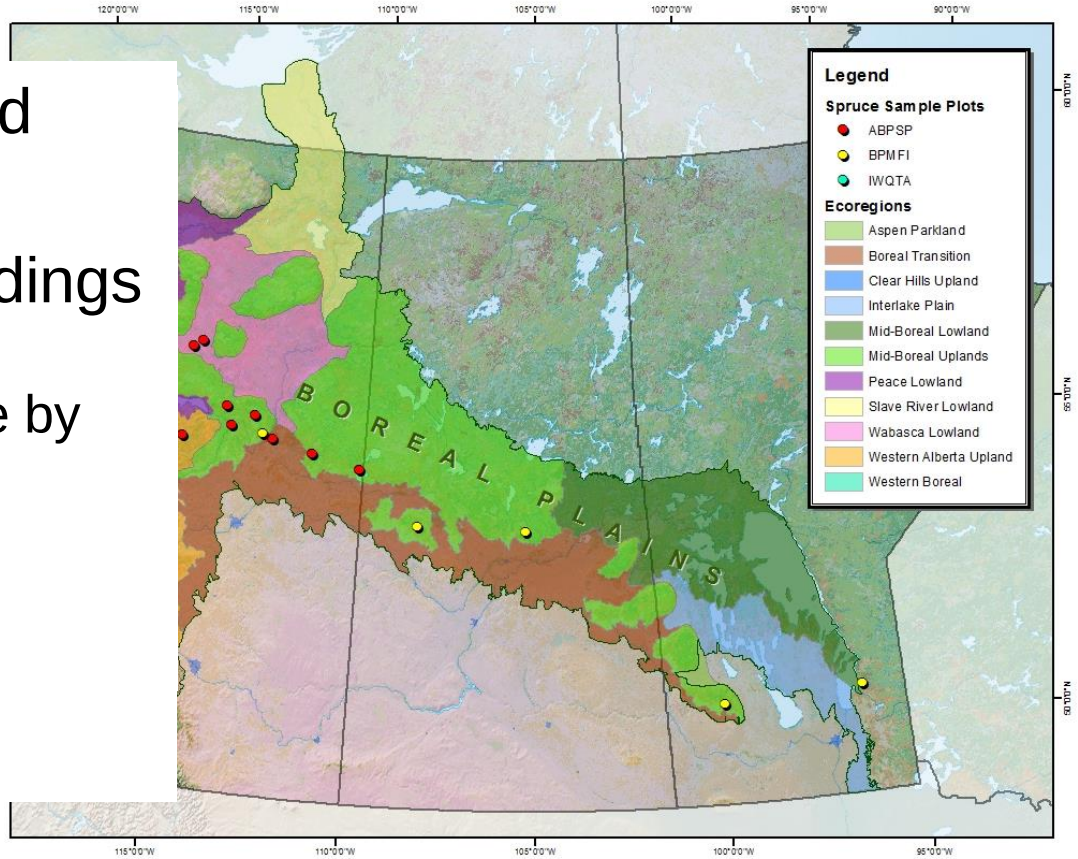
Location Effects?





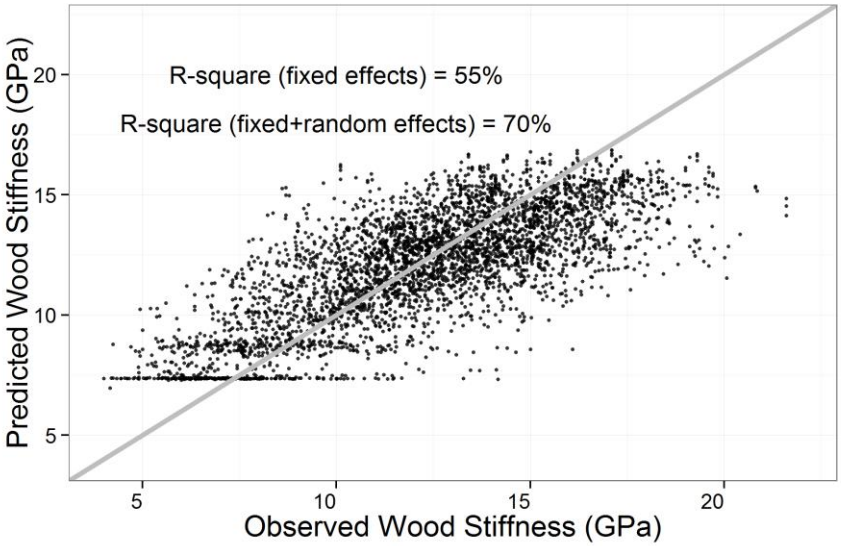
Climate Effects?

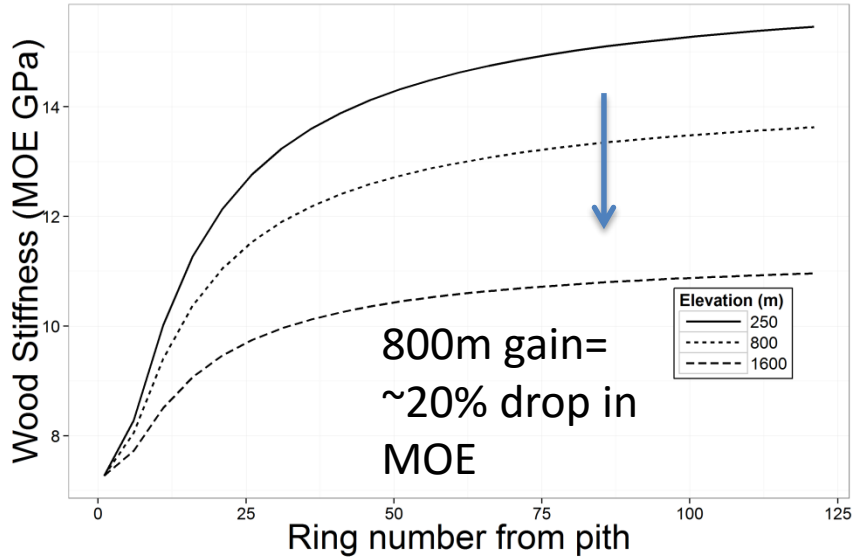
- Fall climate variables had greatest effect
- Agrees with previous findings (Lachenbruch et al. 2010)
  - **Wood Stiffness** influence by **Latewood Density**



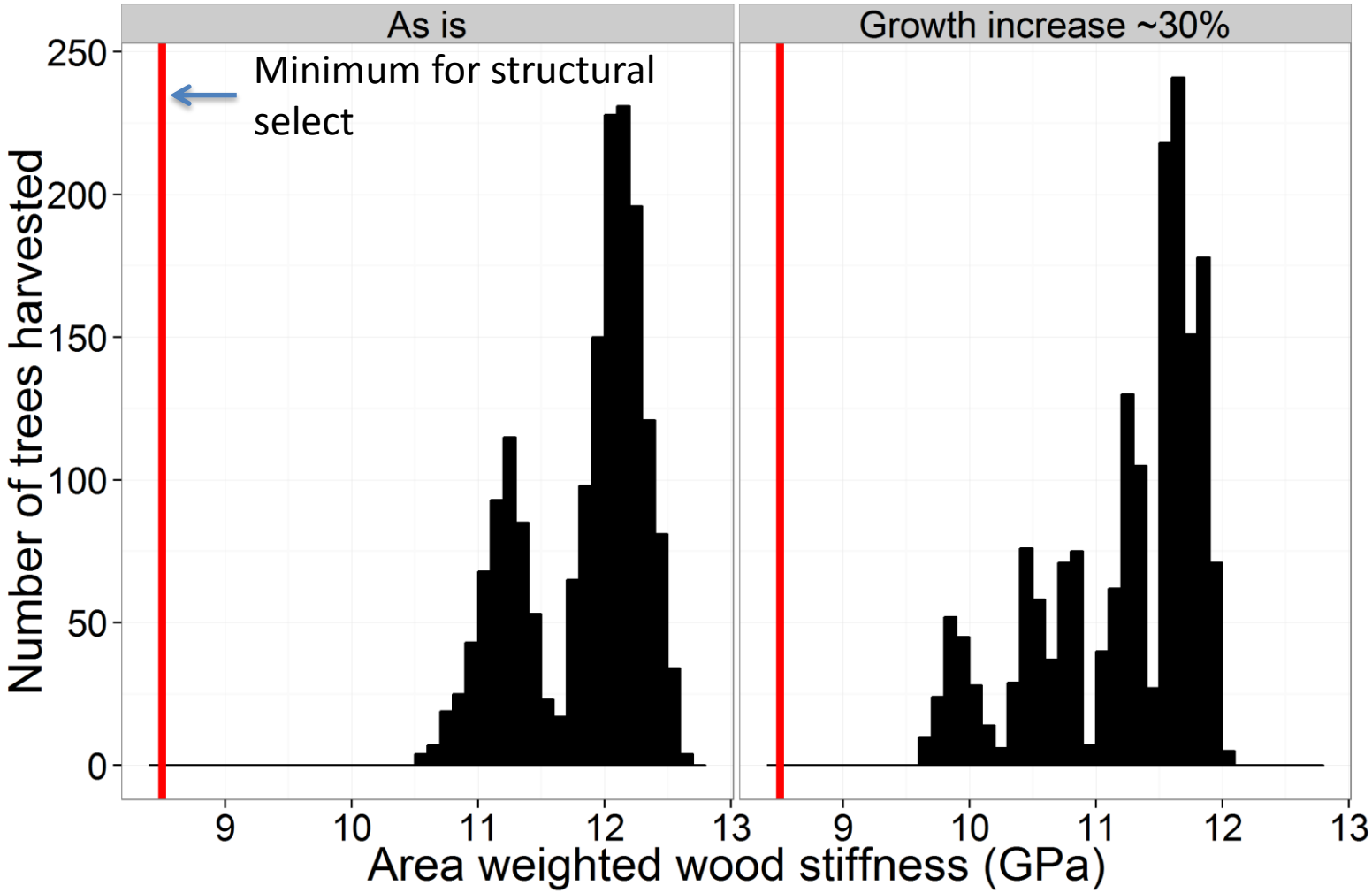
New Model for Wood Stiffness

- New Model (v2.0):
- $MoE_i = f(Cambial\ Age + Growth\ rate + Climate + Elevation)$





New Model for Wood Stiffness

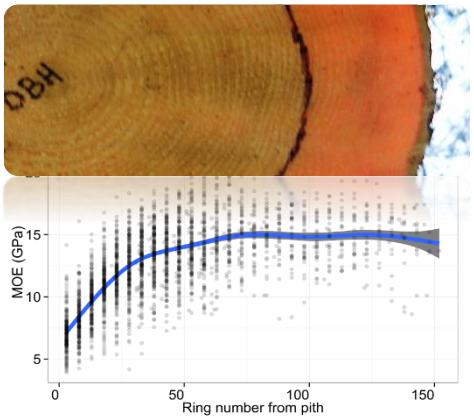


Working together to optimize wood fibre value – creating forest sector solutions with FPInnovations

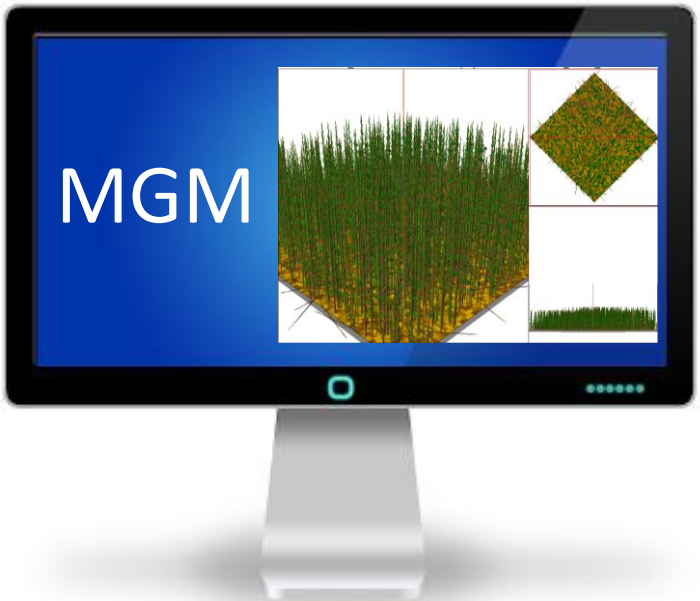
Adapted from Peng and Stewart (2013)

Application: WQ-4-MGM

Wood stiffness model



Mixedwood Growth Simulator



Wood stiffness: $f\begin{pmatrix} Cambial\ age + \\ Growth\ Rate + \\ Elevation + \\ ? \end{pmatrix}$

Summary

- New model/parameters for the prediction of pith to bark wood stiffness in white spruce
- ↑ growth rate = ↓ wood stiffness
- ↑ elevation = ↓ wood stiffness
- Need for regional-specific parameters?
- Application via WQ-4-MGM package

- Questions?