Growing confidence in forestry's future Research Programme

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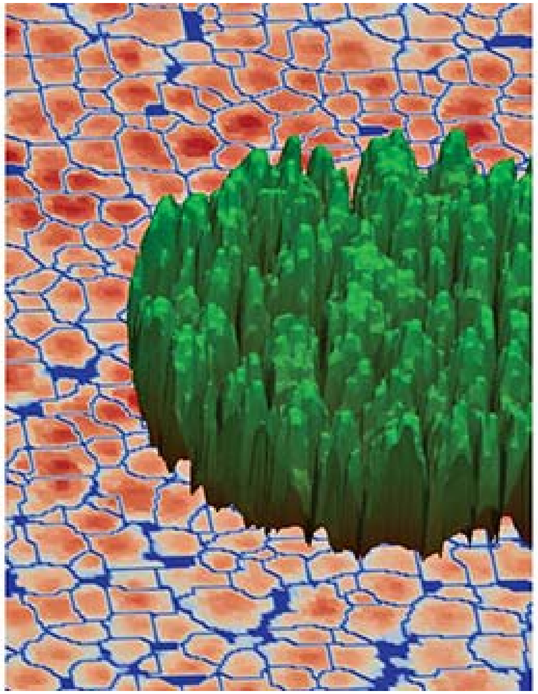
Quantifying wood property variation in radiata pine and implications for segregation

John Moore, Dave Cown, Russell McKinley, Jonathan Dash, Peter Carter, Marco Lausberg



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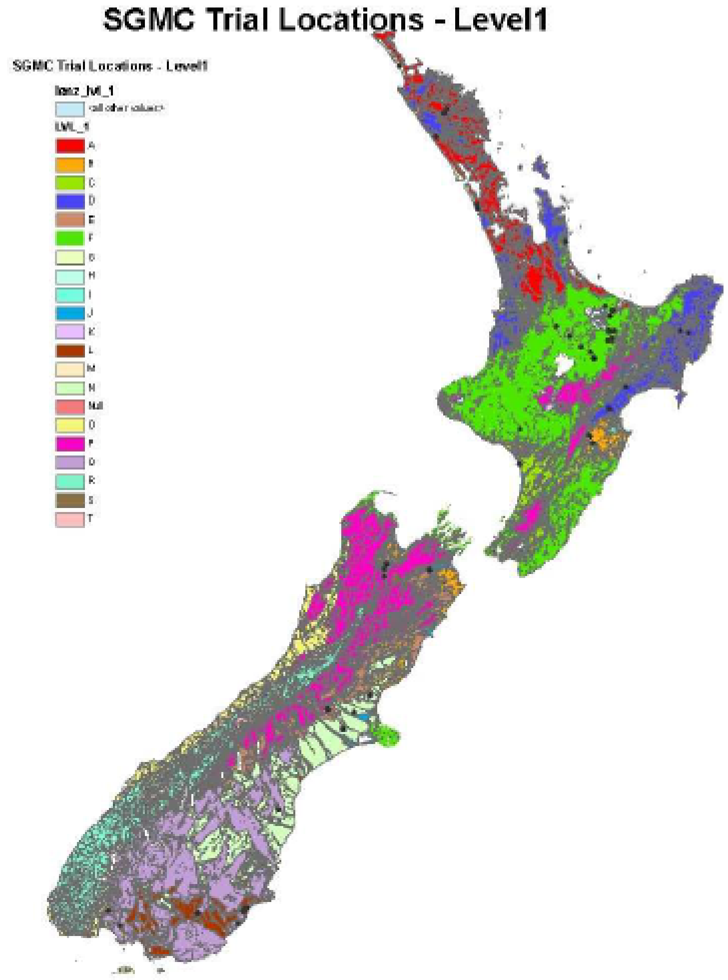
FOREST OWNERS ASSOCIATION

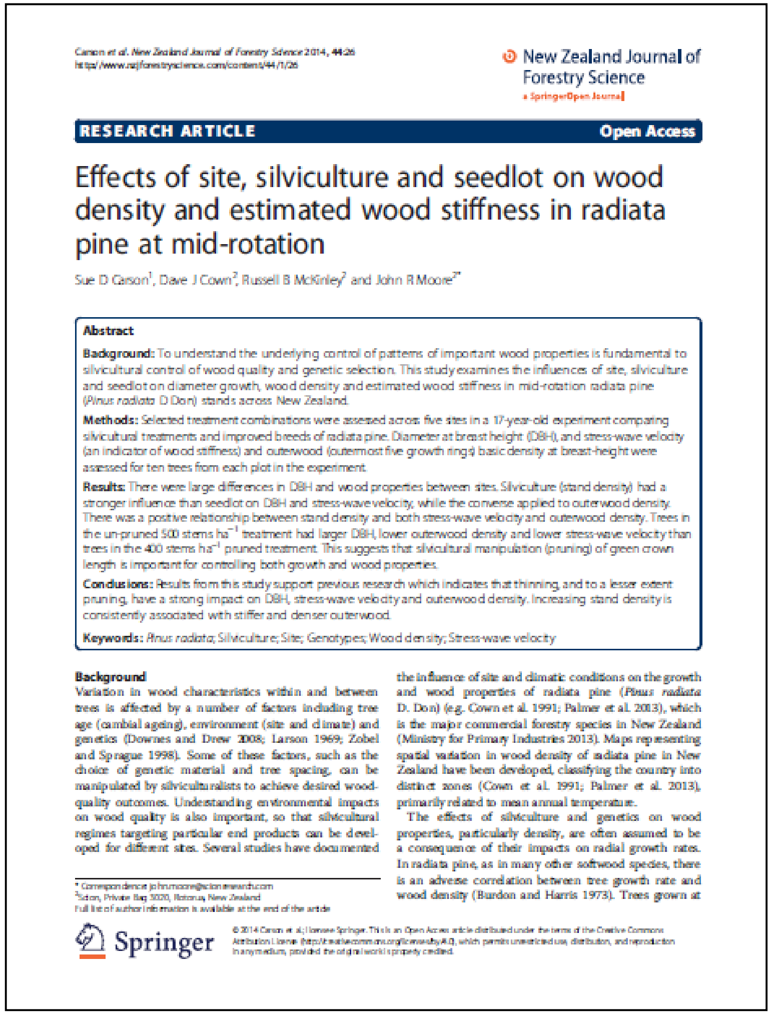
Quantifying Wood Quality Variation

- Characterise the resource to enable it to be best utilised
  - How do different combinations of site, silviculture and genetics affect growth and wood properties?
  - Key experiments can help to provide data
    - Silvicultural-breeds trials
    - Improved breeds trials
    - Silviculture x traits trials



We have some information from mid-rotation

- More variation in DENS and SWV between trees within plots than between sites
- More variation in DENS between seedlots
- More variation in SWV between silvicultural treatments
- No seedlot x silviculture interactions
- 400 stems/ha better than 500 stems/ha??



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RESEARCH ARTICLE Open Access

Effects of site, silviculture and seedlot on wood density and estimated wood stiffness in radiata pine at mid-rotation

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Abstract

Background: To understand the underlying control of patterns of important wood properties is fundamental to silvicultural control of wood quality and genetic selection. This study examines the influences of site, silviculture and seedlot on diameter growth, wood density and estimated wood stiffness in mid-rotation radiata pine (*Pinus radiata* D Don) stands across New Zealand.

Methods: Selected treatment combinations were assessed across five sites in a 17-year-old experiment comparing silvicultural treatments and improved breeds of radiata pine. Diameter at breast height (DBH), and stress-wave velocity (an indicator of wood stiffness) and outerwood (outermost five growth rings) basic density at breast-height were assessed for ten trees from each plot in the experiment.

Results: There were large differences in DBH and wood properties between sites. Silviculture (stand density) had a stronger influence than seedlot on DBH and stress-wave velocity, while the converse applied to outerwood density. There was a positive relationship between stand density and both stress-wave velocity and outerwood density. Trees in the un-pruned 500 stems ha^{-1} treatment had larger DBH, lower outerwood density and lower stress-wave velocity than trees in the 400 stems ha^{-1} pruned treatment. This suggests that silvicultural manipulation (pruning) of green crown length is important for controlling both growth and wood properties.

Conclusions: Results from this study support previous research which indicates that thinning, and to a lesser extent pruning, have a strong impact on DBH, stress-wave velocity and outerwood density. Increasing stand density is consistently associated with stiffer and denser outerwood.

Keywords: *Pinus radiata*; Silviculture; Site; Genotypes; Wood density; Stress-wave velocity

Background

Variation in wood characteristics within and between trees is affected by a number of factors including tree age (cambial ageing), environment (site and climate) and genetics (Downes and Drew 2008; Larson 1969; Zobel and Sprague 1998). Some of these factors, such as the choice of genetic material and tree spacing, can be manipulated by silviculturalists to achieve desired wood-quality outcomes. Understanding environmental impacts on wood quality is also important, so that silvicultural regimes targeting particular end products can be developed for different sites. Several studies have documented the influence of site and climatic conditions on the growth and wood properties of radiata pine (*Pinus radiata* D. Don) (e.g. Cown et al. 1991; Palmer et al. 2013), which is the major commercial forestry species in New Zealand (Ministry for Primary Industries 2013). Maps representing spatial variation in wood density of radiata pine in New Zealand have been developed, classifying the country into distinct zones (Cown et al. 1991; Palmer et al. 2013), primarily related to mean annual temperature.

The effects of silviculture and genetics on wood properties, particularly density, are often assumed to be a consequence of their impacts on radial growth rates. In radiata pine, as in many other softwood species, there is an adverse correlation between tree growth rate and wood density (Burdon and Harris 1973). Trees grown at

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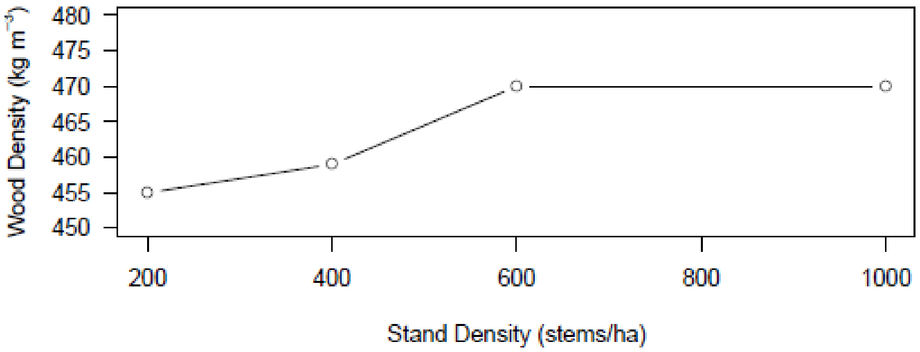
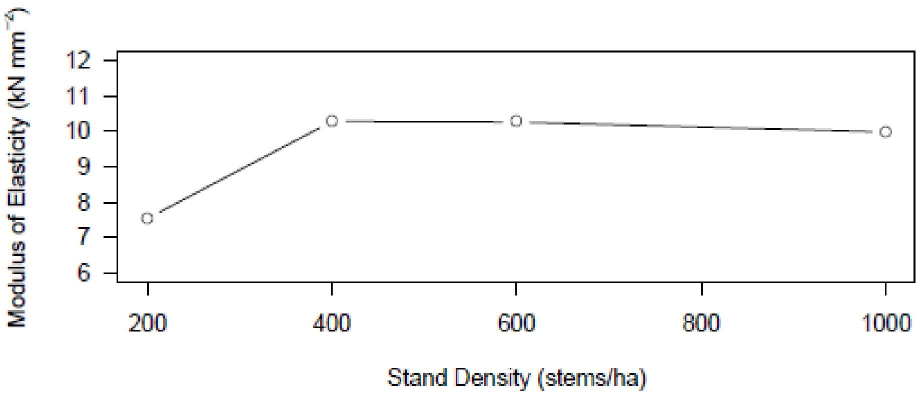
FR121 – Shellocks Forest

- 1990 trial converted to dairy at age 15 years
- Wood property sampling undertaken by WQI
- Avoid waste thinning to below 400 stems/ha
- GF25 had lower density and MOE than GF6





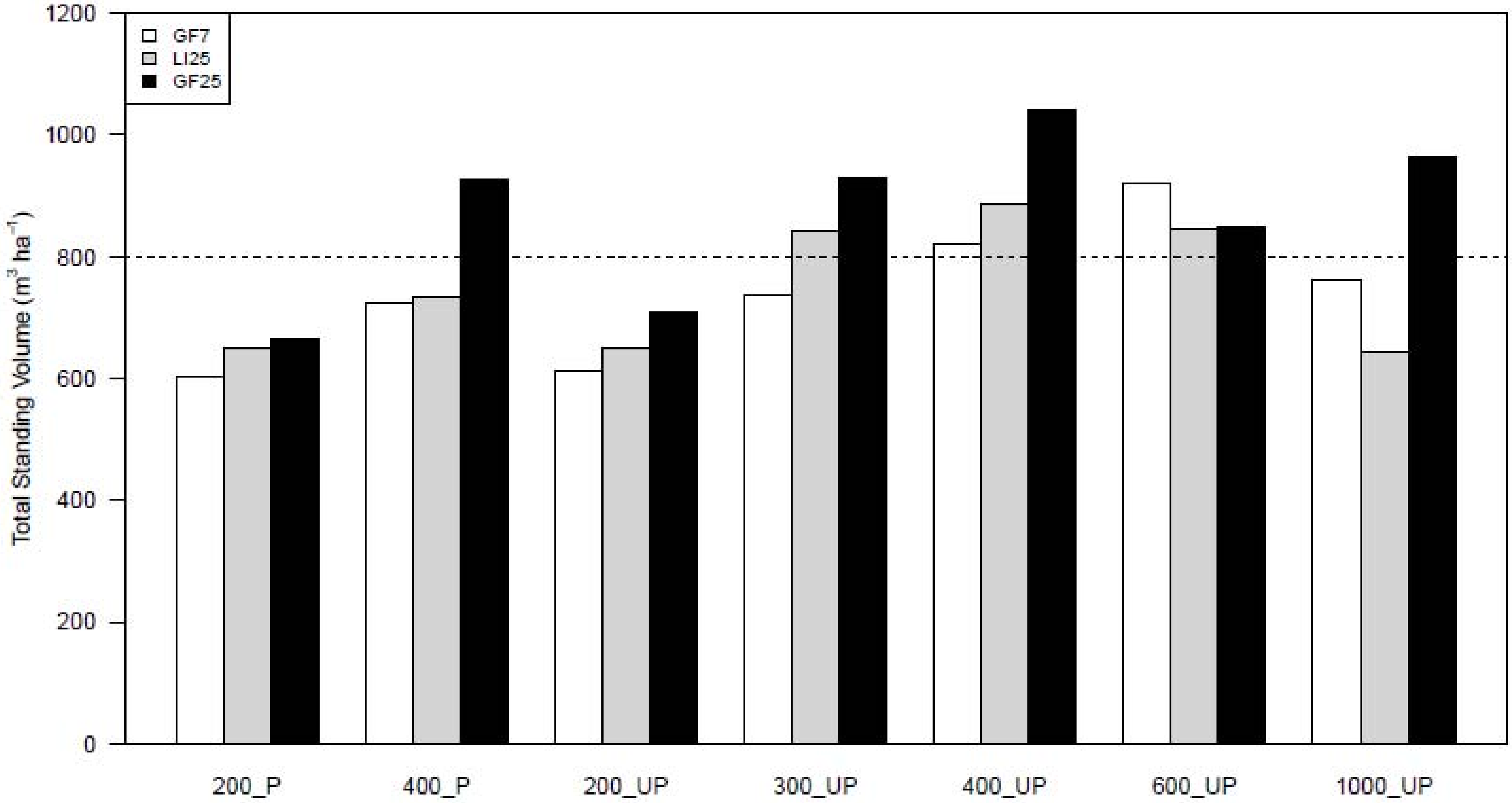
FR121/2 - Atiamuri

Treatment Structure

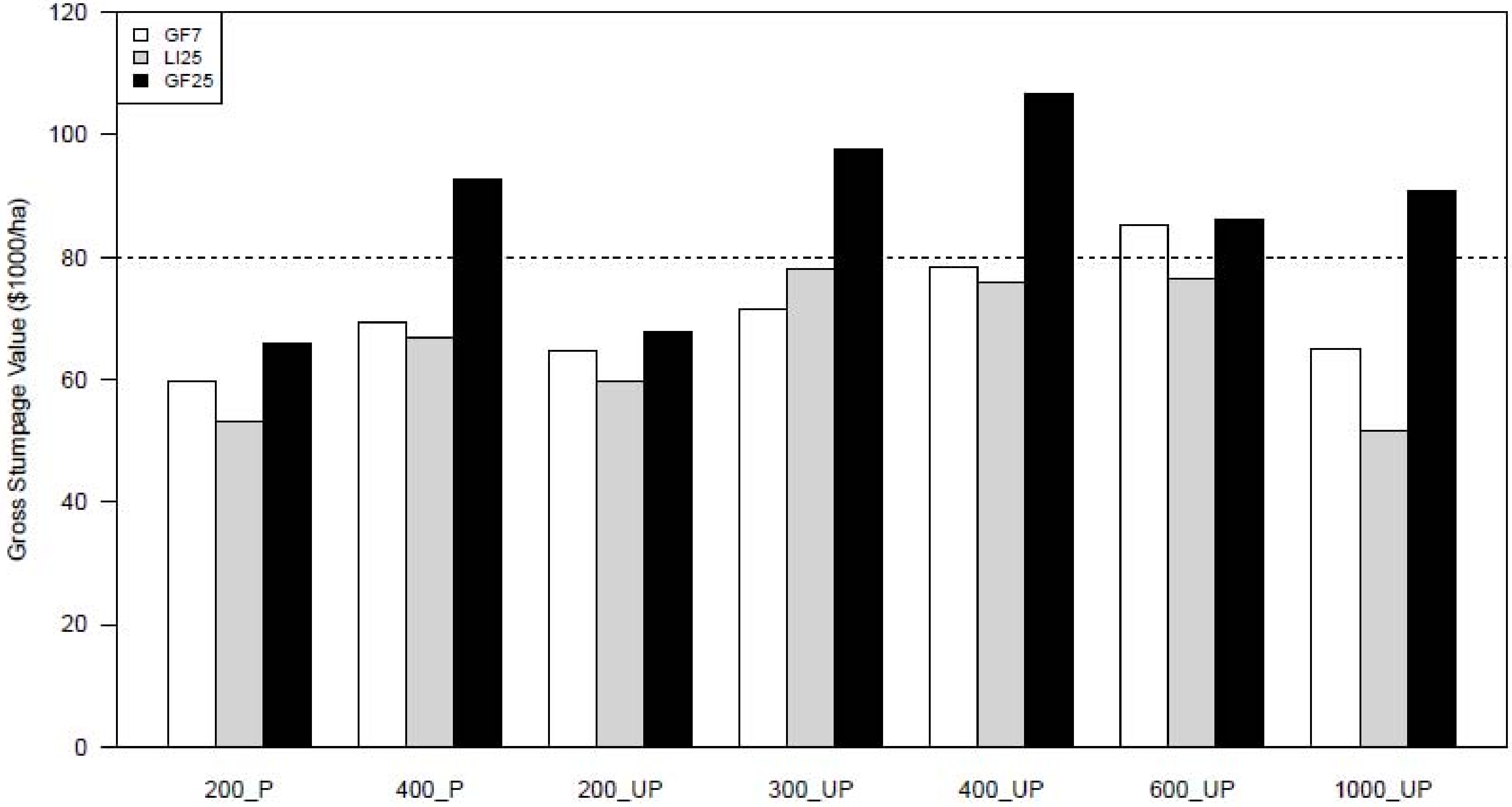
	Silviculture					Planting stock				
Trt	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF7 (FRI79/2320)	GF14 (88/105)	GF16 (88/201)	GF25 (89/708)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•[1)]			•	•
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•
8	"	722	300	6.2	2.4:1	•	•	•	•	•

Wood Quality Assessment in FR121/2

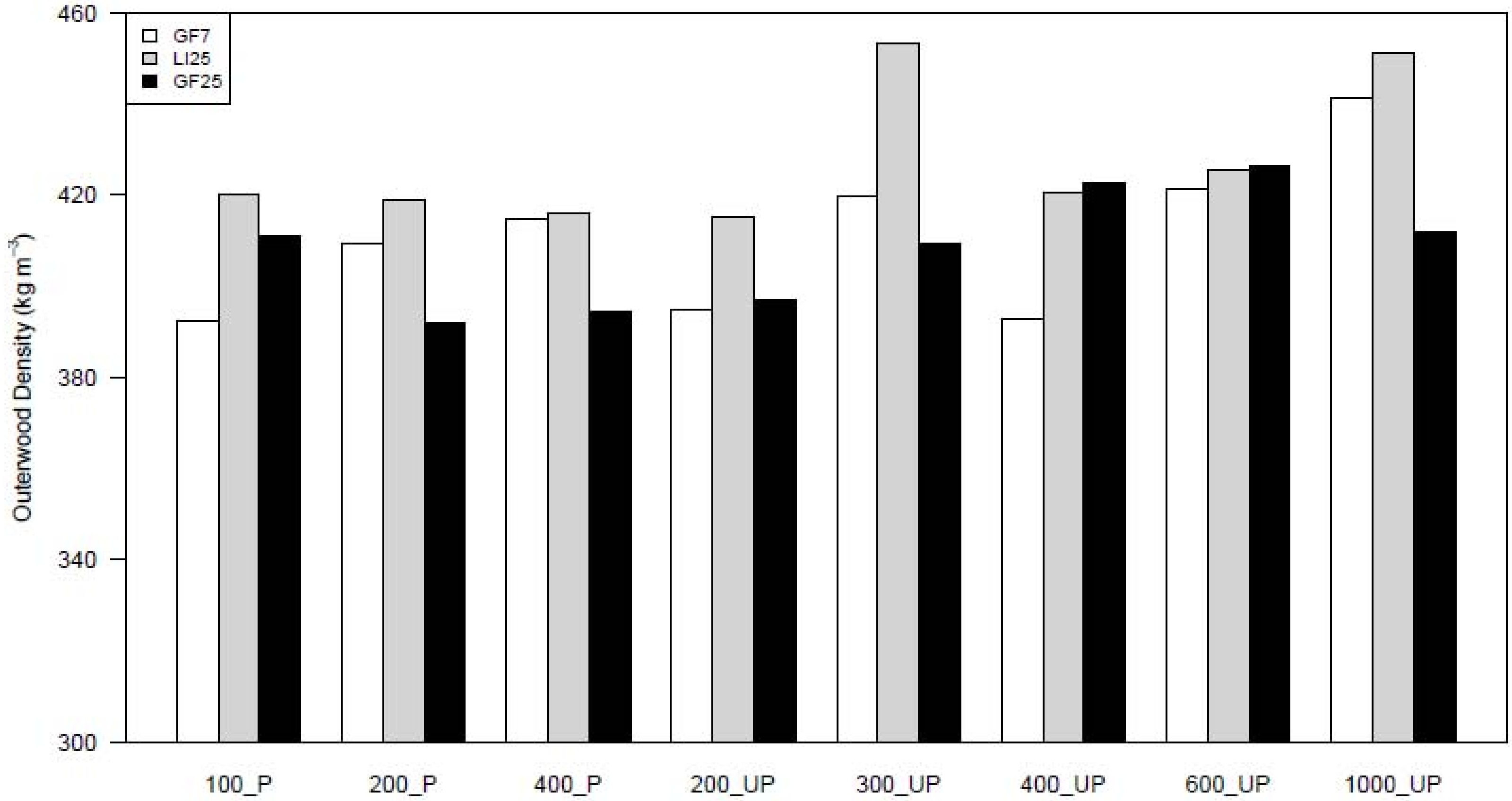
Standing Tree Results – Total Standing Volume



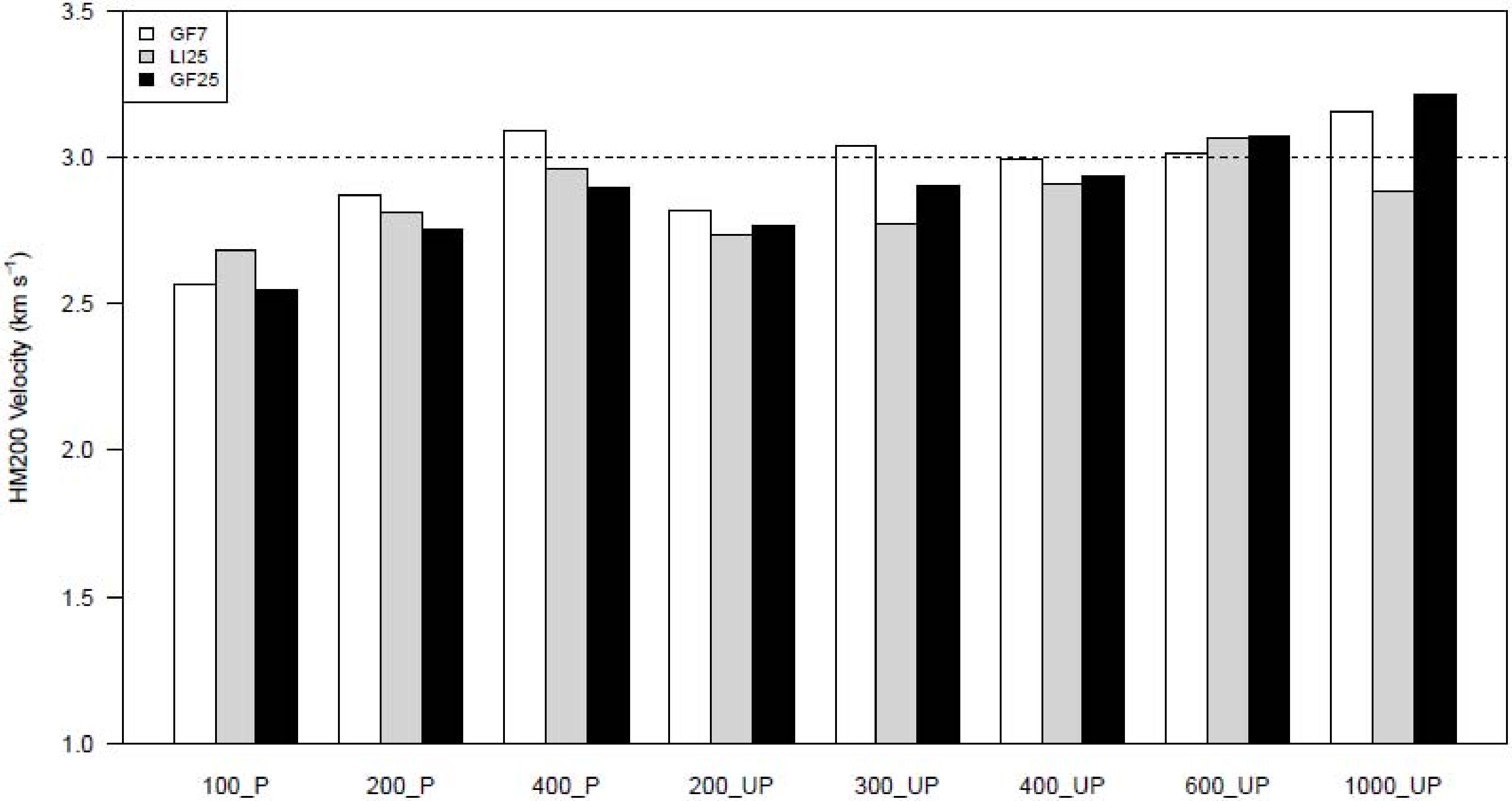
Gross Stumpage Value



Breast Height Outerwood Density



Acoustic Velocity of Felled Stems

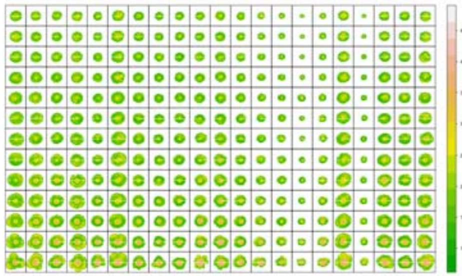
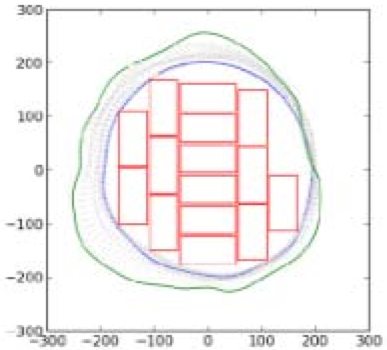


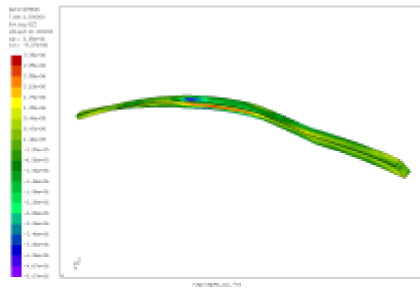
But what does this mean for end product quality?



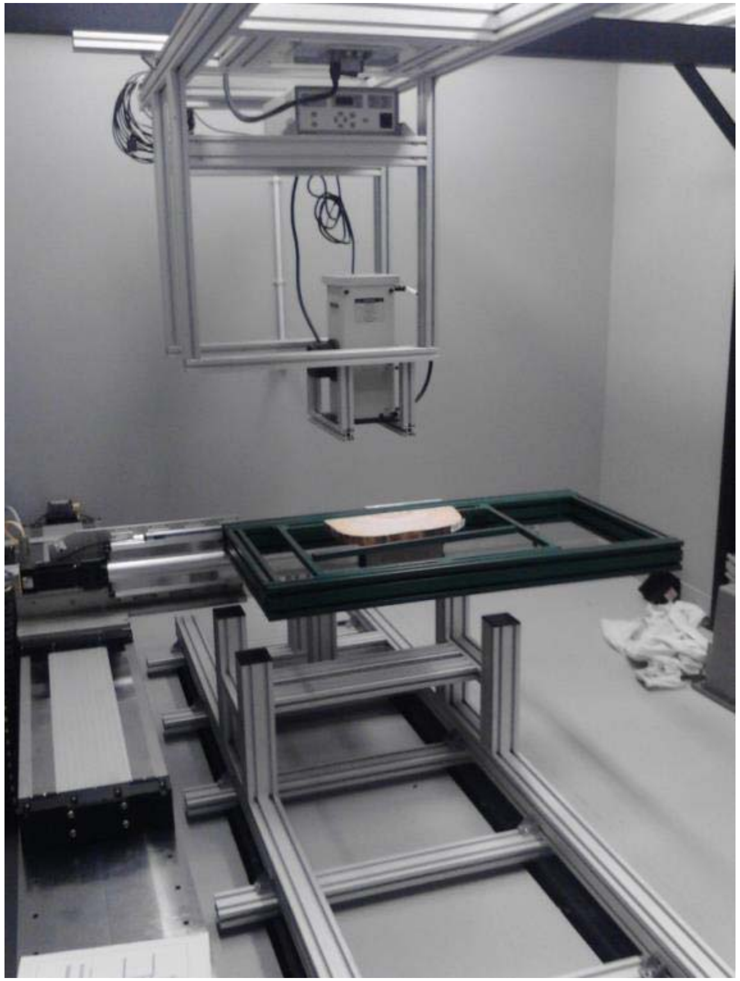

Tree → Board





Conditioned Storage and Scanning Facility



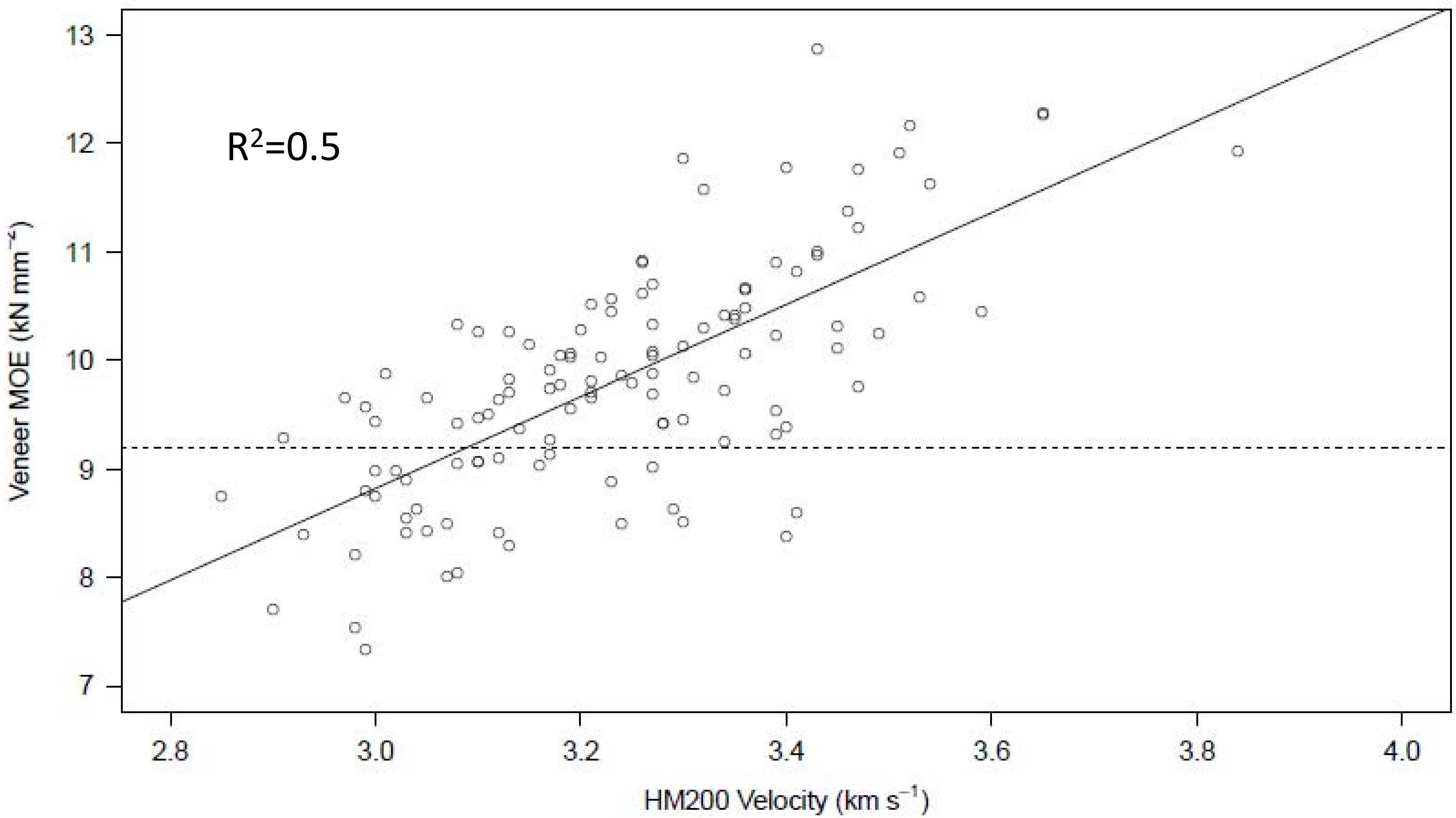
Cost-Effective Segregation

- What is the best way to recover value at the end of the rotation?
- Working with a range of technologies
  - Acoustic tools
  - LiDAR
- Understand the implications of decisions on the skid further along the supply chain

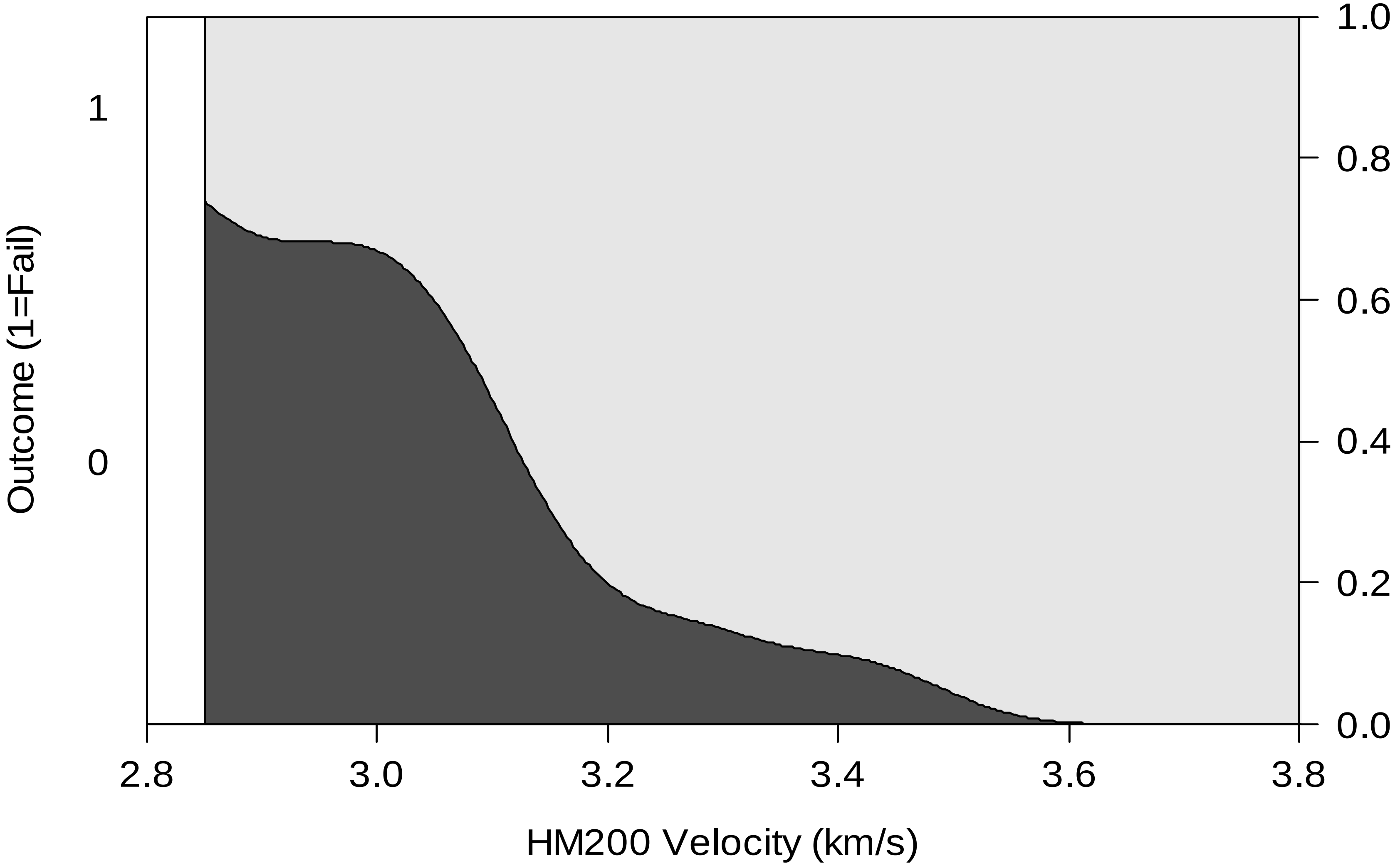
Segregating Veneer Logs

- Worked with Fibre-gen, Nelson Pine, SWI and Nelson Forests
- Assessed 119 logs with 3 acoustic tools
  - PH330
  - ST300
  - HM200
- Processed logs into veneers and looked at the impacts of different segregation approaches on veneer stiffness
- Goal was to deliver batches of logs that would meet target veneer stiffness

Relationship between HM200 and Veneer MOE



Assessing the Efficacy of Segregation Tools



Effective segregation is possible in the forest

Segregation method	Criteria	Mean veneer stiffness	Reject rate (%)	Pass rate (%)	Yield reduction vs HM (%)
HM200	HM200>3.1	10.159	26.0	74.0	-
PH330	HM200>3.1	10.159	43.7	56.3	17.7
HM200	90% of logs with HM200>3.1	10.091	19.3	80.7	-
PH330	90% of logs with HM200>3.1	10.091	37.0	63.0	17.7

Summary

- Site, silviculture and genetics have a strong influence on wood properties
  - Thinning to below 400 stems/ha has negative impact on wood quality
  - Gross value also maximised at this level of stand density

- Silviculture breeds trials are an excellent resource for understanding impacts of GxExS
  - Growth and yield
  - Wood quality
  - End product quality

- Acoustic tools are an effective means of segregating trees and logs on the basis of stiffness

What next?

- Scan discs from FR121/2 to map wood properties and predict stiffness and distortion of structural lumber

- Collect data from FR10 at Glengarry
  - Very high productivity stands (MAI > 45 m^3/ha/yr)

- Develop a model of the forest to mill (and port) supply chain
  - Quantify the impacts of segregation decisions for both growers and processors

http://research.nzfoa.org.nz/
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