Juvenile wood

What is it and why should we be concerned?

What is juvenile wood? A brief recap.

There is no universally accepted definition of juvenile wood.

It is typically described as follows

- zone near to the pith
- displays marked ring to ring changes in its properties, but zone ends gradually
- no clear consensus as to where this zone ends => generally thought to end at 10-20 rings from pith, but dependent on species
- transition from juvenile to mature wood in Sitka spruce appears to occur ~ rings 12-13 (Brazier and Mobbs 1993, Cameron et al. 2005)

The theory is that trees have evolved to have more flexible wood in the canopy to better dissipate wind forces, but stiffer (mature) wood in the stem to keep the stem upright.

Brazier J D and Mobbs I D (1993) The influence of planting distance on structural wood yields of unthinned Sitka spruce. Forestry 66: 333-352.

Cameron A D, Lee S L, Livingston A K and Petty J A (2005) Influence of selective breeding on the development of juvenile wood in Sitka spruce. Canadian Journal of Forest Research 35: 2951-2960.

Properties of juvenile wood => these are usually described in terms of

- short cell length
- high microfibril angle
- low density (high proportion of early wood formed)
- high grain angle

These characteristics are associated with

- poor timber strength
- increased risk of warping on drying

Formation of juvenile wood

- traditionally thought to form within the living tree crown
- researchers now make the distinction between ‘juvenile wood’ and ‘crown formed wood’ (e.g. Amarasekara & Denne 2002, Gartner et al. 2002)

Amarasekara H and Denne M P (2002) Effects of crown size on wood characteristics of Corsican pine in relation to definitions of juvenile wood, crown formed wood and core wood. Forestry 75: 51-61.

Gartner B L, North E M, Johnson G R and Singleton R (2002) Effects on live crown on vertical patterns of wood density and growth in Douglas fir. Canadian Journal of Forest Research 32: 439-447.

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'Juvenile wood' => region around the pith in which its properties are associated with cambial age, independent of crown influences

'Juvenile wood' formation => strong relationship between increasing tracheid length (and microfibril angle) and increasing cambial age.

There is evidence that the transition phase between the formation of juvenile wood and mature wood at the tree base coincides with the culmination of the current annual increment (Kucera 1994).

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Gartner B L, North E M, Johnson G R and Singleton R (2002) Effects on live crown on vertical patterns of wood density and growth in Douglas fir. Canadian Journal of Forest Research 32: 439-447.

Kucera B (1994) A hypothesis relating current annual height increment to juvenile wood formation in Norway spruce. Wood and Fiber Science 26: 152-167.

Formation of 'crown formed wood'

'Crown formed wood' => describes variations in wood properties associated with the size of the crown => these are superimposed on inherent properties due to cambial age.

'Crown formed wood' => strong correlation between increasing canopy size (leaf dry weight) and increasing ring width and decreasing % latewood.

'Crown formed wood' is usually dominated by knots.

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So, what does this mean?

- there is a more or less fixed period of juvenile wood formation that appears to be under strong genetic control
- crown-formed juvenile wood is associated with canopy size and is largely under silvicultural control

How does growth rate affect juvenile wood content in trees?

Experiment (Cameron et al. 2005)

- 24 year old Sitka spruce progeny test
- 6 progenies* (3 fast growing, 3 slow growing) and QCI control with a growth rate similar to slow-growing progenies were sampled
- measurements => annual ring width, density, tracheid length and diameter, and microfibril angle

* Selection based on growth only, wood properties not considered

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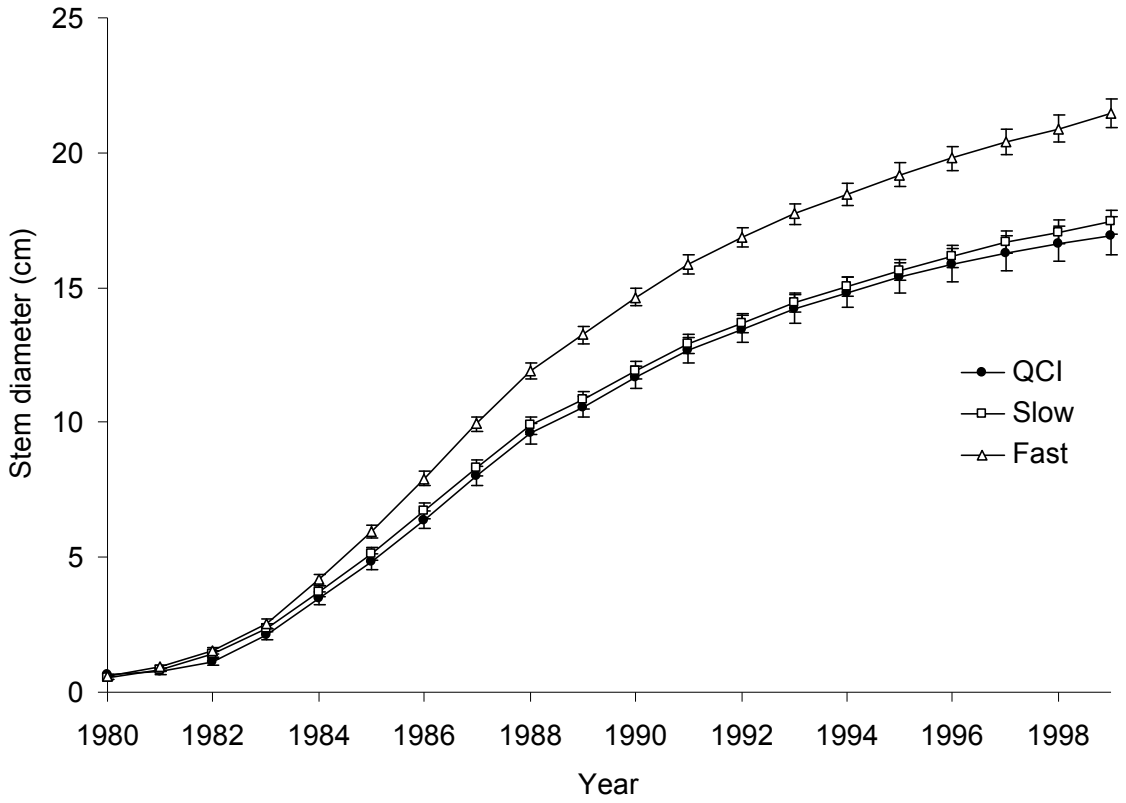
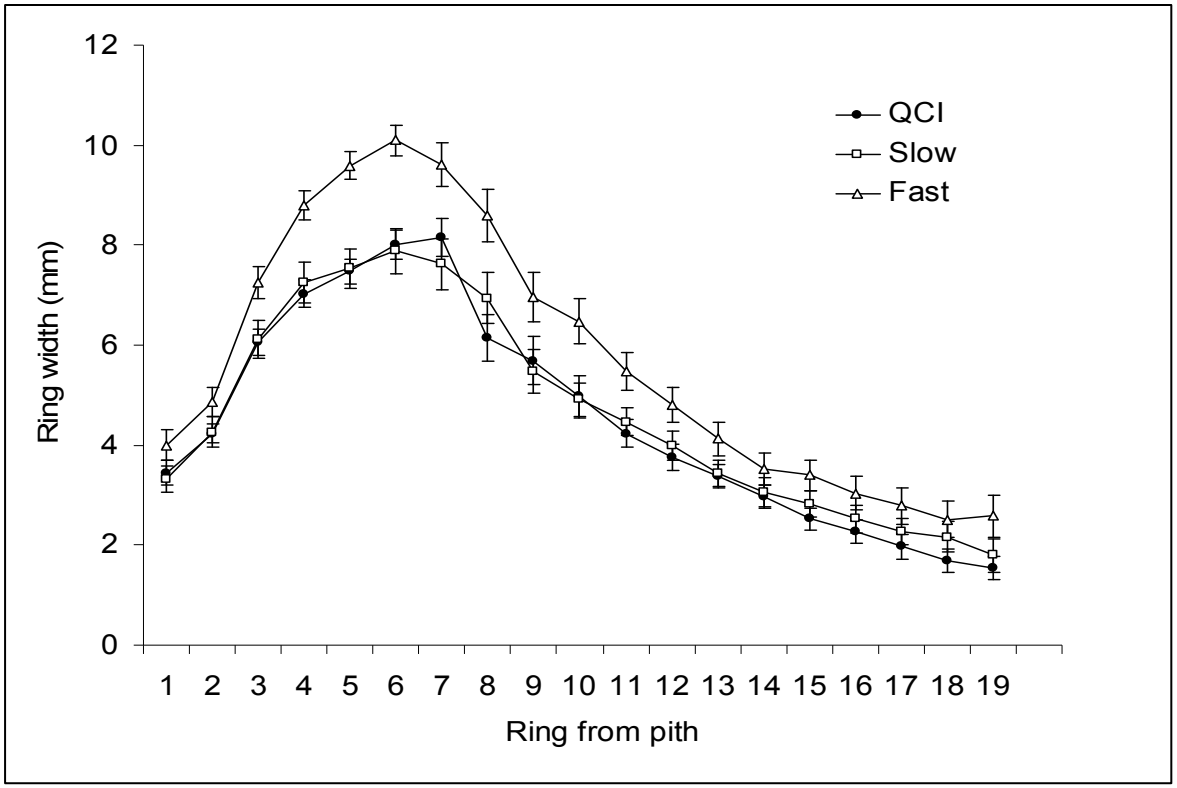
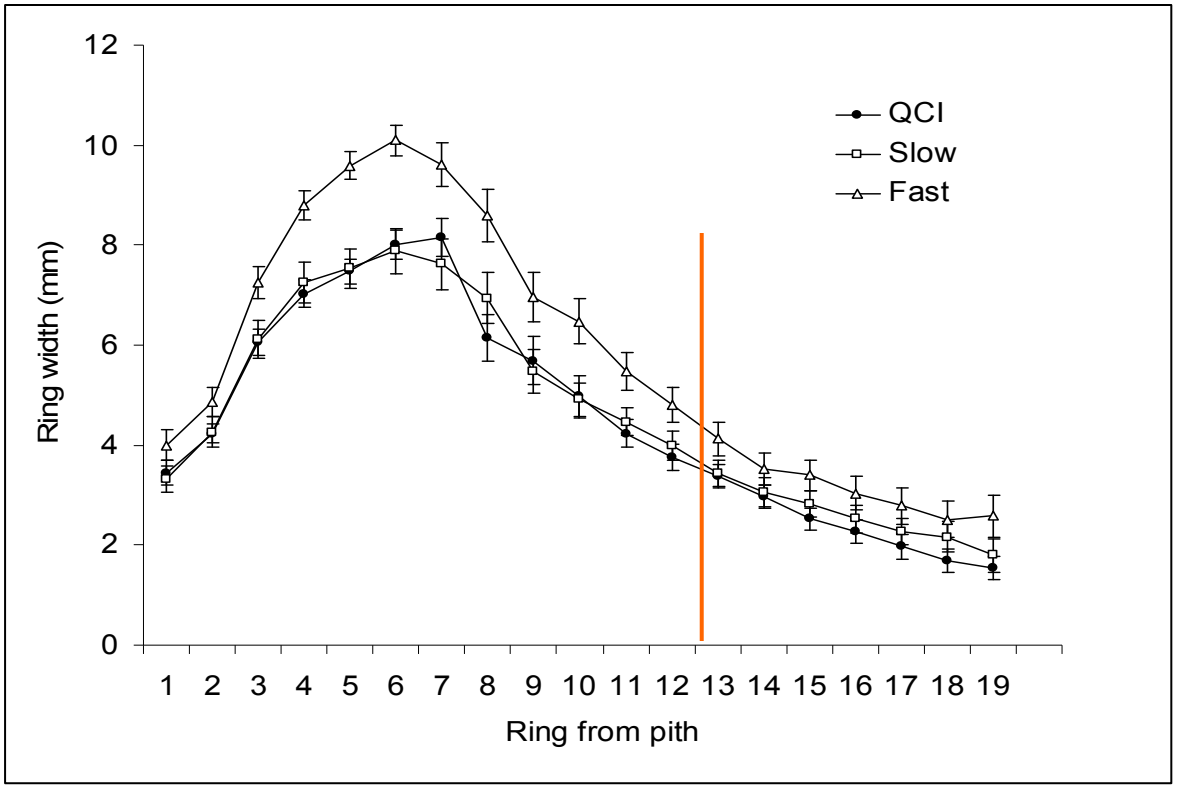


Mean cumulative diameter increment with cambial age of fast- and slow-growing progenies, and an unimproved QCI provenance of Sitka spruce. Bars represent +/- 1 s.e.



Variation in mean ring width with ring number from the pith of three fast growing and three slow-growing progenies, and an unimproved QCI provenance of Sitka spruce. Bars represent +/- 1 s.e.



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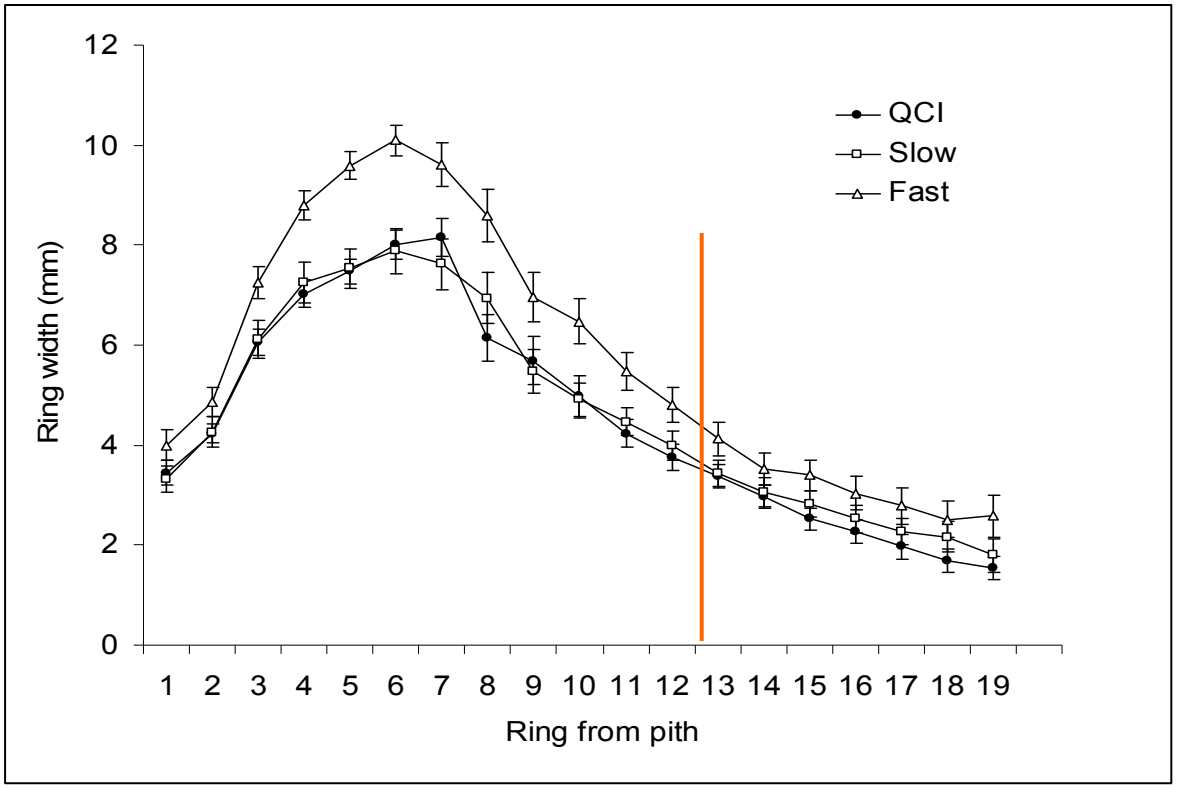
Red line shows the approximate limit of juvenile wood formation



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Conclusion => if juvenile/mature transition zone occurs ~ ring 12-13 (determined by MFA and tracheid length), then

- greatest growth of fast-growing progenies takes place during period of juvenile growth
- significantly greater cross-sectional area of wood at a given rotation will be juvenile

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Tree breeding

• select for density and stiffness in wood within the juvenile zone (Stuart Kennedy's research project, University of Aberdeen)

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Silviculture

• restrict early growth by establishing at stocking densities higher than 2500-2700 stems per ha (but higher establishment costs!)

• greater use of natural regeneration?

➢ effect of very high stocking density of naturally regenerated Sitka spruce on wood properties is currently being studied in joint study between FR and University of Aberdeen