Forest Research

Wood and Timber Properties Programme Update

Timber Quality Steering Group

24th September 2012

Staffing changes

- Staff left or leaving
  - Barry Gardiner – December 2011
  - Stefania Pizzirani – February 2012
  - Shaun Mochan – March 2012
  - John Fonweban – September 2012
- New staff
  - Andrew Price – April 2012
  - Timber properties modeller – to be recruited

Resource Assessment

- Stem straightness in production forecast:
  - Models based on Sitka spruce developed - to be combined with inventory data, format of output under discussion
- Research report on wood properties of Scots pine – due for completion March 2013
- Models of wood properties for larch and Douglas fir – from PhD projects at Napier nearing completion
- Online decision support software – predicting wood properties:
  - Prototype versions available for Sitka spruce and Scots pine
  - Larch and Douglas fir to be added
  - Format to be reviewed
- Linking airborne LiDAR with terrestrial laser scanning and timber quality models – field assessment planned for autumn/winter

Alternative Silviculture - Glentress Forest

Glentress Trial – timber study

- Objectives of study:
  - To assess the wood properties of Sitka spruce trees felled within the trial area
  - To compare these results with data from even aged stands of Sitka spruce and wood property model simulations
  - To investigate the influence of stand structure, competition and individual tree growth on key wood properties
- Sample of 20 trees selected, 5 each from 4 DBH classes

Assessments

- Accumulated temperature and wind exposure (from models)
- Standing trees
  - Diameter and height
  - Stem straightness score
  - Acoustic velocity
  - Competing tree diameter and distance
- Felled trees
  - Length to lowest dead branch, live branch and live whorl
  - Taper (diameter every metre)
  - Log acoustic velocity
- Samples - 15cm disc and 50 cm billet taken at breast height and at base of crown

Laboratory measurements

- Disc surface optically scanned – heartwood area & ring widths
- Radial strips (north) cut for x-ray densitometry
- Small clear samples cut from billets (north side)
- Static bending stiffness (MOE) and strength (MOR) tested

Results - sample trees

	Mean	Minimum	Maximum
Altitude (m)	393	270	485
Accumulated Temperature (degree days >5ºC)	925	781	1062
Wind exposure (DAMS score)	15	12	21
Tree age at breast height	32	18	68
Diameter at breast height (cm)	46.1	20.8	95.7
Height (m)	20.7	11.2	31.0
Crown ratio (%)	70	35	91
Slenderness (height:diameter ratio)	52	28	100
Acoustic velocity in standing tree (km/s)	3.1	2.6	4.0

- Only 4 timber sample trees pre-date establishment of trial
- Majority of trees less than 30 years old (at BH)

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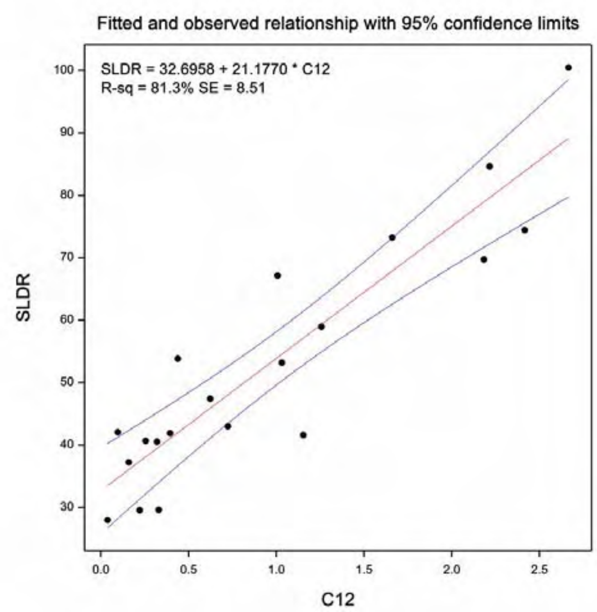
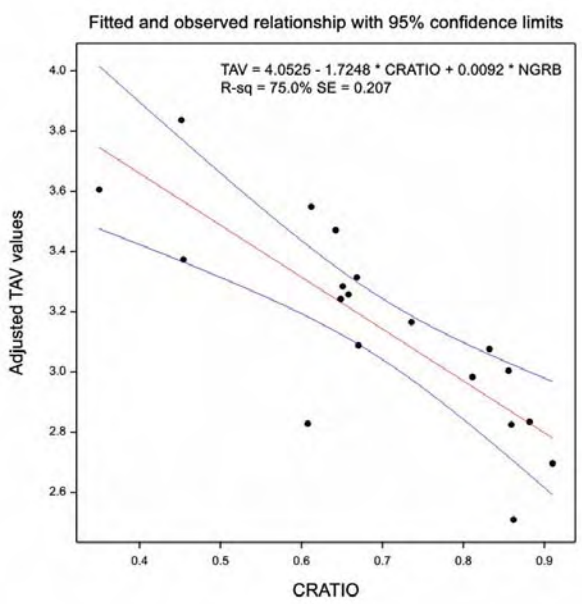
- Wide range of crown ratio and slenderness values, differ from typical values for even-aged stands:
  - Crown ratio 34% (9% - 55%)
  - Slenderness 85 (58 – 106)
- Some of largest trees were virtually open grown

Impact of stand structure

- General (expected) trends were observed:
  - Crown ratio decreased with tree age and greater competition, increased with early growth rate (average ring width of 1st 10 growth rings at breast height)
  - Slenderness increased (i.e. trees were less tapered) at older ages and with greater competition
  - Acoustic velocity in standing trees was higher in older trees and in trees with lower crown ratios





Results – wood density

- Mean breast height (BH) density = 0.365 (0.306 – 0.472)
- Average published values 0.33 – 0.44
- Mean BH density was correlated with tree age (R^2 =0.40)
- We compared average density values for rings 1-18 only with similar data from an even aged stand (Kershope):
  - Glentress mean BH density rings 1-18 = 0.352 (0.262 – 0.429)
  - Kershope mean BH density rings 1-18 = 0.378 (0.310 – 0.432)
- Compared Glentress ring density data (967 growth rings) with model predictions from Gardiner *et al.* 2011*
  (ring number and ring width as input variables)

* Gardiner, B., Leban, J-M., Auty, D., and Simpson, H. (2011). Models for Predicting the Wood Density of British Grown Sitka spruce. Forestry 84(2): 119-132.

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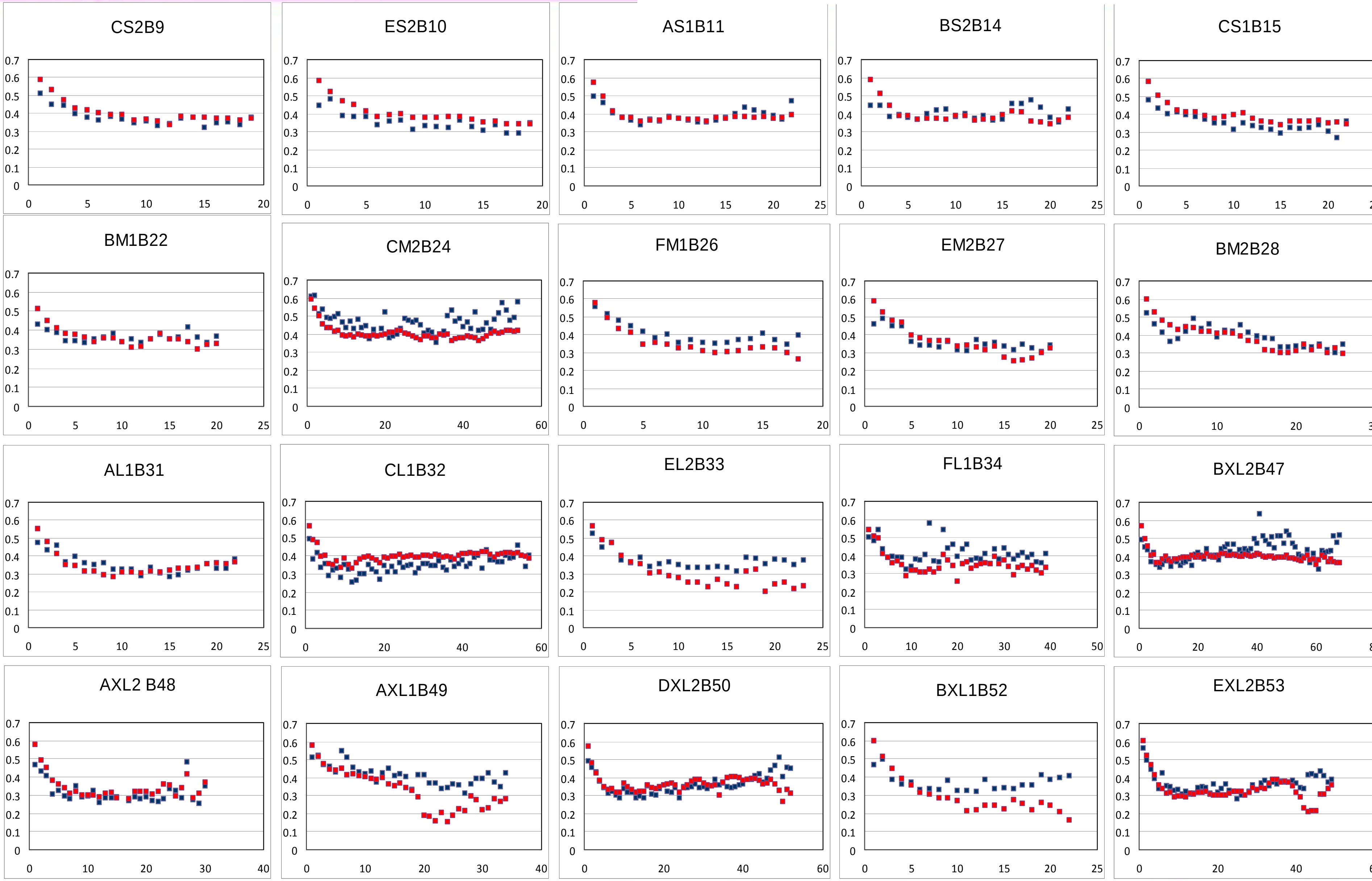
Measured density
Modelled density



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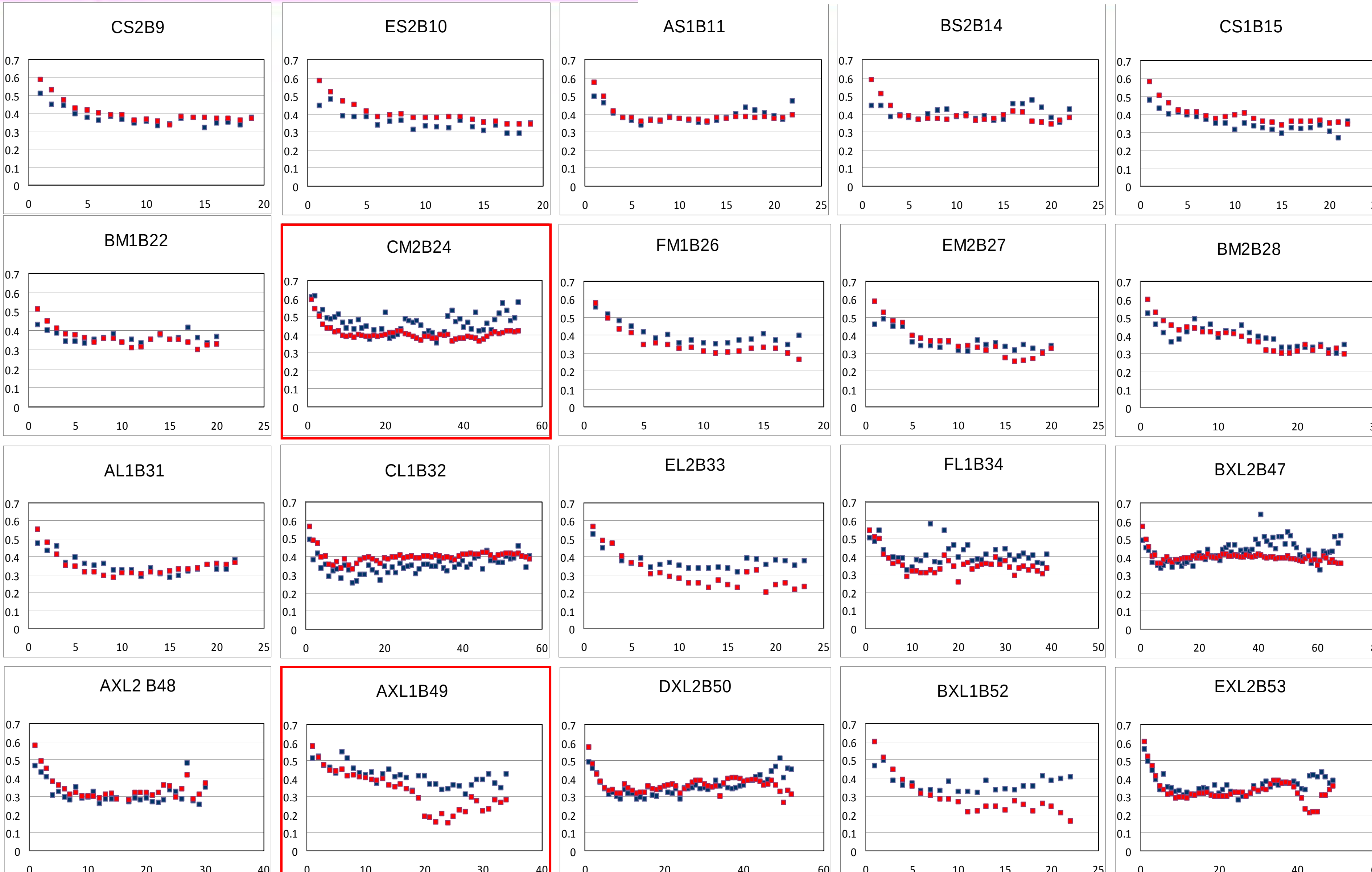
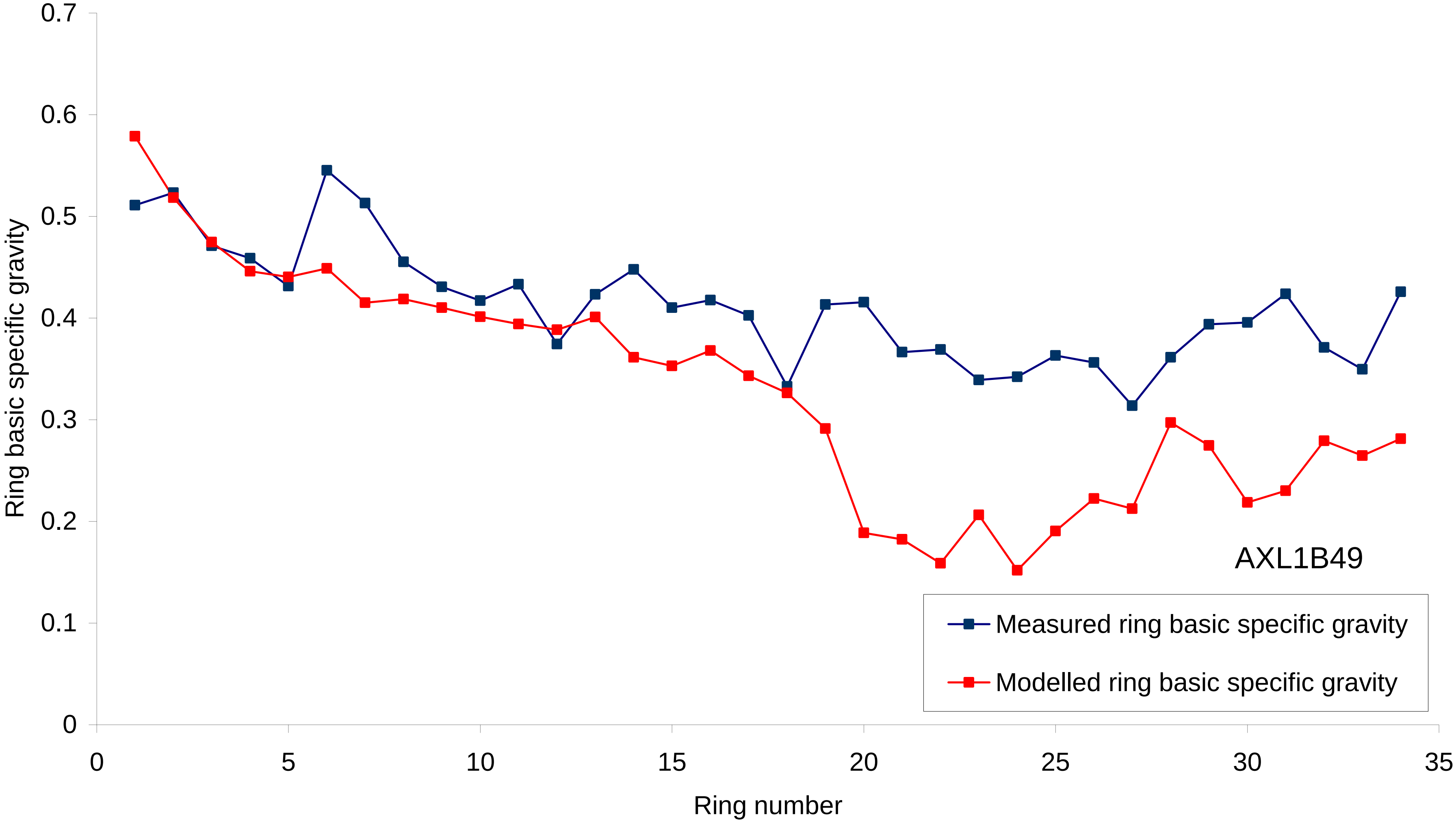
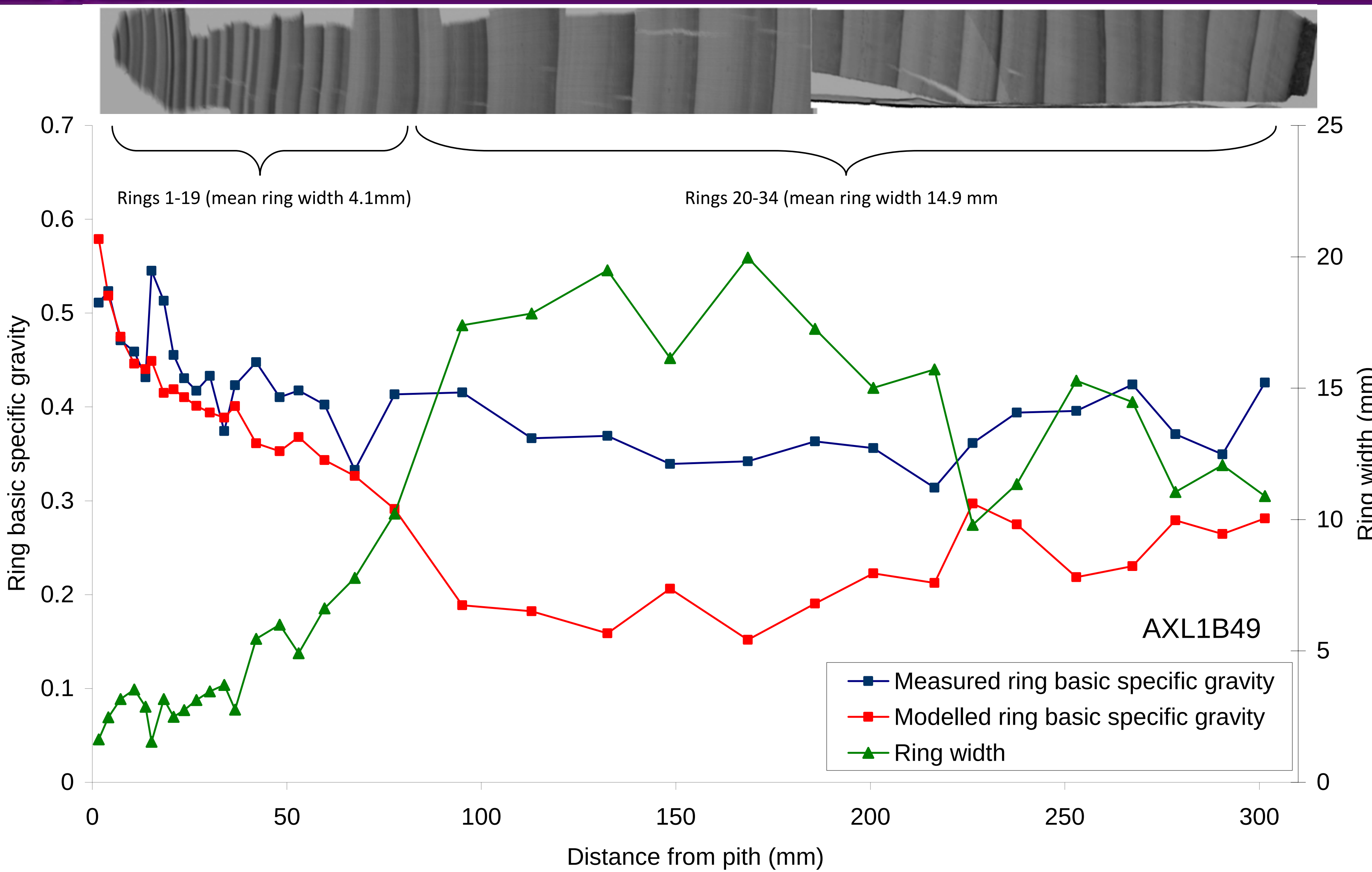
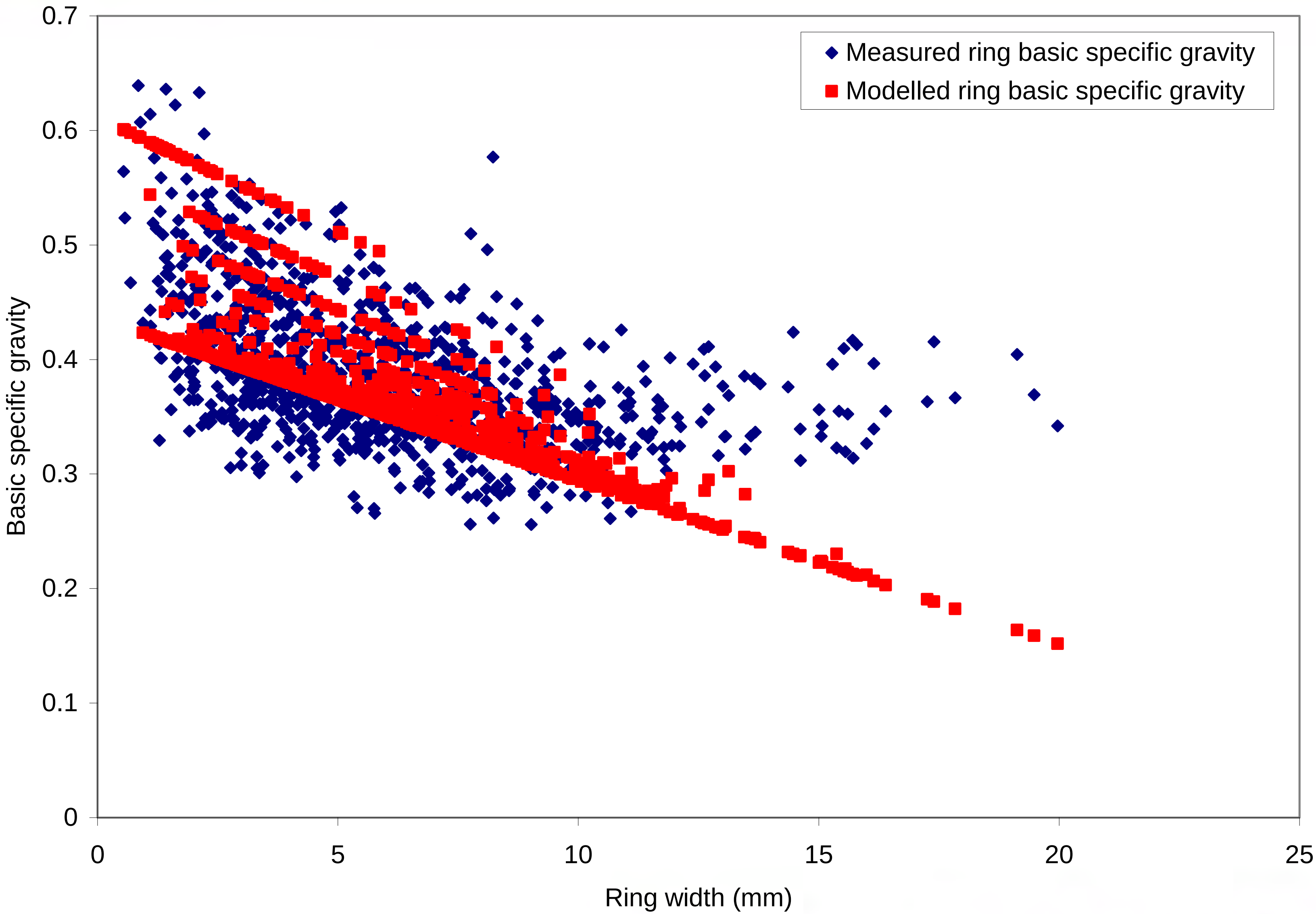
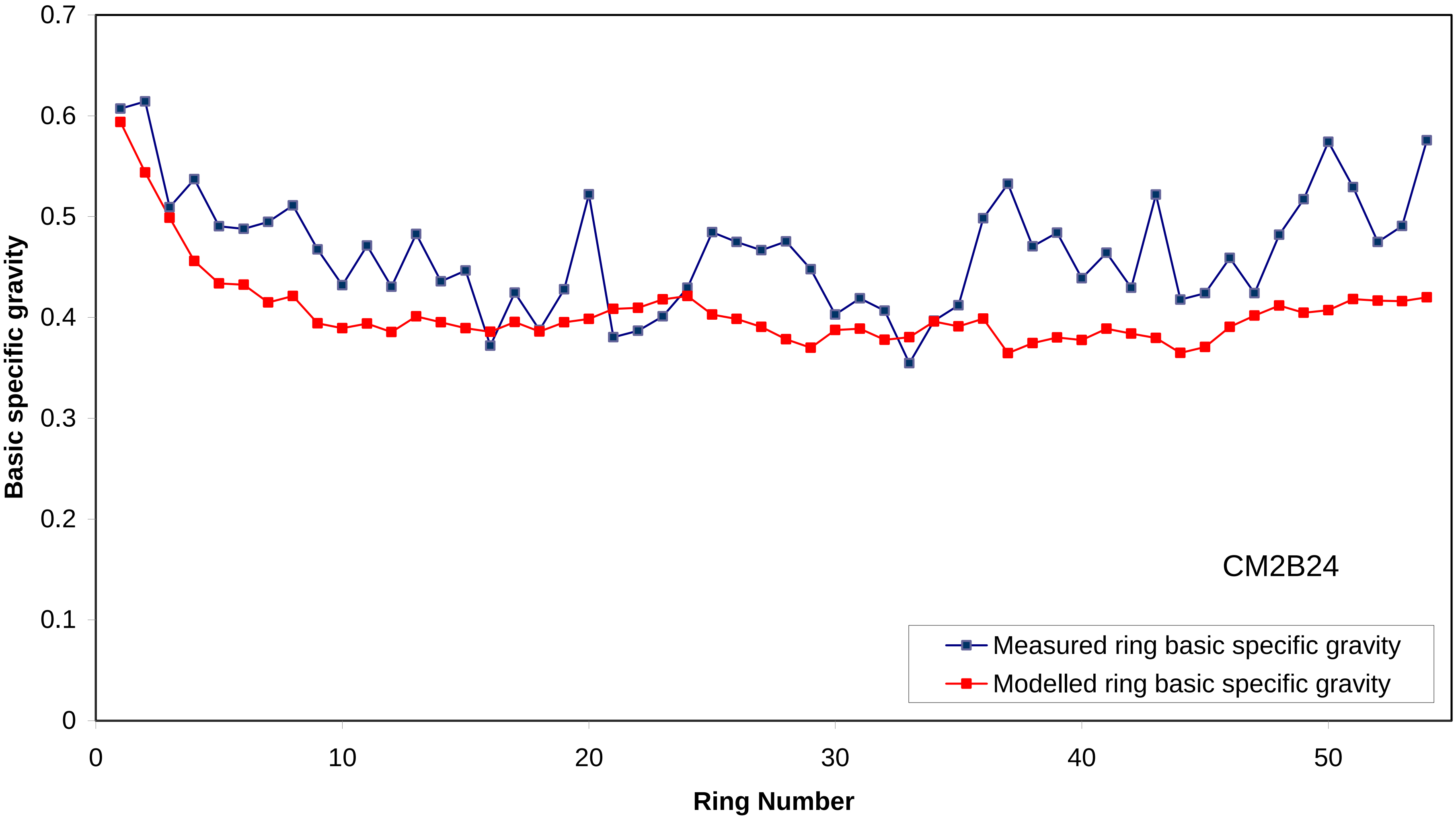
Measured density
Modelled density

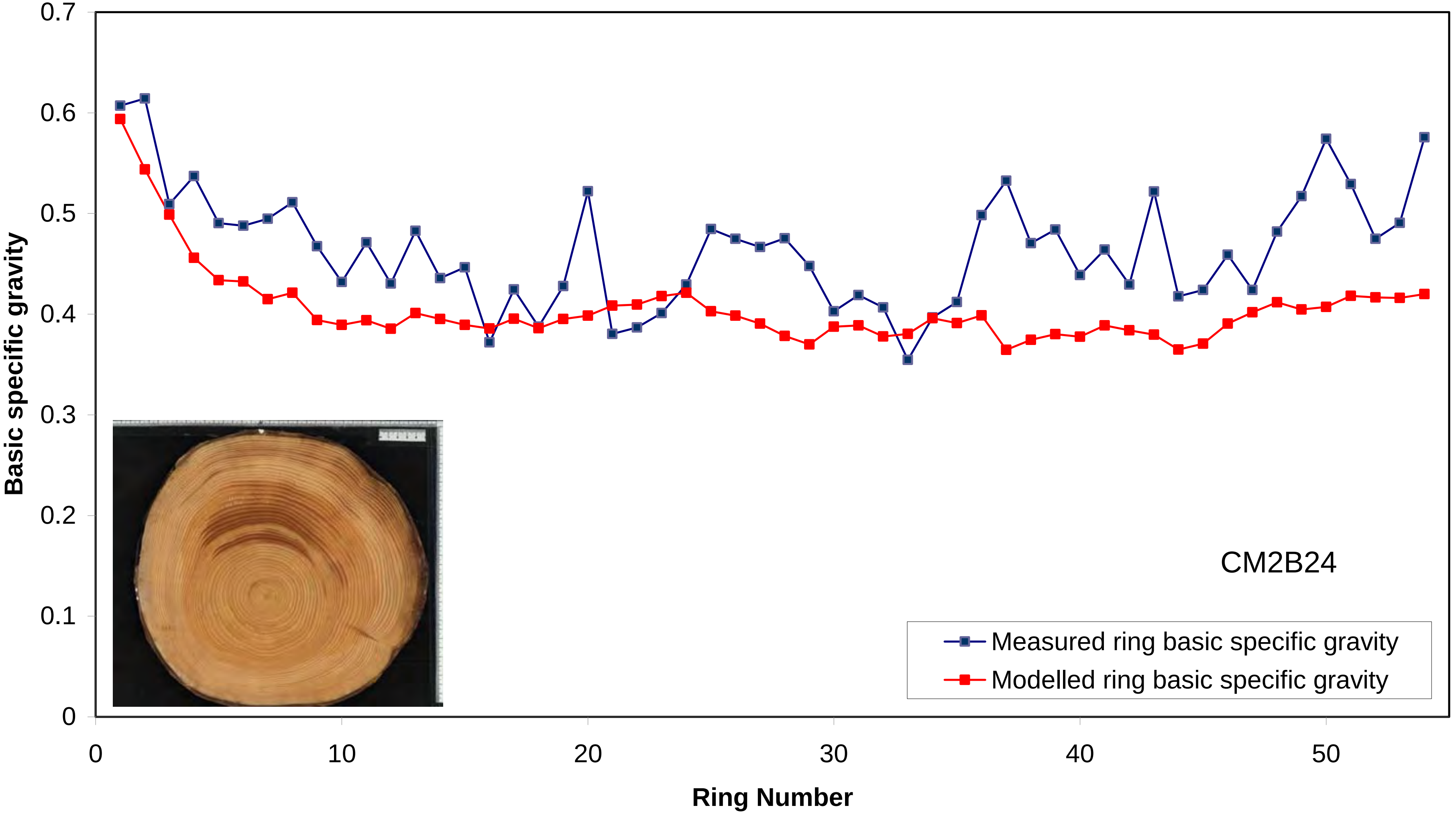


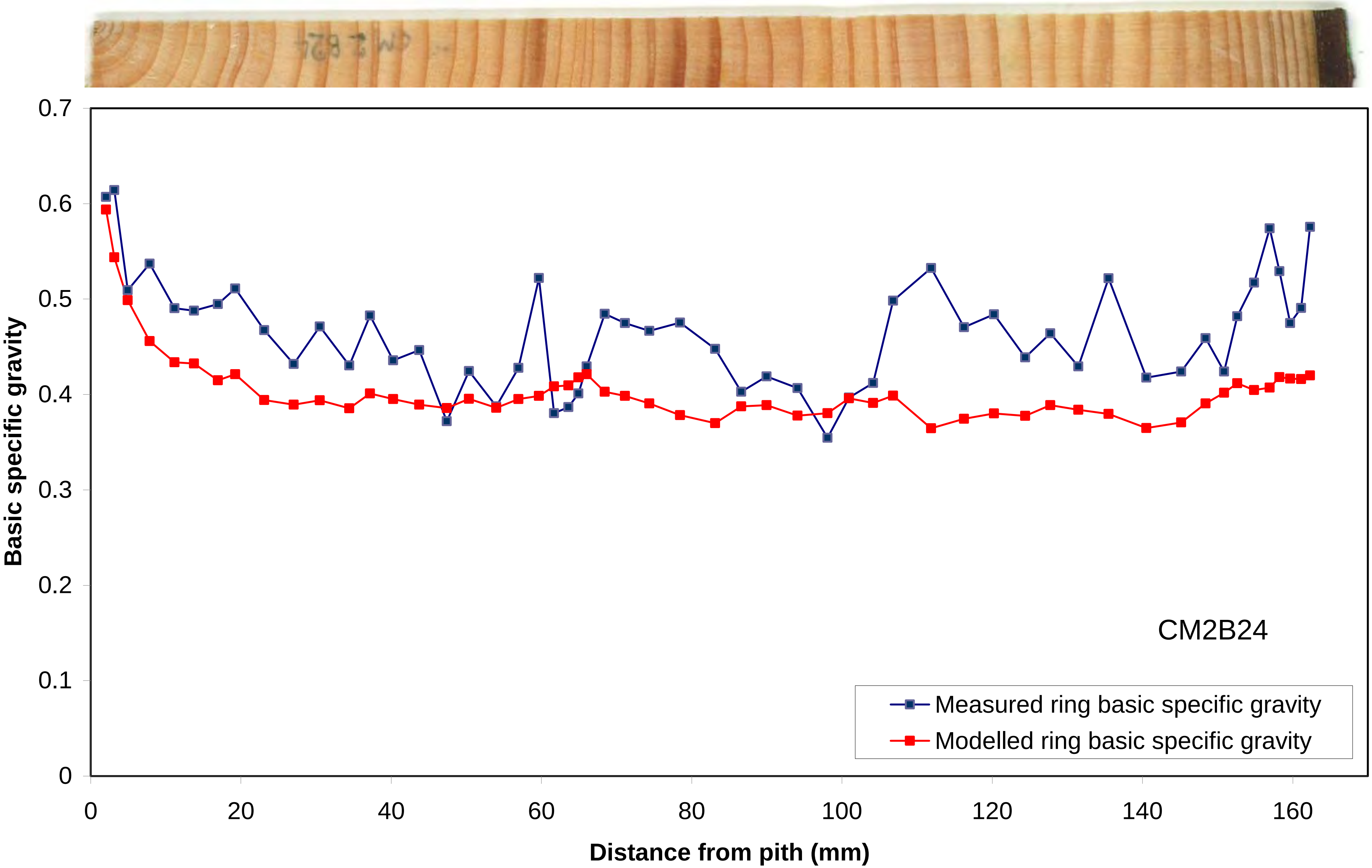

0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Ring basic specific gravity
0
5
10
15
20
25
30
35
Ring number
AXL1B49
Measured ring basic specific gravity
Modelled ring basic specific gravity


Rings 1-19 (mean ring width 4.1mm)
Rings 20-34 (mean ring width 14.9 mm
AXL1B49
Measured ring basic specific gravity
Modelled ring basic specific gravity
Ring width
Ring basic specific gravity
Ring width (mm)
Distance from pith (mm)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
25
20
15
10
5
0
0
50
100
150
200
250
300


0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Basic specific gravity
0
5
10
15
20
25
Ring width (mm)
Measured ring basic specific gravity
Modelled ring basic specific gravity


0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Basic specific gravity
0
10
20
30
40
50
Ring Number
CM2B24
Measured ring basic specific gravity
Modelled ring basic specific gravity

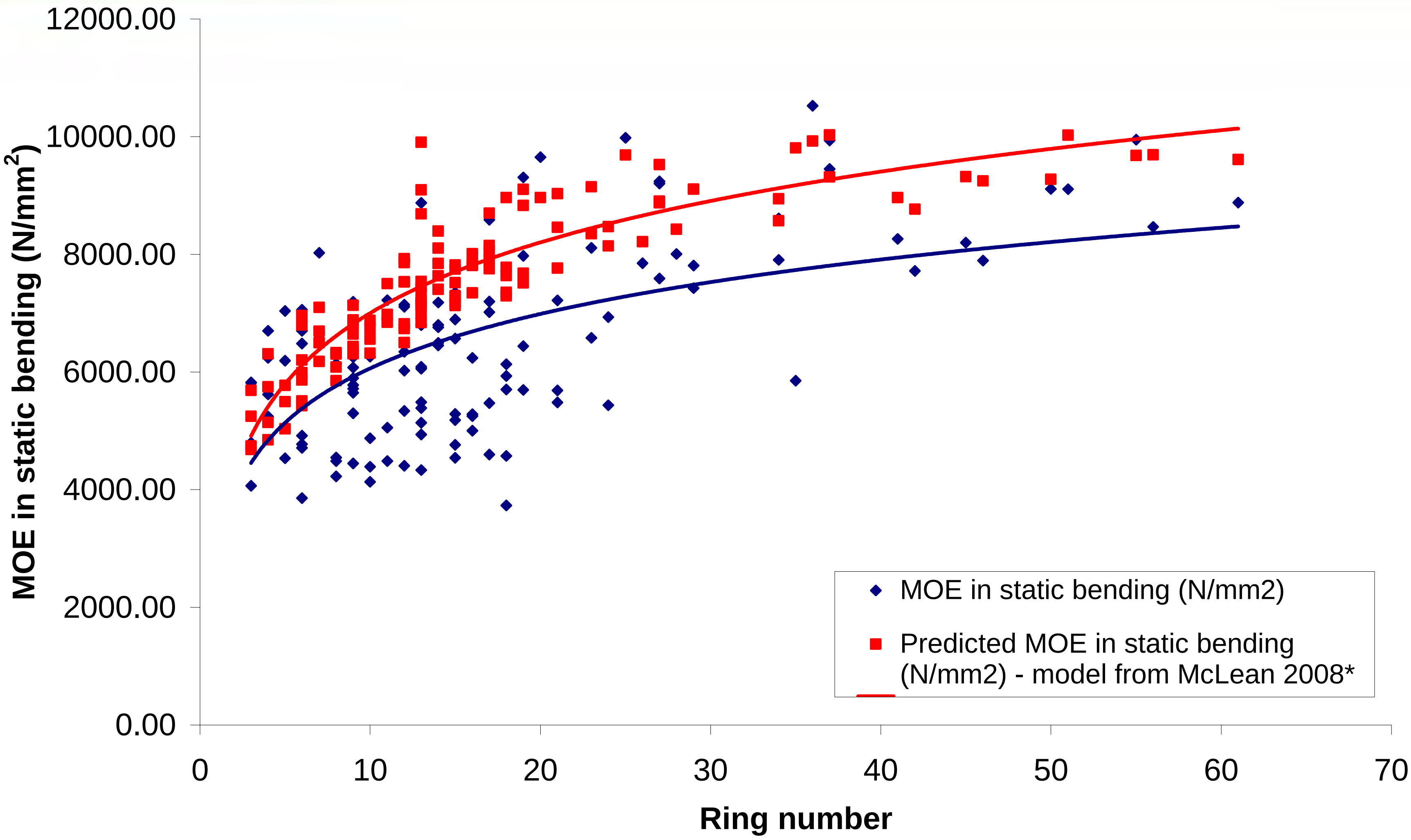

0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Basic specific gravity
0
10
20
30
40
50
Ring Number
CM2B24
Measured ring basic specific gravity
Modelled ring basic specific gravity


0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Basic specific gravity
0
20
40
60
80
100
120
140
160
Distance from pith (mm)
CM2B24
Measured ring basic specific gravity
Modelled ring basic specific gravity

Stiffness in sample trees

- 3 point bending test results obtained for 120 small clear samples
- Average BH MOE: 7013 N/mm^2 (4598 – 9950)
- Published average values: 6680 – 8840 N/mm^2
- Higher values of average BH MOE were associated with older trees, lower crown ratio, and slower early growth
- No apparent effect of competition, tree diameter or stocking density on wood stiffness
- There was a moderate correlation between acoustic velocity in standing trees and average BH MOE

Modelling stiffness



*McLean, J.P. (2008). *Wood properties of four genotypes of Sitka spruce.* PhD Thesis, Department of Analytical and Environmental Chemistry, University of Glasgow.

Conclusions from Glentress study

- There was a wide variation in tree characteristics and wood properties between and within trees
- Wood density was close to predicted values expect in growth rings above 15mm or where compression wood was present
- Clearwood stiffness was lower than predictions based on previous studies
- Deeper crowns are associated with lower slenderness (poorer sawn timber recovery) and lower wood stiffness
- The small number of sample trees limits the extent to which we can extrapolate from these results – further work is needed

Improving mechanical properties through breeding and selection

- Project aim: to improve the mechanical properties of Sitka spruce timber grown in the UK, by assessing opportunities for additional screening and selection in the breeding programme
- 63 full-sib families (40 trees per family) at Spadeadam and Radnor have been assessed for DBH, Pilodyn and acoustic velocity
- Analysis ongoing - a sub-sample of families will be destructively sampled to determine genetic variance components, heritability and breeding values for wood stiffness and other key wood properties
- Trials of small acoustic tool for testing younger trees (2-10cm DBH) are being conducted

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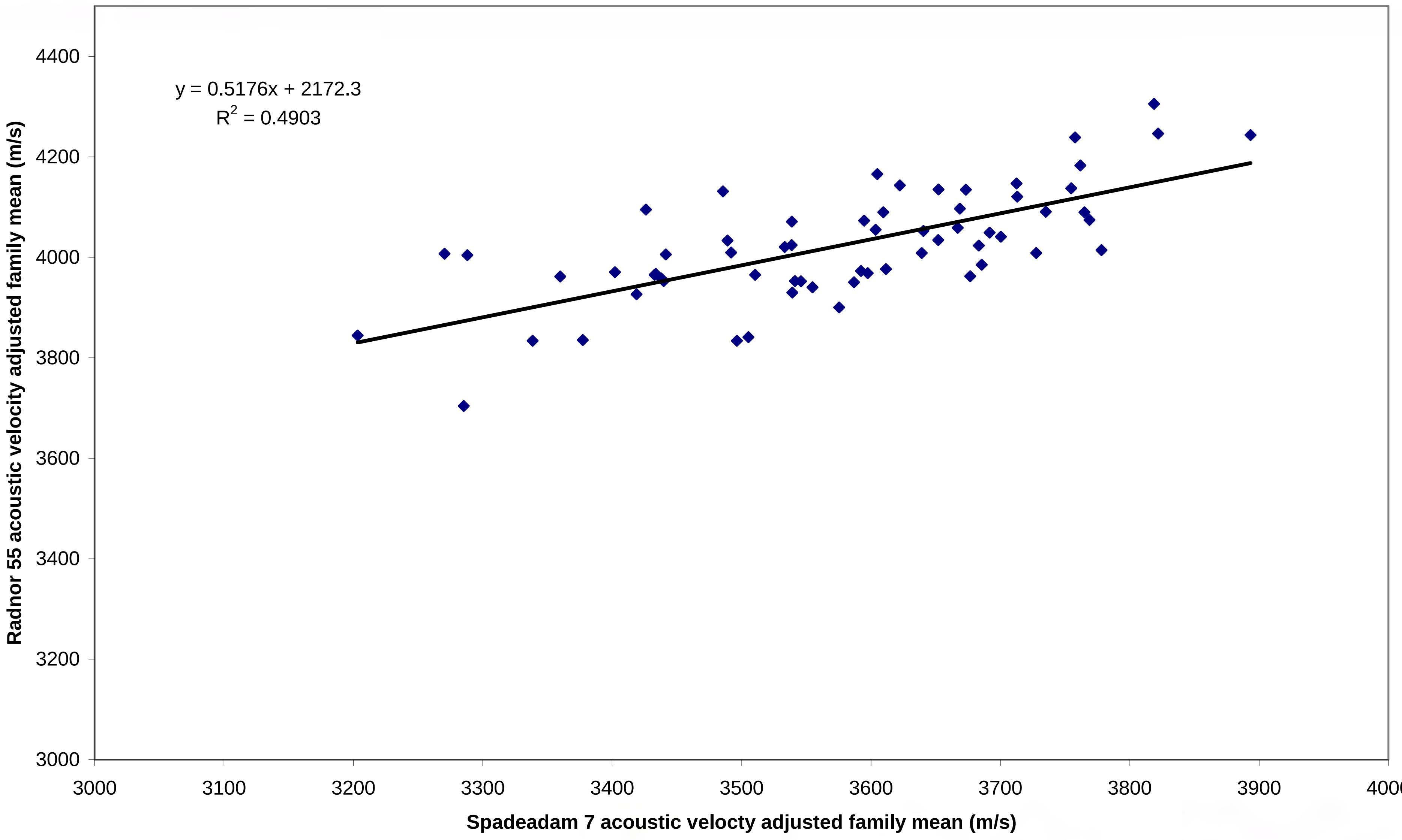
Acoustic velocity at Spadeadam & Radnor

Experiment	Spadeadam adj. mean	Spadeadam Ranking	Experiment	Radnor Adj mean	Radnor Ranking
Spadeadam	3893.3108	1	Radnor 55	4243.297	3
Spadeadam	3821.8862	2	Radnor 55	4245.986	2
Spadeadam	3818.8213	3	Radnor 55	4305.19	1
Spadeadam	3778.0854	4	Radnor 55	4013.988	33
Spadeadam	3768.878	5	Radnor 55	4074.206	19
Spadeadam	3764.9163	6	Radnor 55	4089.5	18
Spadeadam	3761.8186	7	Radnor 55	4182.805	5
Spadeadam	3757.6854	8	Radnor 55	4238.681	4
Spadeadam	3754.7243	9	Radnor 55	4137.156	9
Spadeadam	3735.1501	10	Radnor 55	4090.447	16
Spadeadam	3727.744	11	Radnor 55	4008.23	36
Spadeadam	3713.0385	12	Radnor 55	4120.59	13
Spadeadam	3712.563	13	Radnor 55	4146.691	7
Spadeadam	3700.5014	14	Radnor 55	4041.11	27
Spadeadam	3691.6459	15	Radnor 55	4048.968	26
Spadeadam	3685.5204	16	Radnor 55	3985.047	40
Spadeadam	3683.3303	17	Radnor 55	4023.204	31
Spadeadam	3676.7641	18	Radnor 55	3961.95	49
Spadeadam	3673.3664	19	Radnor 55	4134.471	11
Spadeadam	3668.7952	20	Radnor 55	4096.774	14
Spadeadam	3666.9565	21	Radnor 55	4058.313	23
Spadeadam	3652.2127	22	Radnor 55	4135.02	10
Spadeadam	3652.0051	23	Radnor 55	4034.271	28
Spadeadam	3640.4959	24	Radnor 55	4052.291	25
Spadeadam	3639.2533	25	Radnor 55	4008.589	35
Spadeadam	3622.2755	26	Radnor 56	4142.971	8
Spadeadam	3611.5348	27	Radnor 55	3976.442	41
Spadeadam	3609.5309	28	Radnor 55	4089.658	17
Spadeadam	3604.9601	29	Radnor 55	4165.602	6
Spadeadam	3603.6831	30	Radnor 55	4054.752	24

Acoustic velocity at Spadeadam & Radnor



Testing small trees – Fakopp Ultrasonic tool

Other work

- Impacts of climate change on timber quality
  - PhD at Glasgow University (Steven Adams)
  - Work by John Fonweban within EU projects (ForestClim and Motive) – developing links between ESC climate variables and tree growth, which links to wood properties models
- Identifying shake in standing oak trees – research note reviewing available data and recent trials, due for publication 2013
- Integrating economic assessment with timber quality models – review of methods and preliminary models developed by John Fonweban