WQI Benchmarking Study
Southland Trials - SD564/1, 3 & 4

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Stand Growth Modelling Cooperative in collaboration with WQI Ltd

RADIATA PINE RESOURCE CHARACTERISATION

WQI Benchmarking Study

Laboratory Data Collection–
Site 3 (Southland Forests)

A Report Prepared for WQI Ltd and made available
to the Stand Growth Modelling Cooperative members

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December 2003

WQI LIMITED
New Knowledge in Wood Quality

EXECUTIVE SUMMARY

RADIATA PINE RESOURCE CHARACTERISATION

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Laboratory Data Collection
Site 3 (Southland Forests – Longwood, Rowallan, Blackmount)

Russell McKinley, Dave Cown, Trevor Jones

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Site 3 is a composite of 3 Southland sites, located in Longwood Forest (Trial SD564/1), Rowallan Forest (Trial SD564/3) and Blackmount Forest (SD564/3). In a preliminary study (WQI Pre-screening Study) these sites were shown to represent three of the four "lowest density" sites (average outerwood density 361 kg/m^3). Fifteen stems were selected to cover the density and diameter range within the 3 plots and felled to yield discs at regular intervals up the tree for wood property assessments.

Discs were prepared in such a way as to give data on a range of wood properties:

1. Wood density (5-ring sample blocks)
2. Shrinkage (5-ring sample blocks)
3. Spiral rain (5-ring sample blocks)
4. Colour
5. Internal checking
6. Resinous features
7. *Fibre length*
8. *SilviScan samples*

This report documents some of the findings (1-6 above): the SilviScan and fibre length data for Southland sites will be reported later as they become available.

The sample stems averaged 486 mm DBH and the wood property data confirmed the "low density" classification of the Southland wood and the low density gradient from pith to bark found previously (juvenile wood – 333 kg/m^3; mature wood 348 kg/m^3 in 15 sample trees). Outerwood density values – average 365 kg/m^3 - explained 78% of the variation in stem density. These values are significantly lower than those found in the 1979 Southland Wood Properties Survey in randomly selected stands. The acoustic velocity/density relationship was surprisingly poor; r^2 = 0.10. Heartwood averaged 18% and juvenile wood 53% in the lower 4 logs. Compression wood averaged 9.2% of sample disc area. Shrinkage complied with expected trends, but radial values, at around 1%, were deemed low. Spiral grain values increased from around 2^0 at the base of the trees to over 6^0 in the upper 50% of the stems. Seven of the 15 stems showed some internal checking, and all trees had resinous blemishes to a greater or lesser extent.

Summaries of groups of sites will be provided periodically, assessing the overall results to that point. The raw data have been entered into an Access WQI database and will contribute to modelling the effects of site, silviculture and genetics on wood formation.

WQI BENCHMARKING STUDY
Site 3 (Southland Forests)

Laboratory Data Collection

BACKGROUND

A major component of WQI Objective 1 - Radiata Pine Resource Characterisation - is a survey of the existing forest resource, collecting standard wood samples (non-destructive and destructive) from a significant number of well-documented sites and completion of comprehensive analyses of site factors affecting levels and distributions of major wood properties. Previous regional wood quality studies have identified a gradient in various properties, apparently associated with climatic and site effects (Cown, 1979; Cown & McConchie 1983; Cown & Ball, 2001). These WQI "benchmarking" studies have been planned to use trials comprising known genetic material, located in diverse environments (1978 Genetic Gains Trials). The actual stand conditions vary somewhat due to priorities of individual forest owners and environmental influences (climate, grazing, etc).

The data will provide comprehensive information on:

- Geo-spatial information on wood quality factors (density, shrinkage, spiral grain, microfibril angle, internal checking, fibre length, resin, etc) and material properties (stiffness, strength, stability, appearance features) to yield new information on geographic and within-tree patterns of variability in major wood characteristics.
- Data on specific environmental influences on wood formation (latitude; elevation; soil type; climate).

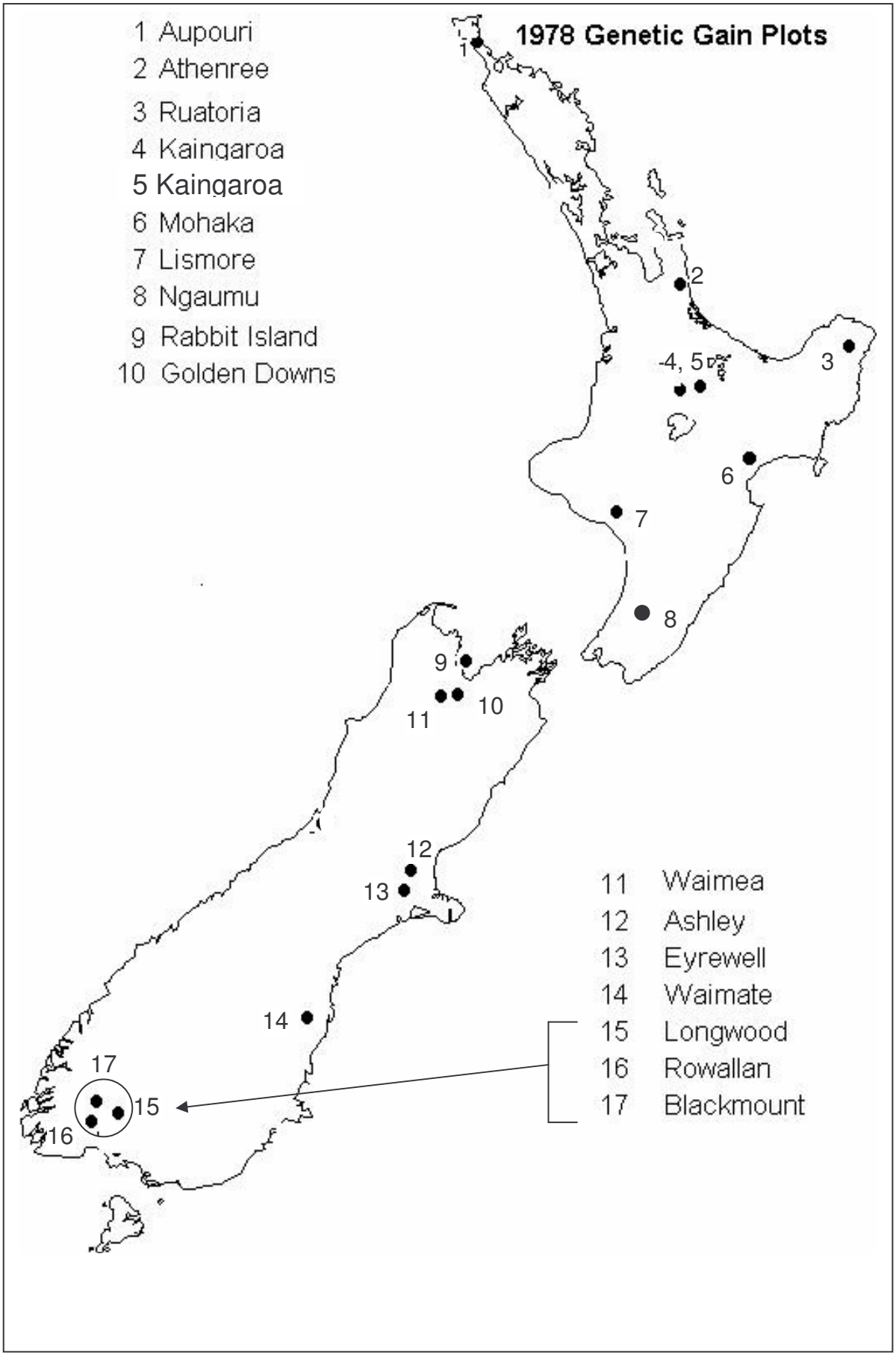
Silvicultural effects -stocking; thinning; pruning; fertilising; rotation length - will be examined later in other trials, subject to WQI priorities. The ultimate objective is to create a new archive of the major wood properties known to influence the value of radiata pine wood products, in relation to the major influencing factors, thus providing a valuable asset to WQI shareholders.

The Genetic Gains Trials were established in 1978 with known genotypes (3 open-pollinated commercial seedlots), sited in (now former) state-owned production forests at 22 sites selected to encompass a broad range of climatic and site conditions (Figure 1). Two plot designs were used:

1) Large plots with trees planted at 1111spha and managed under a typical sawlog regime
2) Row plots where trees were planted in single row plots at 833spha and managed as per the surrounding commercial forest.

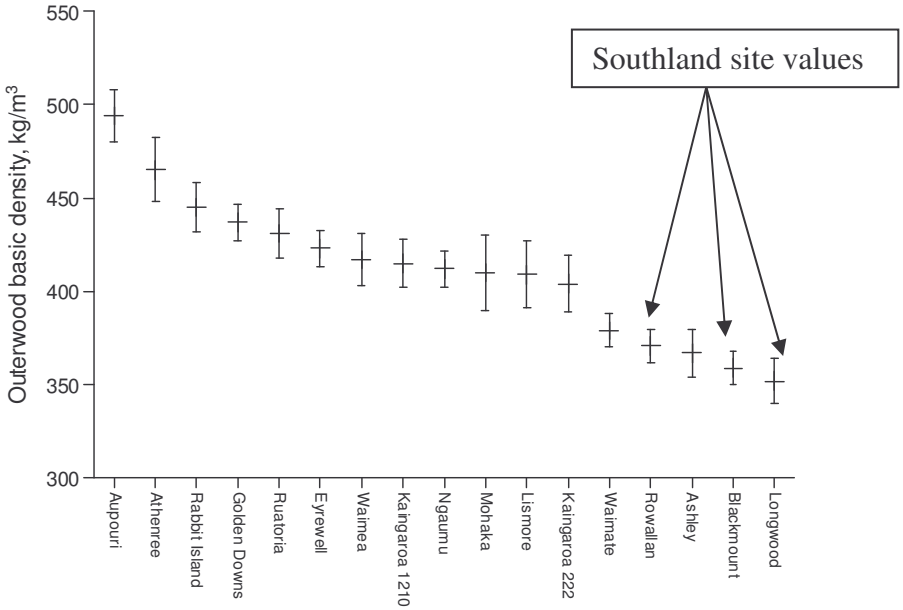
Seedlot WN76/2 (GF 14) was selected for this study as being both well represented in the trial and exhibiting relatively good growth. Classified as GF 14 stock, it represents a significant degree of genetic improvement - similar to many current crops - and is available at a relatively mature age (25 years). Now (2003), in addition to varied silviculture due to management policies, several of the trials have been abandoned as research areas due to damage from excessive grazing or severe storms.

Figure 1 – Sites Sampled



A pre-screening phase was considered advisable to check the current condition of the plots, collect outerwood density cores and assess the potential for further sampling by felling representative stems. The work was contracted to Dean Witehera (Quality Forest Management), who visited the 20 remaining trials and assessed 30 trees/trial of WN76/2 (where available), following standard non-destructive assessment techniques. Outerwood increment core sampling for basic density was undertaken, along with measurement of size (DBH over bark) and visual assessment of sample stems for stem form, branch size, internode length, external resin bleeding and suitability for felling. McKinley and Cown (2003) documented the results of the pre-screening assessment. The pre-screening phase gave a broad picture of wood density variation within the trial (Fig. 2) and allowed for selection of 10 crop trees of reasonable stem form for possible felling, covering the wood density and diameter range at each site. The intention was to provide material for more intensive studies of major wood properties and establish within-tree, between-tree and between-site patterns and relationships between properties. The total number of sites for such intensive study is yet to be established but the intention is to provide as wide a representation of the nation's resource as possible.

Figure 2- Average BH outerwood basic density (mean and standard deviation)



The major findings from the pre-screening study were:

As expected, there was a strong trend for density to decrease southwards. The highest values were found at Aupouri Forest in Northland (494 kg/m^3), and the lowest at Longwood Forest in Southland (352 kg/m^3). These are very significant differences between the various sites in this trial and while the overall trend is clear, there are apparent departures due to local site and climate. There is evidence that the wood density values recorded are significantly reduced from those found in the previous national survey of wood properties (1977-82).

Average for other observed characteristics were:

- *Breast height diameters (average 480 cm) ranged from 356 (Eyrewell) to 580 (Longwood and Mohaka).*
- *Branch index (average 4.3 cm) – 3.4 cm (Golden Downs) to 5.9 cm (Blackmount).*
- *Visual stem resin score (average 0.9) - from 0.5 (Ruatoria, Longwood) to 2.0 (Aupouri).*

DATA COLLECTION PROCEDURES

Prior to felling, visual observation of resin were made (McConchie & Turner, 2002) and the North direction marked at breast height, and a North line marked along the stem after felling. The tree stems were de-limbed and crosscut at a small end diameter of approximately 100mm. The whole stem length was recorded and a CHH Director HM200 acoustic measure made prior to sectioning the stem into log lengths and discs as per Appendix 2. Further Director acoustic measures were made on all individual logs above the 1.4m sampling position. Internode lengths down to 0.2m were measured on the second log, *i.e.* between sampling heights 5m to 10m.

One complete set of discs from all sampling heights (0m, 1.4m, 5m and subsequent 5m intervals down to a SED of approximately 100mm) was removed for basic density, shrinkage and spiral grain assessment by 5-ring groups (Cown & McConchie, 1982, 1983; Treloar and Lausberg, 1995). Samples were also prepared for shipment to CSIRO for SilviScan analyses. Prior to sectioning into 5-ring groups, diameters were recorded over bark, inside bark, for heartwood and juvenile wood (inner 10 rings). Compression wood occurrence per quartile and resinous features were also recorded, along with a total ring count and the number of heartwood rings.

Internal checking analyses were undertaken on all discs up to and including the 10m sampling height, using the "oven drying method" of McConchie (2000). A bark-to-bark strip centred on the pith and an additional adjacent strip were collected at all heights for SilviScan, wood colour and archive samples. SilviScan samples were prepared according to established procedure (*i.e*. soaked in ethanol for several weeks with two changes of ethanol) prior to dispatch to CSIRO, Melbourne. Wood colour measurements were made for heartwood and sapwood in the green and air-dry condition using a Minolta CR-200 colorimeter (Dawson *et al.,* 2003).

Two additional sample discs from all trees (1.4m and 20m) were retained for Norske Skog - for kraft pulping and fibre length and width measurement using a Kajaani Fibrelab instrument.

Results - Site 3 (Southland Forests)

Plot data for the Southland trees, collected during the pre-screening exercise, are tabulated in Appendix 1. Due to the level of malformation and storm damage at each site, insufficient stems of good form remained at any of the individual sites to allow selection of 10 good stems for intensive sampling. Therefore the decision was made to assemble a "Southland composite" by selecting trees from each site, based on the principles of identifying "good" stems across the diameter and wood density range with a mean DBH and density as close as possible to the plot means.

Regarding these 3 sites, Dean commented:

Longwood - *Site fairly clean with some ferns, Rangiora and a few windthrown trees; very large trees growing in gaps >70cm DBHOB*
Rowallan - *Clean site, resin assessment done on wet trees - some difficulties.*
Blackmount - *Clean site with pine needles; block not thinned; extensive snow damage - many broken tops at 10-12m.*

Don McConchie (Wood Quality Focus) subsequently visited the sites, and was contracted to arrange tree felling and disc collection for the detailed wood property analyses.

Tree Stem Characteristics

Appendices 1a,b,c provide the plot information for Longwood, Rowallan and Blackmount forests respectively, as supplied by Dean Witehira. From the total trees assessed in the pre-screening phase, 15 were selected that met the criteria of suitable crop trees as well as covering the outerwood density and diameter range. Table 1 gives all the visually-assessed data from the selected plot trees.

Table 1 – Pre-screening attributes of selected trees

Forest	Tree No.	Outerwood Density (kg/m^3)	DBHOB (mm)	Visual Branch Class (BIX)				IIX	Resin Score #	Comments
				Butt	2nd	3rd	4th			
Longwood	C1	342	556	0	2	2	3	0	0	
Longwood	C2	363	704	0	2	3	3	1	1	Nice big tree, straight
Longwood	C3	340	457	0	2	3	3	1	0	
Longwood	C9	406	526	2	2	3	3	0	0	P4.0, butt fluting
Longwood	C10	354	720	0	1	2	2	2	0	Very nice tree
Longwood	C16	317	752	0	3	3	3	0	2	Edge tree, big branches
Rowallan	D3	386	550	0	1	1	2	0	1	
Rowallan	D7	404	564	0	2	3	3	0	2	Edge trial by gap
Rowallan	D12	341	565	0	3	3	3	0	1	
Rowallan	D13	370	563	0	2	2	3	0	1	Some sweep,
Rowallan	D15	408	568	0	2	3	3	0	1	Edge of trial
Rowallan	D17	359	445	0	1	1	2	0	1	
Rowallan	D19	363	502	0	2	2	2	0	1	
Blackmount	E2	397	434	2	3	3	3	0	0	P1.8
Blackmount	E30	331	425	3	3	3	3	1	1	
Sample mean		365	575		1.9	2.4	2.7	0.3	0.8	
Mean BIX					4.4	5.7	6.6			
Southland mean (73 stems)										
Mean		361	491		2.3	2.5	2.6	0.4	0.7	
Mean BIX					5.4	6.0	6.3			

0 = Nil; 3 = Severe

BIX Score	Average Branch (cm)	Range	IIX Score	Average Internode Index	Description
0	0	No branches	**0**	0.3	No or very few internodes - < 40% of logs made of long internode material
1	3.0	3 cm or less	**1**	0.5	Some internode material - > 40% of logs made of long internode material
2	4.5	3 - 6 cm	**2**	0.7	Long internode material - > 70% of logs made of long internode material
3	7.5	6 - 9 cm			
4	>9.0	9 cm or greater			

Outerwood density and DBHOB of the sample stems averaged 365 kg/m^3 and 575 mm respectively, closely matching the plot values. The butt logs were pruned but assessments of the other logs yielded visual branch assessments averaging 1.9, 2.4 and 2.7 (logs 2-4) which equates to

BIX values of 4.4, 5.7, and 6.6 cm respectively. Many of the 75 stems exhibited some degree of external resin: 51% rated moderate; 7% rated severe.

WOOD PROPERTIES - RESULTS AND DISCUSSION

1. Increment Cores

Previous research has indicated that as far as wood density is concerned, the Southland forests can be quite variable, but basically cover the lower end of the scale (Cown 1979; Cown & McConchie, 1983). Juvenile (inner 10 growth rings) and outerwood wood values averaged 360 kg/m^3 and 425 kg/m^3 respectively. These compared to national averages of about 390 kg/m^3 and 450 kg/m^3. The values represented averages from 36 sites from throughout the whole Southland region – unselected seed; ages 19-50 yrs. at time of sampling and from stands at elevations from 5 – 700m.

It was apparent from the WQI pre-screening exercise (McKinley & Cown, 2003) that outerwood wood density levels were indeed low (Blackmount – 359 kg/m^3; Rowallan – 371 kg/m^3; Longwood - 352 kg/m^3). These values are considerably lower than those found in the 1979 survey work (range 395 to 462 kg/m^3).

2. Disc Properties (diameter, bark, juvenile wood, heartwood, compression wood)

Average disc properties by height are documented in Table 2, with the disc sampling as shown in (Appendix 2). Juvenile wood (inner 10 rings) and heartwood are calculated as the proportion of cross-sectional area of the entire disc. Compression wood was visually assessed by quartile and disc, with Quartile 1 centred on the North line marked on the disc.

Table 2 – Average disc properties by sampling height

Disc ht. (m)	DIB (mm)	Bark (mm)	Total Rings	Heart Wood Rings	Heart Wood (%)*	Juv Wood (%)*	Compression wood by Quartile				
							N (%)	E (%)	S (%)	W (%)	Disc (%)
0	540	27	24	8	12	25	4	4	6	5	5.7
1.4	486	23	22	7	17	33	7	5	6	10	7.7
5	440	13	19	7	23	45	8	7	9	11	9.3
10	383	8	16	5	22	56	8	7	9	9	9.3
15	316	7	13	4	19	70	10	13	15	11	13.0
20	267	6	11	3	13	90	9	15	13	10	11.7
25	199	5	8	2	8	99	6	4	8	10	7.7
										Un-weighted average CW	9.2

* Area based

These data on their own are rather meaningless, and will be discussed in more detail after the first 3 sites have been reported. At that point, realistic site comparisons can be made and trends observed.

3. Wood Density

Wood density values can be assessed in a number of different ways. Outerwood increment core values were determined for plot sample trees in the course of the pre-screening study, and detailed SilviScan within-ring data (resin-extracted) will be collected at all disc sampling levels for all felled sample stems, giving information similar to past densitometry studies (Cown & Ball, 2001). In this part of the study, wood density was measured on 5-ring blocks from the pith outwards at each stem level (unextracted density), as indicated in Appendix 2. The weighted block and disc measurements allowed estimates density for various stem components: juvenile wood (333 kg/m^3), outerwood (348 kg/m^3), log and stem basic density (338 kg/m^3). The unextracted values (Table 3) are influenced to some degree by the presence of heartwood, particularly with height in the stem, but also potentially between sites to some extent (Cown *et al.* 1991a). It may be worth noting that the average stem density for the 25 trees felled in the 1979 survey was 410 kg/m^3 at an average age of 30 yrs (range in current sample 302 – 381 kg/m^3).

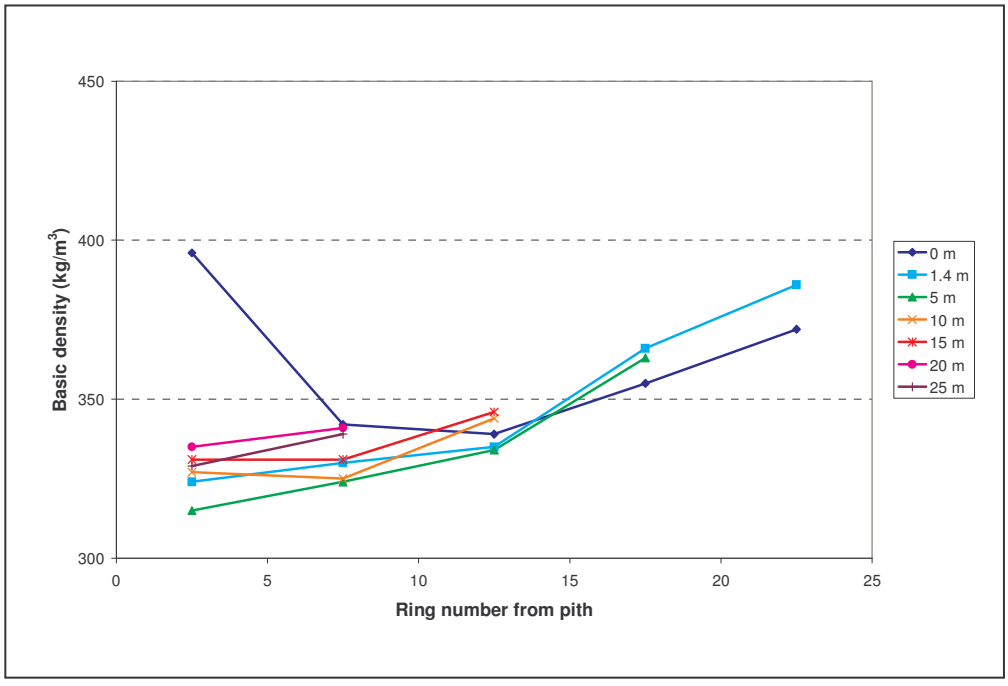
Table 3 – Pith-to-bark basic density trends by sampling height

Disc Ht.	Basic density (kg/m^3) by ring group from pith					Basic density (kg/m^3)		
(m)	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	Juv.#	Outer	Disc
0	396	342	339	355	372	357	352	354
1.4	324	330	335	366	386	329	352	342
5	315	324	334	363		321	345	332
10	327	325	344			326	345	333
15	331	331	346			331	346	334
20	335	341				337		337
25	329	339				331		331
						333	348	338
Average Stem Density: 338 kg/m^3 Range: 302 – 381 kg/m^3								

Inner 10 growth rings

Unextracted densities are plotted by stem levels in Figure 3.

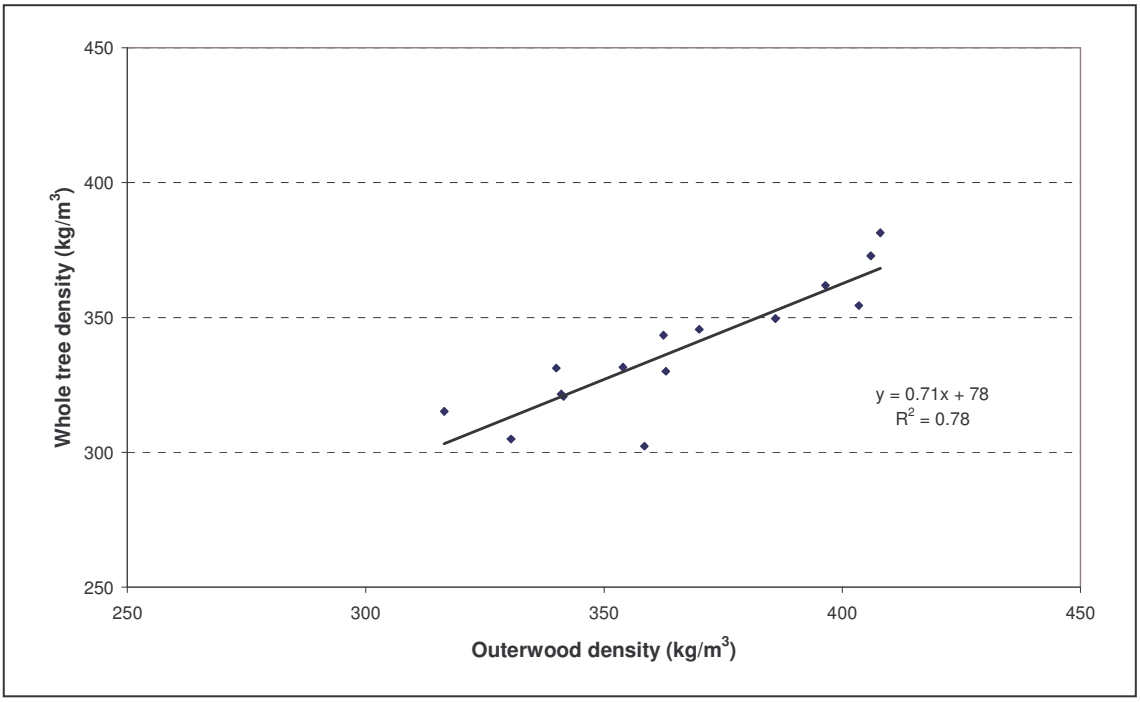
Figure 3 – Basic wood density (unextracted) - all stem levels



Basic wood density values consistently increase outwards from the pith as has been documented in numerous studies. Juvenile wood density (mostly heartwood) was fairly consistent at most levels at around 330 kg/m^3 (the exception being the butt disc) - and the outerwood density decreased slightly with height up the stem, reflecting the increasingly younger wood. The relatively high values for juvenile wood for the butt (0m) disc are simply a reflection of high levels of extractives in the "older" heartwood in these samples. This is very apparent in Fig. 3.

Weighted whole tree density calculated from disc values using Smalian's formula averaged 338 kg/m^3 (range 302 – 381 kg/m^3). The relationship between BH outerwood density and whole-tree density for all 10 trees is shown in Fig. 4 ($r^2 = 0.78$).

Figure 4 – Basic wood density: breast height/whole stem relationship



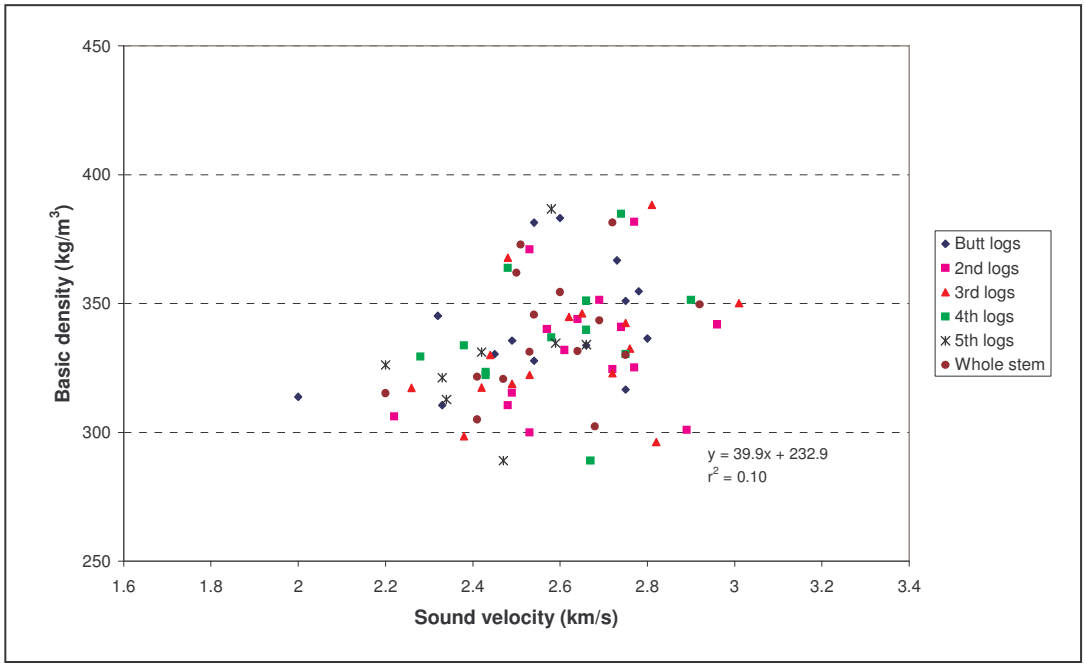
The expected high correspondence was confirmed for these trees.

The dynamic stiffness data (CHH director HM 200 - Table 4) was examined in relation to average log and stem density (Fig. 5).

Table 4 –CHH Director HM200 log and stem acoustic measures

Tree No.	Stem Length (m)	Acoustic data (km/s)					
		Stem	Log 1	Log 2	Log 3	Log 4	Log 5
C1	25	2.47	2.54	2.49	2.42	2.43	2.34
C2	28	2.75	2.8	2.72	2.72	2.75	2.66
C3	15	2.53	2.49	2.61	2.53		
C9	24	2.51	2.54	2.53	2.48	2.48	
C10	25	2.64	2.66	2.77	2.76	2.58	2.42
C16	25	2.2	2	2.22	2.26	2.28	2.2
D3	22	2.92	2.78	2.96	3.01	2.9	
D7	19	2.6	2.73	2.69	2.62	2.38	
D12	24	2.41	2.45	2.48	2.49	2.43	2.33
D13	18	2.54	2.32	2.57	2.65	2.66	
D15	23	2.72		2.77	2.81	2.74	2.58
D17	25	2.68	2.75	2.89	2.82	2.67	2.47
D19	23	2.69	2.75	2.74	2.75	2.66	2.59
E2	17	2.5	2.6	2.64	2.44		
E30	15	2.41	2.33	2.53	2.38		
Mean	21.9	2.57	2.55	2.64	2.61	2.58	2.45

Figure 5 - Relationship between basic density and sound velocity for individual logs and whole stems



Overall, there is a very weak positive relationship, with little indication of trends with log height class or site. There is no obvious reason for this and further analysis of this aspect will await amalgamation of data from several sites.

4. Shrinkage

Shrinkage values were measured on all 5-ring block samples and compared to data previously collected in the course of a national wood properties survey (Cown *et al.,* 1991a). The data are summarised in Tables 5 and 6, and breast height trends plotted in Figures 6a-c. Values are in line with previous results (Cown *et al*., 1991a). In this case, the tangential values vary much more with stem location than the radial values. The negative values for the tree level longitudinal shrinkage averages reflect the difficulty of accurately detecting very small differences on the 5-ring block surfaces and possibly some apparent expansion in the longitudinal direction due to grain imperfections. The actual values are very small and do not represent true expansion.

Table 5 – Average air-dry shrinkage by sampling height

Disc ht. (m)	Air-dry shrinkage* (%)		
	Longitudinal	Radial	Tangential
0	0.01	1.3	4.0
1.4	-0.01	1.2	3.7
5	-0.07	1.1	3.4
10	-0.04	1.1	3.2
15	-0.02	1.0	3.0
20	-0.03	1.0	2.8
25	-0.04	1.0	2.7

* Adjusted to 12% m.c.

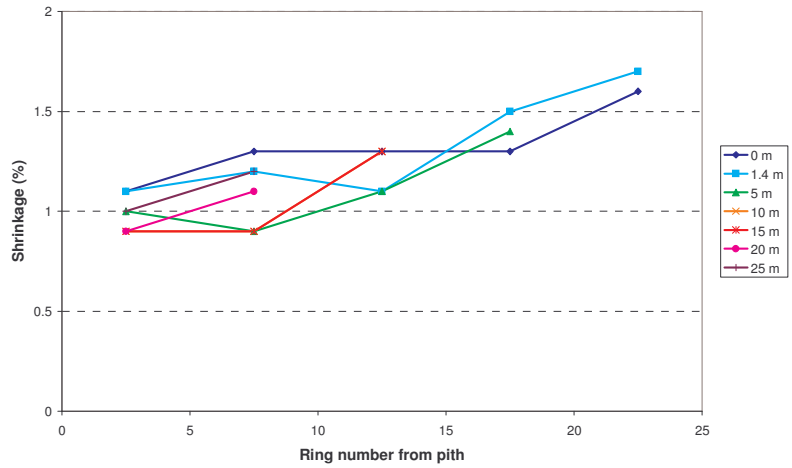
Table 6 – Pith-to-bark air-dry shrinkage trends by sampling height

Disc ht.	Air-dry shrinkage* (%) by ring group from pith									
	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25
(m)	Longitudinal					Radial				
0	0.47	0.08	-0.10	-0.19	-0.21	1.1	1.3	1.3	1.3	1.6
1.4	0.24	-0.02	-0.08	-0.15	-0.20	1.1	1.2	1.1	1.5	1.7
5	0.02	0.00	-0.12	-0.18		1.0	0.9	1.1	1.4	
10	0.03	-0.01	-0.14			0.9	0.9	1.3		
15	0.01	0.01	-0.08			0.9	0.9	1.3		
20	0.00	-0.05	-0.07			0.9	1.1	1.3		
25	-0.03	-0.10				1.0	1.2			
	Tangential									
0	2.9	4.0	4.1	4.5	4.7					
1.4	2.7	3.8	3.8	4.4	4.8					
5	2.6	3.2	3.8	4.0						
10	2.6	3.1	3.8							
15	2.5	2.9	3.6							
20	2.6	2.9	4.1							
25	2.6	3.1								

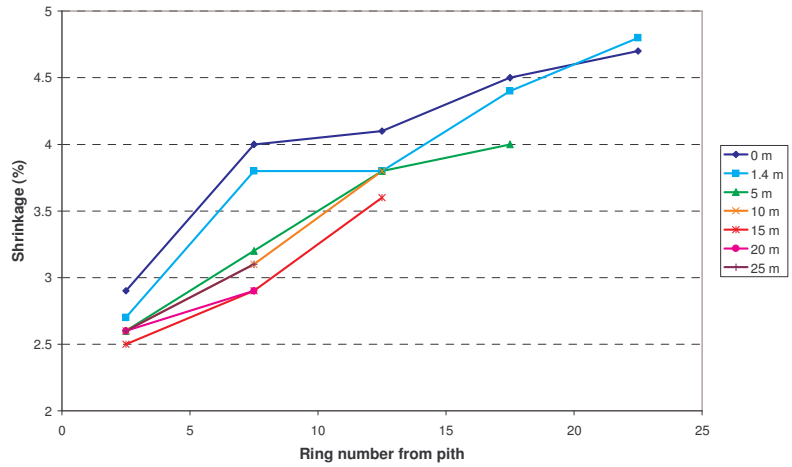
* Adjusted to 12% m.c.

Figure 6 – Shrinkage (green to 12% MC) for all stem levels

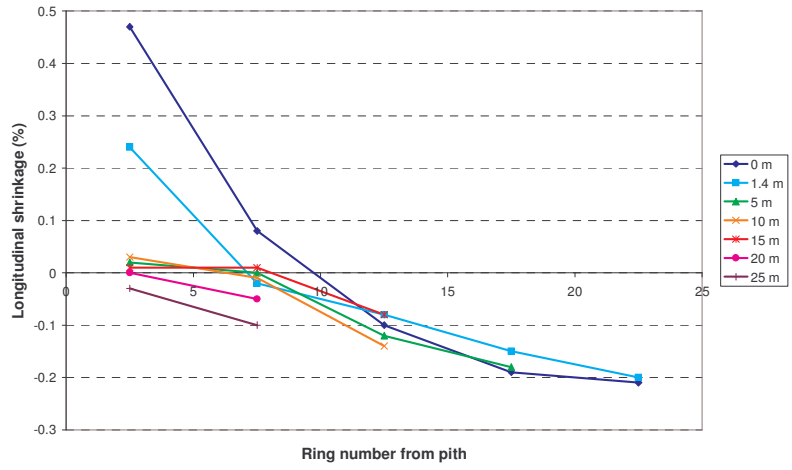
6a: Radial shrinkage



6b: Tangential shrinkage



6c: Longitudinal shrinkage



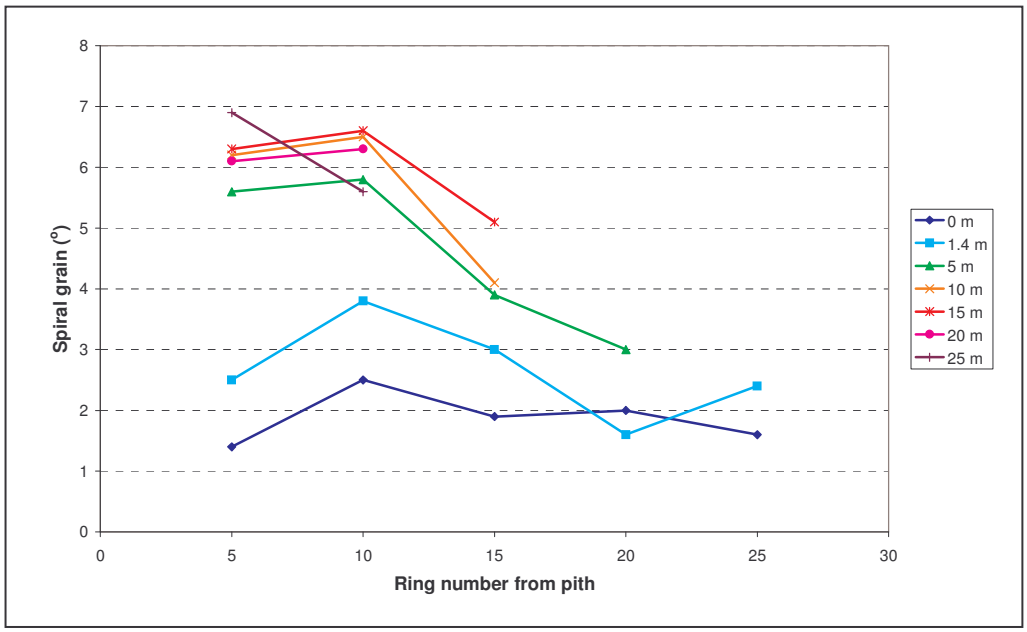
5. Spiral Grain

Average spiral grain values are summarised in Table 7 and Fig. 7. Mean angles ranged from about 1.5^0 to 2.5^0 (outerwood in the lower stem) to 6^0 to 7^0 (inner rings above 5m) in accordance with previously established broad patterns for the Central North Island (Cown *et al.* 1991b). More detailed analyses will await data from more sites.

Table 7 – Average pith-to-bark spiral grain patterns by sampling height

Disc ht. (m)	Spiral grain (°) by ring number from pith				
	5	10	15	20	25
0	1.4	2.5	1.9	2.0	1.6
1.4	2.5	3.8	3.0	1.6	2.4
5	5.6	5.8	3.9	3.0	
10	6.2	6.5	4.1		
15	6.3	6.6	5.1		
20	6.1	6.3			
25	6.9	5.6			

Figure 7 – Spiral grain pattern for all stem levels



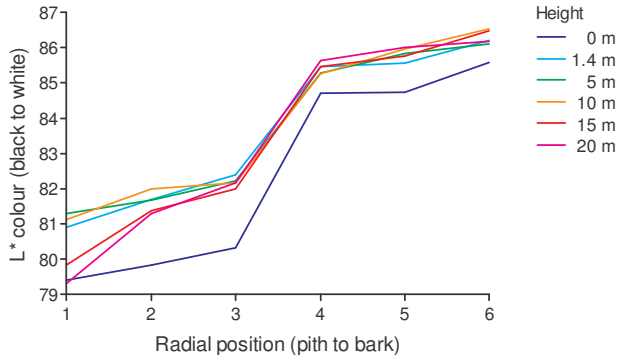
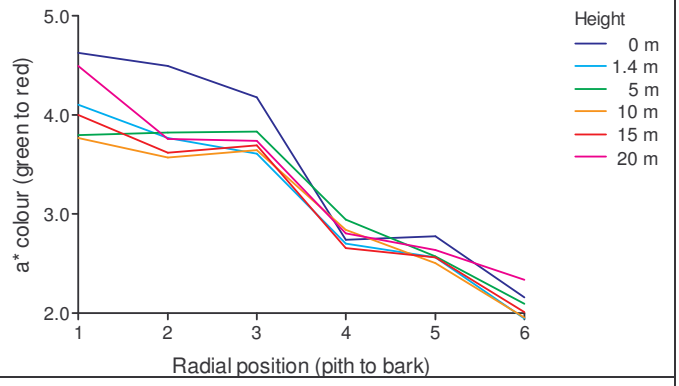
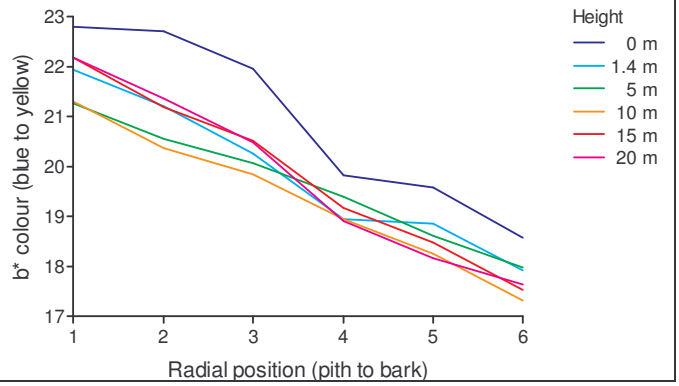
6. Wood Colour

The LAB system of wood colour measurements showed differences in heartwood and sapwood colour with height and radial position within the trees. The heartwood became lighter with height to 5 m (lightness L* values increased), and then declined in lightness to 20 m, with a slight increase in lightness from the inner to outer heartwood (Fig. 8a). The sapwood was lighter in colour that the heartwood, with little change with height and radial position.

The heartwood was redder in colour (a* values higher) at the top of the trees, with little change in the green-red colour from the inner to outer heartwood (Figure 8b). The heartwood was redder in colour than the sapwood, which varied little in green-red colour with height and radial position.

The heartwood was yellower in colour (b* values higher) at the butt of the trees, and in the inner heartwood at the butt (Figure 8c). The yellow colour of the heartwood and sapwood declined from pith to bark (b* values decreased), with the differences in blue-yellow colour with height diminishing in the outer heartwood and sapwood.

Figure 8 – Colour data for Southland Sites

8a) Height and radial patterns of the L* colour co-ordinate (black to white). Radial positions: 1-3 heartwood, 4-6 sapwood.	
8b) Height and radial patterns of the a* colour co-ordinate (green to red). Radial positions: 1-3 heartwood, 4-6 sapwood	
8c) Height and radial patterns of the b* colour co-ordinate (blue to yellow). Radial positions: 1-3 heartwood, 4-6 sapwood.	

7. Internal checking

Within-ring internal checks are often observed at the base of the stem and there have been suggestions that site, climate, genotype and tree age can all have an effect on the levels found (Cown *et al.,* 2003; Beets *et al.,* 2002). At this site, 7 of the 15 felled trees exhibited internal checking (total of 126 checks, or an overall average of just over 8 checks per affected tree for the site). Appendices 3a and 3b give the detailed data by tree number and disc height. Fig. 9 shows a general reduction with stem height and Fig. 10 shows the distribution according to years at BH. Occurrence is spread over about 10 years, with peaks in 1987, 1988 and 1995.

Figure 9 – Internal checks by height (7 trees affected)

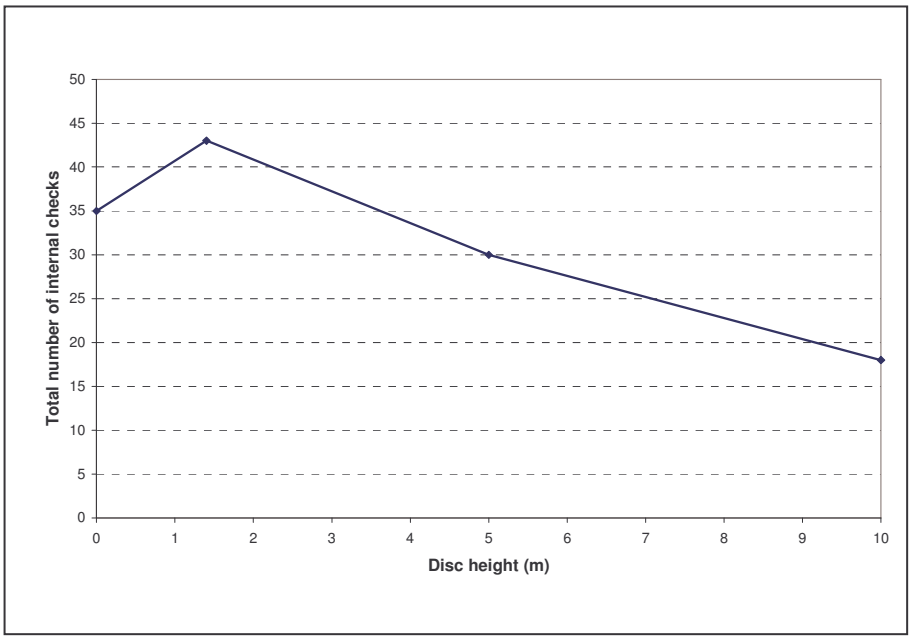
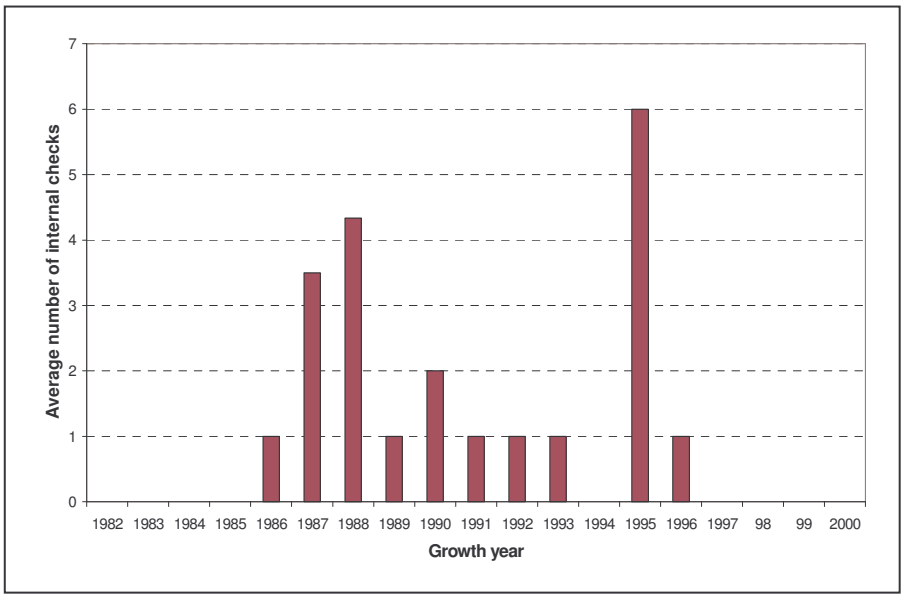


Fig. 10 – Internal check by year (BH level)



8. Resinous Features

In the field, notes were made of the occurrence of resin pockets, blemishes, needle flecks and green intra-ring checks on the fresh discs. The totals for the Southland sites are given in Table 8. Relatively few defects were present in the 15 stems, and most were found in the lower 5m. Needle fleck was an exception – occurrence increasing with stem height. However, none of the felled trees was completely free of blemishes.

Table 8 – Resinous features (totals) by height class

Disc Ht (m)	Resin pockets	Resinous patches*	Blemishes	Needle Fleck	Green Int. checks
0	3	20	15	0	0
1.4	5	0	4	0	0
5	8	1	1	1	0
10	1	0	1	5	1
15	4	0	2	4	1
20	1	0	1	4	0
25	0	0	0	3	0
Totals	22	21	24	17	2

* includes resinous latewood

Note: 4 trees had galls and 1 tree had large wet heartwood zone with a pink outer edge

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Laboratory: Wood property assessments – Pat Hodgkiss, Mike McConchie.

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References

Beets, P.N.; Kimberley, M.O.; McConchie, M. 2002: Internal checking in *Pinus radiata* – an examination of genetic and nutritional factors associated with its occurrence at the Kaingaroa seed orchard. Forest Research, August, 2002 (Unpublished contract report for FCF).

Cown, D.J. 1979: Radiata pine wood properties survey (1978) Interim Report 5 – Southland Conservancy. FRI Forest products division Report FP/WQ 30: 70pp. (Unpublished).

Cown, D.J. and McConchie, D.L. 1982: Rotation age and silvicultural effects on wood properties of four stands of *Pinus radiata.* New Zealand Journal of Forestry Science 12(1): 71-85.

Cown, D.J. and McConchie, D.L. 1983: Studies on the intrinsic properties of new-crop radiata pine. II: Wood characteristics of 10 trees from a 24-year-old stand grown in central North Island. FRI Bulletin No.37.

Cown, D.J. and McConchie, D.L. 1983: Radiata pine wood properties survey (1979-1982). F.R.I. Bulletin No. 50.

Cown, D.J., McConchie, D.L. and Young, G.D. 1991a: Radiata pine wood properties survey. FRI Bulletin No. 50 (revised).

Cown, D.J., Young, G.D. and Kimberley, M.O. 1991b: Spiral grain patterns in plantation-grown *Pinus radiata*. New Zealand Journal of Forestry Science 21(2/3): 206-216. Reprint No. 2435.

Cown, D.J.; Ball, R.D. 2001: Wood Densitometry of 10 *Pinus radiata* families at seven contrasting sites: Influence of tre age, site and genotype. NZ Jour. For. Sci. 31(1): 88-100.

Cown, D.J., McConchie, D.L.; McConchie, M. 2003: Intra-ring Internal Checking in Radiata Pine (P. radiata D. Don) in New Zealand. WQI Report APP1 21pp.

Dawson, B.; Riley, S.R.; Cown, D.J. 2003: Colour measurements of wood. Wood Processing Newsletter, Issue No. 33, July, 2003.

McConchie, M.S. 2000: Internal checking: the oven dry technique. Forest Research Directions Issue No. 28: 5.

McConchie, D.L.; Turner, J. 2002: How external resin on radiata pine logs relates to clearwood quality and value. Wood Processing Newsletter, Issue No. 32, December, 2002.

McKinley, R.B.; Cown, D.J. 2003: Pre-secreening National Survey of 17 "Genetic Gain" Trials for Outerwood Density and Visual Stem Characteristics. WQI Report RES 1.

Treloar, C.; Lausberg, M. 1995: Sampling an data handling techniques for wood quality analyses. *In* Forest Research Wood Quality Workshop ’95. FRI Bulleting No. 201, Klitscher, Cown, Donaldson, eds.

Xin, Tian, Cown, D.J. and Lausberg, M. 1996: Modelling of Radiata Pine Wood properties. Part 1: Spiral Grain. NZ Jour. of Forestry Science 25(2): 200-213.

Appendix 1a – Pre-screening data - Longwood

Trial: SD 564/1 Forest: Longwood Cpt 62 Forest Owner: Southwood Export Assessor: Dean and William Witehira QFM No.: 5
Date: 15/4/03

Trial ID	StandID	Plot#	Tree#	DBH	BIX				IIX	Resin	Suitable to Fell (Y/N)	Acceptable Crop Tree (Y/N)	PSP #	Comments
					Log 1	Log 2	Log 3	Log 4						
SD564/1	L. wood 62	4/11	1	556	0	2	2	3	0	0	y	y	-	
SD564/1	L. wood 62	4/11	2	704	0	2	3	3	1	1	y	y	-	Big tree, straight
SD564/1	L. wood 62	4/11	3	457	0	2	3	3	1	0	y	y	6	
SD564/1	L. wood 62	4/11	4	528	0	1	2	2	2	0	y	n	-	Broken top 23m, stem damage10m
SD564/1	L. wood 62	4/11	5	511	0	3	3	3	0	1	n	n	-	Double leader at 18-20m >150 >200
SD564/1	L. wood 62	4/11	6	459	0	2	2	2	0	1	n	n	8	
SD564/1	L. wood 62	4/11	7	480	3	2	2	2	1	1	n	n	7	P2.0, large defect at 6m & 12m
SD564/1	L. wood 62	4/11	8	485	0	3	-	-	0	1	n	n	5	Top gone at 12m
SD564/1	L. wood 62	4/11	9	526	2	2	3	3	0	0	y	y	4	P4.0, some flutting in butt
SD564/1	L. wood 62	4/11	10	720	0	1	2	2	2	0	y	y	3	Very nice tree
SD564/1	L. wood 62	4/11	11	521	0	2	3	3	0	0	n	n	2	Broken top 15m, multi leader
SD564/1	L. wood 62	4/11	12	699	0	3	3	3	2	0	y	y	1	Ramicorn at 9m >150mm
SD564/1	L. wood 62	4/11	13	681	0	2	3	3	2	0	y	n	11	Broken top 25m but nice tree
SD564/1	L. wood 62	4/11	14	458	0	3	2	2	0	0	y	y	10	Deformed stem at whorls 1 and 5, nodal swelling
SD564/1	L. wood 62	4/11	15	767	3	3	3	3	0	0	y	y	-	P4.2, big heavy upper branches, adjacent to gap
SD564/1	L. wood 62	4/11	16	752	0	3	3	3	0	2	y	y	-	Edge tree by gap, big heavy branches
SD564/1	L. wood 62	4/11	17	463	0	2	3	3	1	0	n	n	13	Broken top at 13m, double leader
SD564/1	L. wood 62	4/11	18	698	0	3	3	3	1	1	y	y	-	Edge tree
SD564/1	L. wood 62	4/11	19	606	0	3	3	3	0	0	y	y	14	
SD564/1	L. wood 62	4/11	20	634	0	2	3	3	0	1	n	n	-	Triple leader at 18m

Appendix 1b – Pre-screening data - Rowallan

Trial: SD 564/3 Forest: Rowallan Forest Owner: Rayonier Assessor: Dean and William Witehira QFM No.: 6
Date: 15/4/03 Cpt 152 Comment: Very wet day, very wet trees, difficult to assess resin

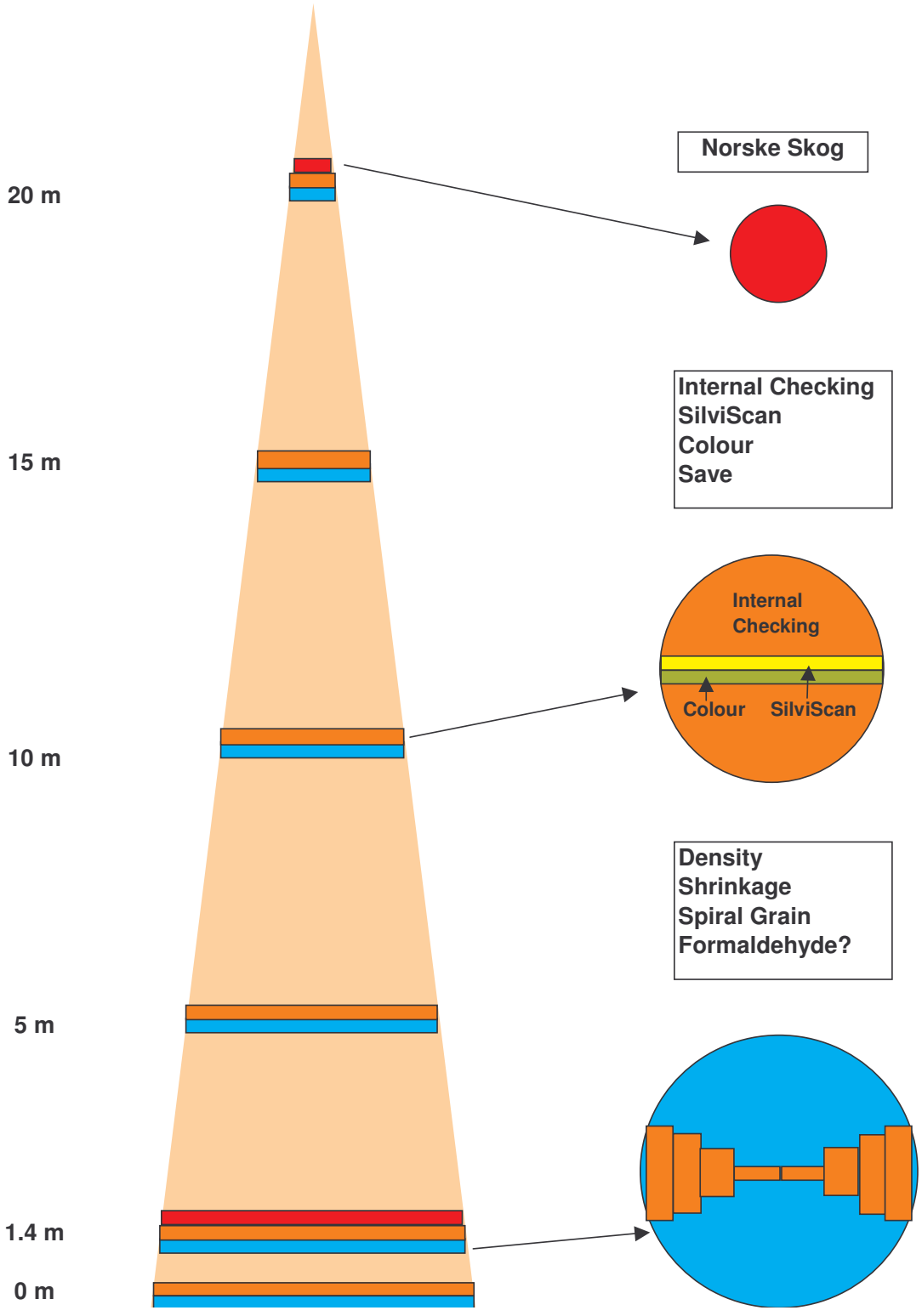
Trial ID	StandID	Plot#	Tree#	DBH	BIX				IIX	Resin	Suitable to Fell (Y/N)	Acceptable Crop Tree (Y/N)	PSP #	Comments
					Log 1	Log 2	Log 3	Log 4						
SD564/3	Row. 152	12	1	615	0	2	3	3	0	1	y	y	-	Fall edge gap
SD564/3	Row. 152	8	2	278	0	1	1	1	0	1	n	y	-	Inside trial
SD564/3	Row. 152	8	3	550	0	1	1	2	0	1	y	y	-	Fell if fell #4 tree
SD564/3	Row. 152	8	4	682	0	3	3	3	0	0	y	y	-	Edge tree by big gap
SD564/3	Row. 152	4	5	588	0	2	2	2	0	0	n	y	-	Inside trial
SD564/3	Row. 152	4	6	669	0	2	3	3	1	0	n	y	-	Inside trial
SD564/3	Row. 152	4	7	564	0	2	3	3	0	2	y	y	-	Edge trial by gap
SD564/3	Row. 152	3	8	506	0	2	3	3	1	0	n	y	-	
SD564/3	Row. 152	3	9	548	0	2	3	3	0	1	n	y	-	
SD564/3	Row. 152	3	10	401	0	2	3	-	0	1	n	n	-	Broken top at 14m
SD564/3	Row. 152	7	11	607	0	3	3	3	0	1	y	y	-	Fell into gap
SD564/3	Row. 152	11	12	565	0	3	3	3	0	1	y	y	-	Fell down behind #13
SD564/3	Row. 152	11	13	563	0	2	2	3	0	1	y	y	-	Some sweep,
SD564/3	Row. 152	10	14	603	0	2	3	3	0	1	y	y	-	Fell toward gap at edge trial
SD564/3	Row. 152	10	15	568	0	2	3	3	0	1	y	y	-	Edge trial
SD564/3	Row. 152	9	16	331	0	2	1	2	0	0	y	y	-	Fell onto #17
SD564/3	Row. 152	9	17	445	0	1	1	2	0	1	y	y	-	Fell into gap at edge trial
SD564/3	Row. 152	5	18	555	0	1	2	2	0	1	n	y	-	
SD564/3	Row. 152	6	19	502	0	2	2	2	0	1	y	y	-	Fell into gap
SD564/3	Row. 152	6	20	697	0	3	3	3	0	1	y	y	-	May fell into gap
SD564/3	Row. 152	6	21	662	0	3	3	3	1	0	n	y	-	Inside trial
SD564/3	Row. 152	2	22	265	0	1	1	1	0	2	n	y	-	Inside trial
SD564/3	Row. 152	1	23	614	0	3	3	3	0	1	n	y	-	Inside trial
SD564/3	Row. 152	1	24	466	0	1	2	2	0	0	n	y	-	Inside trial
SD564/3	Row. 152	1	25	512	0	2	2	2	0	1	y	y	-	Edge trial

Appendix 1c – Pre-screening data - Blackmount

Trial: SD 564/4 Forest: Blackmount Forest Owner: Rayonier Assessor: Dean and William Witehira QFM No.: 7
Date: 17/4/03 Cpt.600 Comment: Lots of snow damage throughout trial

Trial ID	StandID	Plot#	Tree#	DBH	BIX				IIX	Resin	Suitable to Fell (Y/N)	Acceptable Crop Tree (Y/N)	PSP #	Comments
					Log 1	Log 2	Log 3	Log 4						
SD564/4	B'mount 600	9	1	520	3	3	3	3	0	0	y	y	-	P1.8
SD564/4	B'mount 600	9	2	434	2	3	3	3	0	o	y	y	-	P1.8, fell by #1
SD564/4	B'mount 600	9	3	277	3	3	-	-	1	1	n	n	-	Damage at 8m, basket whorl 11m
SD564/4	B'mount 600	9	4	370	2	3	-	-	1	1	n	n	-	Ramicorn at 6m >180mm
SD564/4	B'mount 600	9	5	417	3	3	-	-	1	1	n	n	-	Malformed at 9m, broken top
SD564/4	B'mount 600	10	6	549	3	3	3	3	0	1	ok	n	-	Malformed at 10m
SD564/4	B'mount 600	10	7	419	3	3	3	-	0	1	n	n	-	Broken top at 12m, double leader
SD564/4	B'mount 600	10	8	419	3	3	3	-	1	1	n	n	-	Broken top at 14m
SD564/4	B'mount 600	10	9	407	3	2	2	2	0	0	n	n	-	Double leader at 2m >350 >200
SD564/4	B'mount 600	10	10	458	3	3	2	2	0	0	n	n	-	Broken at 8m, double leader
SD564/4	B'mount 600	6	11	318	2	2	-	-	0	0	n	n	-	Broken at 9m
SD564/4	B'mount 600	6	12	353	2	3	2	-	1	1	n	n	-	Double leader 10m, broken out top
SD564/4	B'mount 600	6	13	464	3	3	3	3	2	1	y	n	-	Double leader 14m, broken out top
SD564/4	B'mount 600	7	14	301	2	2	-	-	0	0	n	n	-	Double at 11m
SD564/4	B'mount 600	7	15	358	2	2	2	-	1	0	n	n	-	Ramicorn 3m, double leader 12m
SD564/4	B'mount 600	7	16	425	1	2	2	2	0	0	n	y	-	Inside trial, nice tree
SD564/4	B'mount 600	7	17	225									-	Dead
SD564/4	B'mount 600	7	18	458	2	2	3	3	0	1	n	y	-	Inside trial, nice tree
SD564/4	B'mount 600	7	19	455	3	3	-	-	1	0	n	n	-	Multiple leaders at 9m
SD564/4	B'mount 600	4	20	300	2	2	1	-	0	1	n	n	-	Broken top at 12m
SD564/4	B'mount 600	4	21	255	2	2	2	-	1	1	n	n	-	
SD564/4	B'mount 600	4	22	289	2	2	2	-	0	2	n	y	-	Lots of resin, double leader 15m
SD564/4	B'mount 600	4	23	283	3	2	2	-	0	1	n	n	-	Small
SD564/4	B'mount 600	4	24	351	2	2	2	2	1	2	n	ok	-	Funny top?
SD564/4	B'mount 600	4	25	292	2	2	-	-	1	1	n	n	-	Broken top at 10m
SD564/4	B'mount 600	5	26	383	2	3	3	3	1	1	n	y	-	
SD564/4	B'mount 600	5	27	418	3	2	2	2	2	0	n	n	-	Malformed at 7m
SD564/4	B'mount 600	5	28	361	2	2	2	-	0	1	n	n	-	Broken at 14m, small leader
SD564/4	B'mount 600	5	29	255							n	n	-	Dead top at 10m
SD564/4	B'mount 600	5	30	425	3	3	3	3	1	1	y	y	-	

APPENDIX 2: DISC SAMPLING PLAN



Appendix 3a – Internal Checking – Disc data (7 of 15 stems)

Tree ID	Sample ht. (m)	Strip width (mm)	HW bdy (mm)	Rings affected	Total checks	Growth year																	
						82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
C1	0	95	87	1	1											1								
	1.4	95	88	1	1															1				
	5	95	91	0	0																			
	10	90	92	0	0																			
C9	0	95	90	0	0																			
	1.4	95	86	2	3						2			1										
	5	95	89	0	0																			
	10	95	92	0	0																			
C10	0	95	89	1	1									1										
	1.4	90	91	0	0																			
	5	90	91	0	0																			
	10	95	93	0	0																			
D3	0	95	87	1	3							3												
	1.4	95	87	5	16					1		5				1	1		8					
	5	90	90	0	0																			
	10	95	92	0	0																			
D12	0	95	variable	5	29				5	9	11	3												
	1.4	95	86	3	13						5	7	1											
	5	95	88	5	29									2	4	6	9		8					
	10	95	90	1	18														18					
D13	0	100	85	0	0																			
	1.4	100	87	5	10							1		3	1	1			4					
	5	95	87	1	1								1											
	10	95	91	0	0																			
D15	0	95	84	1	2				2															
	1.4	95	87	0	0																			
	5	95	88	0	0																			
	10	95	90	0	0																			
Total					**126**																			

Appendix 3b – Internal checking – Totals for checked trees (7 of 15 stems)

Disc ht (m)	No. of checked trees	Years affected	Total checks	Growth year																	
				82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
0	5	6	35				7	9	11	6		1		1								
1.4	5	10	43					1	7	13	1	4	1	2	1		12	1				
5	2	6	30								1	2	4	6	9		8					
10	1	1	18														18					
Overall Totals			126				7	10	18	19	2	7	5	9	10		38	1				
Site Average (15 stems)			**8.4**				**0.5**	**0.7**	**1.2**	**1.3**	**0.1**	**0.5**	**0.3**	**0.6**	**0.7**		**2.5**	**0.1**				