WQI Benchmarking Study
Trial AK 1058: Aupouri Forest

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Stand Growth Modelling Cooperative
in collaboration with WQI Ltd

RADIATA PINE RESOURCE CHARACTERISATION

WQI Benchmarking Study

Laboratory Data Collection
Site 2 : Aupouri Forest (Cpt. 92)

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

WQI REPORT NO. RES 5a

October 2003

New Knowledge in Wood Quality

EXECUTIVE SUMMARY

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This is the second report in a planned series covering wood properties from the 1978 Genetic Gain Trials, established across New Zealand from Northland to Southland.

Site 2 is located in Aupouri Forest (Trial AK 1058) in the northernmost part of the North Island, and was shown in a previous study (WQI Pre-screening Study) to represent the "highest density" site (outerwood density 494 kg/m^3). Ten stems were selected to cover the density and diameter range within the plot 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:

- Wood density (5-ring sample blocks)
- Shrinkage (5-ring sample blocks)
- Spiral Grain (5-ring sample blocks)
- Internal checking
- Colour
- SilviScan samples

This report documents the findings; data are simply presented in Tables and Figures as summaries and averages, for later comparison with the other sites. Summaries will be provided periodically, assessing the overall results to that point. The raw data have been entered into an Access database (WQI database) and will contribute to modelling the effects of site, silviculture and genetics on wood formation.

WQI Benchmarking Study
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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. These “benchmarking” studies have been planned to use trials comprising known genetic material, located in diverse environments (1978 Genetic Gains Trials). The actual silvicultural treatment has varied somewhat due to priorities of individual forest owners and environmental influences.

The data will provide comprehensive information on:

- Geo-spatial information on wood quality factors (density, spiral grain, microfibril angle, internal checking, 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.
- Environmental influences on wood formation (latitude; elevation; soil type; climate).

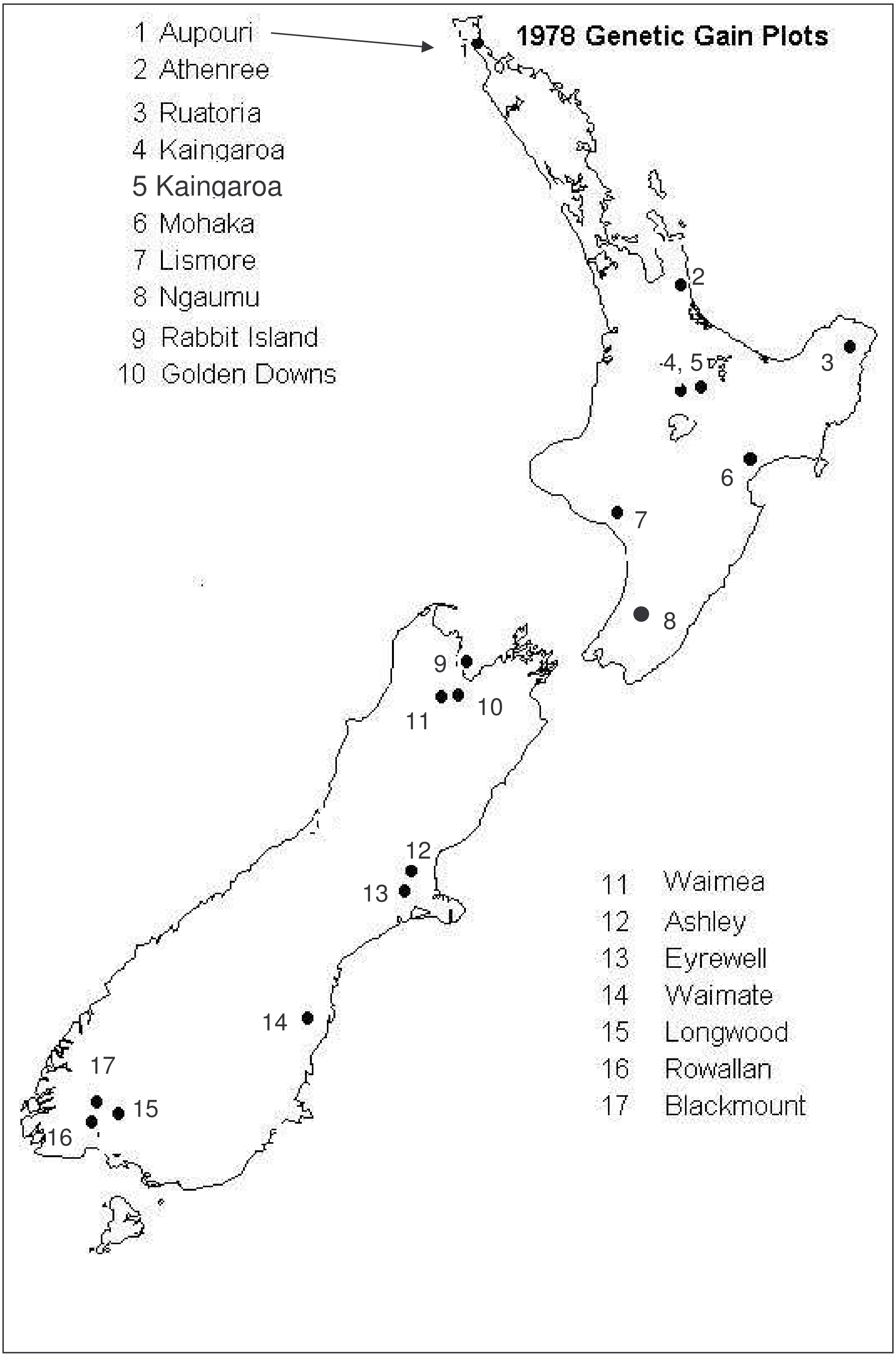
Silvicultural effects -stocking; thinning; pruning; fertilising; rotation length - may be examined in other trials depending on WQI priorities. The ultimate objective is to create a new archive of the major wood properties believed to influence the value of radiata pine wood products, in relation to 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 on former state-owned production forests at 22 sites selected to encompass a broad range of climates (Figure 1 shows the 17 sites that were sampled in the benchmarking study). 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.

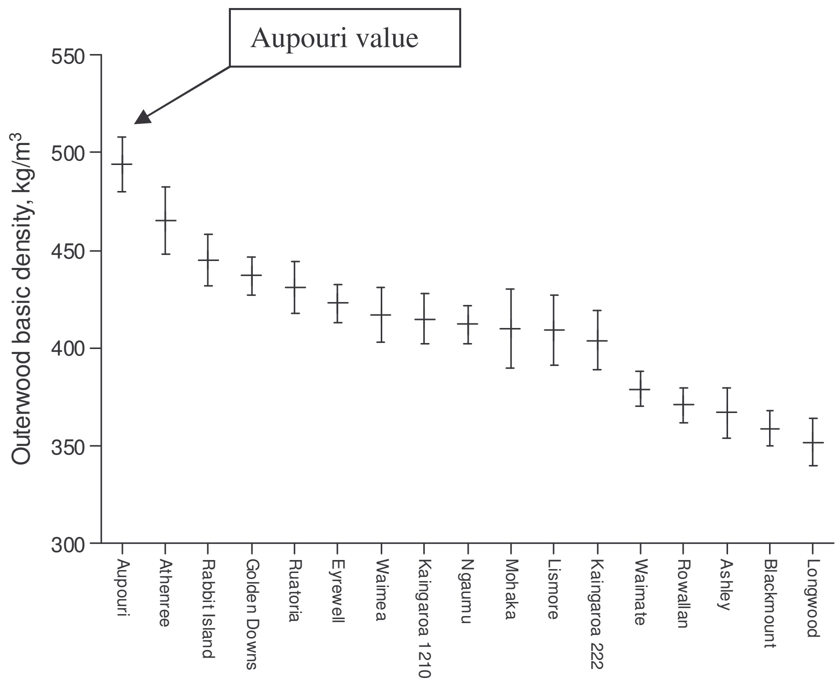
Seedlot WN76/2 (GF 14) was selected as being both well represented in the trial and exhibiting relatively good growth. GF 14 stock, represents a significant degree of genetic improvement - similar to many current crops - and is available at a mature age. In addition to varied silviculture due to management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

Figure 1 – Sites in the 1978 Genetic Gain Trial series across New Zealand



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 of Quality Forest Management, who visited the 17 trials and assessed 30 trees/trial (where available), following standard non-destructive assessment techniques. Outerwood increment core sampling for basic density was undertaken, along with measurement of size (breast height diameter over bark) and visual assessment of sample stems for stem form, branch size, internode length, external resin bleeding and ease of felling. McKinley and Cown (2003) documented the results of the pre-screening. The prescreening phase gave a broad picture of wood density variation within the trial (Fig. 2) and allowed for selection of 10 suitable crop trees for possible felling, covering the 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. Final site selection provided adequate representation of the nation's resource.

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).*

Plot data for the Aupouri trees, collected during the pre-screening exercise, are tabulated in Appendix 1. These data were used to select 10 stems for further work, based on the principles of identifying "good" stems across the diameter range with a mean DBH as close as possible to the plot mean. Don McConchie (Wood Quality Focus) subsequently visited the sites, and was contracted to arrange tree felling and disc collection for detailed wood property analyses.

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.* 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 dry method (McConchie, 2000). A bark-to-bark strip centred on the pith and an 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.

Site 2 – Aupouri (Trial AK 1058)

This site, the northernmost, was confirmed in the pre-screening exercise as showing the highest outerwood density of all the sites sampled (494 kg/m^3). This is very much in line with previous results (Cown & McConchie, 1982; Cown *et al.* 1984).

Dean commented:

" The site is very clean and weed-free. Among the 24 suitable stems, a very high incidence of external resin bleeding and/or lesions was observed, some of it severe. Several stems showed signs of breakage and/or malformation, suggesting there may be compression wood."

Tree Stem Characteristics

Appendix 1 gives the plot information as supplied by Dean Witehira. All stems assessed exhibited some degree of external resin, with 8 (33%) ranked a score of 3 (severe). From the 24 trees assessed in the prescreening phase, 10 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 – Prescreening attributes of selected trees

Tree No.	Outerwood Density (kg/m^3)	DBHOB (mm)	Visual Branch Class				Int. Index *	Resin Score #	Comments
			Butt	2nd	3rd	4th			
1	455	490	0	3	3	3	0	3	Severe resin bleeding
2	508	431	0	2	3	3	2	2	
5	552	434	0	3	3	3	0	2	
7	491	443	0	1	2	2	0	2	Nice tree
9	507	446	0	1	2	2	0	2	
10	446	437	0	1	2	2	0	1	Marginal, 1 to 2 resin
15	438	512	0	2	3	3	0	3	Very severe resin
18	521	546	0	1	3	3	0	1	
19	566	479	0	2	3	3	0	3	Severe resin bleeding
24	490	398	0	1	3	2	0	1	
Sample Mean	**497**	**462**	**0.0**	**1.7**	**2.7**	**2.6**	**0**	**2.0**	
Mean BIX				**4.1**	**6.6**	**6.3**			
Site Means (30 stems)									
Mean	**494**	**440**	**0**	**2.0**	**2.7**	**2.6**	**0**	**2.0**	
BIX				**4.6**	**6.6**	**6.4**			

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 494 kg/m^3 and 440 mm respectively, closely matching the plot values. Three of the sample trees showed severe external resin bleeding. The butt logs were pruned but assessments of the other logs yielded visual branch assessments averaging 1.8, 1.5, 2.1 and 2.3 (logs 2-4) which equates to BIX values of 4.0, 6.6, and 6.38 cm respectively.

Only one tree of the ten had an internode score other than 0 (Tree 2), indicating that branch whorls are relatively closely spaced at this location.

WOOD PROPERTIES - RESULTS AND DISCUSSION

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

Average disc properties by height are documented in Table 2, derived from measurements of discs and 5-ring block samples. 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	443	27	24	8.3	24	29	4	4	2	3	3.25
1.4	408	24	23	7.3	23	32	11	8	7	8	8.5
5	370	10	21	6.3	21	40	4	5	5	4	4.5
10	322	9	18	5.5	18	51	4	2	2	3	2.75
15	263	7	15	4.4	15	60	6	6	5	6	5.75
20	189	6	11	2.1	11	93	5	6	4	2	4.25
23.5	161	5	9	1.25	9	100	3	1	1	5	2.5
							Un-weighted average CW				4.5

* 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.

2. 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 data (resin-extracted) will be collected at all disc sampling levels for all felled sample stems, 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, outerwood, log and stem basic density. 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).

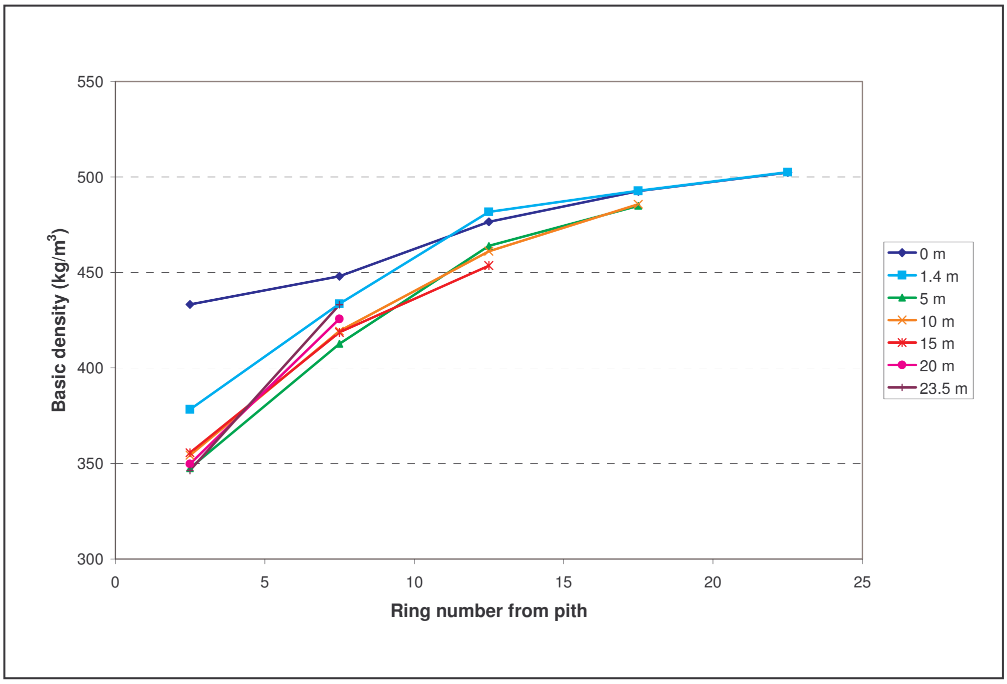
Table 3 – Pith-to-bark basic density trends by sampling height

Disc Ht. (m)	Basic density (kg/m^3) by ring group from pith 1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	Basic density (kg/m^3) Juv.[#]	Outer	Disc
0	433	448	476	493	502	439	489	468
1.4	378	434	482	493	503	406	489	455
5	348	413	464	485		383	474	429
10	354	419	461	486		388	465	420
15	356	419	454			395	460	414
20	350	426				392		394
23.5	346	433				390		390
Average Stem Density: 432 kg/m^3 Range: 381 – 480 kg/m^3						399	475	425

Inner 10 growth rings

Unextracted densities are plotted by stem levels in Figure 3.

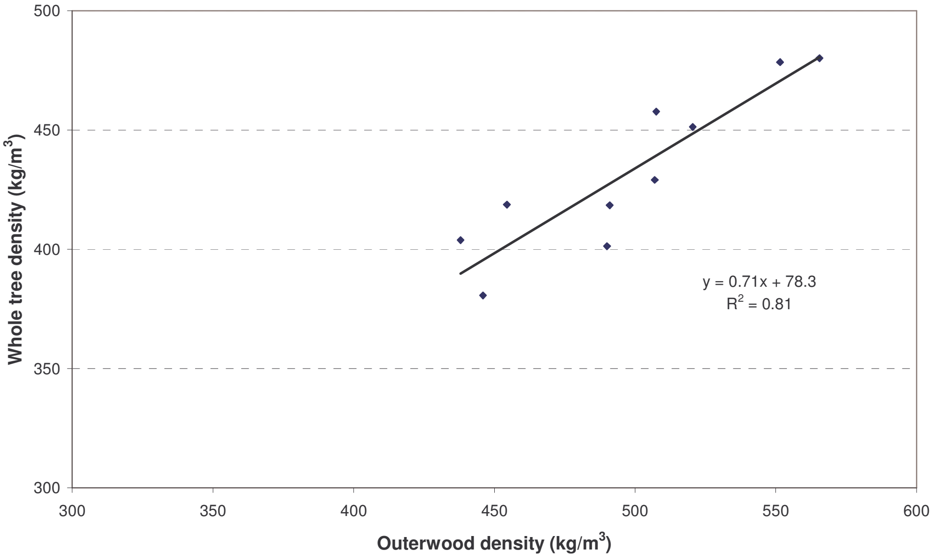
Figure 3 – Basic wood density (unextracted) - all stem levels



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 - around 400 kg/m^3 (the exception being the butt disc, with the highest resin concentration) - and the outerwood density decreased with height up the stem, from 490 to 460 kg/m^3, 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.

Weighted whole tree density calculated from disc values using Smalian's formula averaged 432 kg/m^3 (range 381-480 kg/m^3). The relationship between BH outerwood density and whole-tree density for all 10 trees is shown in Fig. 4 ($r^2 = 0.81$).

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



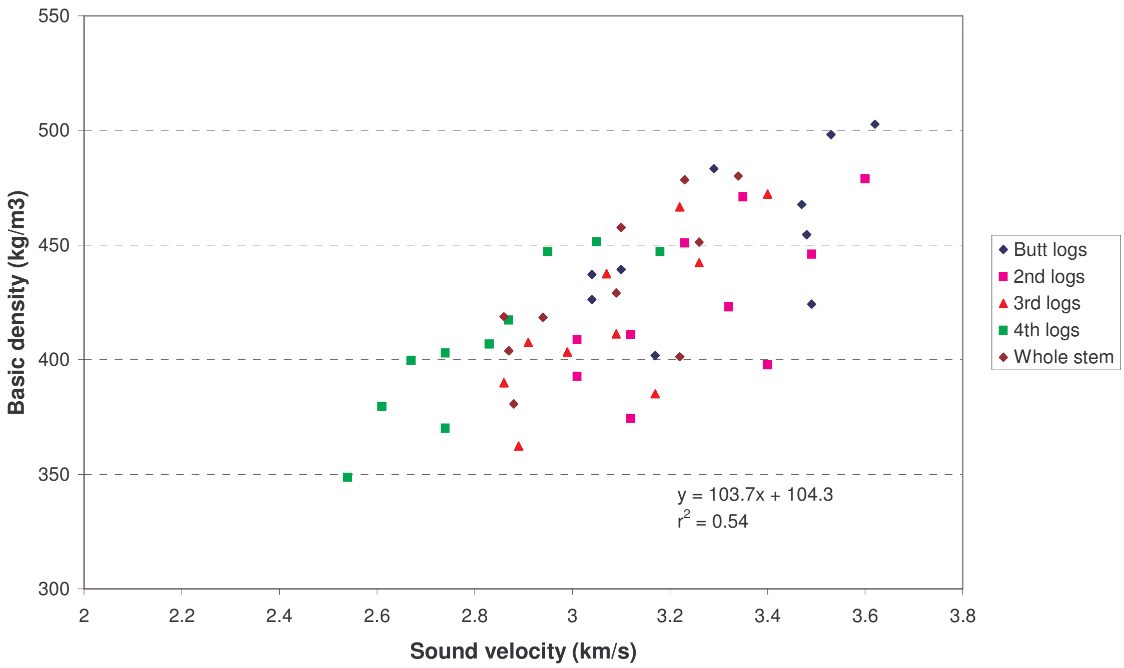
The expected relationship is confirmed in these trees.

The dynamic stiffness data (Table 4) was examined in relation to average 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
1	23	2.86	3.1	3.01	2.91	2.74	
2	20	3.1	3.29	3.23	3.07	2.87	
5	20	3.23	3.53	3.35	3.22	2.95	
7	20	2.94	3.04	3.12	2.99	2.67	
9	23	3.09	3.48	3.32	3.09	2.83	
10	20	2.88	3.17	3.12	2.89	2.54	
15	20	2.87	3.04	3.01	2.86	2.61	
18	25	3.26	3.47	3.49	3.26	3.18	2.91
19	23	3.34	3.62	3.6	3.4	3.05	
24	20	3.22	3.49	3.4	3.17	2.74	
Average	**21.4**	**3.08**	**3.32**	**3.27**	**3.09**	**2.82**	**2.91**

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



Overall, there is a moderate positive relationship, with some indication of trends with log height class. Analysis of this aspect will await amalgamation of data from several sites.

3. 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	-0.04	2.5	4.3
1.4	-0.07	2.3	3.9
5	-0.12	2.0	3.6
10	-0.10	1.9	3.3
15	-0.09	1.8	3.1
20	0.00	1.5	2.7
23.5	-0.03	1.6	2.6

* Adjusted to 12% m.c.

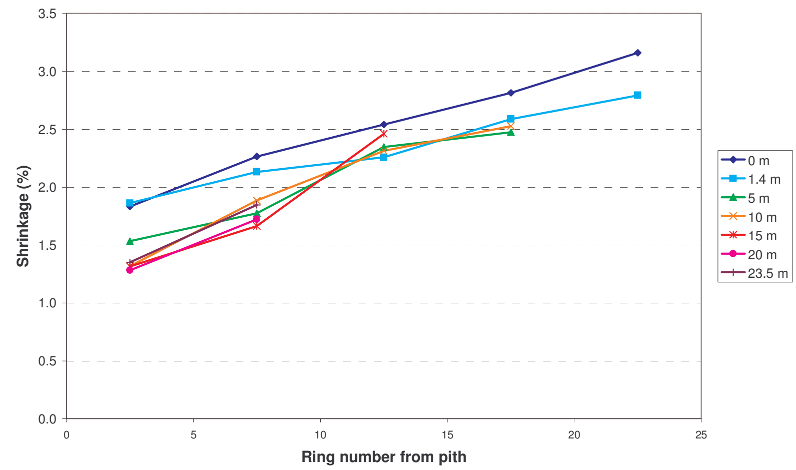
Table 6 – Pith-to-bark air-dry shrinkage trends by sampling height

Disc ht. (m)	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
	Longitudinal					Radial				
0	0.40	-0.06	-0.15	-0.20	-0.17	1.8	2.3	2.5	2.8	3.2
1.4	0.05	-0.11	-0.04	-0.11	-0.18	1.9	2.1	2.3	2.6	2.8
5	-0.12	-0.10	-0.11	-0.13		1.5	1.8	2.3	2.5	
10	-0.03	-0.16	-0.13	-0.07		1.3	1.9	2.3	2.5	
15	-0.06	-0.04	-0.17			1.3	1.7	2.5		
20	0.10	-0.11				1.3	1.7			
23.5	0.00	-0.06				1.4	1.8			
	Tangential									
0	4.1	4.5	4.3	4.4	4.3					
1.4	3.9	4.1	3.9	3.9	3.7					
5	3.3	3.8	3.6	3.6						
10	2.9	3.6	3.5	3.6						
15	2.6	3.1	3.5							
20	2.4	2.9								
23.5	2.3	2.9								

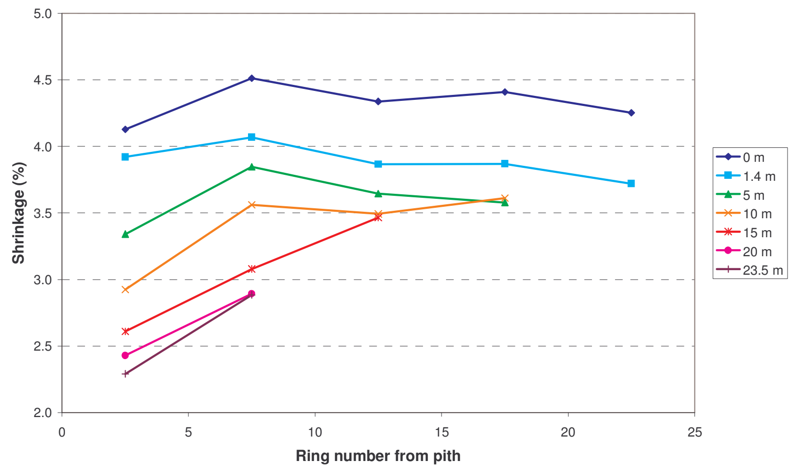
* Adjusted to 12% m.c.

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

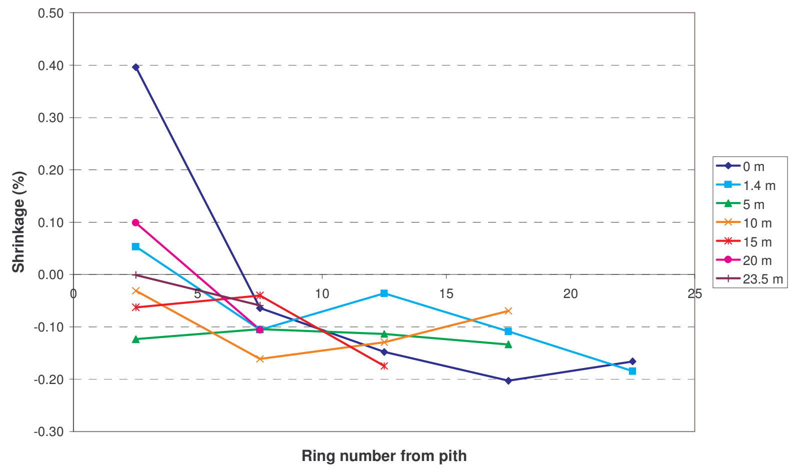
6a: Radial shrinkage



6b: Tangential shrinkage



6c: Longitudinal shrinkage



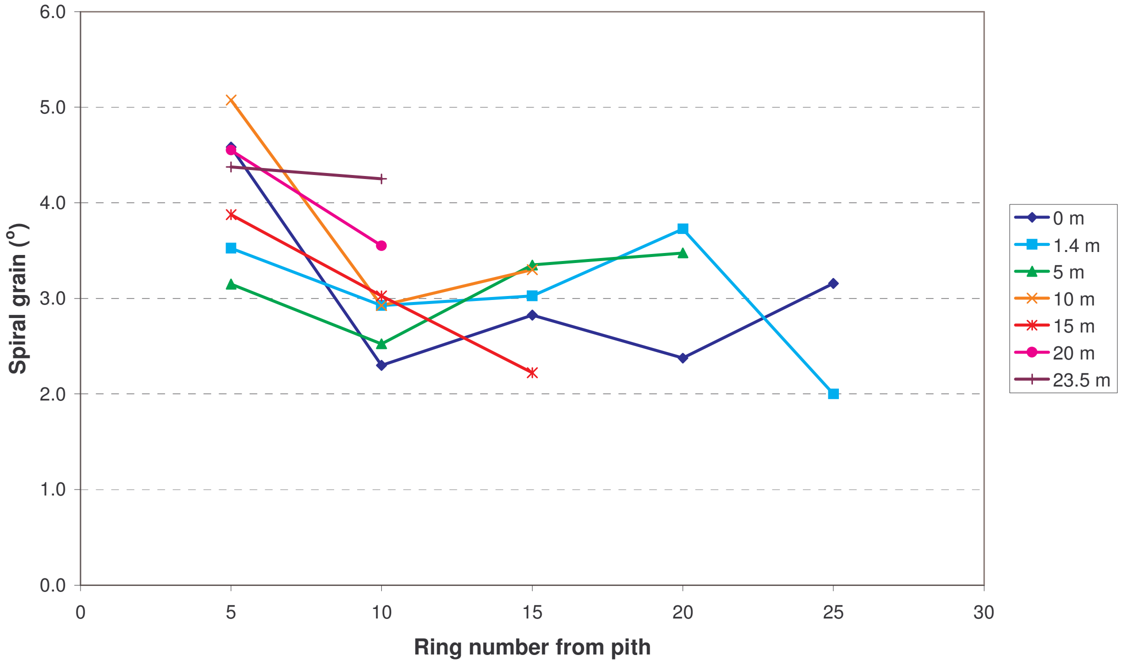
4. Spiral Grain

Average spiral grain values are summarised in Table 7 and Fig. 7. Mean angles ranged from about 2.5^0 to 3^0 (outerwood in the lower stem) to 4.5^0 (some inner rings) in accordance with previously established broad patterns for the central North Island (Cown *et al.* 1991b). However, indications are that the pattern at this site may be somewhat less extreme (lower max. and higher min) than published. 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 (^{o}) by ring number from pith				
	5	10	15	20	25
0	4.6	2.3	2.8	2.4	3.2
1.4	3.5	2.9	3.0	3.7	2.0
5	3.2	2.5	3.4	3.5	
10	5.1	2.9	3.3		
15	3.9	3.0	2.2		
20	4.6	3.6			
23.5	4.4	4.3			

Figure 7 – Spiral grain pattern for all stem levels



5. Wood Colour

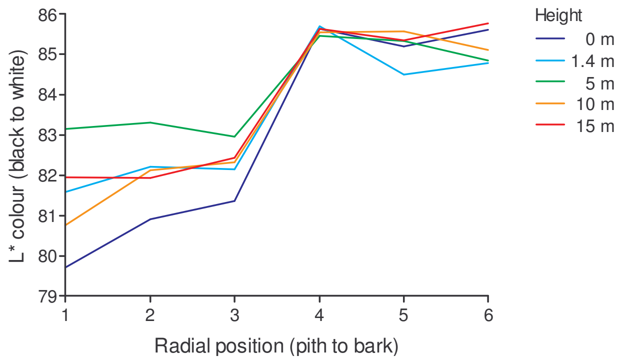
The LAB system of wood colour measurements showed differences in heartwood and sapwood colour with height and radial position within the trees. The heartwood became lighter with height to 5 m (lightness L* values increased), and then declined in lightness to 20 m, with a slight increase in lightness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

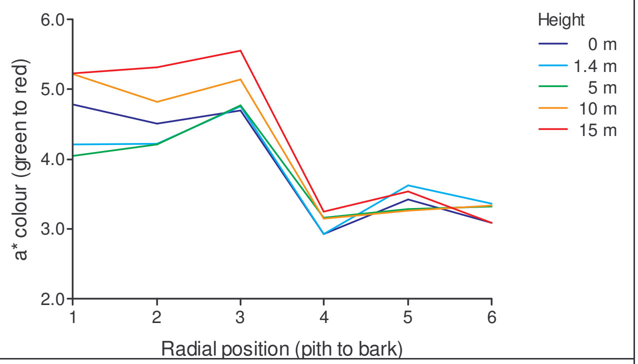
The heartwood was yellower in colour (b* values higher) at the butt of the trees, and in the inner heartwood at the butt (Figure 8c). The yellow colour of the heartwood and sapwood declined from pith to bark (b* values decreased), with the differences in blue-yellow colour with height diminishing in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

Figure 8 – Colour data for Aupouri

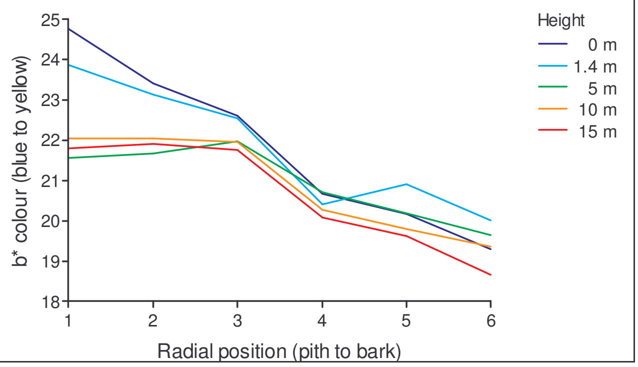
8a) Height and radial patterns of the L* colour co-ordinate (black to white).
Radial positions: 1-3 heartwood, 4-6 sapwood.



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.



6. 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). A study of the Genetic Gains Trial material from Kaingaroa forest (McKinley *et. al,* 2003*)* indicated that years 1988, 1989 and 1993 were particularly prone to checking. In the current study, a different pattern emerged. At this site, only 2 of the 10 felled trees exhibited any internal checking (total of 38 checks, or an overall average of less than 4 checks/tree for the site). Appendices 3a and 3b give the detailed data by tree number and disc height. Fig. 9 shows that the incidence drops off dramatically with stem height (none apparent at 10 m) and Fig 10 shows the distribution according to years at BH. Occurrence is confined to 3 rings, 1987-1989, corresponding to the growth rings immediately outside the heartwood. Figure 11 shows the total nos. of checks (butt, BH, 5m and 10m), averaged over all 10 stems (for future site comparisons).

Figure 9 – Internal checks by height (2 trees affected)

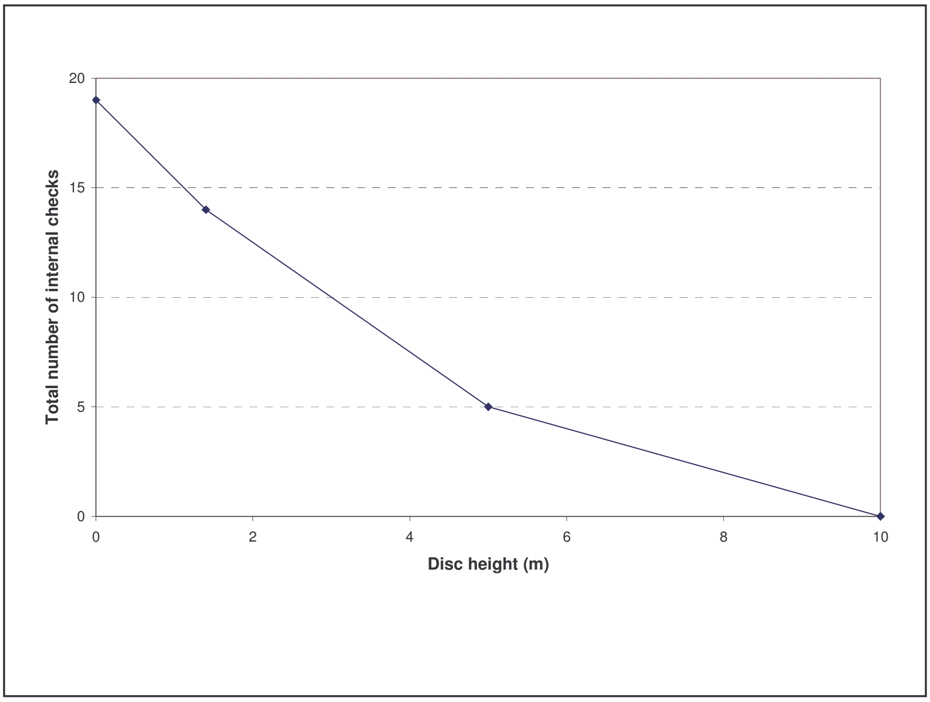


Fig. 10 – Internal check by year (BH level)

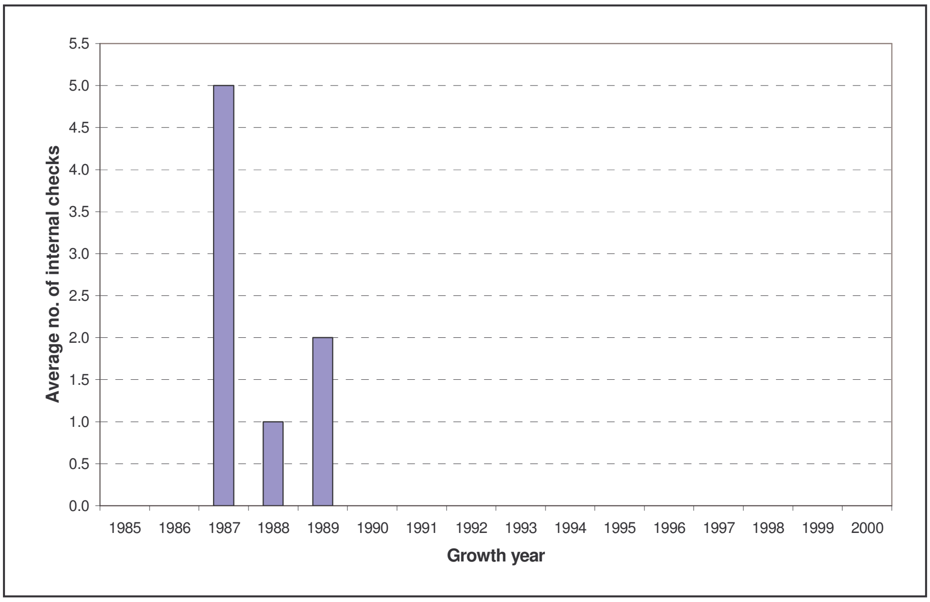
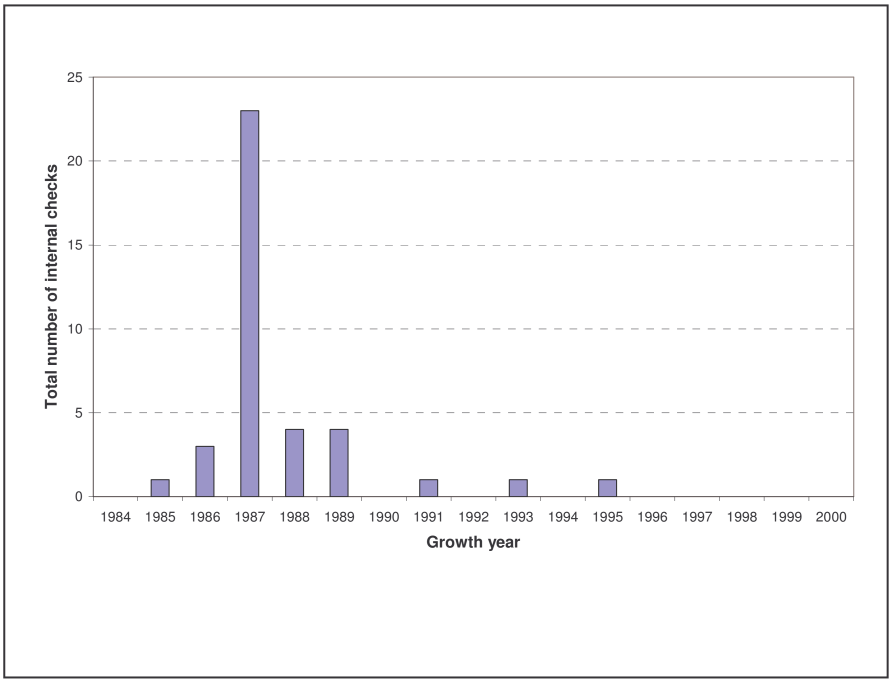


Figure 11 – Distribution of internal checks by years (2 trees – 38 checks)



7. Resinous Features

In the field, notes were made of the occurrence of resin pockets and blemishes on the fresh discs. The totals for Site 2 are given in Table 8. Resin features (particularly blemishes) were comparatively frequent in these stems (7 type-1 resin pockets and some 256 blemishes). Resinous latewood was noted at the butt level in some stems.

Table 8 – Resinous features (totals) by height class

Disc Ht (m)	Resin pockets	Resinous patches*	Blemishes	Needle Fleck
0	0	6	34	0
1.4	3	3	99	0
5	0	0	47	1
10	2	0	40	3
15	2	0	26	3
20	0	0	9	3
23.5	0	0	1	1
Totals	7	9	256	11

* includes resinous latewood

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

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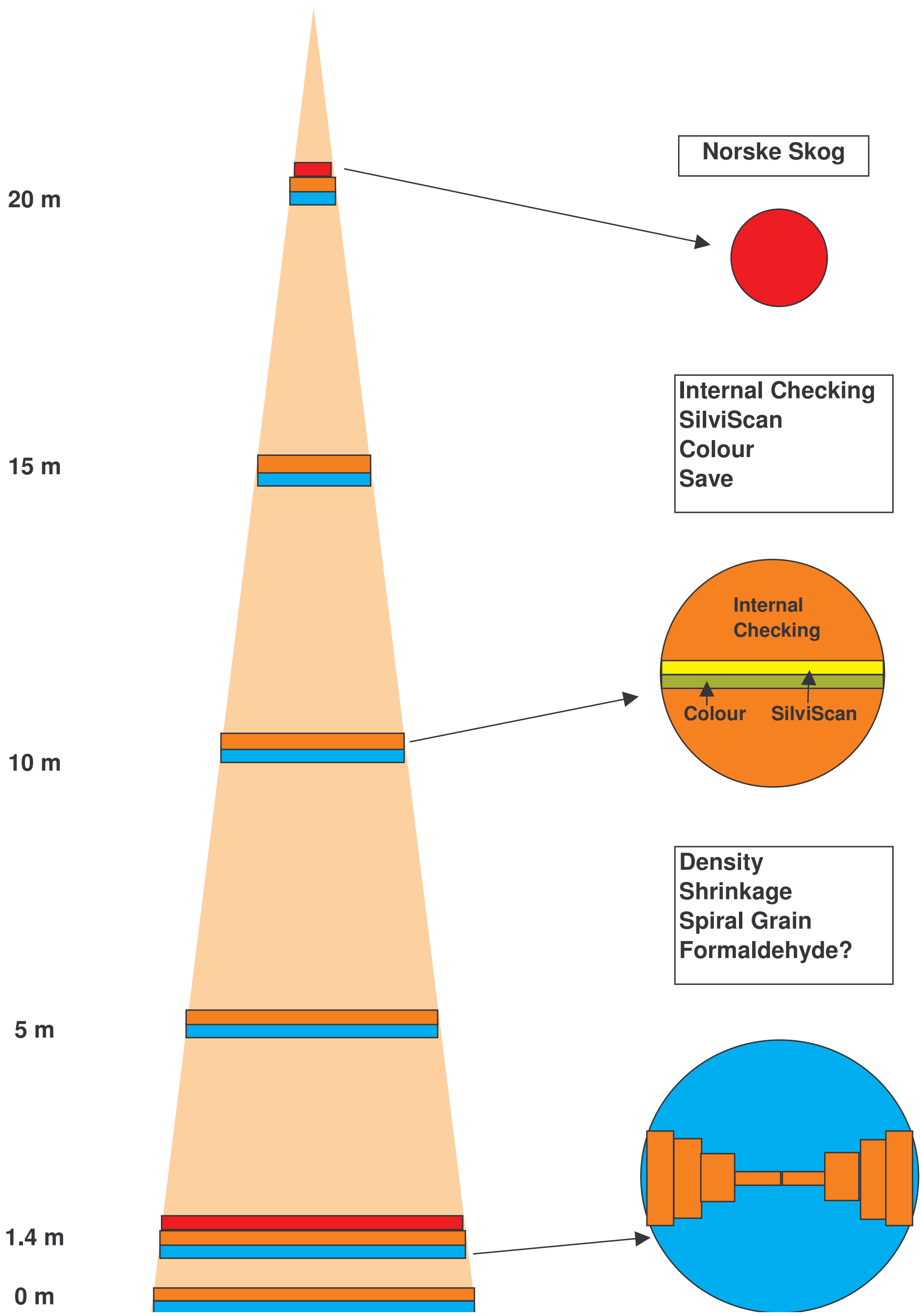
Appendix 1 – Prescreening data

Trial: AK1058 Forest: Aupouri, Cpt 92 Forest Owner: JUKN
Assessor: Dean Witehira/Jaylene Mitchell QFM Trial No.: 15
Date: 26/4/03

Forest Owner	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						
JUKN	AK1058	Aupouri 92	10/51	1	490	0	3	3	3	0	3	y	y	-	Severe resin bleeding
JUKN	AK1058	Aupouri 92	10/51	2	431	0	2	3	3	2	2	y	y	-	
JUKN	AK1058	Aupouri 92	10/51	3	319	0	3	3	-	0	1	y	n	-	Broken top at 15m, multi-leader basket whorl
JUKN	AK1058	Aupouri 92	10/51	4	424	0	3	3	3	0	2	y	y	-	
JUKN	AK1058	Aupouri 92	10/51	5	434	0	3	3	3	0	2	y	y	-	
JUKN	AK1058	Aupouri 92	10/51	6	385	0	3	3	3	0	2	y	n	11	Defect kink at 9m
JUKN	AK1058	Aupouri 92	10/51	7	443	0	1	2	2	0	2	y	y	18	Nice tree
JUKN	AK1058	Aupouri 92	10/51	8	498	0	2	3	3	0	3	y	y	16	Lot of resin bleeding up high
JUKN	AK1058	Aupouri 92	10/51	9	446	0	1	2	2	0	2	y	y	-	
JUKN	AK1058	Aupouri 92	10/51	10	437	0	1	2	2	0	1	y	y	9	Marginal 1/2 resin
JUKN	AK1058	Aupouri 92	10/51	11	447	0	3	2	2	0	2	y	y	12	
JUKN	AK1058	Aupouri 92	10/51	12	443	0	2	2	3	0	1	y	n	-	Stem shift at 13/14m
JUKN	AK1058	Aupouri 92	10/51	13	500	0	3	3	3	0	3	y	y	20	Very severe resin . Worst resin tree seen.
JUKN	AK1058	Aupouri 92	10/51	14	418	0	1	2	2	0	3	y	y	19	Lots of lesions
JUKN	AK1058	Aupouri 92	10/51	15	512	0	2	3	3	0	3	y	y	8	Very severe resin
JUKN	AK1058	Aupouri 92	10/51	16	391	0	2	2	2	0	1	y	y	6	Resin could be a 2
JUKN	AK1058	Aupouri 92	10/51	17	498	0	3	3	3	0	3	y	n	-	Sev res bleeding, sev multi leader at 15m
JUKN	AK1058	Aupouri 92	10/51	18	546	0	1	3	3	0	1	y	y	3	
JUKN	AK1058	Aupouri 92	10/51	19	479	0	2	3	3	0	3	y	y	-	Severe bleeding
JUKN	AK1058	Aupouri 92	10/51	20	460	0	1	3	-	0	3	y	n	-	Broken top at 17m & small leader, sev resin
JUKN	AK1058	Aupouri 92	10/51	21	298	0	2	3	2	0	1	y	n	21	Severe stem wobble at 10m
JUKN	AK1058	Aupouri 92	10/51	22	445	0	2	3	3	0	1	y	y	-	
JUKN	AK1058	Aupouri 92	10/51	23	412	0	2	3	3	0	2	y	n	-	Stem shift at 15m
JUKN	AK1058	Aupouri 92	10/51	24	398	0	1	3	2	0	1	y	y	-	

Trees subsequently selected for felling

APPENDIX 2: DISC SAMPLING PLAN



Appendix 3a – Internal Checking (Aupouri) – Disc data (2 of 10 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
10	0	100	84	3	13					3	8	2												
	1.4	95	86	3	8						5	1	2											
	5	95	88	4	5								2		1		1		1					
	10	100	90	0	0																			
15	0	100	84	2	6				1		5													
	1.4	100	85	2	6						5	1												
	5	100	87	0	0																			
	10	95	89	0	0																			
Total					**38**																			

Appendix 3b – Internal checking (Aupouri) – Totals for checked trees (2 of 10 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	2	4	19				1	3	13	2												
1.4	2	3	14						10	2	2											
5	1	4	5								2		1		1		1					
Overall Totals			38				1	3	23	4	4		1		1		1	-	-	-	-	-