

THE DECAY RESISTANCE OF DOUGLAS FIR, MACROCARPA, LAWSON CYPRESS AND EUROPEAN LARCH FRAMING SUMMARY OF RESULTS AFTER 52 WEEKS EXPOSURE

Summary

Short pieces of 90 x 45mm framing timber of Douglas fir (*Pseudotsuga menziesii*), European larch (*Larix decidua*), Lawson cypress (*Chamaecyparis lawsoniana*), macrocarpa (*Cupressus macrocarpa*) and radiata pine (*Pinus radiata*) were inoculated with brown rot decay fungi and installed in filleted stacks in sealed tanks. The groups included heartwood, sapwood, LOSP treated and boron treated samples.

After 12 months there was severe decay in the untreated radiata pine and in the untreated sapwood of the other species. Decay was becoming established in the untreated heartwood of Douglas fir and larch but only isolated minor spots on the macrocarpa and Lawson cypress. There was isolated light decay in LOSP treated Lawson cypress and macrocarpa, mainly at the joints.

Introduction

New building regulations relating to the durability of timber framing have impacted on the use of species that previously had been used without preservative treatment. These include Douglas fir (*Pseudotsuga menziesii*), European larch (*Larix decidua*), Lawson cypress (*Chamaecyparis lawsoniana*), macrocarpa (*Cupressus macrocarpa*) and Mexican cypress (*C. lusitanica*). These species can not now be used in many situations, or require preservative treatment of the sapwood to the H1.2 specification. This test was established to determine the relative durability of framing from these species, including sapwood that had been preservative treated with boron or light organic solvent preservatives (LOSP).

TEST GROUPS AND INSTALLATION

Fourteen species/treatment combinations were included as follows:

1. Radiata pine, untreated, kiln-dried controls.
2. Douglas fir, untreated air-dried sapwood.
3. Douglas fir, untreated air-dried heartwood.
4. Douglas fir, boron treated (pressure diffusion), air-dried sapwood.
5. European larch, untreated air-dried sapwood.
6. European larch, untreated air-dried heartwood.
7. Lawson cypress, untreated air-dried sapwood.
8. Lawson cypress, untreated air-dried heartwood.
9. Lawson cypress, boron treated (pressure diffusion), air-dried sapwood.
10. Lawson cypress, air-dried LOSP treated (tributyltin naphthenate), sapwood.
11. Macrocarpa, untreated air-dried sapwood.
12. Macrocarpa, untreated air-dried heartwood.
13. Macrocarpa, boron treated (pressure diffusion), air-dried sapwood.
14. Macrocarpa, air-dried LOSP treated (tributyltin naphthenate), sapwood.

There were ten samples of dry planer gauged 90 x 45mm framing, 750mm long, in each group. The radiata pine samples were predominantly sapwood but the sapwood samples of the other species all contained a high percentage of heartwood. A joint was created at one end of each sample by cutting a 90mm long section off and then fixing it back onto the sample with stainless steel staples. Each set of samples was soaked in water for two hours before feeder blocks were attached.

An *Antrodia xantha* feeder block was placed at one end of each sample and an Auckland brown rot (this fungus has been provisionally identified as *Antrodia vallantii*) feeder block at the other. The end with the *A. xantha* feeder block on it was marked with an "X". At the jointed end the feeder block was placed so that it was across the stapled joint. Five samples from each group had *A. xantha* feeder blocks at the jointed end and the other five had Auckland brown rot.

The samples were arranged randomly in filleted stacks, in sealed tanks, in an area where the relative humidity is greater than 95% and the temperature is 25°C. The progress of decay on the samples was assessed after four, 12, 26, 38 and 52 weeks.

ASSESSMENT METHODS

Samples were weighed and this data was compared with estimated oven dry weights to give the approximate moisture content for each sample. Decay mycelium on the framing, the soundness of the wood and the amounts of moulds present were recorded. At the 26, 38 and 52-week assessment the staples were removed from the joint and the internal surfaces were assessed for decay. The decay and mould rating systems were as follows:

Mycelium Spread Rating System

- 1 = No mycelium development onto the framing surface.
- 2 = Mycelium from the feeder block on the framing surface, spread less than 5mm.
- 3 = Active mycelium over <50% of the plate/dwang surface.
- 4 = Mycelium over >50% the plate/dwang surface.
- 5 = Extensive mycelium development over all framing components.

Decay Rating System

- 10 = No decay or insect damage.
- T = Serious discolouration not positively identified as decay.
- 9 = First stages of decay or damage up to 3% of cross-section.
- 8 = Lightly established decay, 3-10% of cross-section.
- 7 = Well established decay, 10-30% of cross section.
- 6 = Deep established decay, 30-50% of cross section.
- 4 = Severe decay, nearing failure, more than 50% of the cross section.
- 0 = Failed, disintegrating.

Mould Rating System

- 1 = No mould.
- 2 = Light mould or a few scattered spots.
- 3 = Widespread scattered mould spots.
- 4 = Patches of mould, <50% of the surfaces covered.
- 5 = Extensive or widespread mould, >50% of the surfaces covered.

RESULTS

The estimated moisture content and mould ratings for each assessment period are summarised in Table 1. Individual sample assessment results are in Appendix I.

TABLE 1
Average Moisture Content and Mould Ratings

Treatment Group	Estimated Moisture Content %				Average Mould Rating			
	12 wks	26 wks	38 wks	52 wks	12 wks	26 wks	38 wks	52 wks
Radiata pine	42.7	43.7	36.9	23.0	3.5	4.0	4.2	4.6
Macrocarpa sapwood	28.6	33.3	36.8	33.4	2.6	3.2	3.3	3.8
Macrocarpa heartwood	29.3	34.1	40.7	39.4	2.7	3.1	3.1	3.9
Macrocarpa Boron	36.8	43.9	51.3	50.1	3.2	4.0	4.1	4.5
Macrocarpa LOSP	28.8	32.1	38.0	37.0	3.9	4.7	4.9	4.9
Larch sapwood	25.9	27.9	27.3	21.0	2.7	3.3	3.5	4.1
Larch heartwood	24.8	28.8	32.0	30.7	2.4	2.7	3.3	3.4
Douglas fir sapwood	26.9	28.7	29.0	22.3	2.6	3.3	3.5	3.8
Douglas fir heartwood	22.6	25.9	28.2	25.3	2.4	2.6	3.1	3.5
Douglas fir Boron	37.2	45.3	51.9	49.6	2.6	3.3	3.8	4.5
Lawson Cypress sapwood	34.7	38.7	42.4	39.8	3.7	4.5	4.6	4.8
Lawson Cypress heartwood	30.8	35.0	40.3	38.6	3.1	4.0	4.2	4.8
Lawson Cypress Boron	36.9	48.0	59.3	58.3	2.8	3.7	3.7	4.1
Lawson Cypress LOSP	33.4	36.7	41.5	38.9	3.7	4.6	4.6	4.8

The average moisture content of samples increased gradually over the first 38 weeks of the trial but decreased slightly over the last 14 weeks of the trial after weekly spraying of the samples was stopped. The moisture content of most sound samples remained in the 30-45% range. The exceptions were boron treated samples, where there were a few samples above 60% moisture content in all species groups. The weights of the untreated radiata pine and some of the untreated sapwood samples have fallen noticeably since the 38-week assessment, due to decay, and this has given falsely low estimates of moisture content in these groups.

Moulds on samples had developed to the point where most samples had moderate-severe discolouration. On some of the more decayed samples it was difficult to determine whether surface discolouration was mould or staining from degenerated decay mycelium. The most severely infected samples were the Lawson cypress, which contained some mould and sapstain at the beginning of the trial, and LOSP treated samples. The least affected were the untreated larch, Douglas fir and macrocarpa heartwood samples. A substantial amount of pale pink, velvety mould developed on boron treated samples in the 38-52 week period.

After only one week's exposure decay mycelium had begun to spread from the feeder blocks onto the surface of the control samples. However, as the trial progressed, many of the feeder blocks became covered with moulds and there was little mycelium development from them, particularly on the preservative treated samples and the untreated heartwood samples. Mycelium spread ratings are summarised in Table 2. Where there was significant mycelium development, this tended to spread to adjacent samples and along fillets to samples in other layers. This resulted in large patches of mycelium, mainly Auckland brown rot, covering parts of several samples, including heartwood, and extending over more than one layer (Figures 3, 7, 8 and 12). There were samples where Auckland brown rot mycelium did not appear to have spread from the original feeder block but had developed away from the feeder block from an outside infection

point (Figure 3). The *Antrodia xantha* mycelium was much less visible and usually restricted to the sample that it had originally developed on (Figure 6).

TABLE 2
Average Mycelium Spread Ratings

Treatment Group	Auckland Brown Rot				<i>Antrodia xantha</i>			
	12 wks	26 wks	38 wks	52 wks	12 wks	26 wks	38 wks	52 wks
Radiata pine	2.7	3.1	3.6	3.4	2.6	2.8	3.4	3.6
Macrocarpa sapwood	2.0	2.2	2.7	3.4	1.3	1.2	2.0	2.9
Macrocarpa heartwood	1.8	1.6	1.5	1.7	1.1	1.0	1.0	1.8
Macrocarpa Boron	1.2	1.4	1.2	1.1	1.2	1.3	1.0	1.5
Macrocarpa LOSP	1.4	1.3	1.1	1.5	1.0	1.0	1.0	1.2
Larch sapwood	2.7	3.6	3.9	5.1	2.0	2.8	4.2	4.5
Larch heartwood	2.1	2.5	2.5	3.8	1.5	1.8	2.4	2.3
Douglas fir sapwood	1.7	2.7	3.1	3.3	1.3	1.5	2.6	2.9
Douglas fir heartwood	2.4	2.4	3.0	3.1	1.8	1.9	2.2	2.4
Douglas fir Boron	1.3	1.4	1.5	1.6	1.2	1.2	1.1	1.5
Lawson Cypress sapwood	2.5	2.5	2.6	4.4	1.3	1.3	2.0	2.6
Lawson Cypress heartwood	1.7	2.0	1.4	2.7	1.0	1.4	1.1	2.1
Lawson Cypress Boron	1.3	1.3	1.0	1.9	1.5	1.3	1.1	1.6
Lawson Cypress LOSP	1.1	1.1	2.4	2.1	1.0	1.0	1.5	1.4

Surface decay ratings are summarised in Table 3. Individual sample ratings are in Appendix I. Severe decay had developed in all of the radiata pine samples and it is likely that most would have failed if mechanically stressed.

TABLE 3
Surface Decay – Index of Condition¹

Treatment Group	Auckland Brown Rot				<i>Antrodia xantha</i>			
	12 wks	26 wks	38 wks	52 wks	12 wks	26 wks	38 wks	52 wks
Radiata pine	9.0	7.8	6.7	5.2	8.7	8.2	6.5	4.5
Macrocarpa sapwood	10.0	9.4	8.5	7.6	10.0	10.0	9.0	8.1
Macrocarpa heartwood	9.8	9.9	9.9	9.7	10.0	10.0	10.0	9.8
Macrocarpa Boron	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Macrocarpa LOSP	10.0	10.0	10.0	9.9	10.0	10.0	9.9	10.0
Larch sapwood	9.2	8.0	7.3	5.2	9.1	7.9	6.7	5.1
Larch heartwood	9.6	9.3	8.9	8.1	9.9	9.9	9.0	8.6
Douglas fir sapwood	9.5	8.8	7.6	6.6	9.7	9.6	7.8	6.5
Douglas fir heartwood	9.3	8.6	8.6	7.5	9.5	9.2	9.1	9.1
Douglas fir Boron	10.0	10.0	9.9	10.0	10.0	10.0	10.0	10.0
Lawson Cypress sapwood	9.7	9.2	8.2	8.2	10.0	10.0	9.8	8.5
Lawson Cypress heartwood	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Lawson Cypress Boron	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Lawson Cypress LOSP	10.0	10.0	10.0	9.7	10.0	10.0	10.0	9.7

¹ Index of condition is the average decay rating for all of the items in a group.

The sapwood on the untreated larch samples and seven of the untreated Douglas fir samples contained severe decay and this was spreading into the heartwood of the same samples (Figure 6). The untreated Larch and Douglas fir heartwood samples also contained occasional patches of decay (Figure 10).

In the macrocarpa and Lawson cypress sapwood samples the sapwood section of the samples generally contained severe decay. However, the decay stopped abruptly at the heartwood, even where there was extensive mycelium cover over the surface of the heartwood (Figure 4). There were minor or lightly established patches of surface decay on one sample each of macrocarpa and Lawson cypress heartwood (Figures 5 and 9).

Two LOSP treated macrocarpa samples contained minor decay, one on the surface and one at a joint, and one Lawson cypress sample contained moderate decay both on the surface and in the joint. Otherwise there was no mycelium spread on the LOSP treated samples and no decay.

None of the boron treated Douglas fir, Lawson cypress or macrocarpa samples had any surface decay. There was minor internal decay in the heartwood section at the joint in one Douglas fir sample (Figure 11).

Decay ratings in the joints are summarised in Table 4. Overall the ratings were similar for surface and joint decay but in the Larch heartwood decay was greater in the joint than on the surface at the Auckland brown rot end. In the Douglas fir sapwood Auckland brown rot was more severe on the surface than in the joint.

TABLE 4
Joint Decay – Index of Condition

Treatment Group	Auckland Brown Rot			<i>Antrodia xantha</i>		
	26 wks	38 wks	52 wks	26 wks	38 wks	52 wks
Radiata pine	7.6	7.2	5.0	7.2	6.6	5.0
Macrocarpa sapwood	9.0	8.8	8.2	10.0	9.6	7.2
Macrocarpa heartwood	10.0	10.0	10.0	10.0	10.0	9.8
Macrocarpa Boron	10.0	10.0	10.0	10.0	10.0	10.0
Macrocarpa LOSP	10.0	10.0	9.8	10.0	10.0	10.0
Larch sapwood	6.0	6.4	5.2	6.8	6.6	6.0
Larch heartwood	7.4	7.2	5.8	9.2	9.4	8.6
Douglas fir sapwood	8.6	8.8	8.0	8.6	7.2	5.8
Douglas fir heartwood	9.0	9.0	8.4	8.4	8.4	8.2
Douglas fir Boron	10.0	10.0	10.0	10.0	10.0	9.8
Lawson Cypress sapwood	9.4	9.0	8.2	9.8	9.8	7.6
Lawson Cypress heartwood	10.0	10.0	9.8	10.0	10.0	10.0
Lawson Cypress Boron	10.0	10.0	10.0	10.0	10.0	10.0
Lawson Cypress LOSP	10.0	9.6	9.2	10.0	10.0	10.0

Discussion

The untreated sapwood of all species contains a significant amount of decay (Figure 1). While untreated radiata pine has decayed more rapidly than the other species the extent of the decay in the sapwood of the other species confirms that significant amounts of sapwood should be avoided where there is a risk that the framing could become wet.

The heartwood of Douglas fir and larch has shown some resistance to decay but this is slowly being overcome where decay fungi are vigorously active. The macrocarpa and Lawson cypress heartwood have shown much greater resistance to decay as only minor decay was present after the first 12 months (Figure 2). The major difference between the untreated heartwood and the LOSP treated framing groups after 12 months is that the decay mycelium has spread much more readily on the surface of the heartwood samples.

Boron diffusion treatment has been almost totally successful in preventing decay over a twelve-month exposure period. Minor decay in the heartwood of one sample is probably the result of poor preservative treatment into the heartwood, something that is to be expected with this type of treatment. Heartwood penetration is not a requirement of the H1.2 treatment specification.

Apart from one Lawson cypress sample, the LOSP treated macrocarpa and Lawson cypress were largely free of decay on the surface. There were minor decay patches on the surface of one macrocarpa sample and internally in the sapwood of another but overall LOSP treatment has largely prevented decay in the first 12 months. The decay that is present in three samples suggests that occasional pieces of LOSP treated sapwood will be susceptible to decay if exposed to wetting for prolonged periods.

Figure 1
Sapwood Decay Rates

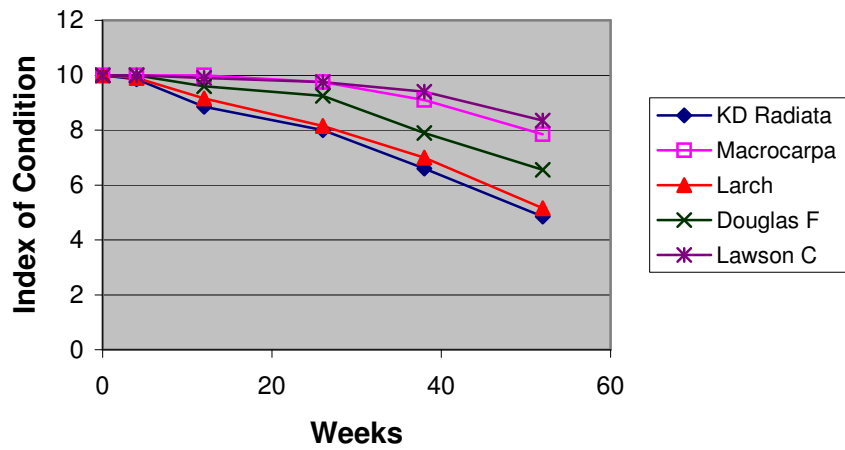


Figure 2
Heartwood Decay Rates

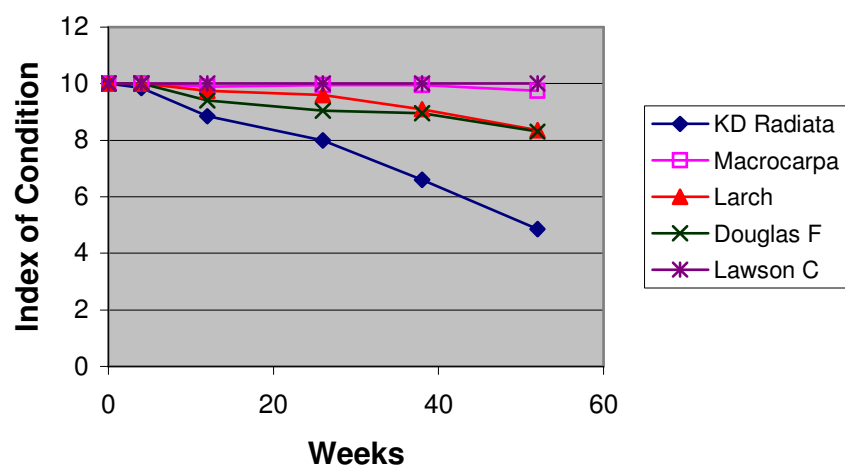




Figure 3 – Layer 6 (2nd from top) Tank 2, after 52 weeks exposure. Extensive Auckland brown rot mycelium at both ends of mainly untreated sapwood samples, some spreading from infected samples in layers above and below. Although sample LS5A had severe mould infection and was surrounded by decaying samples, there was no decay on it.



Figure 4 – Sample MS12A, Layer 6, Tank 2 after 52 weeks exposure. Macrocarpa sapwood sample showing severe Auckland brown rot decay in the sapwood stopping abruptly at the heartwood boundary.



Figure 5 – Sample LH6A, Layer 5, Tank 2 after 52 weeks exposure. This Lawson cypress heartwood sample was severely stained and largely covered by Auckland brown rot mycelium. Although there was minor patch of decay in the joint the sample was otherwise sound.



Figure 6 – Sample LAS3, Layer 4, Tank 2 after 52 weeks exposure. Larch sapwood sample with severe decay extending through the sapwood and into the heartwood. This decay is typical of *Antrodia xantha*, with very little visible mycelium on the surface even when the wood is severely decayed.



Figure 7 – Layer 2 (2nd from bottom) Tank 2, after 52 weeks exposure. Five samples, Larch sapwood, Larch heartwood, Lawson cypress sapwood and radiata pine have extensive Auckland brown rot mycelium on them and this has spread between samples. All contained moderate-severe decay. Sample LS10C is a boron treated Lawson cypress sample with extensive pale coloured mould on the surface but no decay.



Figure 8 – Layer 7 (Top layer) in Tank 1 after 52 weeks exposure. The sample at the right hand end is M15AH, macrocarpa heartwood. Although there was extensive Auckland brown rot mycelium on the surface, spreading from the sample underneath, there was only minor decay associated with it. The other sample with extensive mycelium on it, LS1B (Lawson cypress sapwood) was badly stained but contained very little decay.



Figure 9 – Sample M15AH, Layer 7, Tank 1 after 52 weeks exposure. Extensive Auckland brown rot mycelium on the surface and through the joint of a macrocarpa heartwood sample but only small patches of lightly established decay.



Figure 10 – Sample LAH7 (Larch heartwood), Layer 7, Tank 1 after 52 weeks exposure. There was a small amount of Auckland brown rot mycelium and minor decay on one edge but moderate-severe decay in the joint. Extensive mycelium on the adjacent Lawson cypress sapwood sample, LS1B, appeared to have spread from sample LAH7 but had not caused any significant decay in the Lawson cypress.

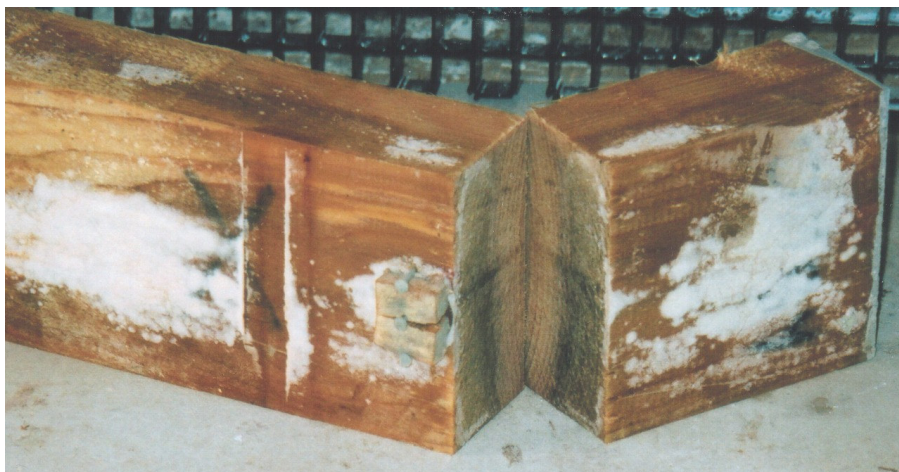


Figure 11 – Sample LS6C (boron treated Lawson cypress sapwood), Layer 6, Tank 1 after 52 weeks exposure. There was extensive mould and sapstain on this sample including the joint surfaces but no decay.



Figure 12 – Layer 2 (2nd from bottom) in Tank 1 after 52 weeks exposure. The four samples from the right hand side are untreated sapwood, Douglas fir, larch, Lawson cypress and macrocarpa, all with moderate –severe decay in the sapwood. The fifth sample is boron treated Lawson cypress with extensive mould and no decay. Sample LAS7 is untreated larch sapwood also decaying. The third sample from the left is an LOSP treated Lawson cypress sapwood sample containing moderate decay under extensive Auckland brown rot mycelium, which appeared to have spread from the layer underneath.

APPENDIX I

Individual Sample Ratings After 12 Months Exposure

Sample No	Weight	Moisture	Mycelium spread		Surface Decay		Joint Decay		Mould Rating	Decay ¹ Reverse
	(g)	Content %	ABR	Ax	ABR	Ax	Type ¹	Rating		
Kiln-dried Radiata Pine (Untreated)										
RP1	1293.1	16.7	5	5	4	4	X	4	4.5	4XA
RP2	1939.8	34.0	1	2	8	7	X	7	4.5	4A
RP3	1267.3	9.8	2	5	4	4	X	4	5.0	4A
RP4	1573.4	8.6	6	na ²	4	4	X	6	5.0	4A
RP5	1350.6	12.5	5	4	4	4	X	4	4.5	4A
RP6	1588.7	14.8	4	3	4	6	A	4	4.0	4A
RP7	2382.2	75.5	2	5	9	4	A	7	5.0	4XA
RP8	1307.1	12.2	3	2	4	4	A	4	4.0	4A
RP9	1537.6	34.6	4	4	7	4	A	6	4.5	7A
RP10	1231.8	10.7	2	2	4	4	A	4	4.5	4A
Average		23.0	3.4	3.6	5.2	4.5		5.0	4.6	4.0
Macrocarpa Sapwood (Untreated)										
MS1C	1878.0	20.2	5	na	4	4	X	4	4.0	T
MS2B	1922.4	25.2	4	4	4	6	X	7	4.5	TA
MS3A	2136.9	37.4	2	1	10	10	X	10	3.5	10
MS4A	2076.3	32.1	5	4	8	8	X	7	4.5	8A
MS6C	2014.3	40.5	2	5	10	8	X	8	4.5	TA
MS7B	2211.8	31.9	4	4	7	9	A	8	3.4	9A
MS7D	2379.9	59.0	2	1	10	10	A	10	3.0	10
MS9A	1945.0	37.4	5	2	6	9	A	7	4.0	T
MS11B	1957.8	31.2	1	1	T	10	A	10	3.5	10
MS12A	1858.7	19.1	4	4	7	7	A	6	3.5	TA
Average		33.4	3.4	2.9	7.6	8.1		7.7	3.8	9.7
Macrocarpa Heartwood (Untreated)										
M3AH	2072.3	37.6	2	1	10	10	X	10	3.5	10
M5AH	2013.8	46.4	2	1	10	10	X	10	3.0	10
M11AH	1776.4	28.0	1	2	10	10	X	10	3.5	10
M14BH	2444.0	52.8	1	2	10	10	X	10	5.0	T
M15AH	2050.0	41.0	5	na	8	8	X	9	4.5	8A
M16AH	2210.5	54.1	2	1	9	10	A	10	4.0	10
M17AH	1835.2	39.6	1	2	10	10	A	10	4.0	TA
M18AH	1936.0	27.9	1	2	10	10	A	10	3.0	9A
M19AH	1928.7	36.0	1	4 ABR	10	T	A	10	4.0	TA
M20AH	1968.8	30.5	1	1	10	10	A	10	4.5	10
Average		39.4	1.7	1.8	9.7	9.8		9.9	3.9	9.7

¹ The major decay fungi present, A = Auckland brown rot, X = *Antrodia xantha*.

² na = not assessed. Surface completely covered by Auckland brown rot mycelium.

APPENDIX I (contd.)

Individual Sample Ratings After 12 Months Exposure

Sample No	Weight	Moisture	Mycelium spread		Surface Decay		Joint Decay		Mould Rating	Decay ¹ Reverse
	(g)	Content %	ABR	Ax	ABR	Ax	Type ¹	Rating		
Macrocarpa Sapwood (Boron Treated)										
MS1A	2362.6	52.6	1	1	10	10	X	10	4.5	TA
MS1D	2166.4	44.7	1	1	10	10	X	10	4.5	TX
MS2A	2038.8	73.7	1	2	10	10	X	10	5.0	10
MS5A	1745.0	44.1	2	2	T	10	X	10	4.5	TA
MS7A	2823.2	79.9	1	1	10	10	X	T	4.5	10
MS8A	1875.8	37.2	1	2	T	10	A	10	4.5	9X
MS12C	2258.1	46.6	1	2	10	10	A	10	4.5	10
MS22A	1671.3	32.8	1	1	10	10	A	10	5.0	10
MS23A	1858.0	38.8	1	2	10	10	A	10	4.0	10
MS25A	2244.6	50.6	1	1	10	10	A	10	4.0	TA
Average		50.1	1.1	1.5	10.0	10.0		10.0	4.5	9.9
Macrocarpa Sapwood (LOSP Treated)										
MS1B	2030.0	30.5	1	1	10	10	X	10	5.0	10
MS4B	2237.9	45.6	2	1	10	10	X	10	5.0	10
MS7C	2107.0	42.8	2	1	9	10	X	10	5.0	T
MS8B	1592.4	32.2	1	1	10	10	X	T	5.0	TX
MS10A	1662.0	43.4	2	1	10	10	X	10	5.0	10
MS12B	2147.9	35.3	1	1	10	10	A	10	4.5	TA
MS14A	2097.6	39.7	1	1	10	10	A	10	5.0	10
MS21A	1719.0	38.3	2	1	10	10	A	9	5.0	10
MS24A	1561.7	27.4	1	2	10	10	A	T	4.5	10
MS26A	1716.0	34.7	2	2	10	10	A	10	4.5	10
Average		37.0	1.5	1.2	9.9	10.0		9.9	4.9	10.0
Larch Sapwood (Untreated)										
LAS1	2110.7	10.8	4	5	4	4	X	6	4.5	7
LAS2	1951.0	19.3	6	4	4	6	X	6	3.5	7X
LAS3	2237.0	27.1	na	6	6	4	X	6	4.5	TX
LAS4	2218.0	37.1	6	3	T	6	X	6	4.0	8A
LAS5	2179.1	20.2	2	6	4	4	X	6	4.5	8X
LAS6	1816.7	23.0	6	na	4	4	A	4	na	7A
LAS7	2081.0	19.5	6	na	4	4	A	6	4.5	9A
LAS8	2183.5	25.0	5	na	6	7	A	6	3.5	8A
LAS9	2191.6	23.0	5	3	6	8	A	6	3.5	7A
LAS10	1408.7	4.5	6	na	4	4	A	4	na	6A
Average		21.0	5.1	4.5	5.2	5.1		5.6	4.1	7.7

APPENDIX I (contd.)

Individual Sample Ratings After 12 Months Exposure

Sample No	Weight	Moisture	Mycelium spread		Surface Decay		Joint Decay		Mould Rating	Decay ¹ Reverse
	(g)	Content %	ABR	Ax	ABR	Ax	Type ¹	Rating		
Larch Heartwood (Untreated)										
LAH1	1983.5	27.2	4	4	8	8	X	4	3.5	8X
LAH2	2009.2	42.9	5	na	7	8	X	9	3.0	TA
LAH3	2313.2	29.7	2	2	10	10	X	10	3.0	10
LAH4	2117.6	37.0	1	1	10	10	X	10	3.5	10
LAH5	2007.2	26.8	2	1	10	10	X	10	3.5	TA
LAH6	2014.0	34.5	5	4	7	8	A	6	3.0	7A
LAH7	2190.7	46.8	2	1	9	T	A	6	3.5	8A
LAH8	1926.8	18.7	6	na	7	7	A	7	na	7A
LAH9	1854.5	17.8	5	3	6	8	A	4	3.5	7A
LAH10	1984.5	25.4	6	na	7	7	A	6	4.0	7A
Average		30.7	3.8	2.3	8.1	8.6		7.2	3.4	8.4
Douglas fir Sapwood (Untreated)										
DS1C	1689.0	17.4	5	na	4	4	X	6	4.5	8A
DS2C	1709.0	18.5	5	4	4	4	X	4	4.0	4A
DS3A	1760.5	32.2	2	4	10	7	X	7	4.5	10
DS3C	1516.6	15.3	4	3	6	6	X	6	3.0	7A
DS4A	1524.0	13.3	6	4	4	4	X	6	3.0	6A
DS4C	1751.2	26.9	2	1	T	10	A	T	4.5	8A
DS5A	1538.2	12.2	5	4	4	4	A	4	3.0	6A
DS5C	1753.0	24.5	2	3	4	6	A	6	4.0	8A
DS6A	1848.7	25.2	1	1	10	10	A	10	3.5	10
DS6C	2002.3	37.1	1	2	T	10	A	T	4.0	10
Average		22.3	3.3	2.9	6.6	6.5		6.9	3.8	7.7
Douglas fir Heartwood (Untreated)										
DH1A	1503.8	19.1	4	4	6	7	X	6	3.5	7A
DH1B	1639.9	24.1	4	2	8	10	X	8	3.0	8A
DH2A	1875.6	38.3	4	3	7	8	X	9	3.5	TA
DH2B	1633.9	23.2	2	1	10	10	X	10	4.0	10
DH3A	1516.5	17.8	4	2	6	9	X	8	3.5	8A
DH3B	1665.8	28.6	2	2	8	10	A	9	3.0	10
DH4A	1689.2	20.9	5	4	6	8A	A	6	4.0	9A
DH4B	1549.7	22.3	2	4	7	9	A	T	3.4	9A
DH5A	1800.9	29.2	2	1	9	10	A	9	3.5	10
DH5B	1615.3	29.6	2	1	8	10	A	8	3.5	9A
Average		25.3	3.1	2.4	7.5	9.1		8.3	3.5	9.0

APPENDIX I (contd.)

Individual Sample Ratings After 12 Months Exposure

Sample No	Weight	Moisture	Mycelium spread		Surface Decay		Joint Decay		Mould Rating	Decay ¹ Reverse
	(g)	Content %	ABR	Ax	ABR	Ax	Type ¹	Rating		
Douglas fir Sapwood (Boron treated)										
DS1B	2117.2	60.7	2	1	10	10	X	T	4.5	10
DS2A	2006.4	39.5	2	1	10	10	X	10	4.5	10
DS2B	1922.5	40.1	2	2	10	10	X	9	5.0	10
DS3B	2091.4	73.7	2	1	10	10	X	10	4.0	10
DS4B	2192.3	50.1	1	2	10	T	X	T	4.5	10
DS4D	2072.6	44.8	2	2	10	10	A	T	4.5	10
DS5B	1994.8	40.3	2	1	10	10	A	T	4.5	10
DS5D	1948.8	49.3	1	2	10	10	A	T	4.5	10
DS6B	1985.7	44.1	1	1	10	10	A	10	4.0	10
DS6D	1981.9	53.8	1	2	10	10	A	10	5.0	10
Average		49.6	1.6	1.5	10.0	10.0		9.9	4.5	10.0
Lawson cypress Sapwood (Untreated)										
LS1B	2360.1	71.0	5	1	T	10	X	10	5.0	TA
LS2A	1687.5	20.7	5	5	9	8	X	8	5.0	9A
LS3A	1838.0	33.2	6	na	7	6	X	7	4.5	7A
LS4A	1706.6	29.9	5	na	7	7	X	7	5.0	9A
LS6A	1800.2	24.8	4	5	8	8	X	6	5.0	TA
LS7B	1866.2	42.6	5	2	8	10	A	9	4.0	9A
LS8A	1998.1	45.5	1	1	10	10	A	T	5.0	10
LS10A	1691.0	33.1	5	na	4	6	A	4	5.0	8A
LS11B	2157.5	67.2	3	2	9	T	A	9	4.5	TA
LS13A	1871.4	30.1	5	2	T	10	A	9	5.0	8A
Average		39.8	4.4	2.6	8.2	8.5		7.9	4.8	9.0
Lawson cypress Heartwood (Untreated)										
LH1A	1823.8	37.1	1	1	10	10	X	10	4.5	10
LH1B	1978.6	45.0	1	2	10	10	X	10	4.5	10
LH2A	2061.7	38.4	2	1	10	10	X	10	5.0	10
LH3A	1799.4	30.1	2	2	10	10	X	10	5.0	TA
LH4A	1854.3	43.4	2	6	T	T	X	T	5.0	TA
LH5A	1971.7	40.3	6	na	T	T	A	T	na	TA
LH6A	1880.6	37.0	6	2	T	10	A	9	4.5	TA
LH7A	1767.1	28.3	2	1	10	10	A	10	5.0	TA
LH8A	2229.0	49.7	3	2	10	10	A	10	5.0	10
LH9A	1948.0	36.9	2	2	T	10	A	T	5.0	T
Average		38.6	2.7	2.1	10.0	10.0		9.9	4.8	10.0

APPENDIX I (contd.)

Individual Sample Ratings After 12 Months Exposure

Sample No	Weight	Moisture	Mycelium spread		Surface Decay		Joint Decay		Mould Rating	Decay ¹ Reverse
	(g)	Content %	ABR	Ax	ABR	Ax	Type ¹	Rating		
Lawson cypress Sapwood (Boron treated)										
LS1C	2085.2	41.4	1	2	10	10	X	10	3.5	TA
LS4D	2156.4	47.1	2	2	10	10	X	10	4.5	10
LS5A	2100.6	52.5	2	1	10	10	X	10	5.0	10
LS6C	2526.2	63.3	2	1	10	10	X	10	4.5	10
L7AS	2293.6	75.5	2	2	10	10	X	10	2.5	10
LS8C	3021.5	92.0	2	2	10	10	A	10	3.0	10
L9AS	1999.9	43.2	2	2	10	10	A	10	4.5	10
LS10C	2128.0	49.5	2	1	10	10	A	10	4.0	10
LS11A	2406.6	68.6	2	2	10	10	A	10	4.5	10
LS12B	1984.0	49.9	2	1	10	10	A	T	4.5	10
Average		58.3	1.9	1.6	10.0	10.0		10.0	4.1	10.0
Lawson cypress Sapwood (LOSP treated)										
LS1A	1879.0	43.1	2	1	10	10	X	10	5.0	10
LS4B	1859.0	37.3	2	2	10	10	X	10	4.5	10
LS6B	2080.3	48.2	2	2	10	10	X	10	4.0	10
L6AS	1937.7	31.3	2	2	10	10	X	10	5.0	10
LS7A	1858.2	31.7	2	1	10	10	X	10	4.5	10
LS8B	1695.0	18.8	6	na	7	7	A	6	5.0	9A
LS9A	1741.1	38.0	1	2	10	10	A	T	5.0	T
LS10B	1807.8	50.3	2	1	10	10	A	10	5.0	10
LS12A	2094.7	57.3	1	1	10	10	A	10	4.5	10
LS13B	1785.6	32.8	1	1	10	10	A	10	5.0	10
Average		38.9	2.1	1.4	9.7	9.7		9.6	4.8	9.9