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The decay resistance of six Eucalyptus species after four years exposure

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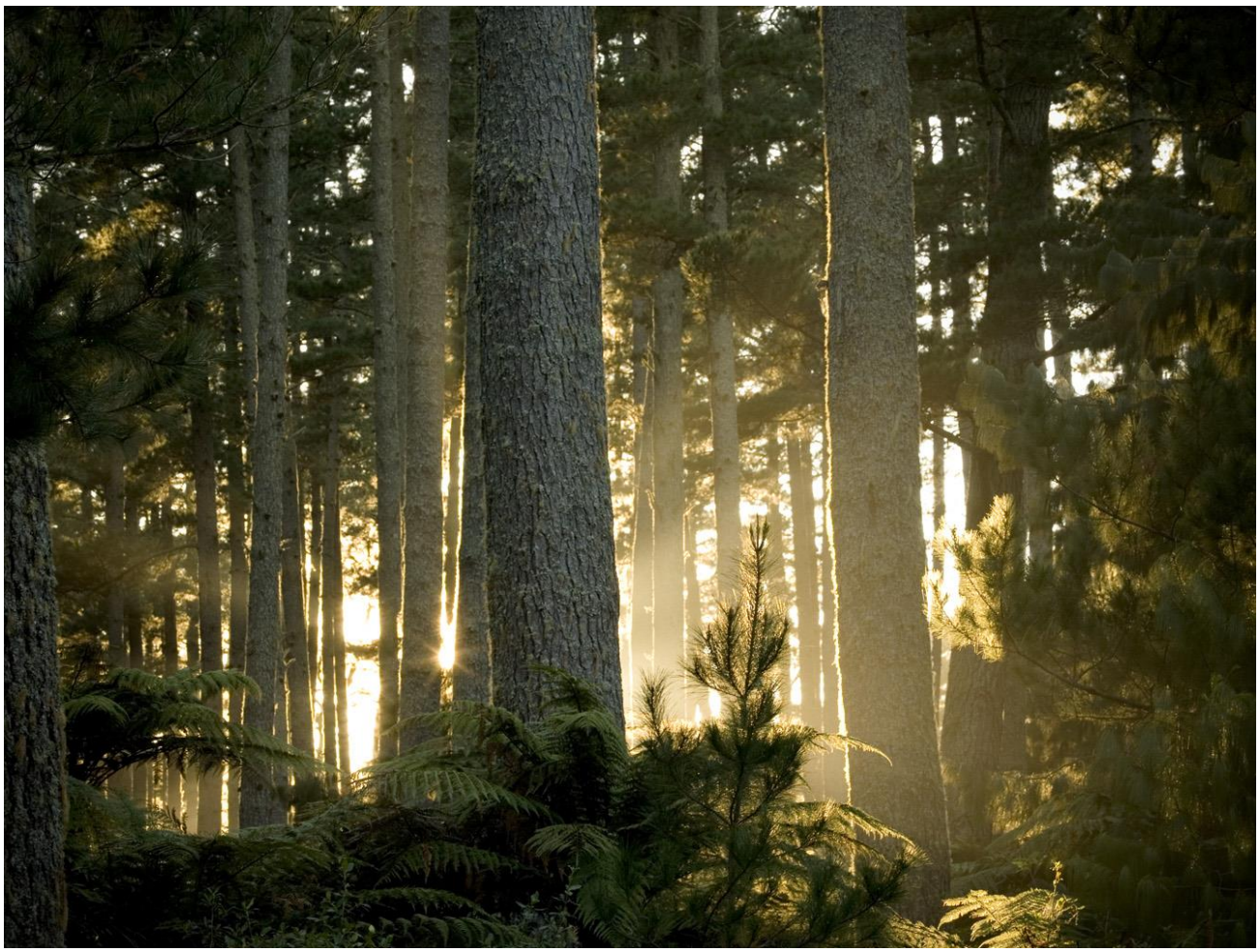

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Report information sheet

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Executive summary

Durability stakes and stakelets were prepared from six different durable Eucalyptus species, (*Eucalyptus bosistoana, Eucalyptus quadrangulata, Eucalyptus pilularis, Eucalyptus sphaerocarpa, Eucalyptus globoidea., Eucalyptus muelleriana).* For each species, timber had been selected from four different trees with samples taken from both inner and outer heartwoods.

Control stake and stakelet samples from *Pinus radiata* sapwood, *Fagus sylvatica* (European beech), and H3.2 and H4 CCA treated *Pinus radiata* sapwood were also included in the test.

The stakes were exposed outdoor at Scion's Whakarewarewa Graveyard, and the stakelets were installed in the Scion's Accelerated Decay House (with a temperature of 27˚C and a relative humidity of 85%).

Stakes and stakelets were prepared from the six different *Eucalyptus* species which had been selected to have high natural durability.

Summary of the stakes: After four years exposure,

- For *Eucalyptus bosistoana*, one stake has failed and the remaining 30 have minor, but established or well established decay.
- *Eucalyptus quadrangulata*, four stakes have failed, and the remaining 31 stakes have minor, but established to severe decay.
- *Eucalyptus pilularis,* one stake has failed, and the remaining 41 stakes have minor, but established to deepening decay.
- *Eucalyptus sphaerocarpa,* all 50 stakes have minor but established to deepening decay.
- *Eucalyptus globoidea,* two stake failures, one has minor, but established decay and 56 have well established to deepening decay.
- *Eucalyptus muelleriana,* 56 stakes have well established to deepening decay and one has severe decay.
- The differences in inner and outer heartwood between trees of the same species is minimal, except for trees where there has been stake failures.

For the controls:

- All the untreated *Pinus radiata* control stakes have failed giving the group an average life of 2.1 years.
- All *Fagus sylvatica* (European beech) control stakes have failed giving the group an average life of 2.1 years.
- In comparison, the H3.2 CCA treated stakes are rated 10 to 9 (sound to minor decay) and the H4 treated stakes T to 6 (Trace to deepening decay).

Summary of stakelets: After 50 months exposure,

- For *Eucalyptus bosistoana*, 30 failures and the remaining 10 have deepening or severe decay.
- *Eucalyptus quadrangulata*, 38 failures and remaining 2 have severe decay.
- *Eucalyptus pilularis*, 38 failures and the remaining 2 have severe decay.
- *Eucalyptus sphaerocarpa*, 37 failures and the remaining 3 have deepening or severe decay.
- *Eucalyptus globoidea*, 33 failures and the remaining 7 have severe decay.
- *Eucalyptus muelleriana*, all 40 stakelets have failed with an average life of 1.7 years.

Across the six Eucalyptus species, a total of 216 stakelets have failed mainly due to soft rot. All remaining samples have a rating of 6 or 4 (deepening to severe decay). Stakelets from 14 individual trees have failed giving them a group average life between one year 5 months to three years 5 months.

The outer heartwood is performing slightly better in most trees than the inner heartwood when comparing the Indexes of Condition. In individual trees where both inner and outer heartwood stakelets have failed, the average life between the inner and outer heartwoood is often the same or the outer heartwood has lasted a few month(s) longer.

- The untreated radiata pine sapwood stakelets had all failed by the 17 month assessment giving the group an average life of 8.9 months.
- The untreated European beech sapwood stakelets had all failed by 11 months giving the group an average life of 6.5 months.
- The first stakelet failed in the H3.2 group, no failures have occurred in the H4 CCA treated group.

The stakelets have considerably lower Indexes of Condition when compared to the in-ground stakes due to their accelerated exposure in the Accelerated Decay House (ADH). The ADH facility is a quicker method to screen samples, but field testing is still required to confirm suitability to outside exposure conditions.

The trials will continue with the stakelets being assessed at three monthly intervals and the next stake inspection will be in June-August 2021.

The decay resistance of six Eucalyptus species after four years exposure

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Introduction

A stake and stakelet trial were established for durable Eucalyptus species selected by the Eucalypt Action Group of Farm Forestry New Zealand. Untreated and CCA treated radiata pine, and untreated European beech were included in the trials for comparative purposes. The stake trial was established in the Whakarewarerwa test area on the Scion campus in June 2016 and the stakelet trial was established in July 2016.

The Eucalyptus species included in the test were:

- *Eucalyptus bosistoana.*
- *Eucalyptus quadrangulata.*
- *Eucalyptus pilularis.*
- *Eucalyptus sphaerocarpa.*
- *Eucalyptus globoidea.*
- *Eucalyptus muelleriana.*

Materials and methods

Materials and Sample Preparation

The test method used in this study is based on the protocols for assessment of wood preservatives produced by the Australasian Wood Preservation Committee (AWPC; 2015), and ASTM standard test methods (ASTM 2006).

Timber approximately 25 x 25 mm, of differing lengths, and from six different Eucalypt species was supplied by Dean Satchell of the Farm Forestry Group to produce stakes and stakelets for durability testing. Timber had been sawn from four different trees for each species and the supplier informed Scion that the trees were 15 years old and grown in Northland. The lengths of timber had been marked with the tree number and whether the timber was from inner or outer heartwood. Some lengths of timber were marked as inner\outer or mixed. Table 1 shows the number of boards supplied for each tree whether the boards contained inner or outer heartwood. Scion relied on the supplier for tree age and origin information. *

On arrival at Scion, the strips were air dried in a heated laboratory for five weeks. At the time of installation, the samples were dry.

Ten stakes were cut for each tree, five from the inner heartwood and five from outer heartwood. Some of the trees did not have 5 inner and 5 outer heartwood samples. In this case extra stakes were cut to give a total of ten stakes for each tree.

Stakes were machined from each length as shown in Table 1 to 20 x 20 x 500 mm. Some stakes were slightly undersized leaving a rough sawn surface. It was observed that the stakes from tree 4 (*E. bosistoana*) appeared darker in colour than stakes cut from the other three trees of the same species.

*All samples came from breast height (1.4m) in the trees (pers. comm. Dean Satchell).

Table 1: Timber supplied to prepare stakes

Eucalyptus species	Tree number	Log number	Number of lengths supplied I = Inner heartwood, O = Outer heartwood M = Mid heartwood
E. bosistoana	1	1	1-I 4-O 1I/O Quite a few short pieces
E. bosistoana	2	1	2-I 3-O
E. bosistoana	3	1	6-I 7-O
E. bosistoana	4	1	3-I 5-O
E. quadrangulata	5	1	4-I 4-O
E. quadrangulata	6	1	4-I 4-O
E. quadrangulata	7	1	7-I 5-O
E. quadrangulata	8	1	3-I 4-O
E. pilularis	9	1	4-I 4-O
E. pilularis	10	1	4-I 6-O 2-M
E. pilularis	11	1	4-I 4-O
E. pilularis	12	1	8-I 8-O
E. sphaerocarpa	13	1	8-I 8-O
E. sphaerocarpa	14	1	7-I 8-O
E. sphaerocarpa	15	1	5-I 6-O
E. sphaerocarpa	16	1	4-I 7-O 1-I/O
E. globoidea	17	1	6-I 6-O
E. globoidea	18	1	4-I 3-O 1-M
E. globoidea	19	1	8-I 8-O 9-M
E. globoidea	20	1	8-I 6-O 8-M
E. muelleriana	21	1	7-I 8-O
E. muelleriana	22	1	8-I 8-O
E. muelleriana	23	1	7-I 8-O 5-M 1 short
E. muelleriana	24	1	8-I 8-O

Untreated radiata pine and European beech (*Fagus sylvatica*) stakes were also included in the trial for comparison purposes. The radiata pine and European beech stakes were taken from previously machined stock held at Scion. Stakes were also cut from CCA treated radiata pine treated to H3.2 and H4 obtained from a local retailer.

Each stake was tagged with a unique number and randomly allocated a plot position in the Whakarewarewa graveyard. Notes were made about each stake, including stakes that were undersized or contained knots and kino.

Stakelets (10 x 5 x 160 mm) were machined from each of the Eucalyptus trees and also from radiata pine sapwood, European beech heartwood and CCA treated radiata pine. They were installed in the prepared soil bed in the Accelerated Decay House (with a controlled temperature of 27^{o}C and a relative humidity of 85%). Before installation into the soil bed, all the stakelets were soaked in water for approximately 30 minutes. Samples are labelled with a unique number and installed randomly in the soil bed at least 60 mm apart. Each specimen is buried to half its' length in the soil. The soil beds are refreshed at the three monthly inspection times.

Installation

The stakes were installed in the Scion outdoor test area in Rotorua on 24 June 2016. The European beech and treated radiata pine stakes were installed on 23 August 2016.

The stakelets were installed in the Accelerated Decay House on 5 July 2016.

Assessment methods

The stakes are assessed yearly, this report covers the fourth inspection and the stakelets at three monthly intervals, using a rating system based on ASTM D-1578 as shown in Appendix 1. The last stakelet assessment included in this report was in June 2020 after 50 months exposure.

Results and discussion

Assessment results

Table 2 contains a summary of the condition of the stakes after four years. Individual ratings are listed in Appendix 2 and 3.

Table 2: Comparison of Index of Condition of stakes and stakelets

Group no.	Tree	Species	Index of Condition [1]	
			Stakes, 4 years exposure	Stakelets, 50 months exposure
1	1	*E. bosistoana*	7.3	0.4 (9)
2	2	*E. bosistoana*	7.2	2.0 (6)
3	3	*E. bosistoana*	7.3	2.6 (5)
4	4	*E. bosistoana*	5.9 (1)	**Av. life 2.1 years**
5	5	*E. quadrangulata*	6.1 (1)	0.8 (8)
6	6	*E. quadrangulata*	4.9 (2)	**Av. life 1.6 years**
7	7	*E. quadrangulata*	6.7	**Av. life 1.7 years**
8	8	*E. quadrangulata*	5.9 (1)	**Av. life 1.7 years**
9	9	*E. pilularis*	6.8	0.4 (9)
10	10	*E. pilularis*	6.2 (1)	**Av. life 1.7 years**
11	11	*E. pilularis*	6.5	**Av. life 2.1 years**
12	12	*E. pilularis*	6.7	0.4 (9)
13	13	*E. sphaerocarpa*	6.9	**Av. life 3.0 years**
14	14	*E. sphaerocarpa*	7.2	0.8 (8)
15	15	*E. sphaerocarpa*	7.1	0.6 (9)
16	16	*E. sphaerocarpa*	6.8	**Av. life 2.1 years**
17	17	*E. globoidea*	6.6	1.2 (7)
18	18	*E. globoidea*	6.6	**Av. life 2.5 years**
19	19	*E. globoidea*	6.8	1.6 (6)
20	20	*E. globoidea*	5.9 (2)	**Av. life 2.0 years**
21	21	*E. muelleriana*	6.1	**Av. life 1.5 years**
22	22	*E. muelleriana*	6.9	**Av. life 1.9 years**
23	23	*E. muelleriana*	6.4	**Av. life 1.9 years**
24	24	*E. muelleriana*	6.5	**Av. life 1.4 years**
25	-	*P. radiata* sapwood	**Av. life 2.1 years**	**Average life 8.9 months**
26	-	*F. sylvatica* heartwood	**Av. life 2.1 years**	**Average life 6.5 months**
27	-	*P. radiata* H3.2	9.8	6.2 (1)
28	-	*P. radiata* H4	8.3	8.8

[1] Index of Condition is the average decay rating for all of the samples in a group.
[2] Figures in brackets are number of stakes or stakelets that have failed.

At the latest inspection, the average Indexes of Condition for the Eucalyptus stakes were between 4.9 and 7.3. After four years, only the *E. sphaerocarpa* and *E. muelleriana* groups of stakes have had no failures. Three new stake failures have occurred; one *E. bosistoana* and two *E. quadrangulata*. A total of eight Eucalyptus stakes have now failed. White rot was the main cause of failure. The final *F. sylvatica* heartwood stake failed, giving the group an average life of 2.1 years

(the same as for *P. radiata* sapwood). H3.2 CCA treated stakes are still performing better than the treated H4 stakes with an Index of Condition of 9.8 vs 8.3.

After 50 months, *E. bosistoana* has the least stakelet failures (26 out of 36), followed by *E. globoidea* (33 out of 40). All remaining stakelets regardless of species are rated 6 or 4 (extensive established and deepening decay or deep and severe decay). Failure was mainly due to soft rot. In comparison, one radiata pine H3.2 treated stakelet failed giving an Index of Condition of 6.2 for the group and for the H4 treated stakelets 8.8. The untreated radiata pine samples had an average life of 8.9 months and the European beech 6.5 months.

Table 3 shows the average Index of Condition of the inner and outer heartwood for each tree.

Table 3: Comparison of index of Condition of inner and outer heartwood, for stakes and stakelets.

Group no.	Tree	Species	Index of Condition [1]			
			Stakes 4 years exposure		Stakelets 50 months exposure	
			Inner heartwood	Outer heartwood	Inner heartwood	Outer heartwood
1	1	*E. bosistoana*	7.8	7.4	-	0.7 (5)[2]
2	2	*E. bosistoana*	7.5	7.0	1.2 (4)	2.8 (2)
3	3	*E. bosistoana*	7.2	7.3	2.0 (3)	3.2 (2)
4	4	*E. bosistoana*	7.0	5.2 (1)	**Av. life 1.9 yrs**	**Av. life 2.2 yrs**
5	5	*E. quadrangulata*	5.3 (1)	7.0	1.6 (3)	**Av. life 2.0 yrs**
6	6	*E. quadrangulata*	5.3 (1)	4.5 (1)	**Av. life 1.6 yrs**	**Av. life 1.6 yrs**
7	7	*E. quadrangulata*	6.5	6.8	**Av. life 1.4 yrs**	**Av. life 2.1 yrs**
8	8	*E. quadrangulata*	4.3 (1)	7.0	**Av. life 1.6 yrs**	**Av. life 1.8 yrs**
9	9	*E. pilularis*	6.5	7.0	**Av. life 1.1 yrs**	0.8 (4)
10	10	*E. pilularis*	5.0 (1)	6.8	**Av. life 1.4 yrs**	**Av. life 2.0 yrs**
11	11	*E. pilularis*	6.5	6.5	**Av. life 1.6 yrs**	**Av. life 2.7 yrs**
12	12	*E. pilularis*	6.8	6.6	**Av. life 2.4 yrs**	0.8 (4)
13	13	*E. sphaerocarpa*	6.7	7.2	**Av. life 2.9 yrs**	**Av. life 3.7 yrs**
14	14	*E. sphaerocarpa*	7.0	7.4	0.8 (4)	0.8 (4)
15	15	*E. sphaerocarpa*	7.0	7.2	**Av. life 2.4 yrs**	1.2 (4)
16	16	*E. sphaerocarpa*	6.5	7.0	**Av. life 1.7 yrs**	**Av. life 2.6 yrs**
17	17	*E. globoidea*	6.4	6.8	1.6 (3)	0.8 (4)
18	18	*E. globoidea*	6.5	7.0	**Av. life 1.8 yrs**	**Av. life 3.3 yrs**
19	19	*E. globoidea*	6.8	7.0	1.6 (3)	1.6 (3)
20	20	*E. globoidea*	5.7 (1)	6.5	**Av. life 1.4 yrs**	**Av. life 2.6 yrs**
21	21	*E. muelleriana*	6.0	6.3	**Av. life 1.5 yrs**	**Av. life 1.5 yrs**
22	22	*E. muelleriana*	6.8	7.0	**Av. life 1.9 yrs**	**Av. life 2.0 yrs**
23	23	*E. muelleriana*	6.2	6.6	**Av. life 1.6 yrs**	**Av. life 2.0 yrs**
24	24	*E. muelleriana*	6.6	6.5	**Av. life 1.1 yrs**	**Av. life 1.7 yrs**

[1] Index of Condition is the average decay rating for all of the samples in a group.
[2] Figures in brackets are number of stakes or stakelets that have failed

After four years exposure, there are minimal differences in the Indexes of Condition between the inner or outer heartwood stakes, except where there has been a stake failure.
The outer heartwood stakelets are performing the same or better than the inner heartwood stakelets when comparing the average life between trees of the same species.

References

ASTM: 2006. Standard test method of evaluating wood preservatives by field tests with stakes. ASTM D-1578.

AWPC; 2015. Protocols for assessment of wood preservatives. A production of the Australasian Wood Preservation Committee.

EN 350-2016. Durability of wood and wood based products – Testing and classification of the durability.

Appendix 1: Rating system

Rating system used for sample assessment

Each stake was assigned a decay rating based on the following system (Appendix 2). The Index of Condition is the average decay rating of all samples in a group (Table 2 and 3).

DECAY/INSECT DAMAGE

10 = No decay or insect damage.
T = "Trace" discolouration, decay suspected but not positively identified.
9 = Minor decay or damage at defects, less than 3% of the cross section.
8 = Minor but established decay, 3 - 10% of the cross section.
7 = Well established pockets or extensive surface damage, 10 - 30% of the cross section.
6 = Extensive established and deepening decay, 30 - 50% of cross section.
4 = Deep and severe decay, more than 50% of cross section.
0 = Disintegrating, failed.

DURABILITY CLASSES

Natural durability stakes are classified according to the Australasian Durability Classification System when the average life of a group has been established. They are as follows:

		50 mm x 50 mm stakes	20 mm x 20 mm stakes
Class 4	Perishable	5 years or less	2 years or less
Class 3	Moderately durable	5 - 15 years	2 - 6 years
Class 2	Durable	15 - 25 years	6 - 10 years
Class 1	Very durable	25 years or more	10 years or more

Appendix 2: Individual stake data after four years exposure

Individual data for *Eucalyptus bosistoana* stakes

Stake ID	Plot location	Tree number	Inner\Outer\Middle	Decay rating
1831	B3	1	I	7
1832	A20	1	O	8
1833	L26	1	I/O	8
1834	F17	1	O	7
1835	L24	1	O	7
1836	E24	1	O	7
1837	H14	2	I	8
1838	M25	2	I	7
1839	L36	2	O	7
1840	N6	2	O	7
1841	K8	2	O	7
1842	F8	3	I	8
1843	I36	3	I	7
1844	I31	3	I	7
1845	D19	3	I	7
1846	N29	3	I	7
1847	Q17	3	I	7
1848	O28	3	O	7
1849	N16	3	O	7
1850	A18	3	O	8
1851	O24	3	O	6
1852	H30	3	O	8
1853	I34	3	O	8
1854	G10	4	I	7
1855	D30	4	I	7
1856	A33	4	I	7
1857	L35	4	O	0
1858	D26	4	O	6
1859	H13	4	O	6
1860	B27	4	O	7
1861	E27	4	O	7

Individual data for *Eucalyptus quadrangulata* stakes

Stake ID	Plot location	Tree number	Inner\Outer\Middle	Decay rating
1862	D20	5	I	0
1863	D13	5	I	7
1864	P16	5	I	7
1865	L30	5	I	7
1866	Q14	5	O	7
1867	J31	5	O	8
1868	N11	5	O	6
1869	M12	5	O	7
1870	O15	6	I	0
1871	G17	6	I	7
1872	C20	6	I	7
1873	I11	6	I	7
1874	P26	6	O	0
1875	M14	6	O	4
1876	J16	6	O	7
1877	H11	6	O	7
1878	C7	7	I	6
1879	D1	7	I	6
1880	B17	7	I	7
1881	D14	7	I	7
1882	P22	7	I	6
1883	O16	7	I	7
1884	D9	7	O	6
1885	D36	7	O	7
1886	D11	7	O	7
1887	Q11	7	O	7
1888	C30	7	O	7
1889	G19	7	O	7
1890	D7	8	I	6
1891	C36	8	I	7
1892	K11	8	I	0
1893	E25	8	O	7
1894	J19	8	O	7
1895	D31	8	O	7
1896	D16	8	O	7

Individual data for *Eucalyptus pilularis* stakes

Stake ID	Plot location	Tree number	Inner\Outer\Middle	Decay rating
1897	Q7	9	I	6
1898	B14	9	I	7
1899	N12	9	I	6
1900	A9	9	I	7
1901	Q27	9	O	7
1902	I17	9	O	7
1903	D4	9	O	7
1904	B22	9	O	7
1905	D28	10	I	7
1906	O23	10	I	0
1907	A8	10	I	7
1908	J8	10	I	6
1909	Q28	10	O	6
1910	N4	10	O	6
1911	A19	10	O	8
1912	B25	10	O	8
1913	D29	10	O	6
1914	D18	10	O	7
1915	K9	10	M	7
1916	J25	10	M	6
1917	A7	11	I	7
1918	K27	11	I	6
1919	F23	11	I	7
1920	E9	11	I	6
1921	E1	11	O	6
1922	E18	11	O	7
1923	G3	11	O	6
1924	K20	11	O	7
1925	J13	12	I	7
1926	A24	12	I	8
1927	I24	12	I	6
1928	I10	12	I	7
1929	P1	12	I	6
1930	M7	12	I	7
1931	F27	12	O	7
1932	G33	12	O	7
1933	D5	12	O	4
1934	G29	12	O	7
1935	M35	12	O	7
1936	C13	12	O	7
1937	I4	12	O	7
1938	G8	12	O	7

Individual data for *Eucalyptus sphaerocarpa* stakes

Stake ID	Plot location	Tree number	Inner\Outer\Middle	Decay rating
1939	P25	13	I	6
1940	L23	13	I	6
1941	P24	13	I	6
1942	H27	13	I	7
1943	A10	13	I	8
1944	J27	13	I	7
1945	E12	13	I	7
1946	B12	13	O	7
1947	I12	13	O	7
1948	G27	13	O	7
1949	C31	13	O	8
1950	B19	13	O	7
1951	H31	13	O	7
1952	F21	14	I	7
1953	K1	14	I	7
1954	N21	14	I	8
1955	D8	14	I	7
1956	Q18	14	I	6
1957	L9	14	I	7
1958	O35	14	I	7
1959	H32	14	O	8
1960	E17	14	O	7
1961	O13	14	O	7
1962	B11	14	O	7
1963	K35	14	O	7
1964	A31	14	O	8
1965	H3	14	O	8
1966	F10	14	O	7
1967	G35	15	I	7
1968	I23	15	I	7
1969	I16	15	I	7
1970	F15	15	I	7
1971	J23	15	I	7
1972	G30	15	O	7
1973	G14	15	O	7
1974	N5	15	O	7
1975	C8	15	O	7
1976	C10	15	O	7
1977	M9	15	O	8
1978	G12	16	I	6
1979	J15	16	I	7
1980	O17	16	I	6
1981	C3	16	I	7
1982	H6	16	O	7
1983	D21	16	O	7

1984	J14	16	O	6
1985	M1	16	O	8
1986	K33	16	O	7
1987	K7	16	O	7
1988	L27	16	I/O	7

Individual data for *Eucalyptus globoidea* stakes

Stake ID	Plot location	Tree number	Inner\Outer\Middle	Decay rating
1989	K28	17	I	6
1990	I30	17	I	7
1991	A13	17	I	7
1992	J10	17	I	6
1993	M36	17	I	6
1994	Q20	17	I	B*
1995	E4	17	O	7
1996	A5	17	O	7
1997	D34	17	O	7
1998	K29	17	O	7
1999	H35	17	O	7
2000	K6	17	O	6
2001	G21	18	I	7
2002	B20	18	I	7
2003	P33	18	I	6
2004	E30	18	I	6
2005	E31	18	O	7
2006	F1	18	O	7
2007	A30	18	O	7
2008	K22	18	M	6
2009	N23	19	I	7
2010	P5	19	I	7
2011	F35	19	I	6
2012	E7	19	I	7
2013	H12	19	I	6
2014	J30	19	I	7
2015	F20	19	I	7
2016	C32	19	I	7
2017	J35	19	O	7
2018	M31	19	O	6
2019	H26	19	O	8
2020	Q25	19	O	7
2021	I29	19	O	7
2022	D15	19	O	7
2023	G15	19	O	7
2024	C22	19	O	7
2025	Q10	19	M	7
2026	M11	19	M	7
2027	F13	19	M	7
2028	O5	19	M	6
2029	G22	19	M	7
2030	Q8	19	M	7
2031	Q35	19	M	6
2032	H18	19	M	7
2033	K34	20	I	7

2034	A15	20	I	7
2035	N34	20	I	6
2036	B26	20	I	7
2037	E33	20	I	7
2038	C29	20	I	0
2039	K36	20	I	6
2040	N9	20	O	7
2041	N28	20	O	6
2042	O12	20	O	B*
2043	C1	20	O	7
2044	N2	20	O	6
2045	M22	20	M	7
2046	P27	20	M	0
2047	N24	20	M	7
2048	I7	20	M	7
2049	C14	20	M	7
2050	H2	20	M	7

*Stakes 1994 and 2042 were broken and not reinstalled.

Individual data for *Eucalyptus muelleriana* stakes

Stake ID	Plot location	Tree number	Inner\Outer\Middle	Decay rating
2051	M34	21	I	6
2052	C26	21	I	6
2053	M17	21	I	6
2054	B24	21	I	6
2055	C19	21	I	7
2056	P23	21	I	4
2057	A1	21	I	7
2058	B31	21	O	6
2059	I28	21	O	6
2060	D12	21	O	6
2061	G32	21	O	6
2062	D22	21	O	7
2063	F22	21	O	7
2064	F18	21	O	6
2065	A36	22	I	7
2066	J9	22	I	6
2067	A35	22	I	7
2068	G2	22	I	7
2069	O30	22	I	6
2070	K32	22	I	6
2071	H33	22	I	8
2072	H23	22	I	7
2073	J21	22	O	7
2074	O1	22	O	7
2075	C12	22	O	7
2076	L8	22	O	7
2077	H16	22	O	7
2078	G16	22	O	7
2079	C18	22	O	7
2087	G34	22	O	7
2080	I20	23	I	7
2081	B18	23	I	6
2082	E5	23	I	6
2083	D3	23	I	6
2084	Q29	23	I	6
2085	O10	23	I	6
2086	I26	23	O	7
2088	L34	23	O	6
2089	P8	23	O	7
2090	I33	23	O	6
2091	I1	23	O	7
2092	F5	23	M	7
2093	J5	23	M	7
2094	L12	23	M	6
2095	B2	24	I	6

2096	E14	24	I	7
2097	F7	24	I	7
2098	O2	24	I	7
2099	C33	24	I	7
2100	J26	24	I	6
2101	J17	24	I	6
2102	O32	24	O	6
2103	M16	24	O	7
2104	D33	24	O	7
2105	G5	24	O	6
2106	B36	24	O	7
2107	L28	24	O	6

Individual data for Untreated *Pinus radiata* control stakes

Stake ID	Plot location	Decay rating
2108	H7	0
2109	L2	0
2110	I32	0
2111	I25	0
2112	P13	0
2113	H28	0
2114	P19	0
2115	E6	0
2116	F30	0
2117	M2	0

Average life 2.1 years

Individual data for Untreated *Fagus sylvatica* control stakes

Stake ID	Plot location	Decay rating
2119	G7	0
2120	A2	0
2121	B21	0
2122	E20	0
2123	C34	0
2124	N34	0
2125	Q12	0
2126	J12	0
2127	F6	0
2128	C9	B*

Average life 2.1 years

*Stake 2128 was broken and not reinstalled.

Individual data for *Pinus radiata* CCA H4 treated stakes

Stake ID	Plot location	Decay rating
2129	L10	6
2130	M28	T
2131	B6	8
2132	A6	8
2133	N20	8
2134	O8	9
2135	N1	8
2136	G28	9
2137	F3	8
2138	F26	9

Individual data for *Pinus radiata* CCA H3.2 treated stakes

Stake ID	Plot location	Decay rating
2139	E21	10
2140	A34	T
2141	N17	T
2142	C23	T
2143	F11	B*
2144	P18	9
2145	J34	9
2146	Q30	T
2147	D27	10
2148	N7	10

*Stake 2143 was broken and not reinstalled.

Appendix 3: Individual stakelet data after 50 months exposure

Individual stakelet data for *Eucalyptus bosistoana*

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			29	32	35	38	41	44	47	50
1	1	O	0	0	0	0	0	0	0	0
2	1	O	4	4	4	4	4	4	4	4
3	1	O	4	4	4	4	4	0	0	0
4	1	O	0	0	0	0	0	0	0	0
5	1	O	0	0	0	0	0	0	0	0
6	1	O	4	4	4	4	0	0	0	0
7	1	I/O	0	0	0	0	0	0	0	0
8	1	I/O	0	0	0	0	0	0	0	0
9	1	I/O	4	4	4	4	0	0	0	0
10	1	I/O	0	0	0	0	0	0	0	0
11	2	O	6	6	4	4	4	4	4	4
12	2	O	6	6	6	6	6	6	4	4
13	2	O	6	6	6	4	0	0	0	0
14	2	O	6	6	6	6	6	6	6	6
15	2	O	0	0	0	0	0	0	0	0
16	2	I	0	0	0	0	0	0	0	0
17	2	I	0	0	0	0	0	0	0	0
18	2	I	6	6	6	6	4	4	0	0
19	2	I	0	0	0	0	0	0	0	0
20	2	I	6	6	6	6	6	6	6	6
21	3	O	4	4	4	4	0	0	0	0
22	3	O	6	6	6	6	6	6	6	6
23	3	O	6	6	6	6	6	4	4	4
24	3	O	0	0	0	0	0	0	0	0
25	3	O	6	6	6	6	6	6	6	6
26	3	I	6	6	6	6	6	6	6	6
27	3	I	0	0	0	0	0	0	0	0
28	3	I	4	4	4	4	4	4	4	4
29	3	I	4	4	4	4	0	0	0	0
30	3	I	6	6	4	4	4	4	0	0
31	4	O	4	4	0	0	0	0	0	
32	4	O	4	4	4	4	0	0	0	
33	4	O	0	0	0	0	0	0	0	
34	4	O	0	0	0	0	0	0	0	
35	4	O	0	0	0	0	0	0	0	
36	4	I	0	0	0	0	0	0	0	
37	4	I	0	0	0	0	0	0	0	
38	4	I	0	0	0	0	0	0	0	
39	4	I	0	0	0	0	0	0	0	
40	4	I	4	4	4	4	4	4	0	*

***Average life 2.1 years**

Individual stakelet data for *Eucalyptus quadrangulata*

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			29	32	35	38	41	44	47	50
41	5	O	0	0	0	0	0	0	0	0
42	5	O	4	4	4	4	0	0	0	0
43	5	O	0	0	0	0	0	0	0	0
44	5	O	0	0	0	0	0	0	0	0
45	5	O	0	0	0	0	0	0	0	0
46	5	I	4	4	4	4	4	4	4	4
47	5	I	6	6	4	4	4	4	4	4
48	5	I	0	0	0	0	0	0	0	0
49	5	I	0	0	0	0	0	0	0	0
50	5	I	4	4	4	4	0	0	0	0
51	6	O								
52	6	O								
53	6	O								
54	6	O								
55	6	O								
56	6	I								
57	6	I								
58	6	I								
59	6	I	**Final failure at 26 weeks. Average life 1.6 years**							
60	6	I								
61	7	O	0	0	0	0	0			
62	7	O	0	0	0	0	0			
63	7	O	0	0	0	0	0			
64	7	O	4	4	4	4	0			
65	7	O	0	0	0	0	0			
66	7	I	0	0	0	0	0			
67	7	I	0	0	0	0	0			
68	7	I	0	0	0	0	0			
69	7	I	0	0	0	0	0	**Average life 1.7 years**		
70	7	I	0	0	0	0	0			
71	8	O	0							
72	8	O	0							
73	8	O	0							
74	8	O	0							
75	8	O	0							
76	8	I	0							
77	8	I	0							
78	8	I	0							
79	8	I	0	**Average life 1.7 years**						
80	8	I	0							

Individual stakelet data for *Eucalyptus pilularis*

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			29	32	35	38	41	44	47	50
81	9	O	4	4	0	0	0	0	0	0
82	9	O	4	4	4	4	0	0	0	0
83	9	O	4	0	0	0	0	0	0	0
84	9	O	4	4	4	4	4	4	0	0
85	9	O	4	4	4	4	4	4	4	4
86	9	I	0	0	0	0	0	0	0	0
87	9	I	0	0	0	0	0	0	0	0
88	9	I	0	0	0	0	0	0	0	0
89	9	I	0	0	0	0	0	0	0	0
90	9	I	0	0	0	0	0	0	0	0
91	10	O	0	0						
92	10	O	4	0						
93	10	O	0	0						
94	10	O	0	0						
95	10	O	0	0						
96	10	I	0	0						
97	10	I	0	0						
98	10	I	0	0						
99	10	I	0	0	**Average life 1.7 years**					
100	10	I	0	0						
101	11	O	4	4	4	4	4	0		
102	11	O	0	0	0	0	0	0		
103	11	O	0	0	0	0	0	0		
104	11	O	4	4	4	4	0	0		
105	11	O	4	4	0	0	0	0		
106	11	I	0	0	0	0	0	0		
107	11	I	0	0	0	0	0	0		
108	11	I	0	0	0	0	0	0		
109	11	I	0	0	0	0	0	0		
110	11	I	0	0	0	0	0	0	**	
111	12	O	4	4	0	0	0	0	0	0
112	12	O	6	4	4	4	4	0	0	0
113	12	O	6	6	4	4	4	4	4	0
114	12	O	4	4	4	4	4	4	4	4
115	12	O	4	4	4	4	0	0	0	0
116	12	I	0	0	0	0	0	0	0	0
117	12	I	0	0	0	0	0	0	0	0
118	12	I	0	0	0	0	0	0	0	0
119	12	I	4	4	0	0	0	0	0	0
120	12	I	4	4	4	4	0	0	0	0

****Average life 2.1 years**

Individual stakelet data for *Eucalyptus sphaerocarpa*

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			29	32	35	38	41	44	47	50
121	13	O	6	4	4	4	4	0		
122	13	O	4	4	4	4	4	0		
123	13	I	4	0	0	0	0	0		
124	13	I	6	6	4	4	4	0		
125	13	I	0	0	0	0	0	0		
126	13	I	4	4	4	4	0	0		
127	13	I	4	4	4	4	4	0		
128	13	I	4	0	0	0	0	0		
129	13	I	4	4	4	4	4	0		
130	13	I	0	0	0	0	0	0	***	
131	14	O	6	6	6	6	6	4	4	4
132	14	O	6	6	0	0	0	0	0	0
133	14	O	6	6	4	4	4	4	0	0
134	14	O	4	4	4	4	0	0	0	0
135	14	O	4	4	4	4	4	4	0	0
136	14	I	4	4	0	0	0	0	0	0
137	14	I	4	4	4	4	0	0	0	0
138	14	I	4	4	4	4	4	4	4	4
139	14	I	4	0	0	0	0	0	0	0
140	14	I	6	6	6	6	0	0	0	0
141	15	O	4	4	4	4	0	0	0	0
142	15	O	4	4	4	4	0	0	0	0
143	15	O	4	4	4	4	0	0	0	0
144	15	O	6	6	6	6	6	6	6	6
145	15	O	6	4	4	4	4	4	4	0
146	15	I	4	4	0	0	0	0	0	0
147	15	I	4	0	0	0	0	0	0	0
148	15	I	0	0	0	0	0	0	0	0
149	15	I	6	6	4	4	4	0	0	0
150	15	I	0	0	0	0	0	0	0	0
151	16	O	0	0	0	0	0			
152	16	O	0	0	0	0	0			
153	16	O	4	4	0	0	0			
154	16	O	4	4	4	4	0			
155	16	O	4	4	4	0	0			
156	16	I	0	0	0	0	0			
157	16	I	0	0	0	0	0			
158	16	I	0	0	0	0	0			
159	16	I	0	0	0	0	0	**Average life**		
160	16	I	0	0	0	0	0	**2.1 years**		

*****Average life 3.0 years**

Individual stakelet data for *Eucalyptus globoidea*

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			29	32	35	38	41	44	47	50
161	17	O	6	6	6	6	6	4	4	4
162	17	O	0	0	0	0	0	0	0	0
163	17	O	4	4	4	4	0	0	0	0
164	17	O	4	4	4	4	0	0	0	0
165	17	O	4	4	4	4	0	0	0	0
166	17	I	0	0	0	0	0	0	0	0
167	17	I	4	4	0	0	0	0	0	0
168	17	I	0	0	0	0	0	0	0	0
169	17	I	4	4	4	4	4	4	4	4
170	17	I	4	4	4	4	4	4	4	4
171	18	O	4	4	4	4	0	0	0	
172	18	O	4	4	4	4	4	4	0	
173	18	O	4	4	4	4	4	4	0	
174	18	O	0	0	0	0	0	0	0	
175	18	O	4	4	0	0	0	0	0	
176	18	I	4	4	4	4	0	0	0	
177	18	I	0	0	0	0	0	0	0	
178	18	I	0	0	0	0	0	0	0	
179	18	I	0	0	0	0	0	0	0	
180	18	I	0	0	0	0	0	0	0	****
181	19	O	4	4	0	0	0	0	0	0
182	19	O	6	6	6	6	6	4	4	4
183	19	O	0	0	0	0	0	0	0	0
184	19	O	4	4	4	4	4	4	4	4
185	19	O	4	4	0	0	0	0	0	0
186	19	I	4	4	4	4	0	0	0	0
187	19	I	6	6	6	6	4	4	4	4
188	19	I	4	4	4	4	4	4	4	4
189	19	I	4	4	4	4	0	0	0	0
190	19	I	0	0	0	0	0	0	0	0
191	20	O	4	4	4	4	0			
192	20	O	4	4	4	4	0			
193	20	O	4	4	0	0	0			
194	20	O	0	0	0	0	0			
195	20	O	0	0	0	0	0			
196	20	I	0	0	0	0	0			
197	20	I	0	0	0	0	0			
198	20	I	0	0	0	0	0			
199	20	I	0	0	0	0	0	**Average life 2.0 years**		
200	20	I	0	0	0	0	0			

******Average life 2.5 years**

Individual stakelet data for *Eucalyptus muelleriana*

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			29	32	35	38	41	44	47	50
201	21	O	0							
202	21	O	0							
203	21	O	0							
204	21	O	0							
205	21	O	0							
206	21	I	0							
207	21	I	0							
208	21	I	0							
209	21	I	0							
210	21	I	0	**Average life 1.5 years**						
211	22	O	0	0	0					
212	22	O	4	0	0					
213	22	O	0	0	0					
214	22	O	0	0	0					
215	22	O	0	0	0					
216	22	I	0	0	0					
217	22	I	0	0	0					
218	22	I	0	0	0					
219	22	I	4	4	0					
220	22	I	0	0	0	**Average life 1.9 years**				
221	23	O	0	0	0	0	0			
222	23	O	4	0	0	0	0			
223	23	O	6	4	4	4	0			
224	23	O	0	0	0	0	0			
225	23	O	0	0	0	0	0			
226	23	I	0	0	0	0	0			
227	23	I	0	0	0	0	0			
228	23	I	0	0	0	0	0			
229	23	I	0	0	0	0	0	**Average life**		
230	23	I	0	0	0	0	0	**1.9 years**		
231	24	O	0							
232	24	O	0							
233	24	O	0							
234	24	O	0							
235	24	O	0							
236	24	I	0							
237	24	I	0							
238	24	I	0							
239	24	I	0							
240	24	I	0	**Average life 1.4 years**						

Individual stakelet data for *Pinus radiata*

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			2	5	8	11	14	17	20	23
241	25	O	10	7	7	0	0	0		
242	25	O	10	8	8	7	7	0		
243	25	O	9	7	7	0	0	0		
244	25	O	0	0	0	0	0	0		
245	25	O	8	7	7	0	0	0		
246	25	I	0	0	0	0	0	0		
247	25	I	9	7	7	0	0	0		
248	25	I	10	9	8	0	0	0		
249	25	I	8	7	0	0	0	0	**Av. life 8.9 months**	
250	25	I	10	0	0	0	0	0		

Individual stakelet data for *Fagus sylvatica*

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			2	5	8	11	14	17	20	23
251	26	O	8	6	0	0				
252	26	O	8	7	7	0				
253	26	O	8	0	0	0				
254	26	O	8	0	0	0				
255	26	O	8	0	0	0				
256	26	I	8	0	0	0				
257	26	I	8	0	0	0				
258	26	I	8	6	0	0				
259	26	I	8	0	0	0				
260	26	I	8	6	0	0	**Average life 6.5 months**			

Individual stakelet data for *Pinus radiata* CCA treated H3.2

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			29	32	35	38	41	44	47	50
261	27	-	7	7	7	7	7	7	7	7
262	27	-	8	8	8	8	8	8	8	8
263	27	-	9	9	9	8	8	8	8	7
264	27	-	8	8	8	8	8	8	8	7
265	27	-	8	8	8	8	8	8	8	7
266	27	-	8	8	8	8	8	7	7	7
267	27	-	7	7	7	7	7	7	7	7
268	27	-	8	7	7	7	6	4	4	4
269	27	-	8	8	8	8	8	8	8	8
270	27	-	7	7	7	7	0	0	0	0

Individual stakelet data for *Pinus radiata* CCA treated H4

Stakelet ID	Tree number	Inner\Outer\ Middle	Decay ratings – Number of months							
			29	32	35	38	41	44	47	50
271	28	-	9	8	7	7	8	8	8	8
272	28	-	9	9	8	8	9	9	9	9
273	28	-	9	9	9	9	9	9	9	9
274	28	-	8	8	8	8	8	8	8	8
275	28	-	10	10	T	9	9	9	9	9
276	28	-	9	9	9	9	9	9	9	9
277	28	-	10	10	10	10	T	T	9	9
278	28	-	9	9	9	9	9	9	9	9
278	28	-	T	T	T	T	T	9	9	9
280	28	-	T	9	9	9	T	9	9	9