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Warra log decay project: establishment report

Division of Forest Research
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Cover photograph: Emergence traps on Old-growth log OG3, 2003. Photo by Simon Grove.

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Background and rationale

The Warra log decay project was initiated in August 1999 as part of a wider project with the University of Tasmania entitled "Ecologically sustainable forest management: fungal and invertebrate biodiversity". This wider project was supported with three years of funding under the Strategic Partnerships with Industry - Research and Training (SPIRT) program from the Australian Research Council / Department of Employment, Education, Training and Youth Affairs (ARC file number C19906735). Forestry Tasmania (FT), as the main industry partner, supported this project with $15,000 cash per annum for each of the three years of the project, plus a further $43327 in-kind support over the same three years. One outcome of stakeholder meetings held in February and September 1999 was that Rob Taylor (FT) oversaw the project formulation and design, while Caroline Mohammed (CSIRO Forests and Forest Products) managed the project accounts during its first three years. Tim Wardlaw (FT), Alastair Richardson (UTas) and Dave de Little (North Forest Products, now Gunns) were all involved in its early implementation. Dick Bashford (FT) was given the task of designing and constructing the emergence traps and carrying out much of the other groundwork for the FT part of the project.

The ARC project had two main aims:

1. To establish whether small *Eucalyptus obliqua* logs support a similar assemblage of fungal and insect taxa as large logs, decayed to the same extent in the same wet forest type; and
2. To compare the fungal and invertebrate succession in comparable *Eucalyptus obliqua* logs of the same sizes between silvicultural regeneration and old-growth wet forest in equivalent environments.

Research under Aim number 2 was largely conducted through the work of Marie Yee (doctoral student) and Zi-Qin Yuan (postdoctoral research fellow) at the Cooperative Research Centre for Sustainable Production Forestry. Some of the study sites for this project were in the Warra Long Term Ecological Research site in southern Tasmania, while others were in adjacent areas of State Forest. More detailed information on this is available in Yee *et al.* (2001), Yee *et al.* (2005) and Yee (2005).

This establishment report is concerned with Aim number 1. It has become known as the 'Warra log decay project'. The rationale for this project is to better understand the role of log diameter on influencing decomposition processes, decay rates and associated biodiversity. This understanding is expected to aid in the development of forestry practices that better address the maintenance of ecological processes and biodiversity. With regard to decaying logs (coarse woody debris), there is concern that a future production forest estate in which old-growth logs are generally rarer than in natural forest landscapes may not adequately provide for these processes and biodiversity in the absence of specific mitigation measures (Grove & Meggs, 2003). This project, along with others in and around Warra (Grove, 2004; Grove & Meggs, 2005) should aid in the formulation of these measures.

An initial establishment report was prepared by Yuan (2000), This details the physical condition of each log, illustrates its orientation and its setting within the forest, and describes the mycoflora and rots found associated with the log or the surrounding forest at the time of establishment. A shorter summary of the project experimental

design is given in Bashford et al. (2001). A reinterpretation of this, together with a location map and some preliminary findings, are given in Grove and Bashford (2003).

Location of files, data and specimens

Electronic files relating to this project are stored on FT's network at **G:\silv\Forest Research\Warra\Warra project data\1999\99-02 Grove**. An electronic copy of the initial establishment report is stored at FT at **G:\silv\Forest Research\Warra\Warra project data\1999\99-02 Grove\Yuan 2000**. A paper copy is kept in the FT library at **F 181.9(946) YUA.** Other paper documents are archived in FT's filing system in file number **F62074**. A storage area for GIS data related to the project is being set up at the time of writing; it will be in the same general area as other Warra research data. A web page for the project is maintained by the FT conservation biologist at: http://www.warra.com/warra/docs/research_projects/docs/research_project_9902.htm. Temperature readings from the study site are maintained in an Excel spreadsheet at **G:\silv\Forest Research\Warra\Warra project data\1999\99-02 Grove\log decay project temperature readings.xls**. Sample-level information (e.g. sample dates and the numbers of individuals of identified species) is maintained in the FT-TFIC biodiversity database at **G:\silv\Biology & Conserv\Biodiversity databasing\Databases\TFIC\FT-TFIC biodiversity database.mdb**. Unsorted emergence trap samples and sorted residues are stored in 80% alcohol in labelled 'Reflex' boxes on the mezzanine floor of the FT laboratory. Fully labelled and databased beetle specimens (and a few other invertebrate taxa) that have been extracted from these samples are lodged in the Tasmanian Forest Insect Collection (TFIC), also on the mezzanine floor of the FT laboratory. Expenditure against this project can be traced through the FT FinanceOne code **L1W004**.

Tree selection and felling

The project area comprises multi-aged old-growth mixed forest, in State Forest within the Warra LTER site, just beyond the western boundary of coupe (Blakes) BK001B. The study area is accessible by means of a 4WD-quality track leading off Manuka Spur 1 (Figure 1). The track was constructed specifically for the project in May 2000 by D. Doyle Pty Ltd, at a cost of $3000.

Twelve live *E.obliqua* trees were selected, forming three groups, with each group separated by a horizontal distance of about 100 m (Figure 2). The most northerly group (four logs), at about 270 m altitude, is referred to as the 'top site'; the intermediate group (six logs), at about 260 m altitude, as the 'middle site'; and the most southerly group (two logs), at about 240 m altitude, as the 'bottom site'. Six of these trees (half of all logs at each of the three sites) were designated as old-growth trees, and six (the other half of all logs at each of the three sites) as regrowth trees. The regrowth trees were roughly 35-65 cm dbh, suggestive of trees 60-80 years old (i.e. an age typically approaching commercial maturity). In this location, they were perhaps most likely to have begun life following a wildfire in 1934, or perhaps the earlier wildfires of 1914 or 1898 (Hickey *et al.*, 1999). The old-growth trees were roughly 130 to 220 cm dbh, suggestive of trees at least 120 years old (i.e. an age typically beyond commercial maturity). In this location, they were likely to have been substantially older than this: maybe closer to 300 years.

The trees were felled, in pairs each comprising a regrowth and an old-growth tree, over three occasions covering three seasons: 21 May 1999 (autumn/winter: bottom

site and part of top site); 19 October 1999 (spring: part of top site); and February 2000 (summer: middle site). Care was taken to minimise damage to the surrounding forest during felling, such that all the resultant logs lay in semi-closed forest. Each log was at least 16 m long. Table 1 gives some summary statistics for these logs.

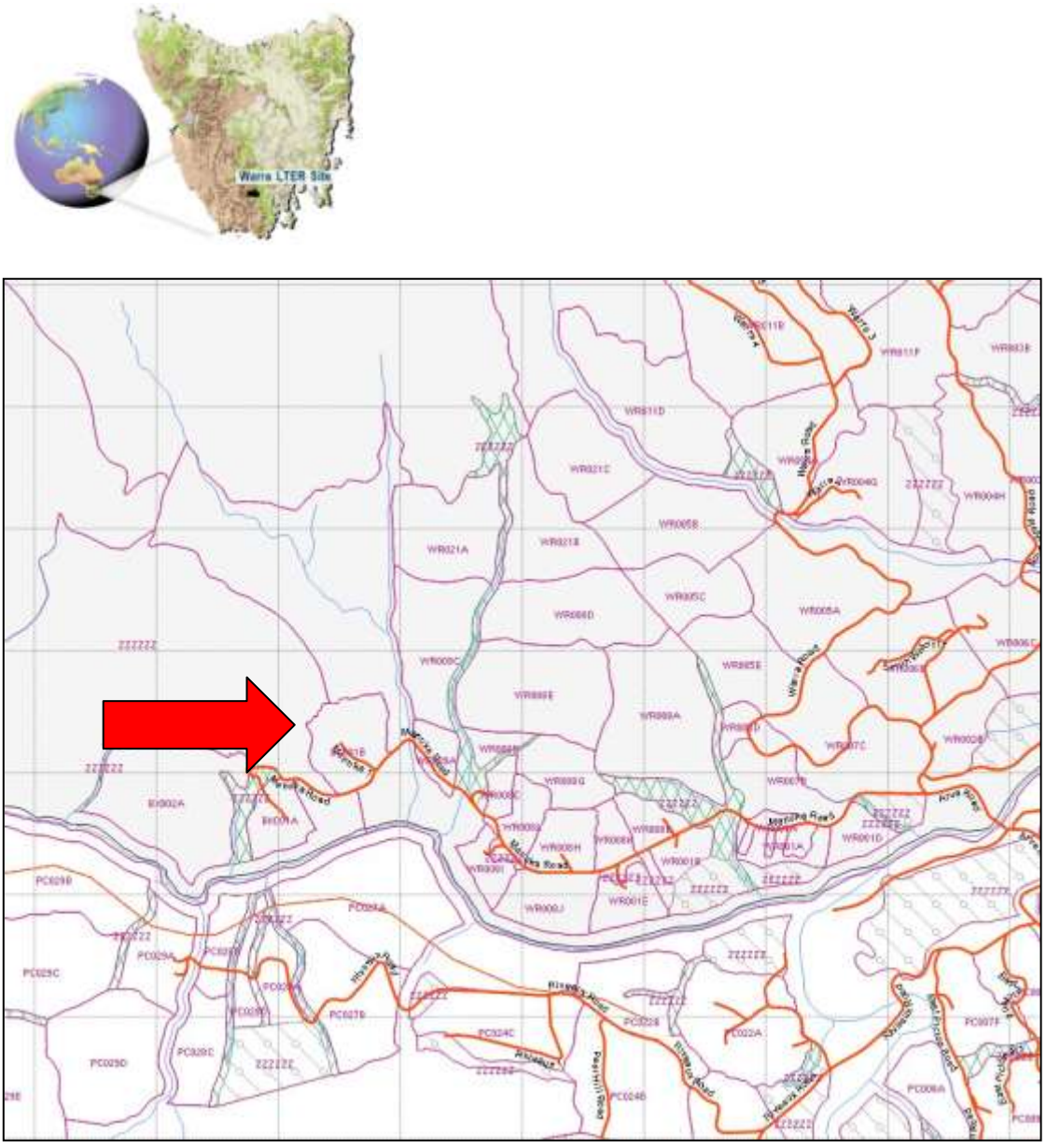


Figure 1. Location of the log decay project study area (red arrow) in the Warra Long Term Ecological Research site, southern Tasmania.

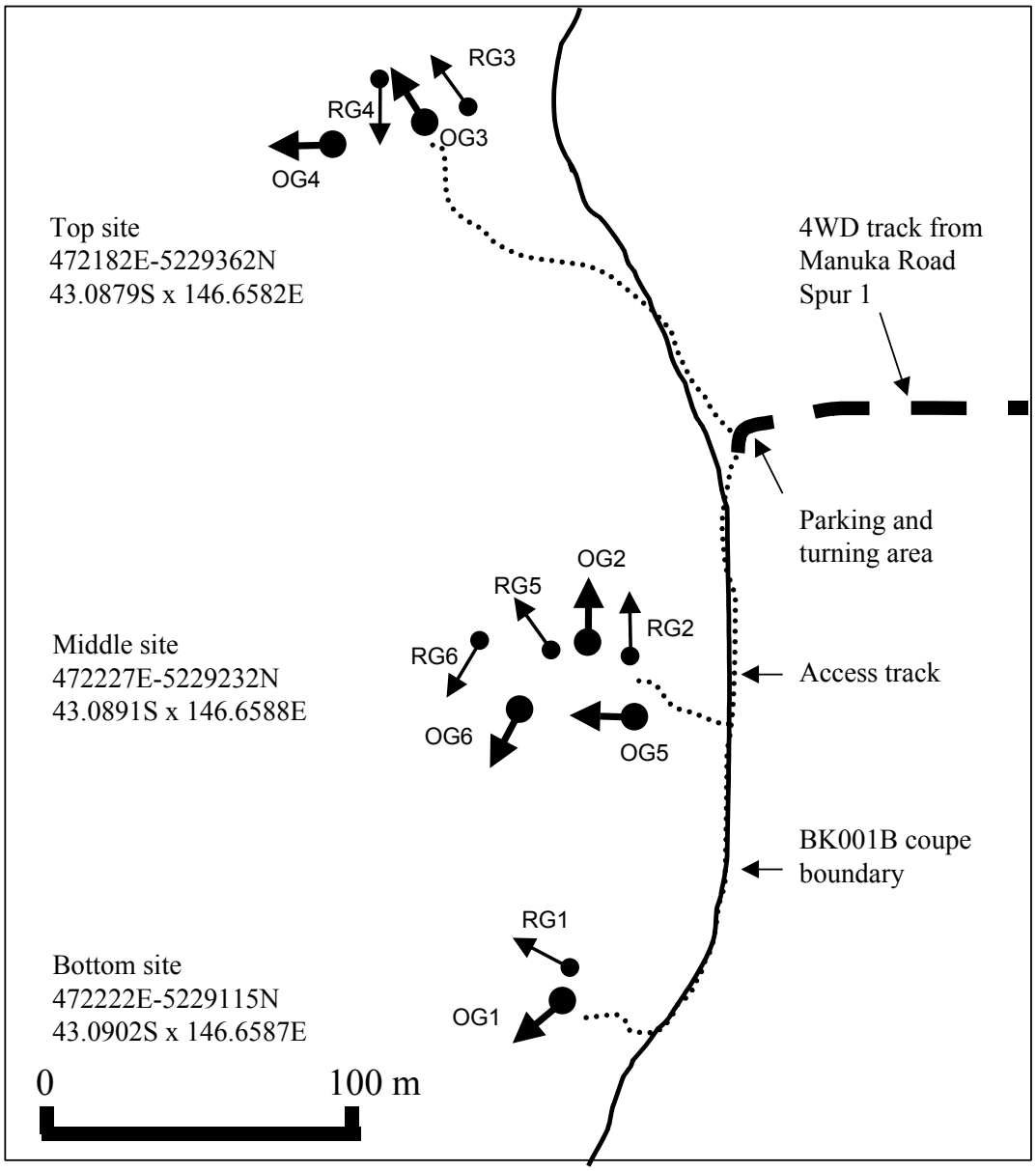


Figure 2. Stylised layout of the log decay project study area in the Warra Long Term Ecological Research site, southern Tasmania. Log directions and orientations are based on information presented in Yuan (2000), apart from the orientations for RG2 and OG5 which have been modified based on ground-checking.

Table 1. Summary statistics for the twelve logs in the Warra log decay project.

Log number	Diameter cm (butt end - measured 12 May 2005)	Category	Date felled	Orientation (large end - small end)	Site
OG1	199	Old-growth	21/05/1999	NE-SW 230^0	Bottom
RG1	43	Regrowth	21/05/1999	SE-NW 330^0	Bottom
OG2	223	Old-growth	21/05/1999	S-N 0^0	Middle
RG2	56	Regrowth	21/05/1999	SE-NW 310^0	Middle
OG3	148	Old-growth	19/10/1999	SE-NW 350^0	Top
RG3	39	Regrowth	19/10/1999	SE-NW 330^0	Top
OG4	140	Old-growth	19/10/1999	E-W 270^0	Top
RG4	38	Regrowth	19/10/1999	N-S 180^0	Top
OG5	189	Old-growth	21/02/2000	NE-SW 220^0	Middle
RG5	57	Regrowth	21/02/2000	SE-NW 356^0	Middle
OG6	206	Old-growth	21/02/2000	NE-SW 195^0	Middle
RG6	69	Regrowth	21/02/2000	NE-SW 210^0	Middle

Log numbering and marking system

The log pairs were numbered sequentially according to when they were felled. The number of each log has been spray-painted onto its butt. Additionally, a standard 50 x 50 cm Warra Research Site 'Corflute' sign has been mounted on a post adjacent to each log, and the log's number and felling date marked on this with permanent marker pen.

Temperature records

Thermometers, located at the base of the stumps belonging to logs OG2 and RG2, have been recording monthly (or two-monthly) minimum and maximum temperatures, as well as the temperature at the time of collection, since March 2003 (Figure 3). Daytime maxima vary more with season than do night-time minima; there is little discernible or consistent difference in the recorded temperatures between the two logs.

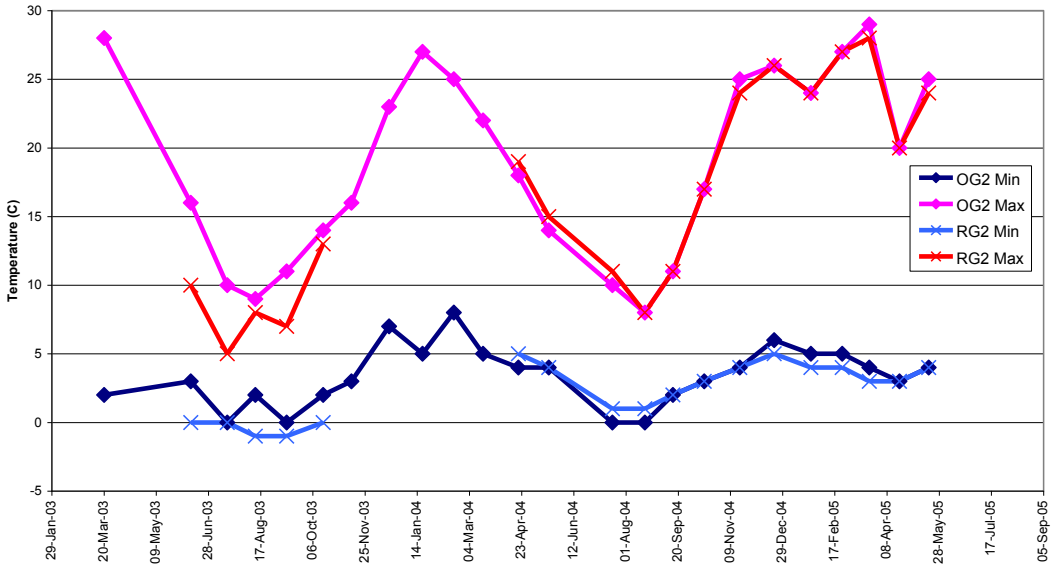


Figure 3. Temperature minima and maxima (^{O}C) at logs OG2 and RG2. Temperatures have been recorded, and the thermometers re-set, at roughly monthly intervals since 20 March 2003. No records are available for RG2 for the first month, nor between November 2003 and March 2004.

Initial assessments of adjacent forest vegetation and fungi

Yuan (2000) details the preliminary findings of surveys of the forest in the immediate vicinity of each log, shortly after project establishment. Vegetation surveys extended 3 m either side of the log and from the stump for a distance of 16 m alongside the log (i.e. the same length of log as is occupied by the emergence traps described below). For every log, the position and species identity of every shrub and tree in this band was marked on a diagram of the log and its vicinity, overlaid with a 1 x 1 m grid. Fresh-cut stumps, old stumps and logs were also marked on the diagrams. It is not clear what minimum stem, stump or log diameter limit was used for this survey; all trees and shrubs are represented on the diagrams as circles of equal diameter, as are stumps, while all logs are represented as lines of equal thickness. The figures from Yuan (2000) are reproduced in Figures 4-9. They have been modified very slightly, primarily to increase legibility and consistency.

Yuan (2000) also reports on surveys of log- or tree-dwelling fungal fruiting bodies noted in the vicinity of the logs in October 1999 and May 2000. Transects were walked through the forest for about 50 m in four directions (N, S, E and W) from each of the study logs, and all logs and living trees (especially *Eucalyptus obliqua*) trees were searched; some ground-dwelling fungi were also recorded en route. It is not clear whether the findings relate to single or multiple visits within these months. The following fungus species were detected: *Cortinarius abnormis*, *Dermocybe austroveneta*, *Dermocybe sanguinea*, *Fistulina hepatica*, *Ganoderma applanatum*, *Grifola campyla*, *Hypholoma* sp. 01, *Hypholoma* sp. 02, *Marasmius* sp., *Phellinus wahlbergii*, *Phellodon niger*, *Piptoporus portentosus*, *Postia pelliculosa*, *Russula persanguinea*, *Stereum ostrea*, *Trametes versicolor* and *Xylobolus illudens*. Most are illustrated and described in Yuan (2000).

Initial assessments of log condition

Yuan (2000) reports on the initial condition of every log, based on visual surveys in the months following felling. Particular attention was given to describing visible rots, wounds and fungi since these features would be most likely to affect the subsequent decomposition process. Tables 2 and 3 summarise the main findings, while the first four pairs of logs at this time are illustrated in Figures 10 and 11. Figures 12 and 13 illustrate the cut basal ends of most of the logs shortly after felling. There are some gaps in the photo coverage at this stage, but further photos for all logs have been taken subsequently and are stored electronically at **G:\silv\Forest Research\Warra\Warra project data\1999\99-02 Grove\Photos.**

Table 2. Condition of the six old-growth logs and their stumps in the months following felling. Summarised from Yuan (2000).

	OG1	OG2	OG3	OG4	OG5	OG6
Bark loss	30% loss on stump; none elsewhere	20% loss on stump; none elsewhere	5% loss on stump; none elsewhere	None	10% loss on stump; 20% loss at 6 - 8 m along log; none elsewhere	None
Creases, holes, wounds, splits, cracks, charcoal etc	Several old wounds at the base of the stump. Splits in stump and in LHS of first 2 m along log; none elsewhere	A 2 m long wound (bark peeled) at RHS 4-6 m along log	A wound present in the stump; a healed wound near the base of the log and a 5 m x 0.2 m wound around 8 m along log. Cracks at 12 - 14 m along log.	Splits in stump and first 2 m along log.	A big healed wound at LHS 6 - 8 m along log. Charcoal present on bark in first 2 m along log.	A large wound on LHS at 8 - 12 m along log. Also a large wound in first 2 m along log.
Visible decay and fungi	Stump is hollow (i.e. heartwood rotted out, but sapwood is healthy). Brown blocky to crumbly rotten heartwood at basal end and visible from basal splits in the LHS of first 2 m along log. Similar rot visible at apical cut end, suggesting a continuous decay column. Clumps of *Grifola campyla* growing from white mycelium mat on stump surface and on basal cut of log five to six months after felling; *Fistulina hepatica* observed in same area after thirteen months. Several *Phellinus wahlbergii* at base of stump.	Centre of basal cut end hollowed out and surrounded by brown crumbly to muddy rot. No decay visible at apical cut end. Recent wound 4 - 6 m along log colonised by blue and white fungi (possibly *Trichoderma* sp.).	Heartwood and most of sapwood in stump completely rotten. Centre of basal cut end hollowed out (c 40 cm dia), and surrounded by brown crumbly to muddy rot. Sapwood at basal cut end had pockets of brown blocky rot. Outer sapwood or cambium had been stained by black and blue stain fungi (*Ceratocystis* sp. and *Penicillium* sp.) in months following felling. Brown heart rot seen in cracks at 12 - 14 m along log, and at apical cut end. No decay or discolouration in sapwood at apical cut end.	Discolouration visible on LHS of first 2 m along log. Centre of basal cut end occupied by a hole (50 x 20 cm) surrounded by brown crumbly to muddy rot. Similar rot visible at branch breakage point around 12 - 14 m along log.	Centre of basal cut end hollowed out (90 cm dia) and surrounded by brown blocky rot. Cambium layer colonised by black stain fungi (*Ceratocystis* sp.). Apical end not cut.	Heartwood at basal cut end composed of brown blocky rot (90 cm dia). Cambium layer colonised by black stain fungi (*Ceratocystis* sp.). White stringy rot visible within wound in first 2 m along log. Apical cut end not observable. Large wound at 8 - 12 m along log covered with black stain and slime.
Bryophytes	Present on stump and on first 2 m along log; otherwise none	Present on stump; otherwise none	None	Present on stump; otherwise none	None	Present on stump and on first 2 m along log; otherwise none.

Table 3. Condition of the six regrowth logs and their stumps in the months following felling. Summarised from Yuan (2000).

Description	RG1	RG2	RG3	RG4	RG5	RG6
Bark loss	Slight loss from 9 - 16 m along log, where bark peeled off during felling	None	None	None	None	None
Creases, holes, wounds, splits, cracks, charcoal etc	Small annual cankers present on LHS around 8 - 12 m along log.	None	None	A healed annual canker (30 x 10 cm) present 2 - 4 m along log	None	None
Visible decay and fungi	None	Black stain fungi (*Ceratocystis* sp.) had colonised outer sapwood or cambium at basal cut end and at apical cut end three months after felling.	Wet-discolouration patches present in the centre of the basal cut end but not at the apical cut end. Outer sapwood or cambium was slightly stained by black stain fungi (*Ceratocystis* sp.) six weeks after felling, at basal and at apical cut end.	Basal cut end has slightly stained outer sapwood or cambium. Small wet-stain patches present at the apical cut end.	Black stains (from *Ceratocystis* sp.) visible in cambium at basal cut end one month after felling. Patchy white discolouration visible in heartwood at apical cut end.	Black stains (from *Ceratocystis* sp.) visible in cambium at basal cut end and at apical cut end one month after felling.
Bryophytes	None	None	None	None	Present on stump; otherwise none	None

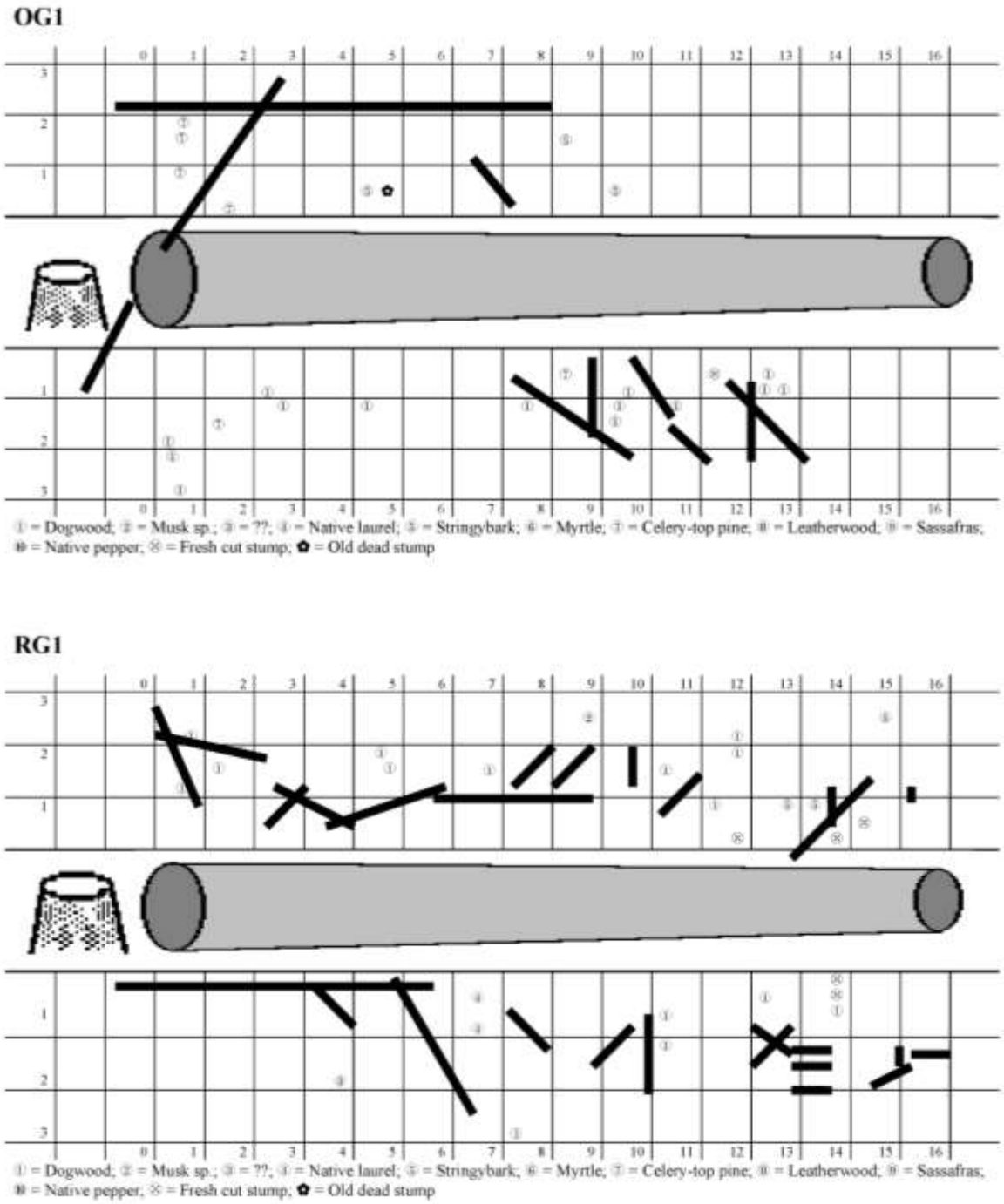


Figure 4. Forest vegetation and structure around logs OG1 and RG1. Modified from Yuan (2000).

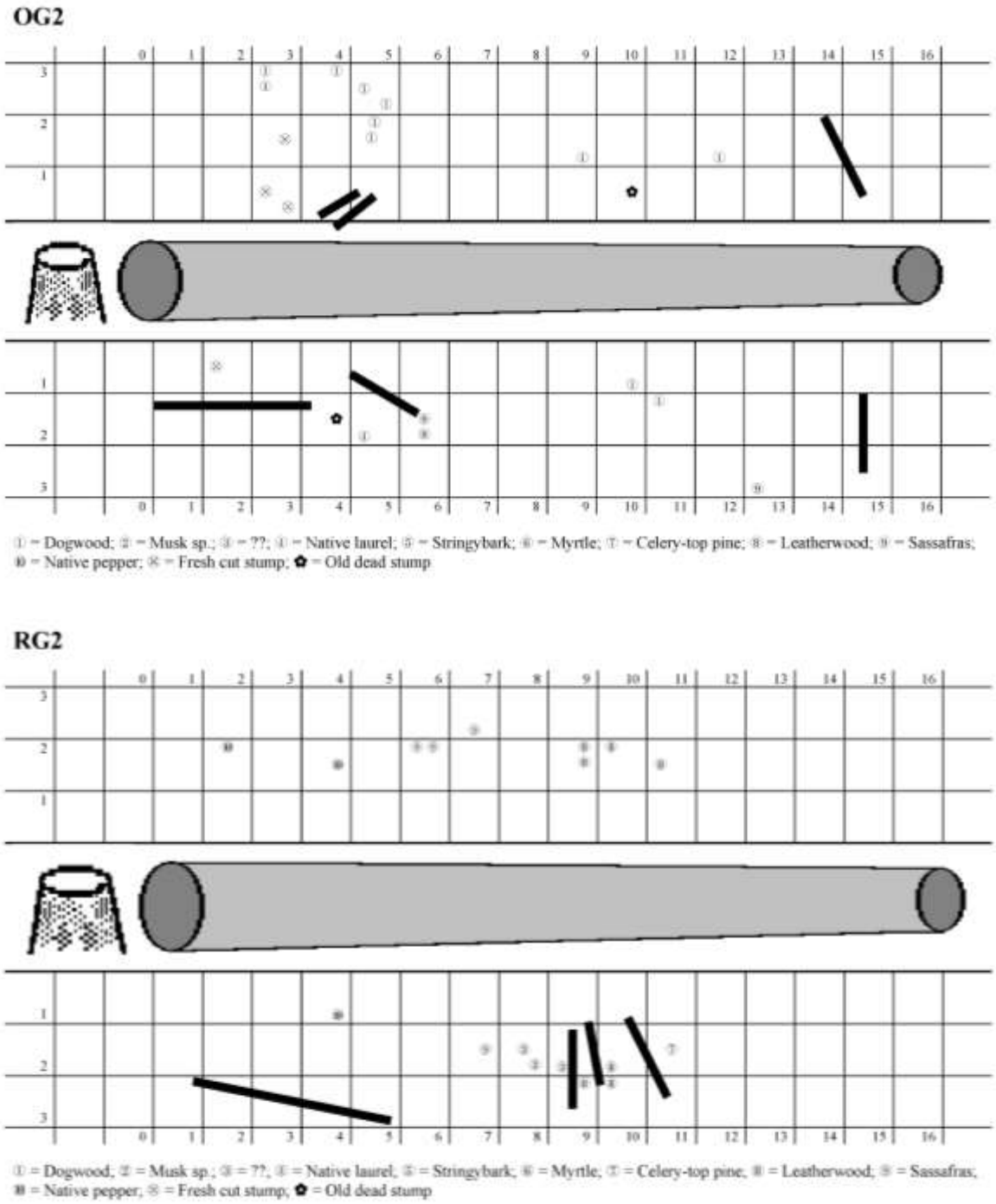


Figure 5. Forest vegetation and structure around logs OG2 and RG2. Modified from Yuan (2000).

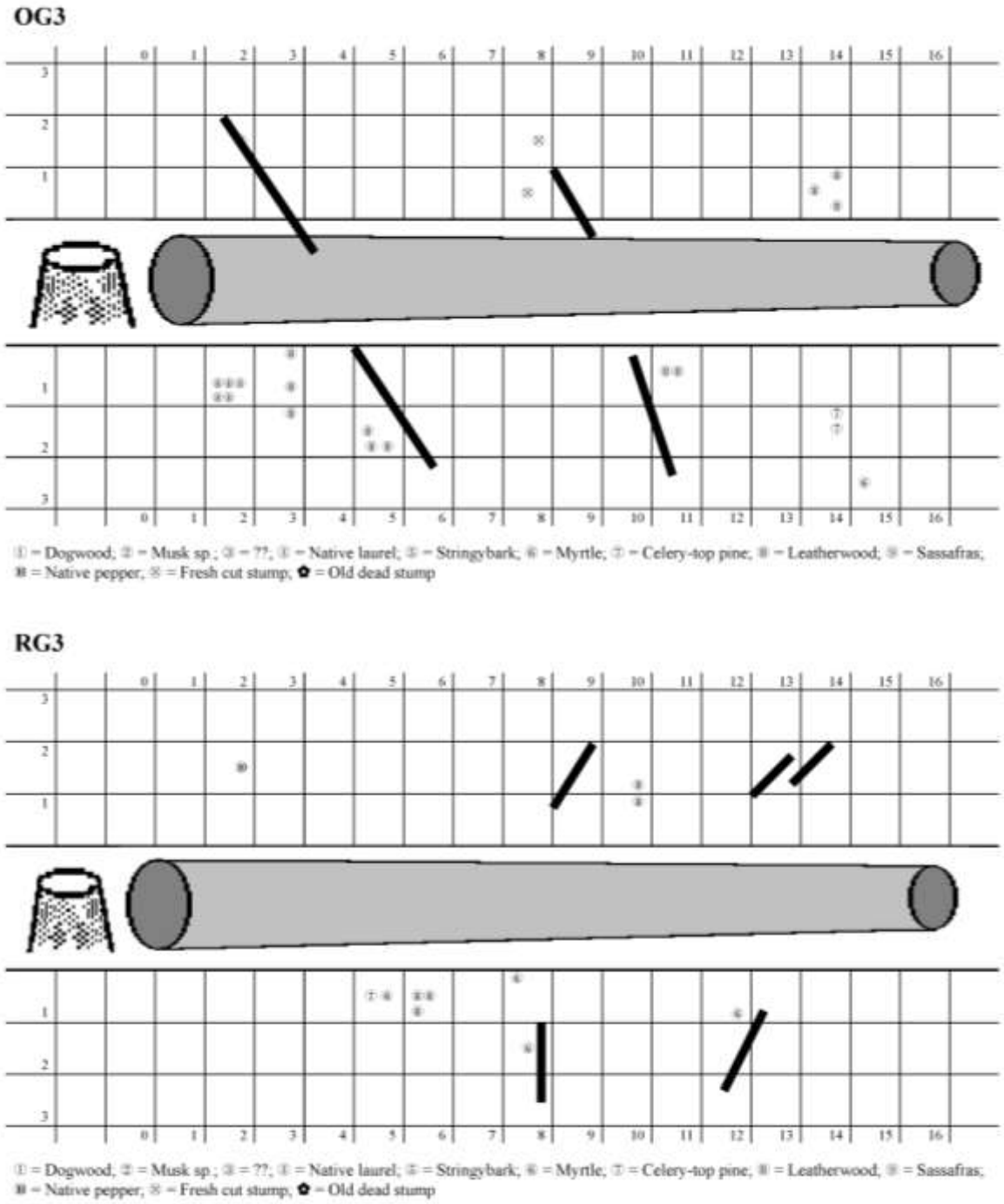


Figure 6. Forest vegetation and structure around logs OG3 and RG3. Modified from Yuan (2000).

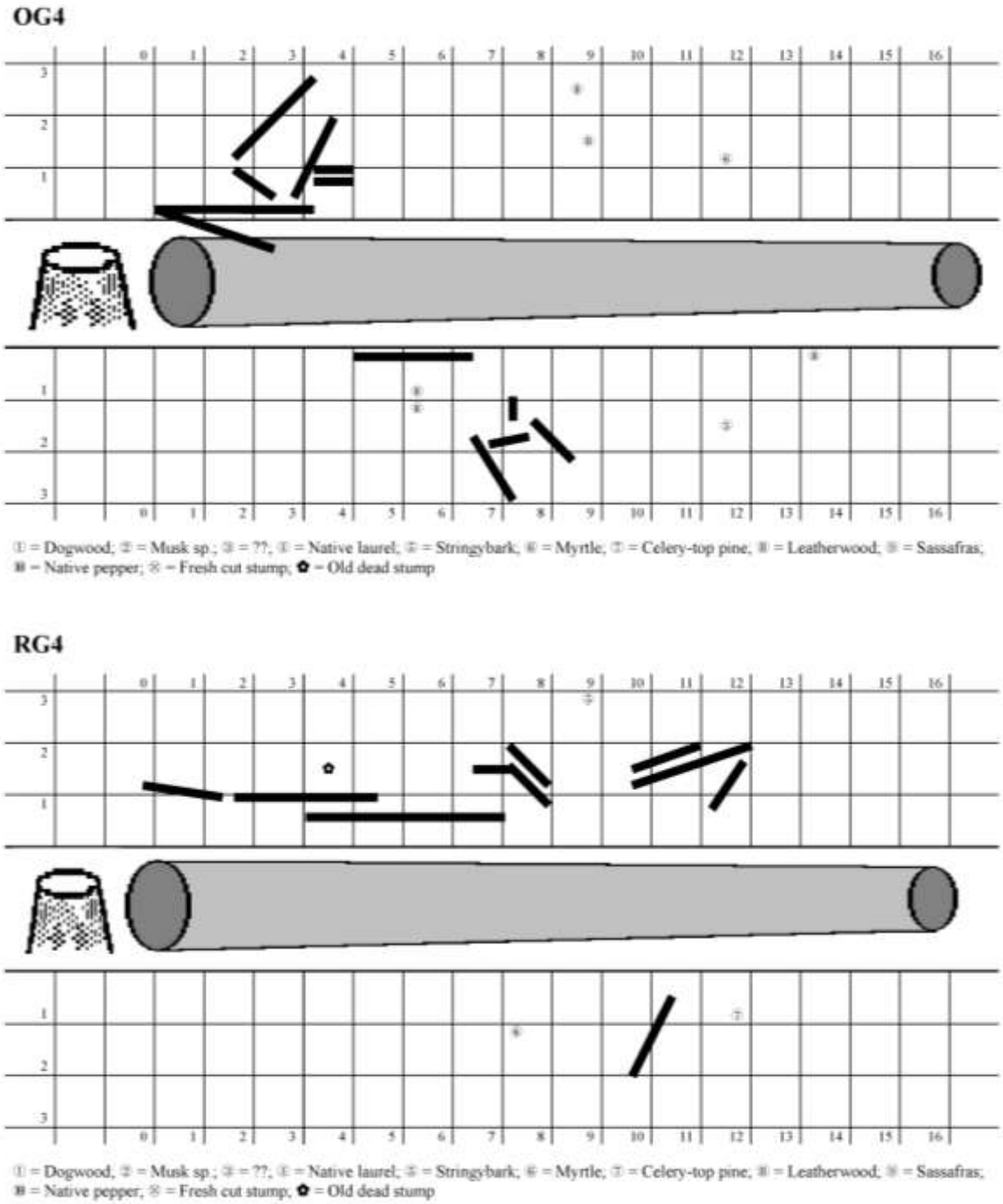


Figure 7. Forest vegetation and structure around logs OG4 and RG4. Modified from Yuan (2000).

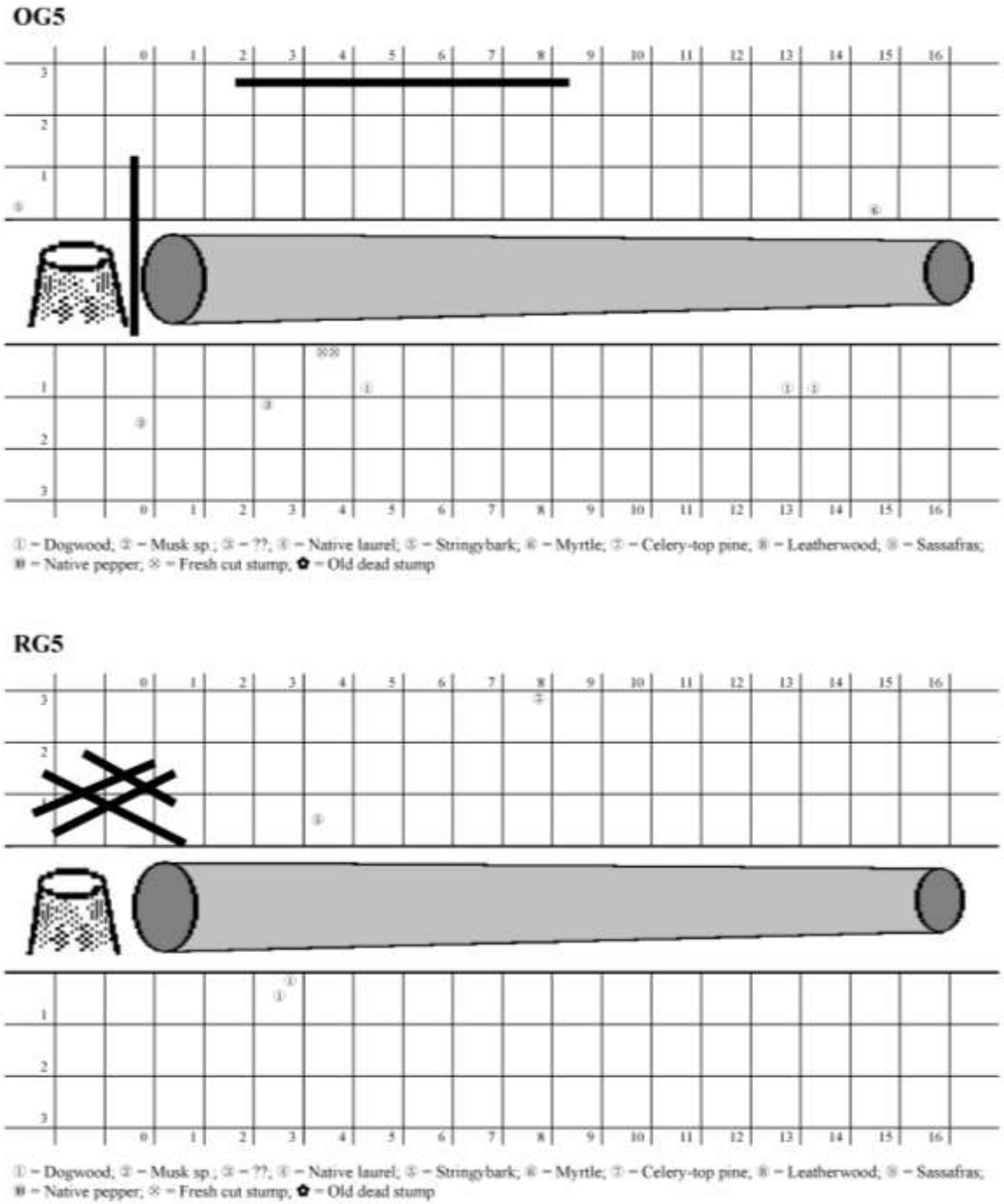
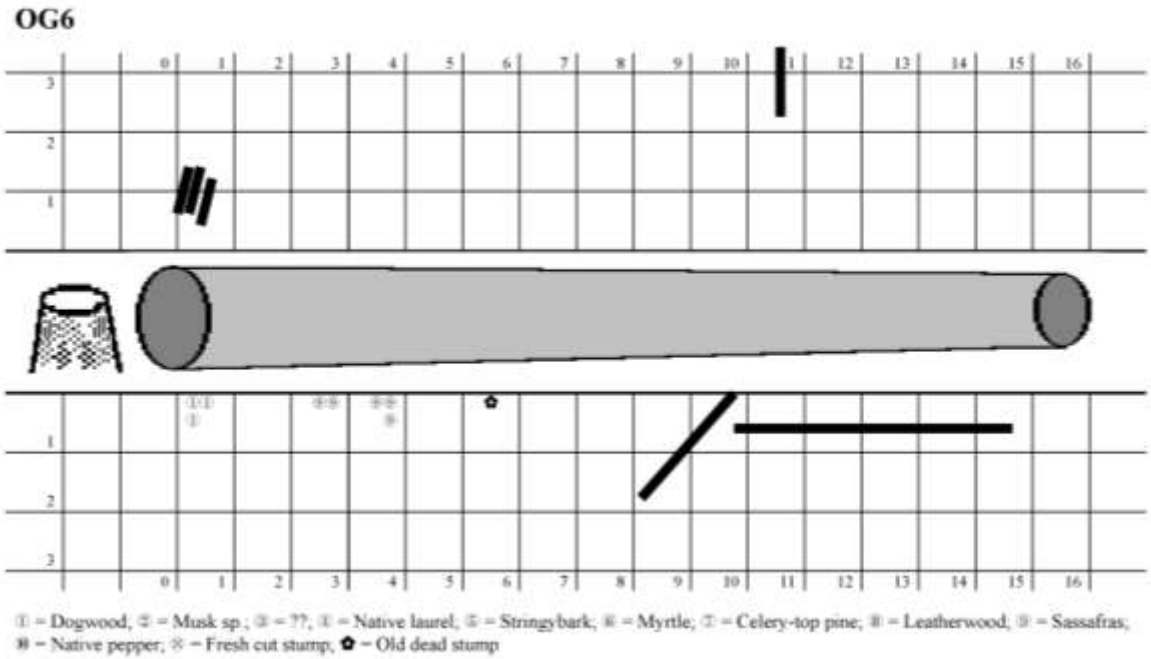


Figure 8. Forest vegetation and structure around logs OG5 and RG5. Modified from Yuan (2000).



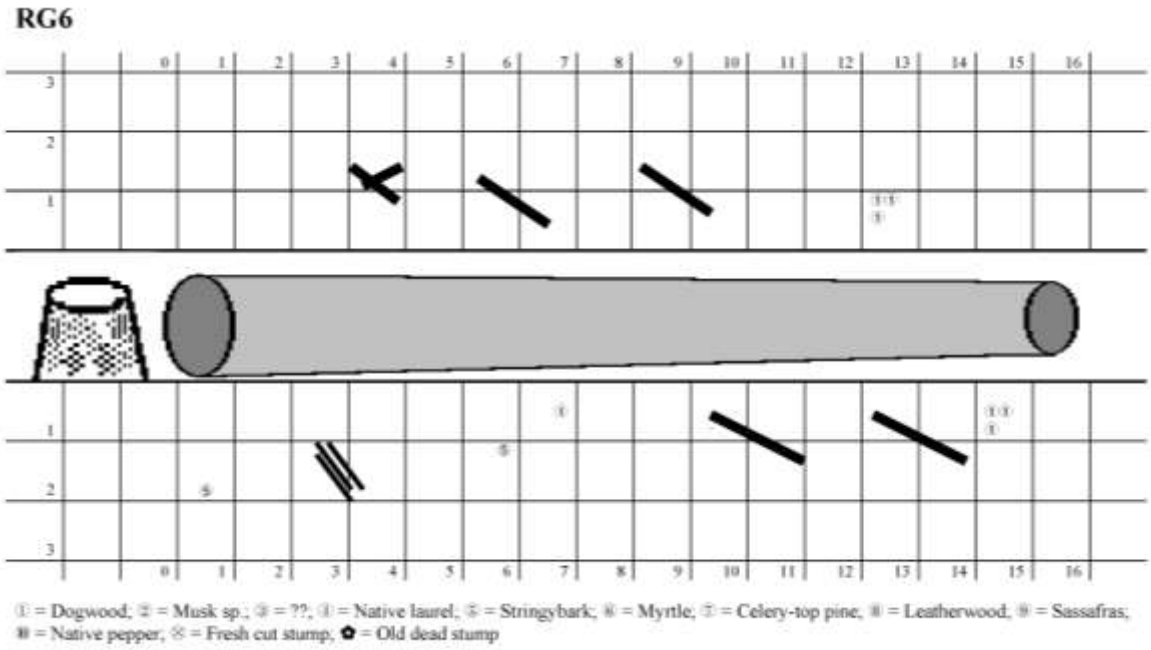


Figure 9. Forest vegetation and structure around logs OG6 and RG6. Modified from Yuan (2000).

Figure 10. The first four old-growth logs shortly after project establishment. From Yuan (2000). No photos for logs OG5 or OG6 at this stage are available.

Figure 11. The first four regrowth logs shortly after project establishment. From Yuan (2000). No photos for logs RG5 or RG6 at this stage are available.

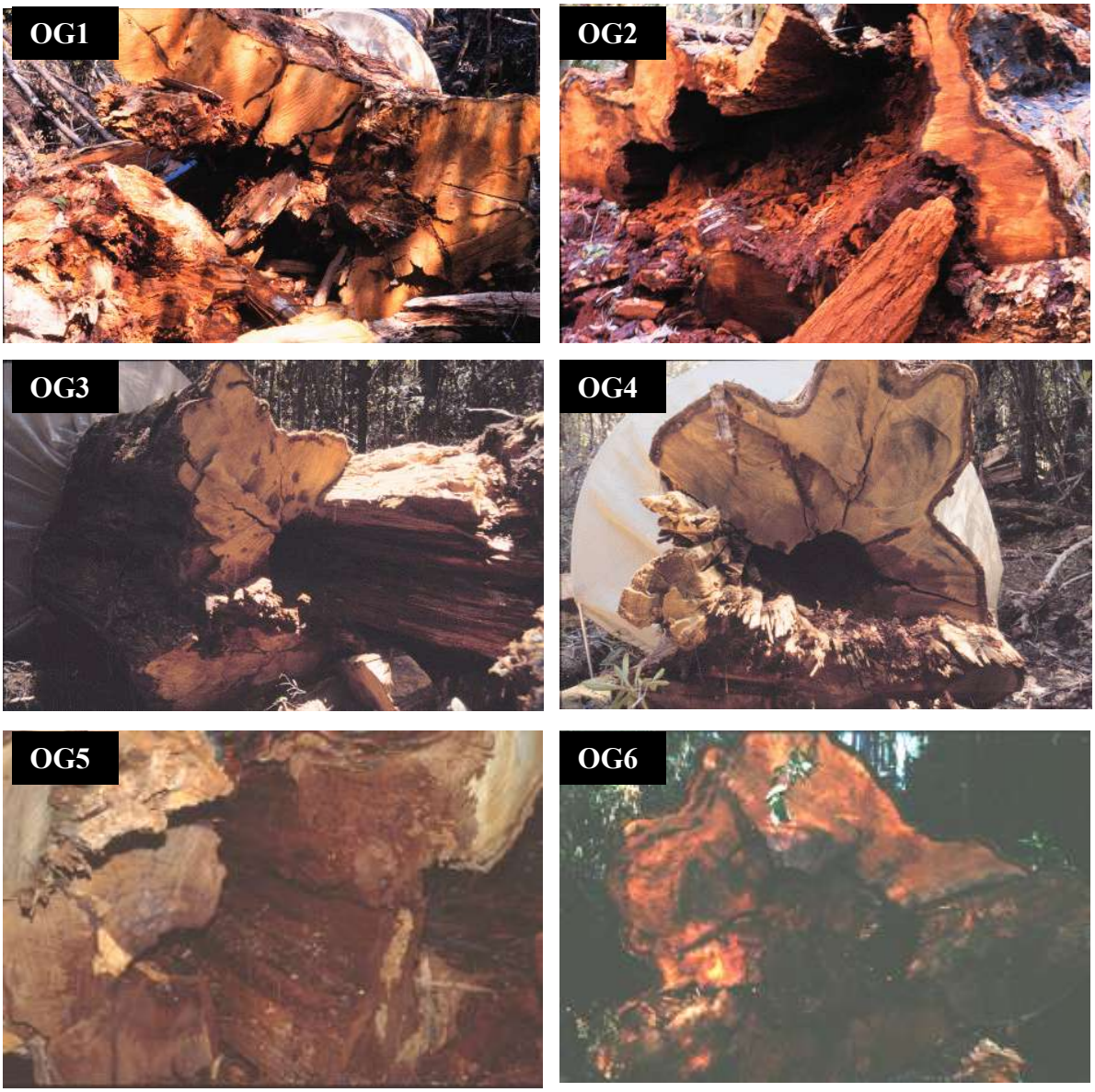


Figure 12. The cut basal ends of the six old-growth logs shortly after felling. From Yuan (2000).

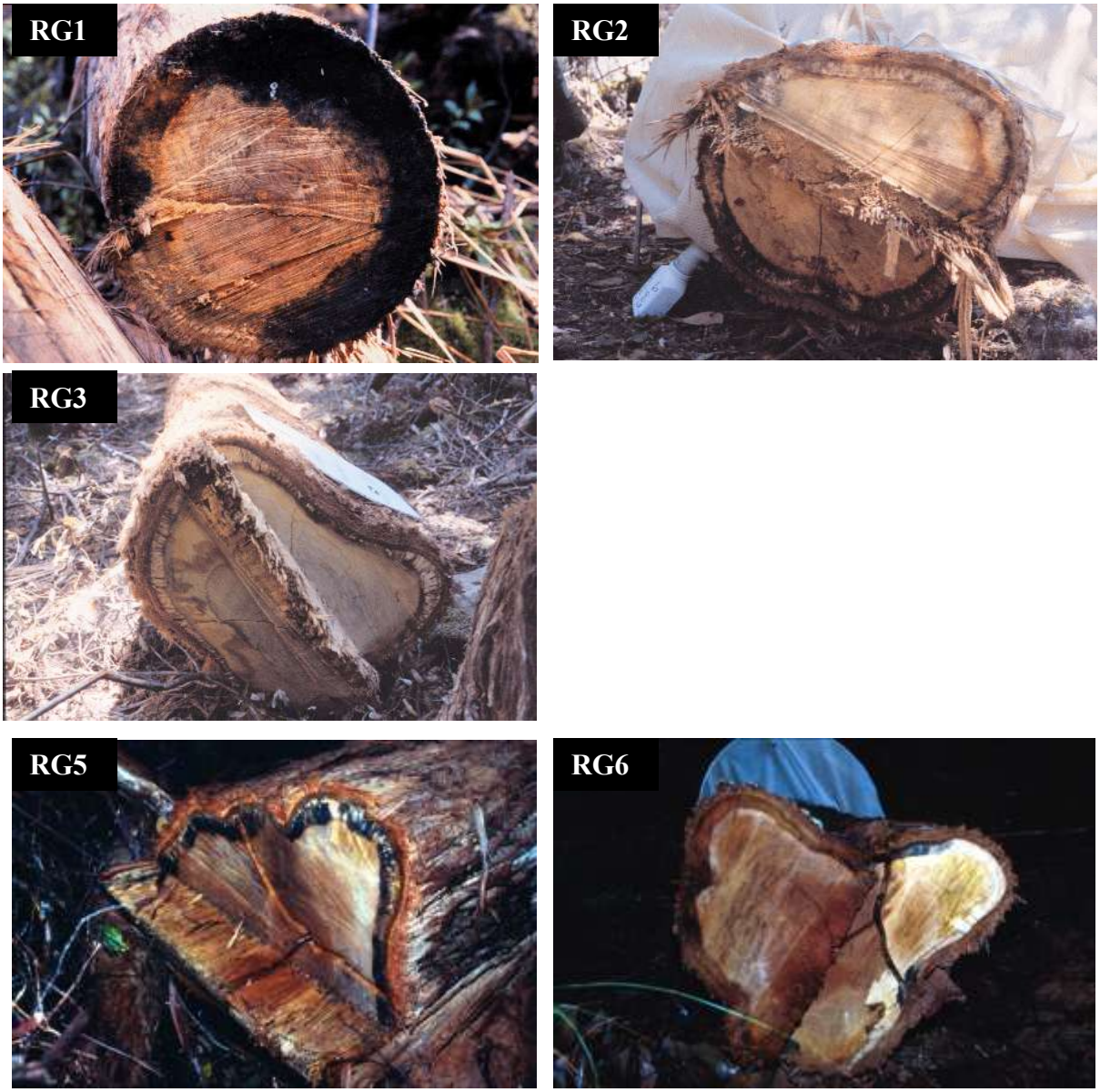


Figure 13. The cut basal ends of the five of the six regrowth logs a few months after felling. From Yuan (2000). No photo for RG3 is available for this stage.

Emergence trapping overview

Five emergence traps were erected on each log, in a chronosequence (but in a random, as opposed to linear, physical sequence, as described below). The first of these was erected immediately after felling, with subsequent traps erected at intervals of three months (Table 4). Each trap was left in position for about three years (or at least two complete summers), and then opened for a further two-year period to expose that section of the log surface to further colonisation by invertebrates before being closed again. This staggered sequence of trap placement, closure and opening is aimed at allowing an assessment of the influence on invertebrate assemblages of season as well as time since felling. During the first complete cycle, from 1999 to 2004, the actual number of months that each log section was enclosed and exposed (Tables 5 and 6) has deviated a little from the planned schedule outlined in Bashford *et al*. (2001). Despite this, it is planned to repeat the cycle at least one more time (Tables 7 and 8), but the format and periodicity of future sampling cycles has yet to be decided and may depend on funding and on the research outcomes from previous cycles.

Table 4. Summary of establishment dates for the sixty emergence traps, and the small-end diameters (cm) of the log sections on which they sit.

Log no	Trap no	Dia-meter	Felled	Established	Log no	Trap no	Dia-meter	Felled	Established
OG1	OG1.1	174	21/05/1999	21/05/1999	RG1	RG1.1	36	21/05/1999	21/05/1999
OG1	OG1.2	168	21/05/1999	24/11/1999	RG1	RG1.2	33	21/05/1999	24/11/1999
OG1	OG1.3	150	21/05/1999	30/05/2000	RG1	RG1.3	31	21/05/1999	30/05/2000
OG1	OG1.4	153	21/05/1999	16/11/2000	RG1	RG1.4	30	21/05/1999	16/11/2000
OG1	OG1.5	156	21/05/1999	23/05/2001	RG1	RG1.5	25	21/05/1999	23/05/2001
OG2	OG2.1	179	21/05/1999	21/05/1999	RG2	RG2.1	45	21/05/1999	21/05/1999
OG2	OG2.2	179	21/05/1999	24/11/1999	RG2	RG2.2	37	21/05/1999	24/11/1999
OG2	OG2.3	161	21/05/1999	30/05/2000	RG2	RG2.3	36	21/05/1999	30/05/2000
OG2	OG2.4	151	21/05/1999	16/11/2000	RG2	RG2.4	34	21/05/1999	16/11/2000
OG2	OG2.5	149	21/05/1999	23/05/2001	RG2	RG2.5	29	21/05/1999	23/05/2001
OG3	OG3.1	133	19/10/1999	20/10/1999	RG3	RG3.1	32	19/10/1999	20/10/1999
OG3	OG3.2	118	19/10/1999	10/05/2000	RG3	RG3.2	29	19/10/1999	10/05/2000
OG3	OG3.3	118	19/10/1999	12/09/2000	RG3	RG3.3	28	19/10/1999	12/09/2000
OG3	OG3.4	115	19/10/1999	11/04/2000	RG3	RG3.4	26	19/10/1999	11/04/2000
OG3	OG3.5	106	19/10/1999	18/10/2001	RG3	RG3.5	21	19/10/1999	18/10/2001
OG4	OG4.1	119	19/10/1999	20/10/1999	RG4	RG4.1	31	19/10/1999	20/10/1999
OG4	OG4.2	118	19/10/1999	10/05/2000	RG4	RG4.2	28	19/10/1999	10/05/2000
OG4	OG4.3	124	19/10/1999	12/09/2000	RG4	RG4.3	26	19/10/1999	12/09/2000
OG4	OG4.4	121	19/10/1999	11/04/2000	RG4	RG4.4	22	19/10/1999	11/04/2000
OG4	OG4.5	124	19/10/1999	18/10/2001	RG4	RG4.5	21	19/10/1999	18/10/2001
OG5	OG5.1	139	21/02/2000	22/02/2000	RG5	RG5.1	40	21/02/2000	22/02/2000
OG5	OG5.2	133	21/02/2000	8/08/2000	RG5	RG5.2	39	21/02/2000	8/08/2000
OG5	OG5.3	134	21/02/2000	15/02/2001	RG5	RG5.3	35	21/02/2000	15/02/2001
OG5	OG5.4	134	21/02/2000	22/08/2001	RG5	RG5.4	34	21/02/2000	22/08/2001
OG5	OG5.5	90	21/02/2000	13/02/2002	RG5	RG5.5	33	21/02/2000	13/02/2002
OG6	OG6.1	163	21/02/2000	22/02/2000	RG6	RG6.1	52	21/02/2000	22/02/2000
OG6	OG6.2	145	21/02/2000	8/08/2000	RG6	RG6.2	47	21/02/2000	8/08/2000
OG6	OG6.3	144	21/02/2000	15/02/2001	RG6	RG6.3	45	21/02/2000	15/02/2001
OG6	OG6.4	132	21/02/2000	22/08/2001	RG6	RG6.4	42	21/02/2000	22/08/2001
OG6	OG6.5	126	21/02/2000	13/02/2002	RG6	RG6.5	41	21/02/2000	13/02/2002

Table 5. Summary of actual sample collecting dates for emergence traps on the old-growth logs for the first complete sampling cycle, 1999-2004. A '1' in a cell indicates that samples were collected from that emergence trap on that date as part of the first cycle. A 'c' indicates the closure date, an 'o' indicates the opening date. A '1' in a cell indicates that samples were collected from that emergence trap on that date as part of the first cycle, and a '2' in a cell indicates that samples were collected from that emergence trap on that date as part of the second cycle.

Date	16-Jun-99	14-Jul-99	18-Aug-99	15-Sep-99	27-Oct-99	24-Nov-99	16-Dec-99	20-Jan-00	23-Feb-00	16-Mar-00	12-Apr-00	12-May-00	11-Aug-00	13-Sep-00	17-Oct-00	17-Nov-00	14-Dec-00	18-Jan-01	20-Feb-01	21-Mar-01	24-May-01	19-Jul-01	19-Sep-01	18-Oct-01	15-Nov-01	18-Dec-01	16-Jan-02	13-Feb-02	12-Mar-02	17-Apr-02	22-May-02	17-Jul-02	14-Aug-02	18-Sep-02	15-Oct-02	12-Nov-02	05-Dec-02	15-Jan-03	11-Feb-03	20-Mar-03	07-May-03	11-Jun-03	16-Jul-03	12-Aug-03	11-Sep-03	16-Oct-03	11-Nov-03	18-Dec-03	19-Jan-04	18-Feb-04	17-Mar-04	20-Apr-04	19-May-04	19-Jul-04	19-Aug-04	01-Sep-04	01-Oct-04	01-Nov-04
OG1.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																						c	2	2	2
OG1.2						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																										c
OG1.3													c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																					
OG1.4															c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o													
OG1.5																							c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o									
OG2.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																						c	2	2	2
OG2.2						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																										c
OG2.3												c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																					
OG2.4															c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o													
OG2.5																							c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o									
OG3.1				c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																									c	2	2
OG3.2												c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																					
OG3.3														c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o											
OG3.4																					c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o									
OG3.5																							c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o		
OG4.1				c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																								c	2	2
OG4.2											c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																					
OG4.3														c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o											
OG4.4																						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o					
OG4.5																								c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o		
OG5.1									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																					
OG5.2													c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o									
OG5.3																			c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o						
OG5.4																						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o				
OG5.5																									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o
OG6.1									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																					
OG6.2													c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o											
OG6.3																			c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o						
OG6.4																						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o				
OG6.5																									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o

Table 6. Summary of actual sample collecting dates for emergence traps on the regrowth logs for the first complete sampling cycle, 1999-2004. A 'c' indicates the closure date, an 'o' indicates the opening date. A '1' in a cell indicates that samples were collected from that emergence trap on that date as part of the first cycle, and a '2' in a cell indicates that samples were collected from that emergence trap on that date as part of the second cycle.

Date	16-Jun-99	14-Jul-99	18-Aug-99	15-Sep-99	27-Oct-99	24-Nov-99	16-Dec-99	20-Jan-00	23-Feb-00	16-Mar-00	12-Apr-00	12-May-00	11-Aug-00	13-Sep-00	17-Oct-00	17-Nov-00	14-Dec-00	18-Jan-01	20-Feb-01	21-Mar-01	24-May-01	19-Jul-01	19-Sep-01	18-Oct-01	15-Nov-01	18-Dec-01	16-Jan-02	13-Feb-02	12-Mar-02	17-Apr-02	22-May-02	17-Jul-02	14-Aug-02	18-Sep-02	15-Oct-02	12-Nov-02	05-Dec-02	15-Jan-03	11-Feb-03	20-Mar-03	07-May-03	11-Jun-03	16-Jul-03	12-Aug-03	11-Sep-03	16-Oct-03	11-Nov-03	18-Dec-03	19-Jan-04	18-Feb-04	17-Mar-04	20-Apr-04	19-May-04	19-Jul-04	19-Aug-04	01-Sep-04	01-Oct-04	01-Nov-04
RG1.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																							c	2	2	2
RG1.2						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																								c	2
RG1.3												c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o															
RG1.4																c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																					
RG1.5																						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o								
RG2.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																						c	2	2	2
RG2.2						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																									c
RG2.3												c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																				
RG2.4																c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o												
RG2.5																						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o								
RG3.1				c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																							c	2	2
RG3.2											c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																			
RG3.3														c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o										
RG3.4																					c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o								
RG3.5																									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o		
RG4.1				c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																							c	2	2
RG4.2											c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																			
RG4.3														c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o										
RG4.4																					c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o								
RG4.5																									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o		
RG5.1									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																				
RG5.2													c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o										
RG5.3																			c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o							
RG5.4																						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o			
RG5.5																									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o
RG6.1									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o																				
RG6.2													c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o										
RG6.3																			c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o							
RG6.4																						c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o			
RG6.5																									c	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	o

Table 7. Summary of actual or scheduled sample collecting months for emergence traps on the old-growth logs for the second complete sampling cycle, 2004-2009. . A 'c' indicates the closure date, an 'o' indicates the opening date. A '2' in a cell indicates that samples were collected, or are scheduled to be collected, from that emergence trap on that date as part of the second cycle, and a '3' in a cell indicates that samples are scheduled to be collected from that emergence trap on that date as part of the third cycle, assuming the same format and periodicity is retained.

Month	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09
OG1.1	c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					c	3	3	3	3	3	3	3	3	3	3	3
OG1.2				c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					c	3	3	3	3
OG1.3										c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
OG1.4																c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																	
OG1.5																						c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o											
OG2.1	c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					c	3	3	3	3	3	3	3	3	3	3	3
OG2.2				c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					c	3	3	3	3
OG2.3										c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
OG2.4																c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																	
OG2.5																						c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o											
OG3.1		c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					c	3	3	3	3	3	3
OG3.2								c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
OG3.3														c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																				
OG3.4																				c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o														
OG3.5	1	o																							c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o								
OG4.1		c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					c	3	3	3	3	3	3
OG4.2								c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
OG4.3														c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																			
OG4.4																				c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o														
OG4.5	1	o																							c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o							
OG5.1							c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
OG5.2													c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																			
OG5.3																			c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o													
OG5.4																								c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o							
OG5.5	1	1	1	o																										c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o	
OG6.1							c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
OG6.2													c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																			
OG6.3																			c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o													
OG6.4																									c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o							
OG6.5	1	1	1	o																										c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o	

Table 8. Summary of actual or scheduled sample collecting months for emergence traps on the regrowth logs for the second complete sampling cycle, 2004-2009. A 'c' indicates the closure date, an 'o' indicates the opening date. A '2' in a cell indicates that samples were collected, or are scheduled to be collected, from that emergence trap on that date as part of the second cycle, and a '3' in a cell indicates that samples are scheduled to be collected from that emergence trap on that date as part of the third cycle, assuming the same format and periodicity is retained.

Month	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09
RG1.1	c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																				c	3	3	3	3	3	3	3	3	3	3	3
RG1.2				c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					c	3	3	3	3
RG1.3										c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
RG1.4																c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																	
RG1.5																						c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o											
RG2.1	c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																				c	3	3	3	3	3	3	3	3	3	3	3
RG2.2				c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					c	3	3	3	3
RG2.3										c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
RG2.4																c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																	
RG2.5																						c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o											
RG3.1		c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							c	3	3	3	3	3	3
RG3.2								c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
RG3.3														c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																					
RG3.4																				c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o															
RG3.5	2	o																							c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o								
RG4.1		c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							c	3	3	3	3	3	3
RG4.2								c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
RG4.3														c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																				
RG4.4																				c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o														
RG4.5	2	o																							c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o								
RG5.1							c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
RG5.2													c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																				
RG5.3																			c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o															
RG5.4																								c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o								
RG5.5	2	2	2	o																										c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o	
RG6.1							c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																							
RG6.2													c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o																				
RG6.3																			c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o														
RG6.4																									c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o								
RG6.5	2	2	2	o																										c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	o	

Emergence trap design

Each emergence trap encloses a three-metre long section of log. The frames were designed, and their components cut to size, at the FT workshops by Byron Garrod. The frame itself encompasses the middle two metres of this section, and is made from 16 mm aluminium rods, some of which are curved to form 3 partial hoops, 1 m apart along the log section. These hoops ensure that there is an airspace of about 50 cm between the log surface and the shade cloth. The rods are joined together with blocks made from 50 mm lengths of 50 x 50 mm aluminium bar. Paired 17 mm holes are drilled through each block in two planes, allowing for the rods to be inserted and held in place by 3 mm grub-screws (Figure 14a). A sheet of 80% density white shade cloth is then laid over the frame, and nailed to the log just above soil level through 25 mm wide strips of metal strapping (Figure 14b). The ends of the trap are sealed around the exposed circumference of the log with nails and further metal strapping.

Each trap bears two sorts of collecting apparatus. One is a single collecting head attached at the highest point of the trap. The bottle from this is referred to as the 'upper' collecting bottle (though sometimes called the 'Malaise' collecting bottle because of the analogy with Malaise trapping). The head consists of two aluminium plates, each with a 40 mm hole. The inside plate is welded inside the top of the end hoop of the aluminium frame, while the outside plate has a 42 mm dia x 80 mm length aluminium pipe welded to one side. A PVC 'u' bend plumbing fitting (iPLEX D0024088) of 40 mm diameter fits inside the aluminium tube and is held in place with a grub-screw (Figure 14c). A small hole is made in the shade cloth and the fitting is pushed through from the inside. The aluminium plates fit either side of the shade cloth and are held in place with cable ties, securing the fitting in a downward-facing position and forming a tight seal around the surrounding shade cloth. The cap of the collecting bottle is drilled out to 40 mm and then sealed to the externally protruding end of the fitting with waterproof plumbing cement. The collecting bottle is then screwed back into its cap.

The other sort of collecting apparatus is represented by two bottles at two of the lowest points of the trap. One in attached in one of the corners of the trap on the left-hand side of the log and the other in one of the corners of the trap on the right-hand side. Together they are referred to as the 'lower' collecting bottles (though sometimes called 'pit' bottles because they are analogous to pitfall trapping). These bottles are affixed to the corners of the trap using the same 'u' bend plumbing fitting as for the upper collecting head. The cap of the collecting bottle is drilled out to 40 mm and sealed to the end of the fitting with waterproof plumbing cement. A small hole is made in the shade cloth, and the other end of the fitting is inserted into this hole and attached to the surrounding shade cloth with a 40-55 mm diameter hose clamp (Figure 14d), in such a way as it points downwards. The collecting bottle is then screwed back into its cap.

Each emergence trap bears three collecting bottles, as described above. Each is charged with 80% ethanol as the collecting fluid. The upper collecting bottle primarily collects animals that are trying to disperse by flying, but will also collect many crawlers that are positively phototactic. The bottle collecting bottles primarily collect animals that are trying to disperse by crawling, or are otherwise negatively phototactic. They are are distinguished by 'l' for left or 'r' for right. Since the

distinction between the two sides of the log has little ecological significance, the two lower bottle samples are merged on return to the lab into a single 'lower' sample.

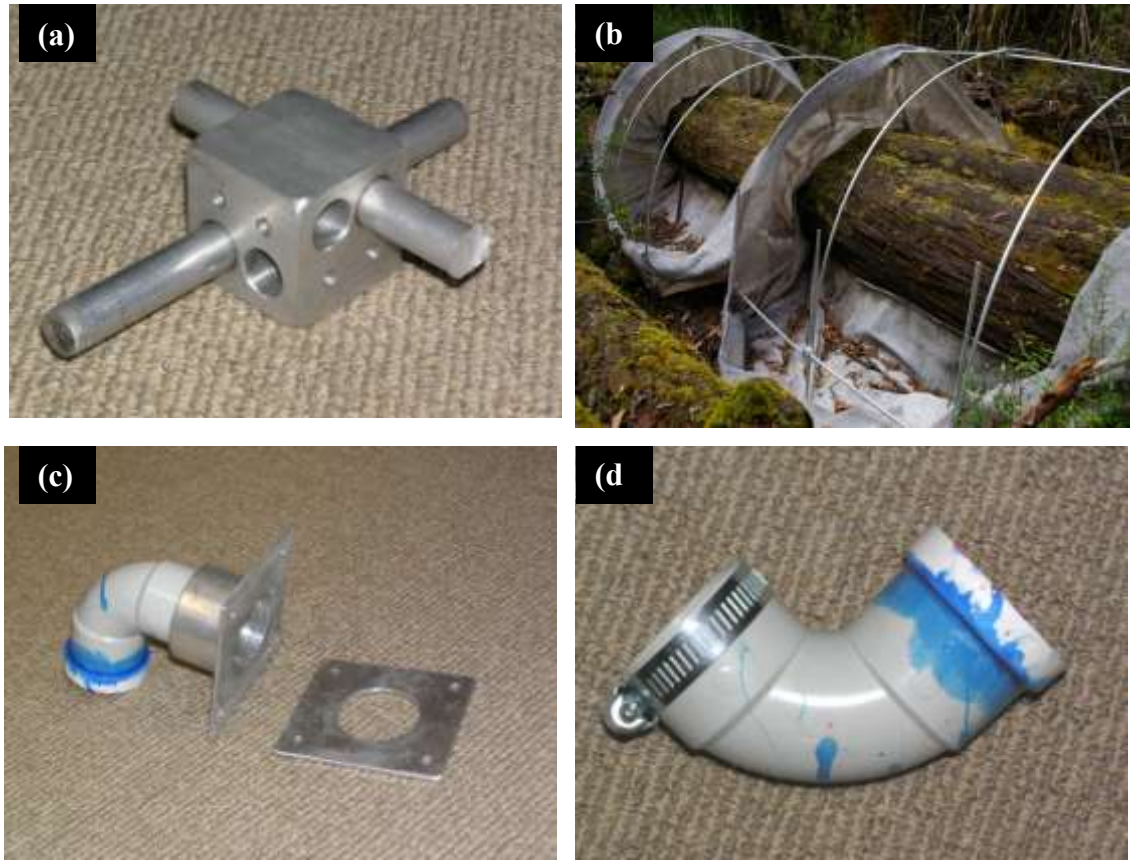


Figure 14. Details of emergence trap construction. (a) Aluminium joining blocks. (b) Trap *in situ* showing aluminium frame. (c) Upper collecting bottle assembly. (d) Lower collecting bottle assembly.

Emergence trap opening and closing

Since the first sampling period has been completed, the traps have been opened up (to re-expose the log to colonisation by invertebrates etc.) by cutting through the shade cloth along the line of the outermost hoops and along the base on one side (i.e. the middle 2 m). The cloth is then rolled back from one side towards the other. The shade cloth is left on site, attached on one side but rolled up. At the start of the second sampling period, the old shade cloth has been re-used but supplemented with a further layer of 65% density shade cloth. To do this, a new 2 m section is affixed with cable ties to the bottom bar and to the end side bars of the trap. The old 2 m section is then unrolled over it and fixed to the frame at the side and end hoops with further cable ties. This means that there is now a double layer of shade cloth over the 2 m central portion of the trap. At the end of this and subsequent sampling periods, the cable ties will be cut and the double layer of shade cloth rolled back to one side.

Emergence trap numbering and marking system

Each of a log's five emergence traps is numbered sequentially from the log's butt end. This numbering system replaces the one initially adopted, which randomly allocated numbers between 1 and 5 to each section. The purpose of this randomisation was to

ensure that the sequence of trap opening and closing was random with respect to trap position along the log. However, once this sampling program had been established, it was felt that there was more room for human error in sample collection if the trap numbers did not correspond to their physical position (this was especially the case when not all the traps had yet been erected). The change to the current system occurred in May 2002. All references to the previous system (e.g. on sample labels, specimen labels and in databases) at FT have been updated so that in theory there is no need to preserve any references to the previous system. However, some material (ants, spiders, millipedes) bearing labels based on the previous system was sent to the Queen Victoria Museum in the first year of the study. Hence a conversion table is retained in Appendix 2.

Each emergence trap bears an aluminium tag, attached with wire next to the upper collecting bottle. The tag is inscribed with the trap's number. This system replaces a previous one in which the trap's number was spray-painted directly onto the fabric. All such paint has now faded.

Sample collection and processing

Sample collection and trap maintenance is overseen by the FT senior silvicultural technician (Dick Bashford) and is carried out by him and by technical officers (to date, Bill Brown, Andy Muirhead, Alison Phillips and Billy Burton). Appendix 1 describes the sample collection protocol - but it should be noted that there is still room for improvement. In particular, it would be preferable to have labels (see below) prepared prior to sample collection, so that these can be put directly into sample bottles as they are collected. This would eliminate the risk of sticky labels become unreadible or peeling off.

Collecting bottles are generally collected monthly, although in winter some have only been collected every other month. Occasionally, sample bottles are found damaged (e.g. chewed by devils) or missing (e.g. due to the glue in the collecting head failing). The incidence of damage by devils may have been reduced recently by applying 'Vicks Vaporub' to the bottles every month. A diary document summarising collection and maintenance visits to the log decay study site has been kept since August 2004 and is stored at **G:\silv\Forest Research\Warra\Warra project data\1999\99-02 Grove\Field work diary_Log decay.doc**. These data are used to periodically update the corresponding sample information in the FT-TFIC biodiversity database.

Follow-up work in the laboratory involves several stages. First, labels are prepared in advance in large batches by exporting the appropriate data from the FT-TFIC biodiversity database. Larger labels, suitable for immersing in sample pots, are printed onto 'Teslin', while multiple copies of smaller versions, suitable for dry-mounted specimens, are printed on acid-free card or parchment. An example of label layout is given in Figure 15. Next, the two lower collecting bottles (i.e. left and right) from each emergence trap are combined into a single sample. Next, sample labels are added to each sample pot (to replace the hand-written ones stuck on the outside of the bottle at the time of collection). Next (for the first sampling cycle at least), beetles (and sometimes other invertebrate taxa of interest) are extracted, sample by sample. Most of this work to date has been accomplished by Dick Bashford. All these beetles are dry-mounted and labelled (to date, by Dick Bashford and Belinda Yaxley). They

are then identified, databased and incorporated into the TFIC (to date, by the FT conservation biologist Simon Grove). Meanwhile, sample residues are archived separately in 80% ethanol, in labelled urine sample pots. The intention is that these will eventually be archived at the Queen Victoria Museum (Launceston), but in the interim they reside on the mezzanine floor of the FT laboratory.

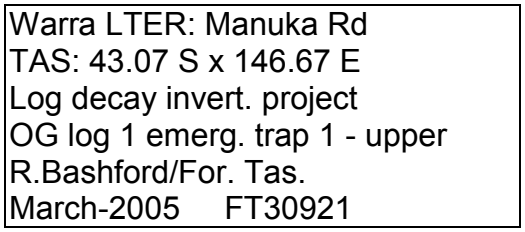


Figure 15. An example of an emergence trap sample or specimen label layout.

Options for future cycles of emergence trapping

The second cycle of collection is currently under way, and it would seem sensible to complete this according to the schedule in Tables 5 and 6. Meanwhile sorting and identification of the first cycle of collection is also under way, and a publication based on the findings is expected late in 2005. Other priorities within FT mean that samples from the second cycle are unlikely to be sorted in the near future.

The shade cloth is meant to last ten years. This means that the cloth, and some other plastic components used in trap construction, may need replacing before a third cycle can be instigated. This may be the time to reassess the format and periodicity of future sampling cycles. It may be that the logs could be left exposed for much longer than two years between cycles as the logs progress towards later, more stable decay classes. It may also be worth discontinuing investigating the seasonal aspects of colonisation and emergence, since this is of less management interest than longer-term successional aspects. Seasonality is also likely to have a diminishing signature as time goes on - or at least it will become more and more difficult, and less and less relevant, to link assemblage composition to the season in which the tree was originally felled. Discontinuing seasonality studies could greatly simplify the sampling design and might reduce the need for so many emergence traps on each log. This, in turn, might free up areas of the same logs for related studies - for instance on succession in cryptogams, or for taking samples of the rotting wood itself to determine decay rates or to culture wood-rotting fungi.

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Appendix 1. Protocol for log decay sample collection.

BEFOREHAND:
Book vehicle.
Prepare equipment:

- Containers (white 500ml rectangular) & lids - 36 to 144 (check Tables 5-6)*
- (either with ethanol already in, or take a barrel of ethanol separately)
- Barrel of ethanol (~75%) (as above)
- Sticky labels
- Permanent marker pen/paint pen
- Lacing needle + cord (for fixing any damage to tents)
- Spare necks and collars (for replacing any damaged ones)
- Stanley-knife (esp. for opening tents)
- Pliers
- Cable ties (esp. when replacing/closing traps)
- Scissors
- Shade cloth
- Army-knife and/or screwdriver
- Chest rub ('Vapo-rub')**
- Flagging tape
- Tape – electrical or duct tape
- Map/ notes
- Field notebook (waterproof paper) and pencil
- First aid kit
- Keys for gates

* Could be anywhere between 36 and 144. Check Tables 5-6, or the calendar in the FT laboratory, and note down how many bottles will be needed plus whether any of the emergence traps will need to be opened or closed.
** 'Vapo-rub' (or equivalent) is for using on collecting heads and bottles that have been previously attacked by Tasmanian devils. It has dubious success, so putting the (attached) bottle into the protection of a piece of plastic piping is a better method to try.

DURING:
Before proceeding to each part of the site (top, middle, bottom) check how many sample collecting bottles will be needed and take at least that many. Also take labels and marker pen, a spare neck and collar and Stanley-knife and/or pliers, cable-ties and shade cloth if any emergence traps are to be opened and/or closed. Also a field notebook to note down what traps have sampled and ANY irregularities/problems with the samples/traps etc. Other equipment can be left at the car and retrieved as necessary.

At each log emergence trap change each of the three collecting bottles (two lower and one upper) and label these straight away. Be careful not to get ethanol on the label or it may become illegible. As a precaution, so as not to forget any of them, it is worth writing on the sticky labels before starting any particular pair of logs. Then if there is a label left over it is clear that there is still a trap to change. The label sticks better on the lid than on the side of the container . If it is raining, try to dry the spot a little before putting the sticker on as it will stick better.

Also, note down the temperatures from the gauges at RG2 and OG2 (middle site; min./max./current temps).

AFTER:
As soon as possible after sampling, make up Teslin sample labels (if these haven't been made in advance). Samples are transferred into the small, round, blue-lidded containers. Replace the ethanol in any rain-diluted samples. All samples are stored in 80% ethanol.

One technique is to pour most or some of the sample through a tea strainer (especially if the volume has increased greatly through dilution with rainwater) and rinse what's left in the bigger container and what's in the strainer all into the smaller container. The upper samples are transferred into one pot (the 'upper' sample), while the two pit samples are combined in this process to just one pot (the 'lower' sample). Make sure the Teslin label is in there, and top up the ethanol to about ¾ full. In this process it is worth arranging the samples in order (in log and trap no.) to make sure that all the samples are present and accounted for. Then they are stored, usually in Reflex paper boxes. Two labels should be printed out for each of these boxes (one for the front and one for the side of the box – at least one of

these is on the base of the box as lids can get muddled up more easily). Then the boxes are stored, in sequence, on the shelving up on the mezzanine floor of the FT laboratory.

Finally, the various bottles and pots that have been used require a quick wash and should then be left to dry, and then repacked ready for the next month's sampling. Any broken ones should be replaced.

In the FT-TFIC biodiversity database, change the sampling date from the default of the 1st of the month to the actual sampling date. Also, record any irregularities in the comments field of the sample table of the database. Update temperature details for logs RG2 and OG2 in the appropriate file too.

Appendix 2. Table for converting position number to trap number. These conversions were put into effect in about May 2002 and have been applied retrospectively to all samples at FT, but those already distributed by this date, e.g. to the Queen Victoria Museum, would still bear the old position number.

OG log 1 trap 1 (formerly position 1)	RG log 1 trap 1 (formerly position 3)
OG log 1 trap 2 (formerly position 2)	RG log 1 trap 2 (formerly position 1)
OG log 1 trap 3 (formerly position 4)	RG log 1 trap 3 (formerly position 5)
OG log 1 trap 4 (formerly position 5)	RG log 1 trap 4 (formerly position 4)
OG log 1 trap 5 (formerly position 3)	RG log 1 trap 5 (formerly position 2)
OG log 2 trap 1 (formerly position 2)	RG log 2 trap 1 (formerly position 5)
OG log 2 trap 2 (formerly position 3)	RG log 2 trap 2 (formerly position 2)
OG log 2 trap 3 (formerly position 4)	RG log 2 trap 3 (formerly position 1)
OG log 2 trap 4 (formerly position 5)	RG log 2 trap 4 (formerly position 3)
OG log 2 trap 5 (formerly position 1)	RG log 2 trap 5 (formerly position 4)
OG log 3 trap 1 (formerly position 1)	RG log 3 trap 1 (formerly position 3)
OG log 3 trap 2 (formerly position 3)	RG log 3 trap 2 (formerly position 4)
OG log 3 trap 3 (formerly position 2)	RG log 3 trap 3 (formerly position 2)
OG log 3 trap 4 (formerly position 5)	RG log 3 trap 4 (formerly position 1)
OG log 3 trap 5 (formerly position 4)	RG log 3 trap 5 (formerly position 5)
OG log 4 trap 1 (formerly position 4)	RG log 4 trap 1 (formerly position 5)
OG log 4 trap 2 (formerly position 1)	RG log 4 trap 2 (formerly position 1)
OG log 4 trap 3 (formerly position 2)	RG log 4 trap 3 (formerly position 3)
OG log 4 trap 4 (formerly position 5)	RG log 4 trap 4 (formerly position 4)
OG log 4 trap 5 (formerly position 3)	RG log 4 trap 5 (formerly position 2)
OG log 5 trap 1 (formerly position 3)	RG log 5 trap 1 (formerly position 4)
OG log 5 trap 2 (formerly position 1)	RG log 5 trap 2 (formerly position 5)
OG log 5 trap 3 (formerly position 5)	RG log 5 trap 3 (formerly position 1)
OG log 5 trap 4 (formerly position 4)	RG log 5 trap 4 (formerly position 3)
OG log 5 trap 5 (formerly position 2)	RG log 5 trap 5 (formerly position 2)
OG log 6 trap 1 (formerly position 2)	RG log 6 trap 1 (formerly position 4)
OG log 6 trap 2 (formerly position 1)	RG log 6 trap 2 (formerly position 2)
OG log 6 trap 3 (formerly position 3)	RG log 6 trap 3 (formerly position 1)
OG log 6 trap 4 (formerly position 4)	RG log 6 trap 4 (formerly position 3)
OG log 6 trap 5 (formerly position 5)	RG log 6 trap 5 (formerly position 5)