

## FLORISTIC COMPOSITION OF A SIX-YEAR-OLD CLEARFELLED COUPE IN THE WELD/HUON VALLEY

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### SUMMARY

The floristic composition of a 160 ha coupe, Warra 011B, was surveyed six years after it was clearfelled, burnt and sown (CBS) and compared with a pre-harvest survey to determine the change in species composition due to the silvicultural treatment. The comparison is limited because the pre-harvest survey was based on a planned walk that sampled a range of environments and maximised species richness information whereas the post-harvest survey was based on 9 randomly located 100 m<sup>2</sup> plots plus a reconnaissance walk across the coupe. Additional uncertainty resulted from different botanical skill levels in pre-harvest and post-harvest surveyors.

The pre-harvest survey recorded 54 species. Of these, 31 species (57%) were also recorded in the regeneration at age 6. Fifty-seven native vascular plant species were present in the regeneration, which included 26 species that had not been recorded in the coupe before harvest. Twenty-three species that had been recorded before logging were not found in the regeneration. Eleven of these were epiphytic ferns, which may re-establish as moist microhabitats develop within the growing forest. Although the CBS treatment has changed species assemblages, the regeneration includes a diverse flora with a high representation of early successional species.

A weak negative relationship was found between distance from the mature forest edge and the richness of rainforest species, which suggests that retained mature forest edges facilitate the recolonisation of rainforest species. There was no significant relationship between edge distance and the richness of non-rainforest species, which suggests that the distribution of propagules for these species was more even.

The results will be used to inform guided visitors to the coupe, which currently number about 300 people annually. An ongoing study at the nearby Warra Silvicultural Systems Trial, based on multiple measurements of

permanent plots established prior to harvesting, should more precisely determine the long-term effects of clearfell, burn and sow, and alternative silvicultural practices, on the floristic composition of wet eucalypt forests.

## INTRODUCTION

Warra 011B (GDA 476000E 5232500N) is a 160 ha coupe (Figure 1) with an altitudinal range of more than 200 m. It is accessed via Warra Road and is often used visited on guided tours to the Warra Long Term Ecological Research Site ([www.warra.com](http://www.warra.com)). About 300 people are guided through the Site annually. An informal lookout above a quarry at Warra 011B provides excellent views of the Weld Valley, Snowy Range, Barn Back and, in the distance, Mt Wellington.



**Figure 1.** Aerial view of Warra 011B in 1998. Note Weld Ridge in the background and Warra 012E (clearfelled, burnt and sown in 1989) to the right. The informal lookout is located above a quarry near the centre of the coupe.

A pre-harvest botanical survey (Williams 1986) resulted in a list of communities and vascular plant species for the coupe. Harvesting of special timbers commenced in 1985 and clearfelling was carried out over the period from 1991 through to 1996. The coupe was enlarged due to the lengthy delay in approval of annual woodchip licences for new coupes while the Australian and Tasmanian Governments negotiated arrangements for the Comprehensive Regional Assessment process that led to the 1997 Regional Forest Agreement. The coupe was burnt and sown in March 1998 with a mixture of *Eucalypt-*

*tus obliqua* and *E. delegatensis* (sowing mix 38% and 62% respectively).

A short study was undertaken in December 2004 to record vascular species richness and abundance in the six-year-old regeneration and compare it with the species recorded from the pre-harvesting survey. The main purpose was to provide information for mooted interpretation development at the informal lookout. A secondary aim was to compare the local floristic changes after clearfelling at Warra 011B with broader studies conducted elsewhere, e.g. Hickey (1994). It was also of some interest to compare findings at Warra 011B with a report (Green *et al.* 2004) of another regenerated coupe in the Weld Valley (Warra 15H) where the authors reported only 12 vascular species in the regeneration.

## METHODS

### *Pre-harvest survey*

A pre-harvest botanical survey was carried out over Warra 012A and 011A (Williams 1986). Warra 011A was since integrated into the larger 011B coupe. Species found in 012A but not in 011A were excluded from the comparison. Williams undertook a planned walk that encompassed a range of environments to maximise species richness information. The lower elevations of 011B, with tall *E. obliqua* mixed forest were not included in the sampling area. Some 54 vascular species were recorded within Warra 011B, including 44 classified as rainforest species (after Jarman *et al.* 1991).

Three forest communities were recorded by Williams (1986):

- Tall *E. delegatensis* over *Nothofagus cunninghamii*, *Phyllocladus aspleniifolius*, *Eucryphia lucida* and *Atherosperma moschatum* thamnic rainforest.
- Tall *E. delegatensis* forest over *Atherosperma moschatum*, *Eucryphia lucida* and *Nothofagus cunninghamii* with a predominant *Dicksonia antarctica* understorey.
- Tall *E. nitida* forest over *Phyllocladus aspleniifolius* implicate rainforest.

### *Post harvest survey:*

Species frequency and abundance was determined from nine 10 m by 10 m plots previously established for a study of *E. obliqua*–*E. delegatensis* seedling dominance (Neyland and Dingle 2000) which stratified the coupe into three altitude zones:

- High (approx 520-450 m)
- Middle (approx 450-380 m)
- Low (approx 380-300 m)

Three plots within each altitude zone were randomly selected using a random number table. The plots were sampled in December 2004 for landform, drainage, slope, aspect, rock cover and floristics. All vascular species present at each plot were noted and recorded using the Braun-Blanquet scale (Mueller-Dombois and Ellenberg 1974).

A reconnaissance walk through the coupe, covering all three altitudinal zones, was carried out in January 2005 to identify species that may have been present in the coupe but absent from the nine sample plots due to their low frequency in occurrence.

#### *Data analysis*

The data were used to compile a list of species present before and after logging, species present before logging and absent after, and previously unrecorded species that had colonised the disturbed area. Species richness was considered within life-form classes: trees, tall shrubs, low shrubs, ground ferns, epiphytic ferns, herbs and sedges and climbers, based on the dominant form of the mature plant.

Mean frequency (the number of plots with a particular species as a percentage of the total number of plots) and mean percent cover was calculated for each species. In order to establish mean percent cover, the Braun-Blanquet classes were transformed to their midpoints as follows: <1= 0.5%, 2=3%, 3=15%, 4=37.5%, 5=62.5%, 6=87.5% and then meaned across the nine sample plots.

Edge effects on floristics were determined by categorising plots into two classes, up to 100 m from the mature forest edge (3 plots) and those beyond 100 m from the forest edge (6 plots). Rainforest species, non-rainforest species and total vascular species richness all were compared between classes using t tests. The effect of edges on the life-form of species present was also considered, using the divisions of <100 m and >100 m from the mature forest edge. Herbs and sedges, ground ferns and climbers were not analysed due to very low species counts.

## **RESULTS**

Total vascular species richness increased slightly from 54 species prior to treatment to 57 species at six years post-harvest (Table 1).

**Table 1.** Species richness prior to (Oldgrowth), and six years after (Regeneration), at a clearfell, burn and sow treatment at Warra 011B.

Life-form	Mean Species Richness	
	Old growth	Regeneration
Trees	8	13
Tall Shrubs	13	19
Low shrubs	9	16
Herbs & sedges	5	3
Epiphytic ferns	11	0
Ground ferns	6	5
Climbers	2	1
<b>Total</b>	<b>54</b>	<b>57</b>

Twenty-three of the 54 species recorded at the site in 1986 were not found in regeneration at WR011B. The number of tree species, tall shrubs and low shrubs increased, while the number of herbs and sedges, ground ferns, epiphytic ferns and climbers decreased. No species of epiphytic fern persisted in any of the areas surveyed, accounting for 48% of all species that failed to be detected.

Table 2 shows species recorded at either the pre-harvest, post-harvest or both surveys. Some 43% (23 species) of species identified in the pre-harvest survey were not recorded in the regeneration. Conversely, 46% (26 species) of species identified in the regeneration had not been recorded in the pre-harvest survey. Several *Acacia* and *Leptospermum* tree species were recorded in the regeneration but not in the oldgrowth forest. The absence of *Eucryphia milliganii* in the regeneration may reflect a localised occurrence in the oldgrowth forest, because its congeneric, *Eucryphia lucida* was found at both surveys. The apparent absence of *Eucalyptus obliqua* in the oldgrowth forest is an obvious anomaly and reflects the fact that the pre-harvest survey did not sample the lower elevations of the coupe. The sclerophyllous tall shrubs *Banksia*, *Cassinia*, *Notelaea*, *Prostanthera* and *Zieria* were found in the regeneration, but not recorded in the oldgrowth forest. The sclerophyllous low shrubs *Bauera*, *Correa* and *Lomatia* were recorded in the regeneration but not in the oldgrowth. Although *Coprosma nitida* appears to be absent from the regeneration this may be a result of some confusion with the similar species *Coprosma quadrifida*, which was recorded after logging.

**Table 2.** Species list, grouped by life-form and survey. # indicates found only on reconnaissance walk, not on plots.

Species	Survey	Species	Survey
<b>Trees</b>		<b>Low Shrubs</b>	
<i>Acacia dealbata</i>	Post	<i>Aristotelia peduncularis</i>	Both
<i>Acacia melanoxylon</i>	Post	<i>Bauera rubioides</i>	Post
<i>Acacia riceana</i>	Both	<i>Coprosma nitida</i>	Pre
<i>Acacia verticillata</i>	Post	<i>Coprosma quadrifida</i>	Post
<i>Atherosperma moschatum</i>	Both	<i>Correa lawrenceana</i>	Post
<i>Eucalyptus delegatensis</i>	Both	<i>Cyathodes glauca</i>	Both
<i>Eucalyptus nitida</i>	Both	<i>Gaultheria hispida</i>	Post#
<i>Eucalyptus obliqua</i>	Post	<i>Leptecophylla juniperina</i>	Both
<i>Eucryphia lucida</i>	Both	<i>Lomatia tinctoria</i>	Post
<i>Eucryphia milliganii</i>	Pre	<i>Monotoca submutica</i>	Both#
<i>Leptospermum lanigerum</i>	Post	<i>Olearia persoonioides</i>	Both#
<i>Leptospermum scoparium</i>	Post	<i>Oxylobium arborescens</i>	Post#
<i>Nothofagus cunninghamii</i>	Both#	<i>Pimelea cinerea</i>	Post
<i>Phyllocladus aspleniifolius</i>	Both	<i>Pimelea drupacea</i>	Post
<b>Tall Shrubs</b>		<i>Senecio</i> spp	Post
<i>Agastachys odorata</i>	Both#	<i>Telopea truncata</i>	Pre
<i>Anodopetalum biglandulosum</i>	Both#	<i>Trochocarpa cunninghamii</i>	Both#
<i>Anopterus glandulosus</i>	Both	<i>Trochocarpa gunnii</i>	Both
<i>Banksia marginata</i>	Post	<i>Zieria arborescens</i>	Post
<i>Cassinia aculeata</i>	Post	<b>Herbs and sedges</b>	
<i>Cenarrhenes nitida</i>	Both	<i>Acianthus viridis</i>	Pre
<i>Hakea lissosperma</i>	Post#	<i>Calorophus elongatus</i>	Pre
<i>Leptospermum glaucescens</i>	Both#	<i>Dryophila cyanocarpa</i>	Both
<i>Leptospermum nitidum</i>	Both#	<i>Gahnia grandis</i>	Both
<i>Monotoca glauca</i>	Both	<i>Gnaphalium collinum</i>	Post
<i>Notelaea ligustrina</i>	Post	<i>Uncinia tenella</i>	Pre
<i>Olearia argophylla</i>	Both#	<b>Epiphytic ferns</b>	
<i>Orites diversifolia</i>	Pre	<i>Asplenium bulbiferum</i>	Pre
<i>Persoonia</i> spp	Both#	<i>Asplenium flaccidum</i>	Pre
<i>Nematolepis squamea</i>	Both	<i>Grammitis billardierei</i>	Pre
<i>Pittosporum bicolour</i>	Both	<i>Hymenophyllum australe</i>	Pre
<i>Pomaderris apetala</i>	Both	<i>Hymenophyllum flabellatum</i>	Pre
<i>Prostanthera lasianthos</i>	Post	<i>Hymenophyllum peltatum</i>	Pre
<i>Tasmania lanceolata</i>	Both#	<i>Hymenophyllum rarum</i>	Pre

Table 2 contd.

Epiphytic ferns (contd.)		Ground ferns (contd.)	
<i>Microsorium pustulatum</i>	Pre	<i>Blechnum watsii</i>	Both
<i>Polyphlebium venosum</i>	Pre	<i>Sticherus tener</i>	Pre
<i>Rumohra adiantiformis</i>	Pre	<i>Hypolepis rugosula</i>	Both#
<i>Tmesipteris obliqua</i>	Pre	<i>Gleichenia microphylla</i>	Post#
Ground ferns		Climbers	
<i>Dicksonia antarctica</i>	Pre	<i>Clematis aristata</i>	Pre
<i>Pteridium esculentum</i>	Post	<i>Billardiera longiflora</i>	Post
<i>Polystichum proliferum</i>	Pre	<i>Prionotes cerinthoides</i>	Pre
<i>Histiopteris incisa</i>	Both		

Three species of herbs and sedges, *Acianthus*, *Calorophus* and *Uncinia*, appeared to be absent at the post-harvest survey, but this may be attributable to localised occurrences or the relevant inexperience of the post-harvest survey team, compared to the pre-harvest surveyor. Of the ground ferns, *Blechnum watsii*, *Histiopteris incisa* and *Hypolepis rugosula* persisted within the coupe. Three species of ground fern were not recorded in the post-harvest survey, including *Dicksonia antarctica*, which is an important substrate for epiphytic species. None of the 11 epiphytic fern species recorded in the oldgrowth forest were found in the regeneration. Of the climbers, *Prionotes* and *Clematis* were not found in the regeneration whereas *Billardiera* appeared to be an early colonising species.

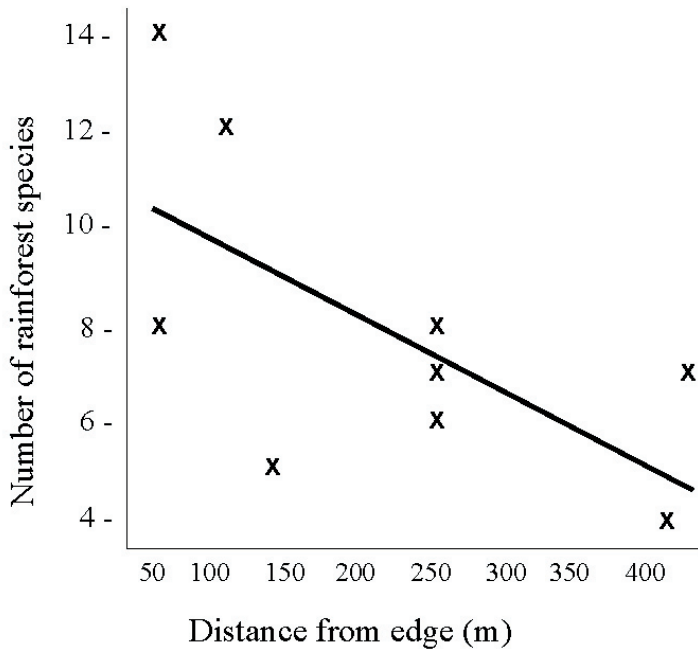
Mean frequency and percent cover is presented in Table 3 for the post-harvest survey. Four species, *Eucalyptus delegatensis*, *Eucalyptus obliqua*, *Nematolepis squamea* and *Gahnia grandis* were found on all plots. Only ten species (four trees, threetallshrubs, twolowshrubsandonesedge) had a percent cover of greater than 1%.

#### *Edge Effects on Floristics*

Vascular species richness was found to be significantly greater up to 100 m from a mature forest edge, compared to beyond 100 m (t test:  $t = 4.23$ ,  $df = 7$ ,  $P = < 0.01$ ). The rainforest species richness was significantly different between the two distances, up to 100 m had a mean rainforest species richness of 11.3, compared with 6.2 for distances greater than 100 m from an edge (t test;  $t = 3.54$ ,  $df = 7$ ,  $P = < 0.01$ ).

A line was fitted to the data to model a linear relationship between distance from edge and rainforest species richness (Figure 2). Other models may have provided a better fit but a simple approach was adopted because of the small data set. The regression coefficient  $R^2$  was determined to be 0.39

( $P = 0.07$ ), indicating a weak negative relationship between edge distance and rainforest species richness. Figure 2 indicates an outlying point 130 m from the mature forest boundary. When this particular point is removed from the analysis,  $R^2$  increases to 0.58. It is suggested that the point is an unusual observation and a larger sampling may have resulted in a stronger negative correlation between edge distance and rainforest species richness.



**Figure 2.** Relationship between edge distance and rainforest species richness

The species richness for non-rainforest species (including those species classified as unlikely rainforest species by Jarman *et al.* 1991) was not significantly related to distance from the forest edge ( $t$  test:  $t = 2$ ,  $df = 7$ ,  $P > 0.05$ ). Furthermore, only low shrubs showed a significant difference in the number of species present up to 100 m of the forest edge in comparison with the count found beyond 100 m, with a greater number of shrubs occurring up to 100 m from the boundary.

**Table 3.** Mean frequency and percent cover for vascular species at Warra 011B

Species	Freq	Cover	Species	Freq	Cover
<b>Trees</b>		<b>%</b>	<b>Low shrubs</b>		<b>%</b>
<i>Acacia dealbata</i>	0.1	0.3	<i>Aristotelia peduncularis</i>	0.2	0.1
<i>Acacia melanoxylon</i>	0.4	0.2	<i>Bauera rubioides</i>	0.1	1.7
<i>Acacia riceana</i>	0.6	3.5	<i>Coprosma quadrifida</i>	0.2	0.1
<i>Acacia verticillata</i>	0.2	2	<i>Correa lawrenceana</i>	0.1	<0.01
<i>Atherosperma moschatum</i>	0.2	0.1	<i>Cyathodes glauca</i>	0.8	1.2
<i>Eucryphia lucida</i>	0.3	0.2	<i>Leptecophylla juniperina</i>	1	4.6
<i>Eucalyptus delegatensis</i>	1	47.8	<i>Lomatia tinctoria</i>	0.1	1.7
<i>Eucalyptus nitida</i>	0.1	<0.01	<i>Pimelea cinerea</i>	0.1	<0.01
<i>Eucalyptus obliqua</i>	1	25.8	<i>Pimelea drupacea</i>	0.3	0.2
<i>Leptospermum lanigerum</i>	0.3	0.17	<i>Senecio</i> spp	0.7	0.3
<i>Leptospermum scoparium</i>	0.4	0.5	<i>Trochocarpa gunnii</i>	0.7	0.3
<i>Phyllocladus aspleniifolius</i>	0.7	0.3	<b>Herbs and sedges</b>		
<b>Tall shrubs</b>			<i>Dryophila cyanocarpa</i>	0.1	<0.01
<i>Anopterus glandulosus</i>	0.3	0.17	<i>Gahnia grandis</i>	1	18.2
<i>Banksia marginata</i>	0.2	0.1	<i>Gnaphalium collinum</i>	0.1	0.06
<i>Cassinia aculeata</i>	0.2	0.1	<b>Ground ferns</b>		
<i>Cenarrhenes nitida</i>	0.2	0.1	<i>Blechnum watsii</i>	0.7	0.3
<i>Monotoca glauca</i>	0.9	15.4	<i>Histiopteris incisa</i>	0.4	0.2
<i>Notelaea ligustrina</i>	0.1	<0.01	<i>Pteridium esculentum</i>	0.1	0.3
<i>Nematolepis squamea</i>	1	5.9	<b>Climbers</b>		
<i>Pittosporum bicolour</i>	0.3	0.2	<i>Billardiera longiflora</i>	0.6	0.3
<i>Pomaderris apetala</i>	0.4	8.7			
<i>Prostanthera lasianthos</i>	0.1	<0.01			
<i>Zieria arborescens</i>	0.2	0.1			

## DISCUSSION

Species richness was found to have marginally increased at Warra 011B following the CBS treatment. This finding accords with many studies that reported an increase in species richness after logging in dry eucalypt forest (e.g. Dickinson and Kirkpatrick 1987), wet sclerophyll forest (eg. Wapstra *et al.* 2003) and mixed forest (eg. Hickey 1994). Green *et al.* (2004) implied a reduction in species diversity and reported only 12 vascular species in regeneration in a nearby clearfelled coupe in the Weld Valley. However they provide few details of their sampling methodology.

An increase in vascular species richness immediately following the logging period is often due to the increased abundance and frequency of species able to colonise disturbed environments (Wapstra *et al.* 2003). If Warra 011B had been surveyed at an earlier stage after harvesting, a greater increase in species richness may have been observed. Harris (2004) showed the early increase in vascular plant richness after logging in the Victorian Otway ranges was due to an influx of herbaceous species. Most of these species had their maximum occurrence two or three years after treatment. Many were not recorded after 5 years post harvest, leading to an overall decline in floristic diversity after three years. Six years after the regeneration burn at Warra, herbaceous species that may have been initially present would have declined due to reduced light intensity as the cover of woody species increased. Species richness therefore may have been even higher immediately following the burn and sow, stabilising at six years at a level that is similar to pre-harvest records.

The mean number of rainforest species fell from 44 pre-harvest to 30, six years after the regeneration burn. This accounted for the majority of species that were not recorded in the regeneration. The most significant loss was that of the epiphytic ferns. All 11 species recorded prior to treatment had failed to regenerate in any of the sample areas. Such a finding is consistent with numerous studies (Hickey 1994, Ough 2001, Wapstra *et al.* 2003, Harris 2004) that have found that the single most significant loss after clearfelling is that of epiphytic fern species.

Three ground fern species including *Dicksonia antarctica* failed to be detected both within the sample plots and along the reconnaissance walk across the coupe. Tree ferns can rapidly resprout from protected growing points on the top of their trunks after fire. However extensive mechanical disturbance from logging may have removed mature stems so that recolonisation would largely depend on spores from offsite sources. Moist stable conditions conducive to spore regeneration may not develop for decades after logging has occurred (Smith *et al.* 2004).

However, usually some *Dicksonia* individuals resprout after a regeneration burn and it has been suggested that Warra 011B had few mature tree ferns prior to the CBS treatment. This may account for the failure to locate surviving individuals.

The lack of *Dicksonia* in the regeneration has implications for the recovery of epiphytic ferns, because tree fern trunks provide ideal substrates for colonisation by epiphytes. Peacock and Duncan (1994) showed that some vascular epiphytes may take 50 years to recolonise regrowth after clearfelling. The availability of suitable micro-habitats and substrates within Warra 011B will play a pivotal role in determining the rate at which epiphytic ferns will be able to recolonise the area.

Twenty-six additional species colonised Warra 011B after logging, including three *Acacia* species (*A. melanoxylon*, *A. dealbata*, *A. verticillata*). Howard (1974) reported acacias germinating from viable ground stored seed in rainforest stands where they had been absent previously. Many of the species now occupying Warra 011B regenerate profusely from ground-stored seed and protected root-stocks following disturbance. However excessive disturbance by machinery or intense fire can kill ground-stored propagules. Where the humus has been destroyed, regeneration frequencies are generally smaller (Duncan 1985). This effect was evident in some parts of Warra 011B, particularly on snig tracks which are now largely colonised by the hardy sedge *Gahnia grandis*, which has bird-dispersed and ground-stored seed.

Low frequencies were observed for three of the four major rainforest trees (*Atherosperma moschatum*, *Nothofagus cunninghamii* and *Eucryphia lucida*). The other, *Phyllocladus aspleniifolius*, is capable of regeneration from ground-stored and bird-dispersed seed and was the most commonly occurring rainforest tree, at a frequency of 0.7. *Nothofagus cunninghamii*, which regenerates mainly from seed from adjacent mature trees, was absent from the sampled plots. A small individual was found persisting on a road side verge during the reconnaissance walk. *Nothofagus cunninghamii* may be slow to re-establish on large clearfelled areas due to limited dispersal capabilities (Hickey *et al.* 1982, Lindenmayer *et al.* 2000). Therefore distances from viable seed sources and dispersion capabilities are crucial factors in ensuring successful rainforest regeneration after logging. Leatherwood (*Eucryphia lucida*), which regenerates from wind-blown seed and by coppicing, was only found up to 100 m of a mature forest edge. These results are consistent with those of Tabor (2004), who investigated edge effects on the regeneration of the four major rainforest trees. He concluded that by 200 m from a suitable seed source, the frequency of *Nothofagus cunninghamii*, *Eucryphia lucida*, and *Atherosperma*

*moschatum* was much reduced. The ability of *Phyllocladus aspleniifolius* to regenerate from ground-stored seed allowed it to persist throughout coupes.

Distances from the edge of the surrounding mature forest were found to have a significant impact on the number of rainforest species able to regenerate within the coupe. Non-rainforest species with long-lived ground stored seed such as *Acacia dealbata* and *Nematolepis squamea* were advantaged by the burning treatment and regenerated in large numbers. There was no significant difference in the number of non-rainforest species and distance from forest edge, indicating a fairly even distribution of propagules, i.e. seed or rootstocks. In a clearfelled coupe, the majority of species regenerate by seed rather than by vegetative reproduction (Murphy and Ough 1997).

The presence of weeds was confined to an internal quarry and on road verges. Although no weeds were found on the sample plots, *Erica lusitanica*, *Hypochoeris radicata* and *Centaureum erythraea* were all noted during the coupe walk. Weed species were not included on the species list, so as to avoid giving a false impression of the species richness of the coupe. They were not seen to be a major concern within Warra 11B, as they only persisted in isolated areas along roadside cuttings.

Several limitations of this study must be acknowledged. The sample plots constituted 900 m<sup>2</sup> of area whereas the pre-harvest survey was carried out over a planned transect, designed to incorporate several smaller sub-environments within the coupe such as riparian zones, to maximise species richness. This issue was partly addressed by the post-harvest reconnaissance walk through the coupe after sampling the plots, to integrate such areas and locate species that had lower frequencies within the coupe. This increased the post-harvest species list by some 36 percent, which highlights the difficulty of comparing pre- and post harvest species richness that are based on different sampling techniques. Also arising is the question of accurate identification of species, especially where pre- and post surveys are undertaken by different observers and with varying botanical expertise. For example, *Coprosma nitida* was recorded pre-harvest, yet *Coprosma quadrifida* was identified later. It must be questioned whether this is a true representation of ecological processes within the coupe, or is it more likely to be due to differences in observers. These difficulties can be partly overcome through the acquisition of voucher specimens that can be referenced by subsequent surveyors.

The species list from this study is by no means absolute. It is a compilation of the minimum number of species persisting at Warra 011B and a larger sampling may have yielded several other species. It is clear however, that the

CBS treatment has changed species assemblages and resulted in a diverse flora with a high representation of early successional species. Further study on the impact of silvicultural practices on Tasmanian tall eucalypt forests (Hickey *et al.* 2001) and based on precisely located permanent plots established prior to harvesting (Neyland 2001) should help determine the long-term effects of clearfell, burn and sow practices on understorey floristic composition.

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