FOREST CHECK

DEPARTMENT OF Conservation AND LAND MANAGEMENT

GOVERNMENT OF WESTERN AUSTRALIA

REPORT OF PROGRESS
2003 – 2004

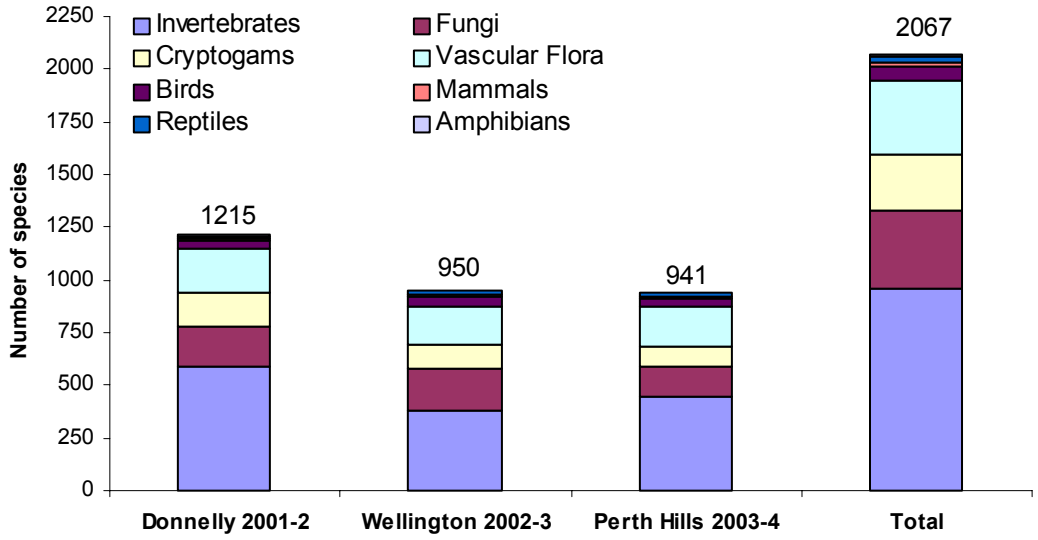
Science Division
November 2004

CONTENTS

EXECUTIVE SUMMARY

This report documents the sites monitored and the results of the third round of sampling in the FORESTCHECK monitoring program. Eight sampling grids were established in Jarrah forests within the Perth Hills District, and sampled in the spring of 2003 and the autumn of 2004. This brings the total number of FORESTCHECK monitoring grids to 27, having previously established grids in Donnelly and Wellington Districts in 2001 and 2002 respectively. These reports can be viewed on CALM's Naturebase website at http://www.calm.wa.gov.au/science/science.html.

During the three years of FORESTCHECK, information on over 2000 species of plants, animals and fungi has been gathered.



Some interesting information has been recorded and interesting patterns are emerging. Many of the species recorded were previously unknown or have been recorded for the first time in WA. A species of *Peripatus* recorded in the Perth Hills is thought to be a relict from Pangea and is considered a living invertebrate fossil, representing the link between present day annelids and arthropods. Other interesting points to have emerged from the Perth Hills monitoring grids are:

- Stand structure on the Perth Hills sites reflected the declining contribution that Marri has in the northern and eastern Jarrah forest, with Jarrah comprising 63-97% of the eucalypt regeneration.

- Surface soils in the Perth Hills have lower extractable P and total P concentrations than on sites in Donnelly and Wellington.

- Mature Marri leaves have higher P and K concentrations than leaves from either advanced growth or saplings of both Jarrah and Marri. N concentration was similar for both Jarrah and Marri in all growth stages.

- Litter loads in all treatments generally reflected time since the last fire.
- Fungal species richness recorded in the Perth Hills was about 25% lower than that recorded in Donnelly and Wellington.
- Over 900 morphospecies of invertebrates have been recorded across all FORESTCHECK sites.
- Species richness of vascular plants differed little between the Donnelly, Wellington and Perth Hills FORESTCHECK sites.
- Foxes were not recorded on the Perth Hills FORESTCHECK sites, but pigs were.
- Bird species numbers were similar in all treatments, but abundance was lower in gap release grids.

Some overall trends that appear to be emerging are:

- There is a mean increase of 20% in soil bulk density across all FORESTCHECK sites that is attributed to timber harvesting.
- The diversity of cryptogams is consistently higher in the external controls across all FORESTCHECK sites.
- Changes in species composition of cryptogams on control sites reflect changes in climatic conditions across all FORESTCHECK sites.
- Timber harvesting has had little impact on the species richness and abundance of vascular plants across all FORESTCHECK sites.
- FORESTCHECK is also helping to quantify the effect of environmental gradients on species distribution and diversity within the SW forests, some of which are well known (eg. the lower proportion of Marri trees in the northern Jarrah forest) and others which have not previously been documented (eg. the lower number of cryptogam species and lower fungal abundance in the drier Jarrah forests).

I thank the FORESTCHECK team for their continued commitment to the arduous field and laboratory components of this project. The report was compiled and editied by Verna Tunsell and Richard Robinson.

Dr Neil Burrows
Director Science Division
November 2004

INTRODUCTION

Scope

This report has been compiled from chapters prepared by scientists and technical staff involved in the FORESTCHECK monitoring program. It represents a summary of activities completed as part of the monitoring program during the 2003-2004 financial year.

FORESTCHECK is an integrated monitoring system that has been developed to provide information to forest managers in the southwest of Western Australia about changes and trends in key elements of forest biodiversity associated with a variety of forest management activities. Although the initial focus of FORESTCHECK will be on timber harvesting and silvicultural treatments in Jarrah (*Eucalyptus marginata*) forest, the intention is to extend the scale of monitoring over time to include other forest ecosystems, fire (prescribed and wildfire), mining, the effects of forest disturbance for utility corridors (e.g. roads, power transmission lines), and the impacts of recreation uses. (Note, however, that the Forest Products Commission will only fund the part of FORESTCHECK that is specific to its activities).

FORESTCHECK was developed to meet a range of compliance conditions placed on the Forest Management Plan 1994-2003 through Ministerial Conditions and the Codd Report of 1999 and is included as an operational program in the current Forest Management Plan 2004-2013. Integrated monitoring is a fundamental component of Ecologically Sustainable Forest Management (ESFM), and is necessary for reporting against the Montreal Process criteria and indicators for ESFM. In addition, monitoring forms the basis for adaptive management, which is recognized as an appropriate strategy for managing under conditions of uncertainty and change.

The Science Division of the Department of Conservation and Land Management has primary responsibility for the implementation of FORESTCHECK. The development of the program took place over 2 yrs and included input from scientists and managers within the Department of Conservation and Land Management, and from a number of external scientific agencies. The background to this process is described in the FORESTCHECK Concept Plan, and details of methods are provided in the FORESTCHECK Operations Plan. Annual Progress Reports, the Concept Plan and Operations Plan may be viewed on CALM's Naturebase website at http://www.calm.wa.gov.au/science/science.html.

Sampling strategy

Since 1995 timber harvesting in Jarrah forests has been undertaken according to Silvicultural Guideline 1/95, which recognizes three silvicultural objectives.

1. Thinning – to promote growth on retained trees,
2. Release of regeneration by gap creation, where existing advance growth is encouraged to develop unimpeded by the removal of competing overstorey,
3. Regeneration establishment by shelterwood, where seedlings are encouraged to establish and develop into the lignotuberous ground coppice stage. This is achieved by reducing the competition from the overstorey, but retaining sufficient overstorey to provide a seed source and maintain

other forest values until the ground coppice is developed and capable of responding to release.

Silvicultural guidelines have been revised in conjunction with the preparation of the Forest Management Plan (2004-2013) and changes to the guidelines are detailed in Appendix 5 of the plan.

Gap creation and shelterwood treatments are being given priority in the initial stages of FORESTCHECK as these are the most widespread operations and involve the greatest extent of disturbance to the forest. Thinning will also be monitored where the structure of the forest dictates that this treatment is appropriate on a significant scale.

SITES AND GRID ESTABLISHMENT

FORESTCHECK sites are being established at a number of locations across the forest, stratified according to recognized ecological gradients of rainfall, evapo-transpiration and soil fertility Forest ecosystem mapping (Mattiske and Havel 1998[1]) provides a systematic basis for stratification of sampling. Allocation of sites also takes account of scheduled future harvesting within the Jarrah forest, with priority given to those ecosystems likely to be subject to harvesting on an extensive scale in the next decade.

Each FORESTCHECK site consists of up to 4 sampling grids. Grids will be established in forest subject to the following treatments:

1. Gap release
2. Shelterwood
3. Coupe buffer or internal reference forest, i.e. temporary exclusion areas (TEAS) between adjacent gaps or shelterwood forest
4. External reference or control forest i.e. not recently harvested, or has had minimal harvesting, and will not be subject to harvesting in the foreseeable future.

The intention is that grids be closely matched in terms of site characteristics (climate, geomorphology, soils, topography, altitude, aspect), pre-harvest forest structure and vegetation attributes in order that differences between grids reflect the effects of harvesting, rather than inherent site differences. Not all treatment types will be found in the one locality and it is expected that external reference forest may have to be located some distance from their harvested counterparts. It may not always be possible to find gap release and shelterwood treatments together, because underlying relationships between rainfall, soil fertility and Jarrah lignotuber development influence the broad pattern of silvicultural treatment across the Jarrah forest, as have previous silvicultural activities.

[1] Mattiske, E.M. and Havel, J.J 1998. Vegetation Mapping in the South West of Western Australia. CALM, Perth.

Methodology
A range of ecosystem attributes are monitored at each site including:

1. Forest structure and regeneration stocking
2. Foliar and soil nutrients
3. Soil disturbance
4. Coarse woody debris and leaf litter
5. Macrofungi
6. Cryptogams
7. Vascular flora
8. Invertebrate fauna
9. Vertebrate fauna (birds, herpetofauna, and mammals).

Sampling methodologies for each set of ecosystem attributes are described in the FORESTCHECK Operations Plan, together with examples of protocols for data collection and storage. Monitoring of biodiversity is based on a sample grid. The main grid is 100 m x 100 m, with 30 m x 30 m vegetation sample plots at each corner.

Sampling in Perth Hills District during 2003/04
Eight FORESTCHECK monitoring grids were established in State Forest in the Perth Hills District and sampled during 2003/04. Three grids (FC 25-27) were established within Occidental and Lesley blocks in the northern range of the district, about 30 km northeast of Jarrahdale (Fig. 1), in the 900 mm annual rainfall zone, and five grids (FC20-24) were established within Holyoake, Kennedy and Cameron blocks, east and northeast of Dwellingup (Fig. 2) in the 1100 – 1300 mm annual rainfall zone. Grids were identified by alphanumeric codes FC20 to FC27, with the southern and northern locations being about 55-60 km apart.

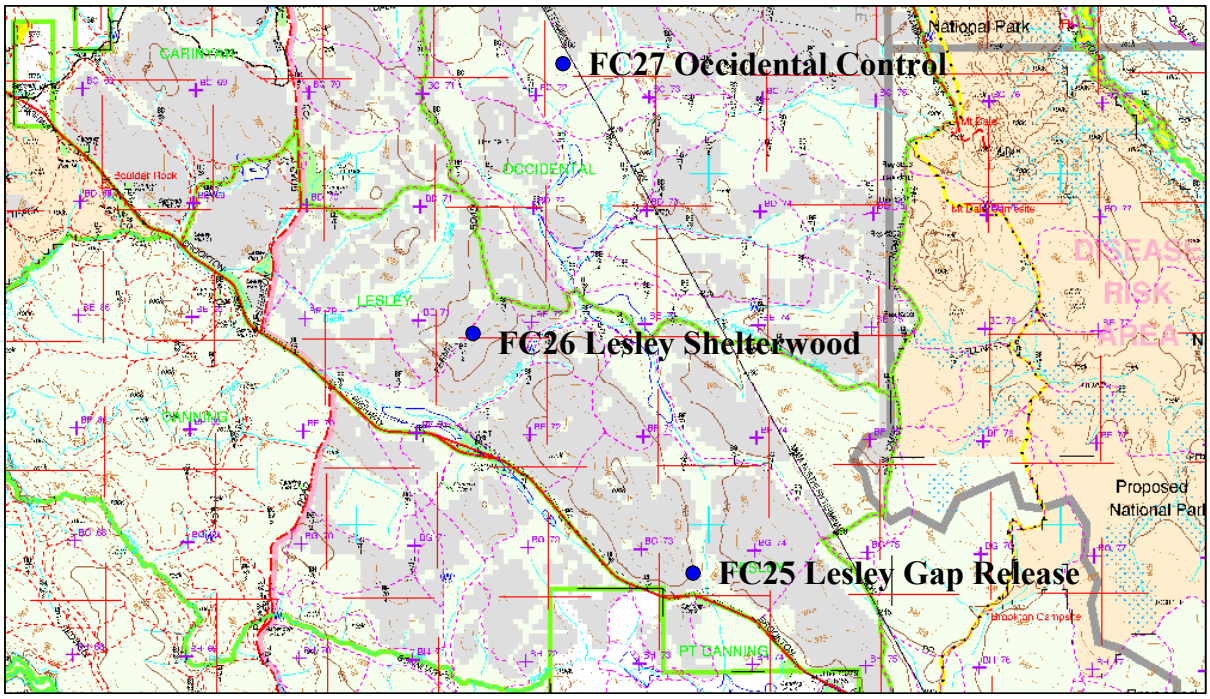


Figure 1. Location of the three 'northern' FORESTCHECK sampling grids established in the Perth Hills District during 2003/04.

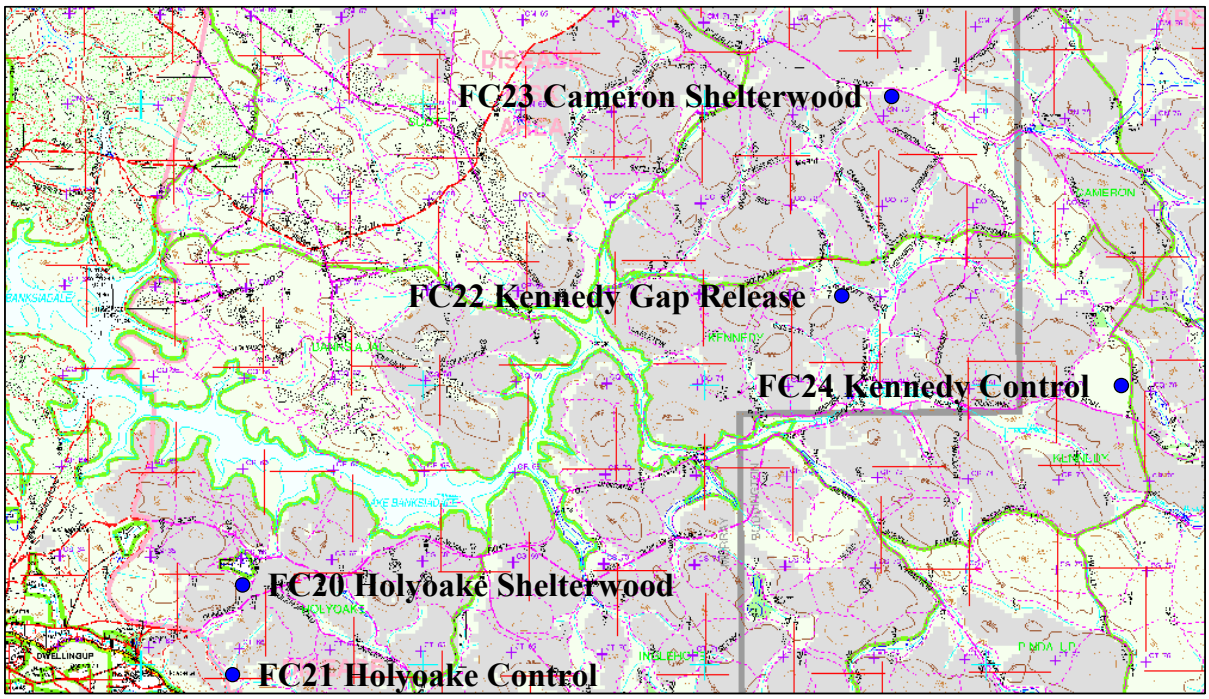


Figure 2. Location of the five 'southern' FORESTCHECK sampling grids established in the Perth Hills District during 2003/04. The town of Dwellingup is situated in the lower left hand corner of the map.

Grids are located within the Dwellingup1, Dwellingup 2, Yarragil 1 and Yarragil 2 vegetation complexes of Mattiske and Havel (1998). These complexes are found in open forests of Jarrah and Marri (*Corymbia calophylla*), with Dwellingup 1 located on lateritic uplands in the humid and subhumid zones, Dwellingup 2 on lateritic uplands in subhumid and semiarid zones, Yarragil 1 on valley floors in the humid and subhumid zones, and Yarragil 2 on valley floors in the subhumid and semiarid zones. Other eucalypt species such as *E. megocarpa, E. patens* and *E. rudis* may also be present in the Yarragil complex. Upland sites have mild slopes (generally <10 degrees, except FC21 which was 13 degrees) and are at elevations between 220 and 320 m ASL (Table 1).

Table 1. Grid locations and attributes.

Grid ID	Forest block	Vegetation complex	Latitude (S)	Longitude (E)	Elevation (m)	Aspect	Slope (degrees)
FC20	Holyoake	Dwellingup 1	32° 42' 16"	116° 06' 38"	300	E	5
FC21	Holyoake	Yarragil 1	32° 43' 10"	116° 06' 45"	220	W	13
FC22	Kennedy	Yarragil 2	32° 39' 26"	116° 13' 48"	280	NE	2
FC23	Cameron	Dwellingup 1	32° 37' 31"	116° 14' 19"	330	NNE	3
FC24	Kennedy	Dwellingup 1	32° 40' 19"	116° 16' 46"	310	E	2
FC25	Lesley	Yarragil 2	32° 10' 43"	116° 15' 17"	300	E	9
FC26	Lesley	Dwellingup 2	32° 09' 08"	116° 13' 15"	320	SE	9
FC27	Occidental	Dwellingup 2	32° 06' 54"	116° 16' 07"	320	S	2

Table 2. Logging and fire history at each grid[1].

Grid ID	Block	Silvicultural treatment	Year of most recent cut	Decades of previous cutting	Year of most recent burn	Burn type
FC21	Holyoake	Control	Pre 1920	N/A	1999	Fuel reduction
FC24	Kennedy	Control	1930-34	Pre 20	1975	Fuel reduction
FC27	Occidental	Control	1930-39	20	1984	Fuel reduction
FC20	Holyoake	Shelterwood	1995	Pre 20, 20	2002	Establishment
FC23	Cameron	Shelterwood	1989	Pre 20, 30	1984	Advance
FC26	Lesley	Shelterwood	1997	Pre 20	1998	Establishment
FC22	Kennedy	Gap release	1988	Pre 20, 30	1991	Regeneration release
FC25	Lesley	Gap release	1998	Pre 20	1998	Regeneration release

[1] Cutting and burn data retrieved from Forest Management Branch SILREC files.

Photographs taken in each of the eight sampling grids are presented in Figs. 3-10. All photos were taken from peg W2.1 looking towards the centre peg (W2.3) (see Fig. 11), and allow changes in vegetation structure and condition to be determined in eachtsubsequent photograph. All photographs were taken on 20-21 May 2004.

Northern Grids:

Figure 3. FC25 Lesley forest block; gap release.

Figure 4. FC26 Lesley forest block; shelterwood.

Figure 5. FC27 Occidental forest block; control.

Southern Grids:

Figure 6. FC22 Kennedy forest block; gap release.

Figure 7. FC23 Cameron forest block; shelterwood.

Figure 8. FC24 Kennedy forest block; control.

Figure 9. FC20 Holyoake forest block; shelterwood.

Figure 10. FC21 Holyoake forest block; control.

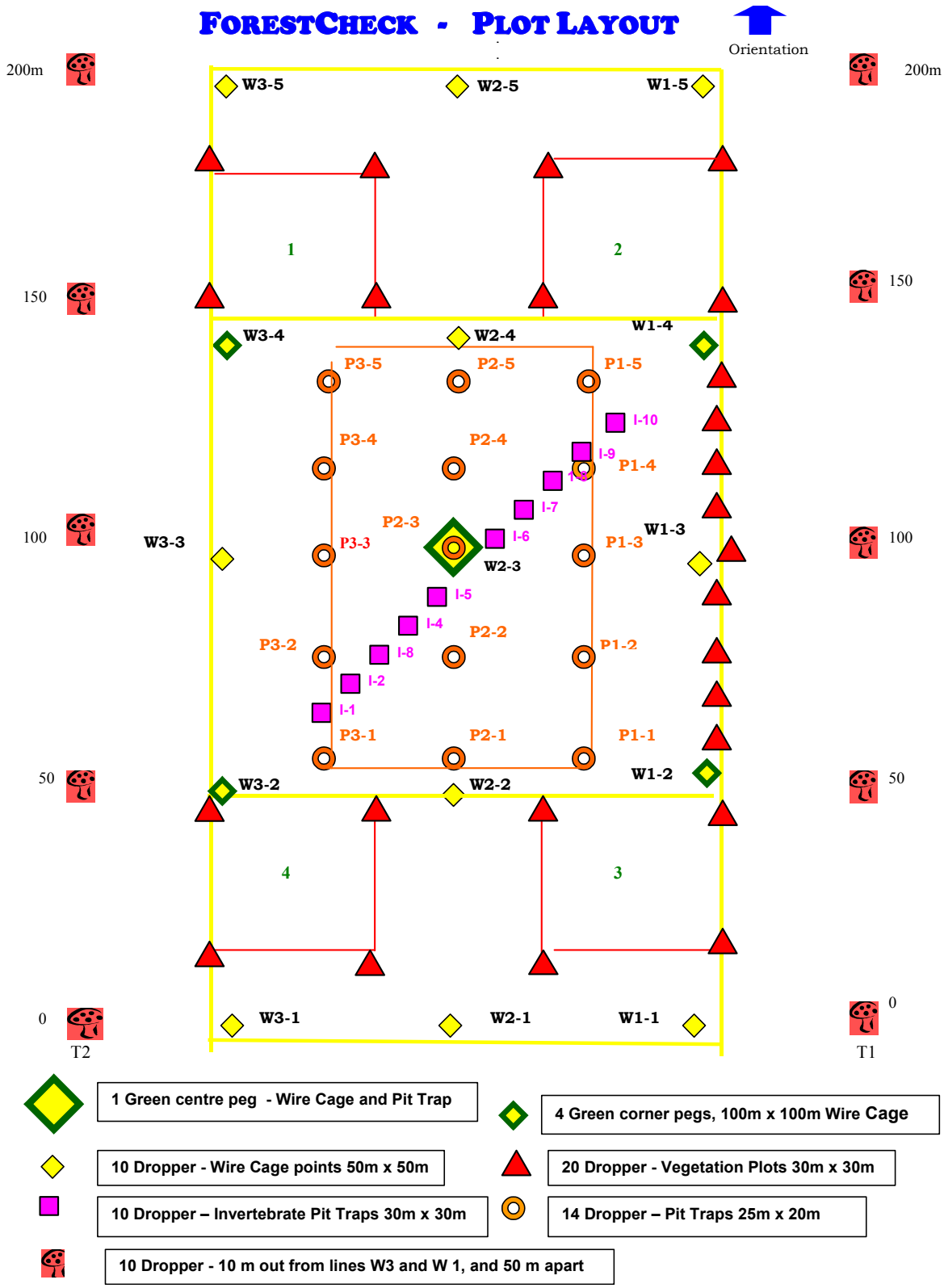


Figure 11. The layout of a FORESTCHECK sampling grid.

Expenditure
The budget for establishing and monitoring the FORESTCHECK grids in the Perth Hills District in 2003-2004 is shown in Table 4.

Table 4. FORESTCHECK budget for 2003/04**.**

Task/Activity	TOTALS
OPERATING EXPENDITURE	
(including grid establishment, sampling, specimen processing and data management).	142 000[A]
	200 000
SALARY EXPENDITURE	**173 000**
(based on 0.2 FTE allocation for staff participating in FORESTCHECK).	
TOTAL	**373 000**

[A.] Subject to 40 per cent Corporate overhead charge.

FOREST STRUCTURE AND REGENERATION STOCKING

Lachlan McCaw, Bob Smith and John Neal

Introduction

The adequacy of regeneration following harvesting and silvicultural treatment is one of the core indicators of Ecologically Sustainable Forest Management (ESFM). The current framework of regional level indicators provides for assessment of the area and per cent of harvested area of native forest effectively regenerated (Indicator 2.1.g). This is recognized as a Category A indicator that can be reported upon immediately.

Regeneration outcomes have for a number of years been assessed as a matter of routine on at least a portion of the area of forest subject to harvesting. For uneven-aged forest stands, there is a need to consider the existing structure of the stand and whether sufficient sapling and advance growth is present to re-establish the stand following harvesting. Under the current silvicultural guidelines for Jarrah-Marri the density of existing lignotuberous advance growth determines whether the stand should be cut to gap release or shelterwood.

Forest managers also require information about the rate of growth and species composition of stands so that future stand conditions can be projected over time. These attributes can affect the potential of forest stands to produce wood and other products, and to achieve ecological outcomes.

The objectives of this component of FORESTCHECK monitoring are therefore to:

- Describe the stand structure, species composition and developmental stage of tree species present at each sampling grid, and
- Measure the contribution of mid-storey species to stand structure, density and basal area.

Fieldwork

All eight sampling grids in Perth Hills District were assessed over four days in mid March 2004. Grids were located east of Dwellingup (FC 20-24), and north east of Jarrahdale (FC 25-27).

Sampling techniques were the same as used in Donnelly and Wellington Districts in the previous two years. Regeneration stocking was assessed using the triangular tessellation method at 50 points around the outer perimeter of each grid. Triangular tessellation sampling is the standard technique employed for regeneration surveys undertaken before and after timber harvesting operations. Stand structure was assessed by measurement of all trees taller than 2 m in a transect 200 m long by 4 m wide. In stands cut to gap release and shelterwood treatments, the height and species of regeneration was assessed at 4 locations on each grid to indicate the rate of regrowth. Canopy cover was measured as part of the vascular plant assessment.

Data management

Regeneration stocking data are summarized and entered into the FORESTCHECK database. Data are analysed to determine the following key information:

- Whether the grid meets current stocking standards.
- Species composition of overstorey trees and the regeneration cohort.
- Proportion of the grid affected by retained overwood (gap and shelterwood grids only).
- Average density of saplings and ground coppice at points that meet the stocking standard.

Results

Stand structure and species composition

Eucalypt basal areas ranged from 18 to 37 m^2/ha in the three control grids, and were predominantly comprised of Jarrah (Figure 1, Table 1). Midstorey trees of *Allocasuarina fraseriana* contributed a further 9 m^2/ha at Lesley (FC 27), and tall Balga (*Xanthorrhoea preissii*) contributed 9 m^2/ha at Holyoake (FC21). All shelterwood stands had a retained basal area of Jarrah and Marri exceeding 25 m^2/ha, with the Cameron stand (FC23) also having an additional 20 m^2/ha of A. *fraseriana*. The lower basal area in the Lesley shelterwood (FC 26) can be attributed to the more recent (1997) harvesting, reflecting changes introduced in the 1995 silvicultural guidelines and the shorter time period for growth response of established trees and recruitment of saplings. The Kennedy gap release treatment (FC 22) was heavily stocked with Jarrah saplings and had a low level of retained overwood. This stand was cut in 1988 prior to introduction of the requirement for retention of habitat and potential habitat trees and also received post-harvest culling treatment to fell non-commercial trees. The gap release treatment at Lesley block (FC 25) was predominantly stocked with Jarrah saplings and also included a component of pole and mature sized Jarrah.

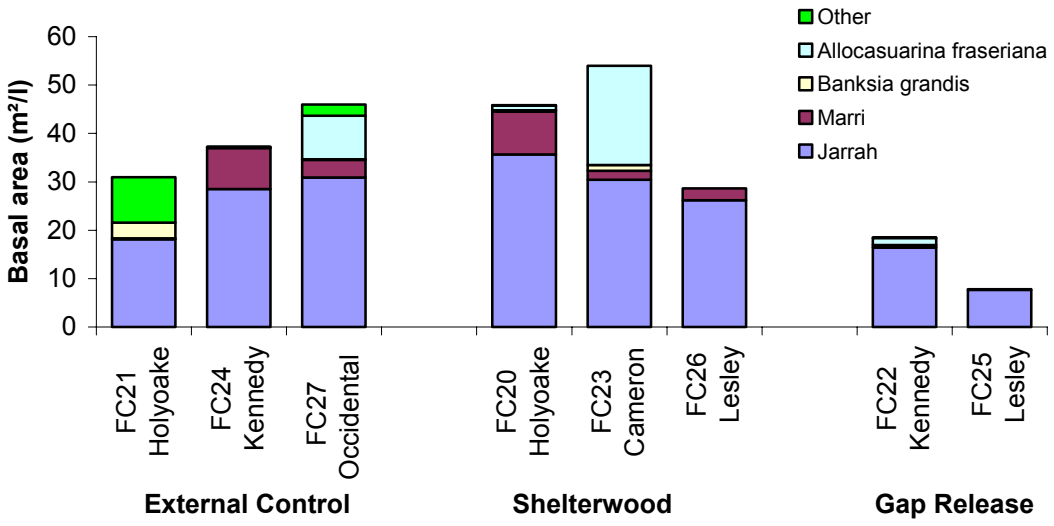


Figure 1. Basal area of Jarrah, Marri and midstorey trees.

Marri was present as a secondary species in all grids but contributed no more than a quarter of the stand basal area. A small number of Yarri (*E. patens*) seedlings were recorded in the gap release treatment at Kennedy block. Relative proportions of Jarrah and Marri were consistent between basal area, stems per ha, and the regeneration cohort of saplings and advance growth (Table 1). The current silvicultural guideline requires that on predominantly Jarrah sites the species mix of the eucalypt regeneration should contain at least 20 % Jarrah. This requirement was achieved in all treated stands.

Table 1. Analysis of eucalypt species composition determined according to basal area and stem density of live standing trees >2 m tall, and the species mix determined in regeneration surveys of nine FORESTCHECK sampling grids in Perth Hills District.

Grid	Basal area (m^2/ha)			Stems/ha			Regeneration species composition	
	Jarrah	**Marri**	**Total**	**Jarrah**	**Marri**	**Total**	**Jarrah**	**Marri**
Control								
FC21	18.11	0.2	18.31	850	25	875	-	-
	99%	*1%*		*97%*	*3%*		*95%*	*5%*
FC24	28.53	8.44	36.97	788	200	988	-	-
	77%	*23%*		*80%*	*20%*		*89%*	*11%*
FC27	30.86	3.69	34.55	850	88	938	-	-
	89%	*11%*		*91%*	*9%*		*91%*	*9%*
Shelterwood								
FC20	35.66	8.54	45.20	500	175	675	-	-
	79%	*21%*		*74%*	*26%*		*63%*	*37%*
FC23	30.43	1.87	32.30	1263	213	1476	-	-
	94%	*6%*		*86%*	*14%*		*75%*	*25%*
FC26	26.18	2.45	28.63	900	75	975	-	-
	91%	*9%*		*92%*	*8%*		*83%*	*17%*
Gap Release								
FC22	16.43	0.51	16.94	2363	150	2513	-	-
	97%	*3%*		*94%*	*6%*		*97%*	*2%*
FC25	7.66	0.13	7.79	325	38	363	-	-
	98%	*2%*		*90%*	*10%*		*91%*	*9%*

Regeneration stocking

The three control grids contained few saplings but had moderate stocking levels of ground coppice and advance growth (Table 2). The general absence of saplings can be attributed to the lack of recent disturbance and associated temporary reduction in competition from the overstorey canopy.

Satisfactory stocking in stands cut to shelterwood is defined as having 65 % of sample points with 500 or more stems/ha of saplings or stool coppice from stumps <30 cm diameter, or 1000 or more stems/ha of saplings, stool coppice and Jarrah ground coppice or Marri advance growth, and can also include lignotuberous seedlings at 5000 or more stems/ha. The Lesley block shelterwood (FC26) was well stocked with saplings and ground coppice and also had substantial areas stocked with lignotuberous seedlings established following the post-harvest burn (Table 2). This stand had a lower level of retained overwood and lower basal area than the shelterwood treatments at Holyoake (FC20) or Cameron (FC23). The latter two stands have an established overstorey of trees 20-50 cm dbhob and the most appropriate silviculture would be to promote growth on the best trees in this cohort, rather than to establishing further seedling regeneration. Previous cutting has resulted in a complex mosaic of stand structure complexity of silviculture over much of the northern Jarrah forest and it is difficult to accurately map the outcomes of treatment at a fine level of resolution.

The gap release at Kennedy block (FC22) had a dense stocking of saplings 4-5 m tall together with a secondary stratum of ground coppice, and easily satisfied the regeneration stocking standard. Good development of saplings at this site can be attributed to the low level of retained overwood (Table 2). Regeneration stocking in the gap release at Lesley block (FC25) was slightly below the specified standard of 65 per cent. The absence of saplings at this grid reflects the relatively short time period elapsed since the post-harvest burn in 1997.

Table 2. Regeneration stocking and species composition for nine FORESTCHECK grids in Perth Hills District assessed during March 2004. Values for per cent stocking are based on 50 sample points per grid. Retained over-wood is not assessed in uncut stands or TEAS buffer strips.

Treatment and Grid Number	Height range of eucalypt regeneration (m)	Percent affected by overwood	Percent stocked with saplings	Percent stocked with saplings & ground coppice	Per cent stocked including seedlings	Per cent not stocked to standard
Control						
FC21	Uncut	N/a	4	50	N/a	16
FC24	Uncut	N/a	2	42	N/a	8
FC27	Uncut	N/a	6	48	N/a	2
Shelterwood						
FC20	3-4	48	0	34	10	20
FC23	3-4	68	2	34	20	16
FC26	1-2.5	36	16	32	42	10
Gap Release						
FC22	4-5	8	56	32	N/a	12
FC25	1.5-3	18	0	58	N/a	38

Regeneration originating from stool coppice on stems >30 cm diameter and from stump coppice is not considered to contribute to the effective stocking at a point. This is because it is prone to wind-throw and is readily damaged by fire if the parent stump catches alight. However on most sites there are a considerable number of additional stems originating from stump coppice that contribute to the initial re-establishment of crown cover and basal area.

The origin of all Jarrah and Marri stems >2 m tall measured in the 4 m x 200 m transect on each grid is shown in Figure 2. All grids had at least 500 trees of Jarrah and Marri that originated from lignotuberous growth, except for the Lesley gap release treatment where the sapling cohort had not yet been re-established following harvesting.

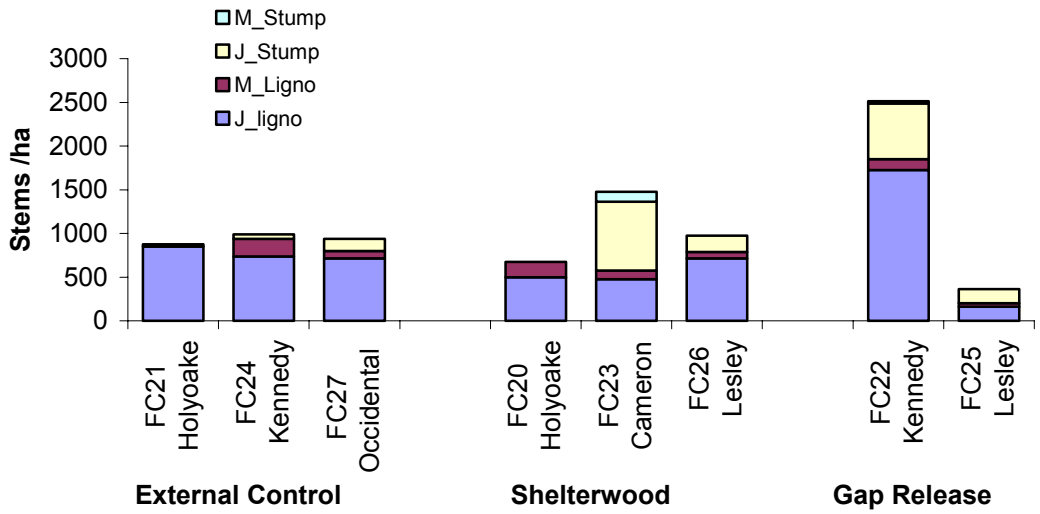


Figure 2. Origin of all Jarrah and Marri stems >2 m tall measured in the 4 m x 200 m transect on eight grids in Perth Hills District.

Canopy cover

Canopy cover in control grids varied from 50-75 % (Fig. 3). Shelterwood stands at Holyoake and Cameron also had more than 50 % canopy cover, but the Lesley shelterwood was somewhat lower reflecting the more recent harvesting in this stand. Gap release stands at Kennedy and Lesley had 20-30 % canopy cover.

Discussion

Jarrah was the dominant tree on all sites in the Perth Hills network of FORESTCHECK sampling grids. This matches the expected pattern of declining Marri contribution in northern and eastern areas of the Jarrah forest. Several indicators (basal area, stems/ha, regeneration species composition) provided similar estimates of the relative contributions of Jarrah and Marri. The potential for timber harvesting and associated silviculture to affect species composition at the stand level is likely to be lower in the

Northern Jarrah forest than is the case further south where Marri is more abundant and is often the predominant species in the lignotuberous advance growth stage. Control grids had been subject to timber harvesting in the early to mid decades of the 20th century, unlike those established previously in Wellington District, which had no recorded history of harvesting. Some of the grids are likely to have been established in forest that was subject to regeneration tending operations undertaken by unemployed workers on sustenance work during the years of the Great Depression (Bradshaw in press). This work included coppicing of young but damaged Jarrah regrowth, the felling of *Banksia*, *Allocasuarina* and Balga, and the ringbarking of larger unwanted trees. Regeneration tending operations are very likely to have influenced the present day structure of the forest and may have had some influence on the species composition and structure of the intermediate tree layer, although this would be difficult to establish with any certainty.

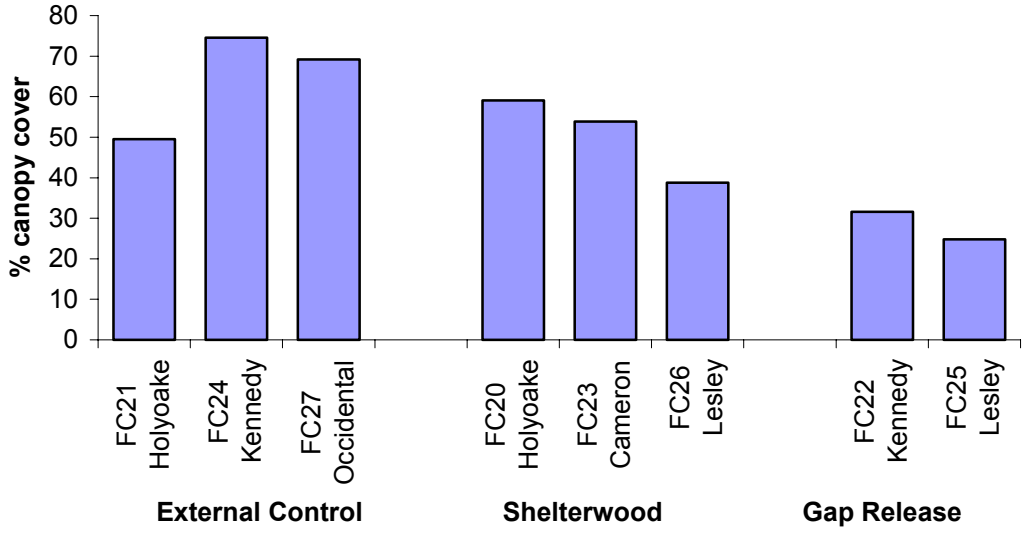


Figure 3. Canopy cover estimated using point intercept sampling.

The five FORESTCHECK grids in the Dwellingup area (Holyoake, Cameron and Kennedy forest blocks) are within the area burnt by the January 1961 wildfires, which burnt 145 000 ha of mostly cut-over forest. Much of the area burnt in 1961 experienced very high fire intensities as a result of extreme weather conditions and the heavy fuel loads that had accumulated during a period of deliberate fire exclusion during the decades of the 1930's and 40's. Maps exist showing the fuel age at the time of the 1961 wildfires (McCaw *et al*. in press) and the resulting levels of crown damage (Peet and Williamson 1965). Information about previous fire history will be collated prior to the analysis phase of the project scheduled for 2006 and used to test hypotheses about possible impacts of extreme fire events on forest condition and biodiversity.

Recommended change to sampling procedure

An important issue highlighted during this year's field sampling was the difficulty in accurately ascribing silvicultural treatments to any particular area of forest on the basis of the SILREC maps. While the maps do indicate the silvicultural objectives applied at a compartment scale, it would be almost impossible to map the actual outcome of treatment at scale of tens of metres. However, such information is important in the interpretation of data collected during FORESTCHECK sampling. The operational procedures used for assessing forest structure will therefore be expanded to include recording the diameter, height and species of stumps removed in past harvesting operations. Stumps will be recorded in the four transect (4 m wide x 25 m long) that are currently used to sample stem diameters of trees >2 m tall. This change will allow stands to be characterised in terms of the basal area removed, as well as retained basal area and stand structure. FORESTCHECK grids previously established in Donnelly and Wellington Districts will be re-visited to collect this data retrospectively.

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FOLIAR AND SOIL NUTRIENTS

Lachlan McCaw, John Neal, Bob Smith, Shelley McArthur and Lin Wong

Introduction

Concentrations of nitrogen (N), phosphorus (P) and potassium (K) in the foliage of advance growth, saplings and overstorey trees, and in surface soils are measured at each FORESTCHECK monitoring grid to provide information about the nutritional status of the forest ecosystem. Data will be used to investigate correlations between macronutrient concentrations and measures of plant and animal abundance, and ecosystem health.

Field Work

Samples of foliage and soil were collected from all grids in Perth Hills District during mid March 2004. The methodology for collection and analysis of samples is described in the Operations Plan. Samples were analysed at the Science Division Soil and Plant Laboratory in Kensington.

Results

Foliar nutrients

Foliage from mature Marri trees tended to have higher concentrations of P and K measured in advance growth or saplings. Growth stage appeared to have little or no effect on concentrations of N, P or K in Jarrah foliage (Table 1). Nitrogen concentrations were similar in mature foliage of Jarrah and Marri, whereas P and K concentrations were higher in Marri than in Jarrah.

Table 1. Concentrations of N, P and K in the foliage of Jarrah and Marri advance growth, saplings and mature trees for eight grids in Perth Hills District. Data are shown as minimum-**mean**-maximum.

Species	Foliage source	Nitrogen (total) (%)	Phosphorus (%)	Potassium (%)
Jarrah	Advance growth	0.56-**0.75**-1.04	0.001-**0.010**-0.013	0.20-**0.25**-0.31
	Sapling	0.64-**0.71**-0.79	0.001-**0.007**-0.140	0.20-**0.27**-0.40
	Mature	0.71-**0. 83**-1.00	0.002-**0.009**-1.021	0.20-**0.22**-0.27
Marri	Advance growth	0.56-**0.79**-0.93	0.006-**0.014**-0.029	0.38-**0.46**-0.54
	Sapling	0.74-**0.91**-1.46	0.003-**0.018**-0.061	0.49-**0.54**-0.60
	Mature	0.82-**0.93**-1.27	0.010-**0.040**-0.122	0.62-**0.70**-0.77

Soil nutrients

Soil N concentrations were quite consistent (0.10-0.13 %) across all grids, except for the Holyoake control (FC21) which had almost twice the level of the other grids (Table 2).

Total P concentrations ranged from 14.4-63.9 ppm, and tended to be lowest in the northern set of grids in Lesley and Occidental forest blocks (FC25-27). Extractable P concentrations were not clearly related to the geographical location of the sites, and the lowest concentration was recorded in the Cameron shelterwood grid (FC23). Total and extractable K concentration varied by a factor of about 2.5 times from the lowest to the highest sample means. The Cameron block shelterwood (FC23) had low concentrations of both extractable and total K, while the Holyoake control (FC21) had the highest ranked concentrations.

Table 2. Mean concentrations of N, extractable and total P, and extractable and total K determined from 5 samples surface soil samples. The overall mean (s.e.m.) for 8 grids in Perth Hills District is indicated.

Grid	**N** (%)	**P-extract.** (ppm)	**P-total** (ppm)	**K-extract.** (ppm)	**K-total** (ppm)
FC20	0.13	1.70	44.40	78.10	164.40
FC21	0.20	2.00	63.90	76.60	245.20
FC22	0.10	1.00	40.70	42.10	113.90
FC23	0.11	0.80	21.40	31.00	100.40
FC24	0.11	1.80	33.30	55.60	113.50
FC25	0.13	1.30	23.00	42.70	124.60
FC26	0.11	1.70	17.70	42.20	91.50
FC27	0.13	1.20	14.40	60.20	132.30
MEAN (s.e.m)	**0.13 (0.03)**	**1.44 (0.42)**	**32.35 (16.71)**	**53.56 (17.19)**	**135.73 (49.45)**

Discussion

The Holyoake control grid (FC21) exhibited superior soil macronutrient concentrations compared to the remaining sites, reflecting its favourable location just upslope from a fertile gully containing good stands of Yarri (*E. patens*) on red loamy soil. The Cameron shelterwood grid (FC23) stood out as having relatively low levels of soil P and K relative to the other sites.

Comparing the overall mean concentrations of soil nutrients measured in previous years for the FORESTCHECK grids in Donnelly, Wellington and Perth Hills Districts (Table 3) we find that:

- Mean N concentrations are similar across grids in all three Districts.
- Grids in Perth Hills have lower extractable and total P concentrations.
- Mean concentrations of extractable and total K are similar across grids in all three Districts.

Foliar nutrient concentrations were generally comparable with those measured in Donnelly and Wellington in previous years.

Table 3. Mean (s.e.m) soil nutrient concentrations for FORESTCHECK grids in Donnelly, Wellington and Perth Hills Districts.

District	**N** (%)	**P-extract.** (ppm)	**P-total** (ppm)	**K-extract.** (ppm)	**K-total** (ppm)
Donnelly	0.12 (0.01)	2.0 (0.4)	65.4 (13.4)	43.8 (5.6)	94.8 (13.5)
Wellington	0.14 (0.01)	2.3 (0.6)	85.2 (16.3)	54.7 (5.6)	119.0 (11.0)
Perth Hills	0.13 (0.03)	1.4 (0.4)	32.3 (16.7)	53.6 (17.1)	135.7 (49.4)

Recommended changes to operating procedure

With the closure of the Kensington soils laboratory in June 2004, analysis of foliar and soil nutrients will be outsourced from 2004/05. Preliminary discussions held with the WA Chemistry Centre indicate that they are capable of taking on the FORESTCHECK analysis work at a reasonable cost.

SOIL DISTURBANCE

Kim Whitford

Introduction

This report covers the 2003/2004 soil disturbance assessments of the FORESTCHECK sites: Holyoake shelterwood (FC20), Kennedy gap release (FC22), Cameron shelterwood (FC23), Kennedy control (FC24), Lesley gap release (C25), and Lesley shelterwood (C26). Only a subset of all FORESTCHECK sites is monitored in the soil disturbance assessment. Bulk density was measured on only two sites: Cameron shelterwood and the Kennedy control. Because snig tracks are the source and location of most soil disturbance produced by logging, mapping of snig track layout and snig track order was attempted on all of the harvested sites.

The objectives of this work wereto:

- Record the extent of soil disturbance on FORESTCHECK monitoring sites where machine disturbance (snig tracks) could be readily identified.
- Monitor the intensity of changes to soil physical properties induced by logging, on selected sites.
- Provide base data that could be used to monitor any change in these soil physical properties over time.
- Contribute data that can be used to relate the operational categories to the intensity of disturbance, where intensity of disturbance is measured as the fine earth bulk density of the soil.

Sampling

Bulk density was measured on two sites: Cameron shelterwood, and the Kennedy control. These sites were selected for measurement of bulk density because: a) the surface soils were relatively free of large boulders or sheet cap rock, b) the two sites were the same Mattiske-Havel vegetation complex and consequently should have similar soils, and c) the snig tracks could be successfully mapped on the Cameron shelterwood site, thus providing information on the operational categories of the bulk density sample points. On the Cameron shelterwood site, sampling of bulk density was stratified on the basis of operational categories. The operational categories are classifications that identify the type of harvesting activities that have occurred at the sample point, e.g. harvested area, unharvested area, log landing, old log landing, old snig track, snig track order.

On the remaining five sites where bulk density was not measured, mapping of snig tracks provided a measure of the amount of disturbance. Incorrect or low quality mapping produces biased measurements of the amount of disturbance. This year mapping of the snig track layout was particularly difficult on some sites because surface rocks and post harvest silvicultural treatment (Kennedy gap release), and relatively light soil disturbance (Holyoake shelterwood and Lesley shelterwood) impeded the identification of snig tracks on these sites. Satisfactory mapping of the snig track layout only occurred on the Cameron shelterwood and the Lesley gap release (see Table 1). Consequently the snig tracks maps for the Kennedy gap release, Holyoake shelterwood and Lesley shelterwood are not presented.

Table 1. The type of assessment and the number of samples collected at each site.

Site	Site label	Snig track map	Operational category sample points	Bulk density sample points	Quality of snig track mapping
Holyoake shelterwood	FC20	No			Very low
Holyoake control	FC21	No			No snig tracks
Kennedy gap release	FC22	Yes			Low
Cameron shelterwood	FC23	Yes	174	174	Satisfactory
Kennedy control	FC24	No	40	40	No snig tracks
Lesley gap release	FC25	Yes			Satisfactory
Lesley shelterwood	FC26	No			Very low
Occidental control	FC27	No			No snig tracks
TOTAL			**214**	**214**	

Results

The sites and treatments assessed and measured are listed in Table 1. Table 2 gives the means and standard errors for total bulk density (TBD) and fine earth bulk density (FEBD), and gravel content for various operational categories on the Cameron shelterwood and the Kennedy control. Although the Kennedy control has been harvested, this last occurred c. 80 years ago. Consequently the visual evidence of any soil disturbance has disappeared and the sample points are classified as unharvested.

Table 3 shows the area of the snig tracks and landings for five sites from the 2002/2003 monitoring, but only for the Lesley gap release site for this years monitoring. Although snig tracks were successfully mapped on two sites, the Lesley gap release was the only site from this years monitoring where the relationship between the snig track pattern and the area of the harvesting was clear. The snig track maps (Figs. 1 and 2) show the location and extent of snig tracks and landings on the Cameron shelterwood, and the Lesley gap release sites.

Table 4 provides a summary of the comparisons of soil bulk density that can be made between the control sites and the recently harvested sites over the three years of FORESTCHECK monitoring. Five such comparisons can be made. For each of the recently harvested sites two values of the mean bulk density are given; one mean for samples collected on the systematically sampled grid points, and another mean for the samples collected from the "harvested area" operational category. The change in bulk density as a result of the harvesting is best estimated by comparison of the mean bulk densities from the unharvested control site and the systematic grid point samples from the recently harvested sites.

Table 2. Bulk density and gravel content for operational categories at two FORESTCHECK sites. Operational categories: Harvested area (HA), Unharvested area (UA), Major snig track into landing (ST0), Primary snig track (ST1), Secondary snig tracks (ST2), Tertiary snig track (ST3), Old Primary snig track from previous logging (OST1), Old Tertiary snig track from previous logging (OST3), Log landing (LL), Old log landing (OLL), Access track (Track).

FORESTCHECK site	Operational category	n	Total bulk density	SE	Fine earth bulk density	SE	Gravel content (%)	SE
FC23 Cameron shelterwood	HA	73	1.466	0.024	0.918	0.013	52.2	1.2
	LL	21	1.856	0.049	1.042	0.041	62.5	1.5
	OLL	1	1.657		0.761		71.5	
	OST1	10	1.520	0.059	0.950	0.035	55.6	2.7
	OST3	4	1.400	0.073	0.931	0.019	50.1	4.8
	ST1	4	1.711	0.050	0.883	0.045	66.8	4.2
	ST2	25	1.520	0.036	1.030	0.028	48.7	2.4
	ST3	31	1.484	0.032	0.969	0.020	49.6	1.9
	Track	5	1.614	0.034	1.045	0.025	56.3	1.3
FC24 Kennedy control	UA	40	1.642	0.029	0.826	0.021	66.6	1.6

Discussion

- The boundaries of the faller's blocks about these 2003/04 FORESTCHECK sites in the northern Jarrah forest were not as well delineated as the faller's blocks assessed in the southern Jarrah forest in 2001/2002. The boundaries of the shelterwood and gap release loggings of the 2001/02 FORESTCHECK sites were marked on the surrounding trees and the paint marks were clearly visible. This was not the case in 2003/04. Consequently the faller's block areas presented in Table 3 are estimates. These areas were estimated from the extent and distribution of the snig tracks on these sites. This reduces the accuracy of the last two columns in Table 3, i.e. the estimates of the area of the landing as a proportion of the faller's block area, and the estimates of the proportion of the faller's block disturbed by snig tracks and landings.
- One of the aims of this work is to identify the impact of timber harvesting on the soil bulk density. Soil bulk density can only be readily measured on sites that are relatively free of cap rock and large boulders, as bulk density is measured by collecting soil cores. This limits the site selection for bulk density measurements to treatment and control sites that are relatively free of cap rock and large boulders. In addition, measurements of bulk density are best collected from treatment sites where the snig tracks can be clearly mapped, so that the operational categories of the sample points are known. For this years set of monitoring sites this restricted the monitoring of bulk density to the Cameron shelterwood, and the Kennedy control.

Table 3. The estimated area of the faller's block surrounding each FORESTCHECK site, the area of snig tracks and landings identified on each faller's block, and the areal proportion of the faller's block that has been disturbed by snig tracks and landings. Snig track classes are: primary (ST1), secondary (ST2), tertiary (ST3), and old snig track from a previous logging (OST). Snig track area calculations are based on measurements of snig track lengths and assumed widths of 4.67 m for ST1, 4.46 m for ST2, and 4.13 m for ST3.

Site	Site code	ST1 (m^2)	ST2 (m^2)	ST3 (m^2)	OST (m^2)	Total snig track area (m^2)	Landing Area (m^2)	Estimated faller's block area (m^2)	Landing area as a percentage of faller's block	Snig track area as a percentage of faller's block	Percentage of fallers block disturbed
Edwards gap release main landing and faller's block	FC11	1365	1346	5326	0	8037	1970	55220	3.6	14.6	18.1
Edwards gap release second landing	FC11	n/a	n/a	n/a	n/a	n/a	2240	n/a			
Edwards gap release third landing	FC11	n/a	n/a	n/a	n/a	n/a	600	n/a			
Ross gap release	FC12	1804	2331	5256	0	9391	4350	105300	4.1	8.9	13.0
Ross shelterwood eastern faller's block	FC13	1112	1560	8262	0	10934	2248	77130	2.9	14.2	17.1
Surface shelterwood	FC15	2351	1761	6908	0	11020	1590	65760	2.4	16.8	19.2
Chalk shelterwood western faller's block	FC18	322	825	5995	2159	9301	2120	43820	4.8	21.2	26.1
Chalk shelterwood eastern faller's block	FC18	444	1511	3596	2739	8290	680	46700	1.5	17.8	19.2
Chalk combined, both faller's blocks	FC18	766	2336	9591	4899	17592	2805	90520	3.1	19.4	22.5
Chalk shelterwood west, excluding OST	FC18	322	825	5995	excluded	7142	2120	43820	4.8	16.3	21.1
Chalk shelterwood east, excluding OST	FC18	444	1511	3596	excluded	5551	680	46700	1.5	11.9	13.3
Chalk combined, excluding OST	FC18	766	2336	9591	excluded	12693	2805	90520	3.1	14.0	17.1
Lesley gap release	FC25					9666	418	120,179	0.4	8.4	

Table 4. A summary of the mean change in surface soil bulk density attributed to timber harvesting operations across all FORESTCHECK sites.

Site	Site code	Operational category	Number of times harvested	Year of last harvest	Years since harvest	Mattiske-Havel vegetation complex	Fine earth bulk density (g cm^{-3})	% Change (grid vs. not harvested)	n	Gravel content (%)	Assessment year
Kingston gap release	FC2	Grid points	3	1995/96	7	Corbalup 2	0.82 ± 0.03		77	33	2001
Kingston gap release	FC2	Harvested	3	1995/96	7	Corbalup 2	0.80 ± 0.02		68	32	2001
Kingston TEAS	FC4	Not harvested	2	1970's	22-32	Corbalup 2	0.92 ± 0.02	-11	39	10	2001
Thornton gap release	FC6	Grid points	2	1991	11	Corbalup 1	1.00 ± 0.02		77	17	2001
Thornton gap release	FC6	Harvested	2	1991	11	Corbalup 1	0.98 ± 0.02		75	17	2001
Thornton TEAS	FC7	Not harvested	1	1940's	52-62	Corbalup 1	0.76 ± 0.04	32	40	47	2001
Carter gap release	FC8	Harvested	2	1999	3	Collis 1	0.80 ± 0.01		137	35	2001
Carter TEAS	FC9	Not harvested	1	1940's	52-62	Collis 1	0.78 ± 0.02	3	40	55	2001
Chalk shelterwood	FC18	Grid points	3	1992	11	Dwellingup 1	0.81 ± 0.02		81	65	2002
Chalk shelterwood	FC18	Harvested	3	1992	11	Dwellingup 1	0.80 ± 0.02		67	65	2002
Tumlo control	FC19	Not harvested	0	virgin	n/a	Dwellingup 1	0.60 ± 0.02	35	40	70	2002
Cameron shelterwood	FC25	Grid points	3	1989	15	Dwellingup 1	0.92 ± 0.01		74	53	2003
Cameron shelterwood	FC25	Harvested	3	1989	15	Dwellingup 1	0.92 ± 0.01		73	52	2003
Kennedy Control	FC24	Not harvested	2	1930-34	74-70	Dwellingup 1	0.83 ± 0.02	11	40	67	2003
Mean								20			

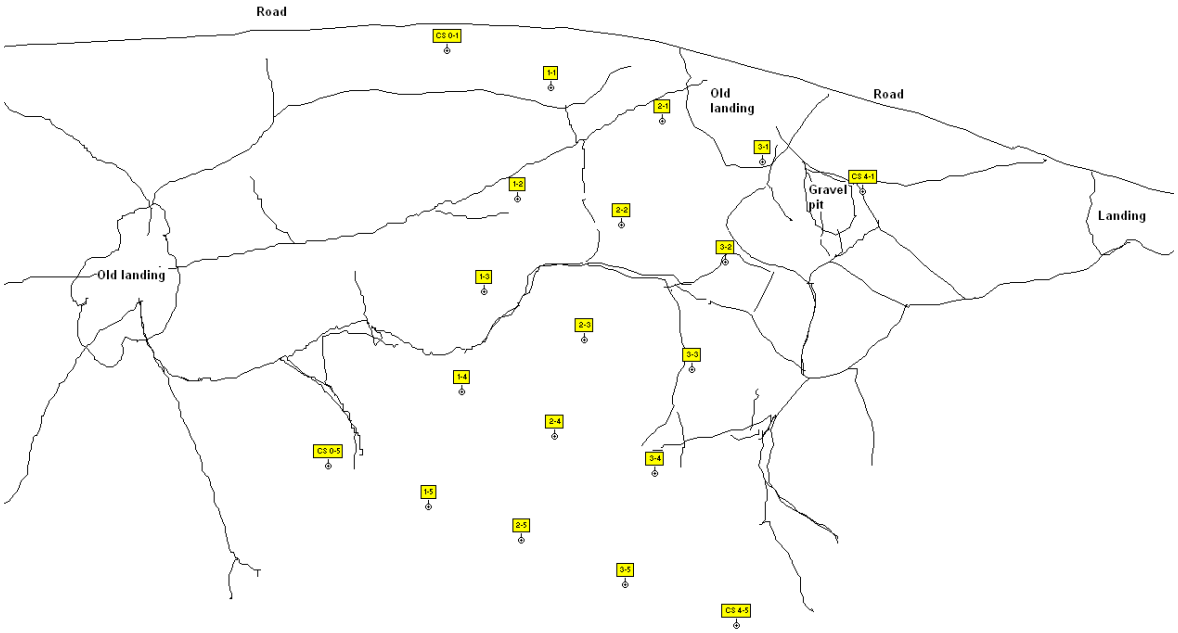


Figure 1. FORESTCHECK site FC 23, Cameron block shelterwood. Scale is given by the grid point spacing of 50 metres.

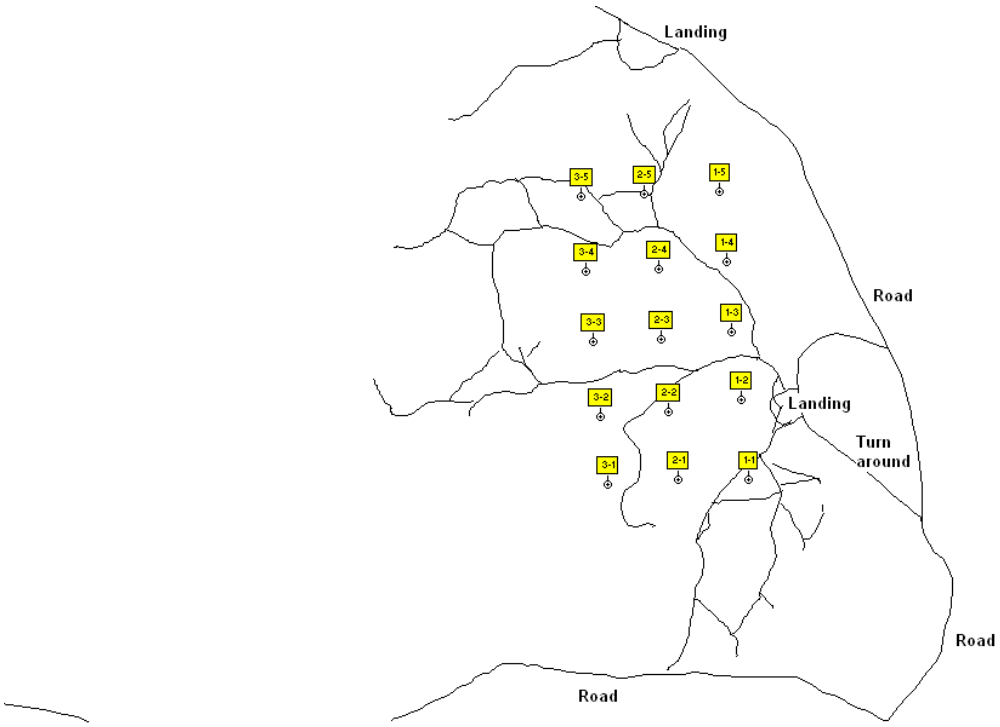


Figure 2. FORESTCHECK site FC 25, Lesley block gap release. Scale is given by the grid point spacing of 50 metres.

- All of the monitoring sites, other than the Holyoake control (logged once) have been logged at least twice. Bulk density was measured on the Cameron shelterwood (logged three times, most recently in 1989) and the Kennedy control (logged twice – 1920s and pre 1920). The Kennedy control is used here as a reference site for comparison with the Cameron shelterwood. The intention of this comparison is to determine the impact of timber harvesting on the soil bulk density. Ideally such comparisons would be made between a logged site and a comparable site that had never been logged. This is not always possible, and the comparison presented here for this years monitoring compares a recently logged site (Cameron shelterwood) with one logged c. 60 years earlier (Kennedy control). Comparing these two sites, the most recent timber harvesting on the Cameron shelterwood produced an increase in fine earth bulk density of the surface soil of c. 11%.
- Table 4 summarizes the mean change in surface soil bulk density attributed to timber harvesting operations across all of the FORESTCHECK sites where bulk density has been measured. The change in bulk density as a result of the harvesting is estimated by comparison of the mean bulk densities from the grid point samples for the recently harvested sites, with the unharvested control sites. The comparisons in Table 4 are made between sites with the same Mattiske-Havel vegetation complex. Generally soils are similar within a Mattiske-Havel vegetation complex, however this is not always the case and one such exception occurred with the Kingston gap release and the immediately adjacent Kingston TEAS sites. The soil on these two sites was very different – the Kingston TEAS being a sand, and the Kingston gap release a gravelly loam. Comparison of bulk density between these two sites is not meaningful because the soils are clearly different.
- Excluding the Kingston gap release site, the mean increase in soil bulk density attributable to timber harvesting across these four sites was 20%. This is a substantial increase in the mean bulk density of the surface soils, and can be identified as a likely impact of timber harvesting. Similar data from a greater number of sites and further comparisons with virgin sites is needed to clarify the validity of this observed increase in bulk density.
- Of these four comparisons shown in Table 4, only one of these, the Chalk Shelterwood and Tumlo control enable a comparison of a virgin site with a harvested site. These two sites reveal the greatest increase in soil bulk density from the unharvested to the harvested site. The Tumlo control site could similarly be used for comparison with the Cameron shelterwood (logged three times) and with the Kennedy control (logged twice) as all of these sites are from the Dwellingup 1 vegetation complex and have similar soils.
- The mean bulk density of the soil on the "harvested area" operational category was relatively high for the Cameron shelterwood.
- The landing size on the Lesley gap release was particularly small. At 418 m^2 this is the smallest landing measured across all of the FORESTCHECK sites, and is only 0.4% of the total faller's block area. Landings are sites of major soil disturbance and reducing landing size is an important component in reducing soil disturbance.
- Across all of the FORESTCHECK sites, landing size has varied from 0.4% to 4.8% of the total area of the faller's block. The mean landing size was 2.4% of the total area of the faller's block.

Conclusions

- The landing at Lesley gap release was the smallest landing so far measured. It was 418 m^2 or c. 0.4% of the faller's block.
- Only 8% of the Lesley gap release faller's block was disturbed by snig tracks and landings. This is a relatively low amount of disturbance.
- The mean fine earth bulk density at Kennedy control site was 0.83 ± 0.02 g cm^{-3} (n = 40), this site has been harvested twice and was last logged between 1930 and 1934.
- The mean fine earth bulk density at Cameron shelterwood was 0.92 ± 0.01 g cm^{-3} (n = 74) (from systematic grid points). This site has been harvested three times and was last logged in 1989.
- The three logging events at the Cameron shelterwood have produced a general increase in soil compaction across this site of c. 11%, when compared with Kennedy control site that has been logged twice.
- Considering all of the FORESTCHECK sites so far monitored for soil bulk density, harvesting produces a mean increase in soil bulk density of 20%.
- Similar differences over a larger number of sites are needed to confidently identify the size of any increase in bulk density caused by harvesting.
- Understanding the impact of harvesting on the soil bulk density on these FORESTCHECK sites would be greatly enhanced if further measurements of soil bulk density were taken on more sites of similar soil types that have never been harvested.

Future tasks

The planned work for the 2003-4 monitoring is complete. The snig track widths used to calculate the area of the snig tracks were mean values determined from earlier work at other sites in the Jarrah forest (Whitford 2001). The addition of measurements of snig track widths on the individual FORESTCHECK sites would increase the accuracy of the snig track areas presented here. It could be helpful in the final analysis of this data to have particle size analysis, soil descriptions and possibly soil mapping for all of the FORESTCHECK sites, but particularly for the 10 sites listed in Table 4 where soil bulk density has been measured. As many of the control sites have been harvested at least once, and have thus experienced soil disturbance which is slow to ameliorate, it may also be valuable to collect bulk density measurements from some additional sites which have not been harvested, to use as reference sites for the harvested treatment sites as well as the control and TEAS sites that have also been harvested some time back.

COARSE WOODY DEBRIS, SMALL WOOD AND TWIGS, AND LITTER

R.H. Smith and R.M. Robinson

Introduction

The quantity of wood and leaf debris on the forest floor has a great influence on the habitat for the fungi, small reptiles, mammals and invertebrates. It is therefore important to ascertain the amount of debris in each area before and after disturbance such as logging and burning. The amount of litter also affects the soil moisture, which in conjunction with micro-organisms affects the soil texture.

This component of FORESTCHECK is intended to:

- Measure and record the amount of litter, small wood and twigs (SWT) and coarse woody debris (CWD) on the ground in the various managed Jarrah forest treatments (ie. Gap Release and Shelterwood) and in uncut forest.
- Analyse trends within and between the treatments over time.
- Make the data available for analysis of distribution patterns of other organisms such as invertebrates, small mammals, fungi and cryptogams.

Data Collection

Sampling in 2004 was carried out on 8-12 March in conjunction with the soil and leaf nutrient sampling and stand structure measurement.

Data Management

The data were entered into Microsoft Excel worksheets. The litter and SWT component was initially calculated in grams then converted to t ha^{-1}. The volume of CWD was calculated to m^3 ha^{-1}.

Results

Litter Weights

Generally the heaviest litter loads occurred on the control sites (8.3 to 11.7 t ha^{-1}) but the long-unburnt Cameron shelterwood site (FC23) had a litter load of 14.2 t ha^{-1}. The lightest loads were in the gap release treatments, with the Lesley site (FC25) having only 2.6 tonnes of litter per hectare. Overall, the litter loads reflected the different crown densities and time since last burn on each site (Fig. 1).

Small Wood and Twigs

The amount of small wood and twigs was similar on all sites, being about 1 t ha^{-1} except on the Lesley gap release treatment (FC25) where it was 2 t ha^{-1} (Fig. 2).

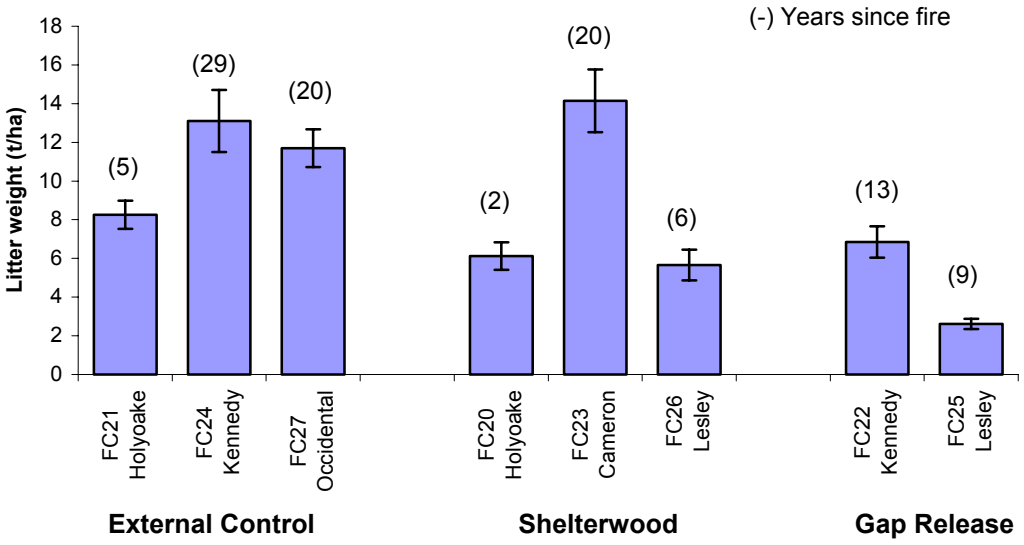


Figure 1. Mean litter loads (t ha^{-1}) calculated at each FORESTCHECK grid in the Perth Hills District in March 2004.

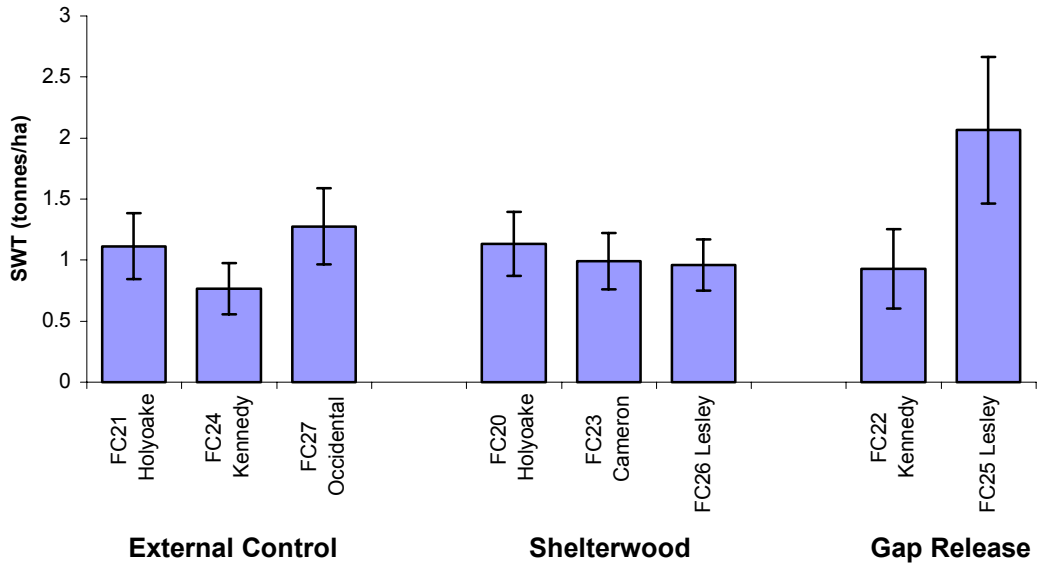


Figure 2. The average weights (t ha^{-1}) of small wood and twigs measured at each FORESTCHCECK site in the Perth Hills District in March 2004.

Coarse Woody Debris

A large amount of variability was encountered within and between treatments in the amount of CWD measured on sites (Fig. 3). This is most likely caused by large logs that have a very big influence on the volume per hectare but are not distributed in great numbers on the sites. The greatest volume of CWD occurred on the Kennedy and Cameron sites with 231 m^3 measured on the gap release (FC22) treatment, 162 m^3 on the external control (FC24) and 145 m^3 on the shelterwood treatment (FC23). The lowest volume of 37 m^3 occurred on the Occidental external control (FC27).

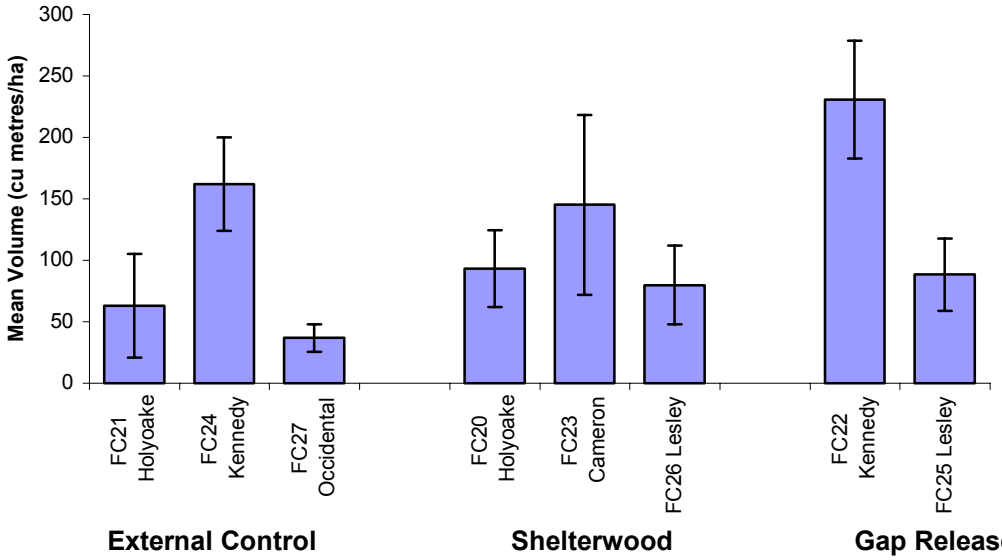


Figure 3. The volume (m^3 ha^{-1}) of coarse woody debris measured at each FORESTCHCECK site in the Perth Hills District in March 2004.

Conclusions

- The amount of litter on each grid generally reflects the time since last burn and the overhead crown densities.
- The amount of small diameter wood and twigs on each grid is similar (c. 1 t ha^{-1}) except on the Lesley gap release that has about twice the amount of the other grids.
- The volume of coarse woody debris on each grid is very variable between treatments as well as within treatments.

Modification to Methods and Difficulties

The method is working well and the results can be expected to improve over time as further data are obtained for each site. Although not used in the calculations, the diameter of all stumps on the sample lines was measured. At present no satisfactory method of estimating their contribution to the amount of coarse woody debris on each site has been made.

MACROFUNGI

R.M. Robinson, R.H. Smith and J.L. McGurk

Introduction

Fungi are considered one of the most important forest organisms in terms of both biodiversity and forest function. Soil, litter and wood inhabiting fungi play major roles in decomposition and nutrient cycling. Mycorrhizal fungi enhance nutrient uptake of plants and may enhance plant resistance to some pathogens. In addition, underground truffle-like fungi are an important food source for small mammals, especially following disturbance such as fire.

Research on fungi in Western Australia's southern forests is in its infancy. Knowledge on fungal diversity and the ecological roles that fungi play is of vital importance to Forest Managers making decisions on Sustainable Forest Management.

The objective of this component of the FORESTCHECK program is to:

- Monitor and record the species of macrofungi in the various treatments of managed Jarrah forest (gap release, shelterwood) and in uncut forest.
- Analyse trends in species composition, richness and abundance and substrate utilization over time.
- Generate detailed descriptions of unknown or unnamed species.

Field and Lab work

Transects to monitor macrofungi were installed at the Perth Hills sites during grid establishment in September-October 2003 and all the sites were monitored in June and again in July 2004. In addition to the Perth Hills sites, Donnelly sites (initially established and monitored in 2002) were also monitored in June 2004.

The emphasis of this report is on monitoring undertaken at Perth Hills, however, a brief report on results obtained at the Donnelly sites in 2004 is also included.

1. PERTH HILLS

Monitoring

As in previous years, monitoring dates were selected on the basis of rainfall and soil dryness index (SDI) statistics provided by the Dwellingup Work Centre, the Perth Hills District office at Mundaring, and the Bureau of Meteorology online SDI statistics for Dwellingup and Bickley. A week of steady rain, from 5-12 June, delivered 166 mm and 151 mm of rain at Dwellingup and Mundaring respectively and all sites were monitored from 21-23 June. However, the plots, especially the northern set located in Occidental and Lesley blocks, still appeared to be quite dry. Steady rain fell once again from 22 June – 8 July delivering a further 160 and 142 mm at Dwellingup and Mundaring respectively. The second monitoring was undertaken from 12-14 July (Fig 1).

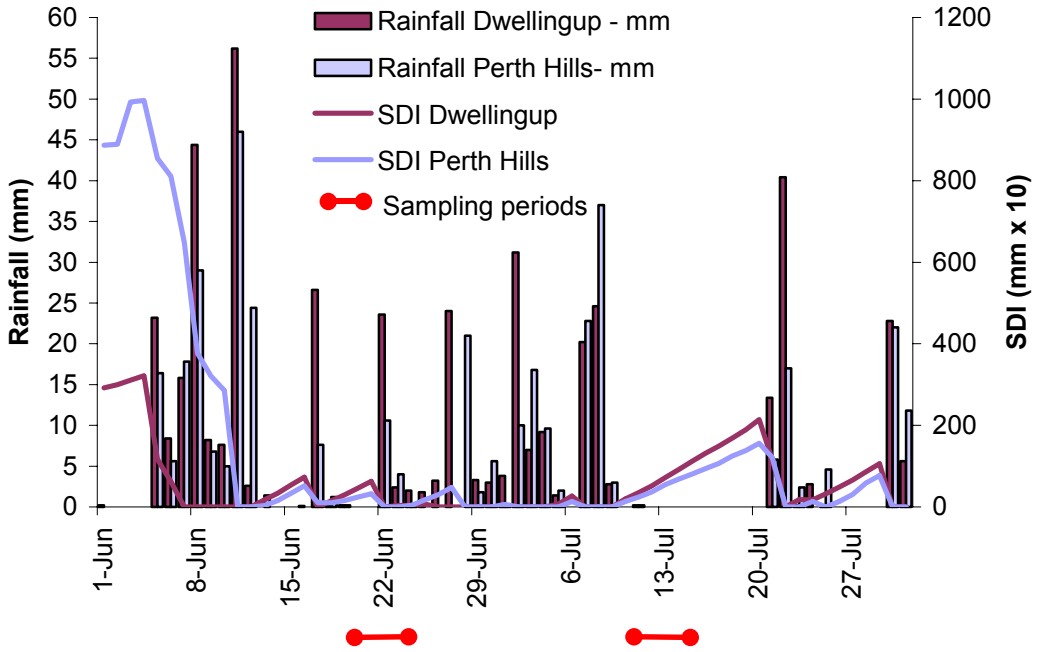


Figure 1. Daily rainfall soil dryness index calculated for Dwellingup and Mundaring (Perth Hills) during the period 1 June to 30 July 2004. The FORESTCHECK sampling period is indicated in red.

Voucher Specimens

Voucher specimens have been processed and where possible identified. An overall species list and one for each individual site has been determined. In total, 185 voucher collections were made representing 76 species. Processing of each voucher was completed on the day of collection or the next day. This included photographing in the field, and preparing morphological descriptions of fresh collections. A total of 32 species had not been encountered previously and detailed descriptions were necessary to validate their identity. All collections were then dried so that microscopic descriptions could be later completed on the dried specimens in the Laboratory at Manjimup Research Centre. All vouchers have been entered onto the WA Herbarium database and are housed at the Tony Annells Herbarium at the Manjimup Research Centre.

Results and Discussion

Similar numbers of species were recorded at both the June and July monitoring periods (Fig. 2). Ninety-five species were recorded in June and 89 species recorded in July. However, the number of fruitbodies recorded in July (1902) was only 40% of that recorded in June (2507). The reason for this appears to be that 42 species of fungi were common to both monitoring periods, but they produced almost twice as many fruitbodies in June (2109) compared to July (1332). The remaining 53 species that were recorded only in June and the 47 species recorded only in July produced similar numbers of fruitbodies, 466 and 507 respectively.

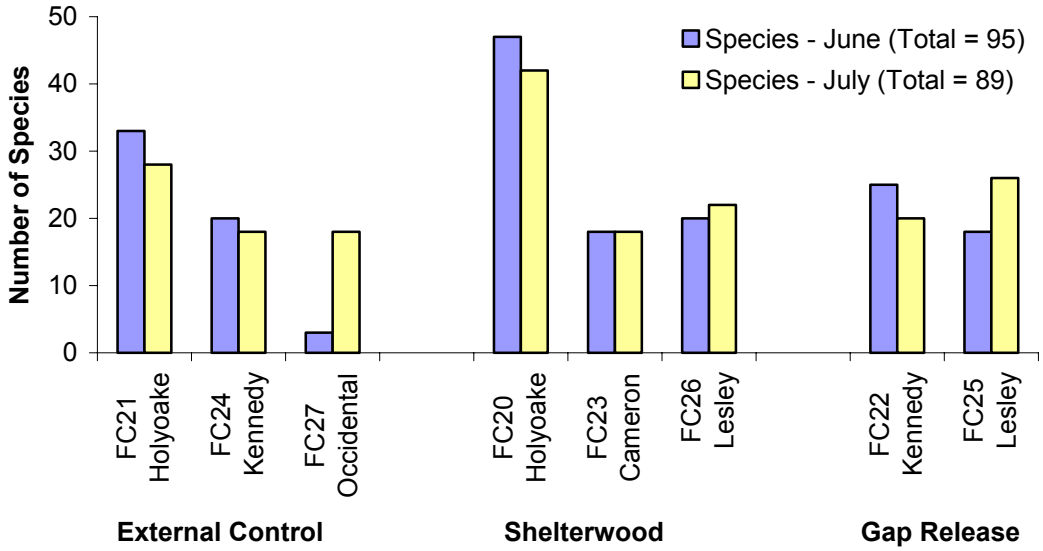


Figure 2. The number of species recorded in June and July at the Perth Hills FORESTCHECK sites.

In total, 142 species of fungi were recorded on the Perth Hills sites (Appendix I). Of these, 23% (42 species) were recorded for the first time in FORESTCHECK. A total of 4,477 fruitbodies were recorded (Appendix I). This is about three-quarters of the number of species recorded in previous years, but the number of fruitbodies recorded in 2004 was only about one-quarter of that previously recorded. This is likely due to the drier environment, especially in the northern sites, in which the 2004 sites were established. The Holyoake sites, both external control and shelterwood treatments, had more species and fruitbodies than the corresponding Lesley/Occidental and Kennedy/Cameron sites (Fig. 3).

On the external controls there appears to be a north-south gradient associated with the number of species and the number of fruitbodies recorded. However within the logging treatments there are similar numbers of both species and fruitbodies on all sites except for the Holyoake shelterwood, which had a more species and fruitbodies. The Holyoake shelterwood had a larger number of species recorded on soil and the species colonizing wood had produced more fruitbodies compared to other sites (Figs 4 and 5).

Generally, in each treatment the majority of species were recorded fruiting on the soil, but the majority of fruitbodies were recorded on wood. Species that fruit on wood tend to produce large numbers of fruitbodies (e.g. Species of *Gymnopilus*, *Calocera* sp. and *Stereum hirsutum* – see Appendix I on page 42). The Occidental and Kennedy controls and the Cameron shelterwood had low numbers of species associated with the litter layer (Fig. 4) despite having a long unburnt history (15-20 years) and carrying the highest litter loads (see chapter on Litter and Coarse Woody Debris). Although the Kennedy gap treatment had not been burnt for 13 years, it carried a low litter load but more litter species were recorded than on the previously mentioned sites. The number of species recorded on wood at each site corresponded closely with the amount of CWD measured at each site (see chapter on Litter and Coarse Woody Debris), but the number of fruitbodies recorded at each site was variable. Firm conclusions cannot be made regarding variation in species composition and fruitbody

production on each site and within treatments until further analysis, which will include site variability, is undertaken.

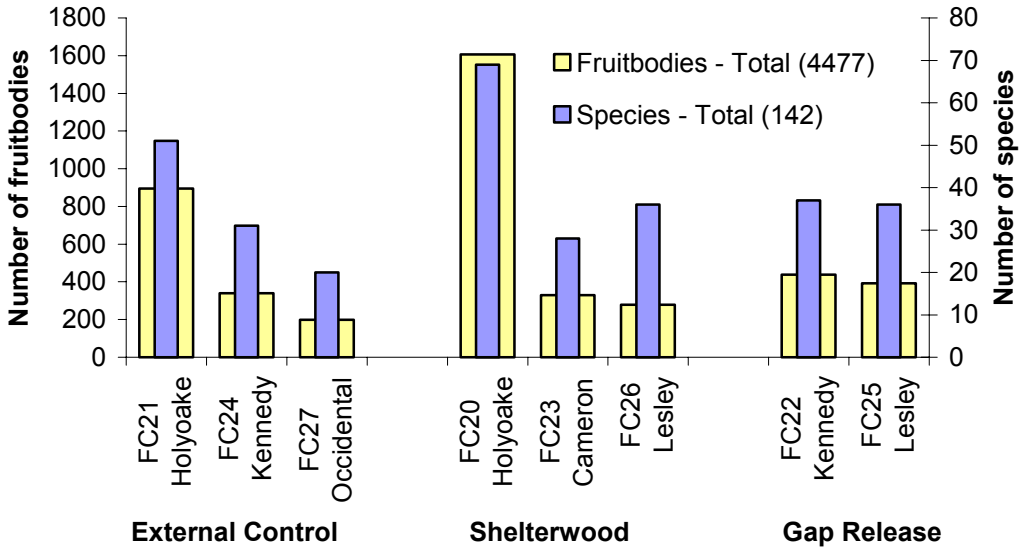


Figure 3. The total number of species and abundance recorded at the Perth Hills FORESTCHECK sites in 2004.

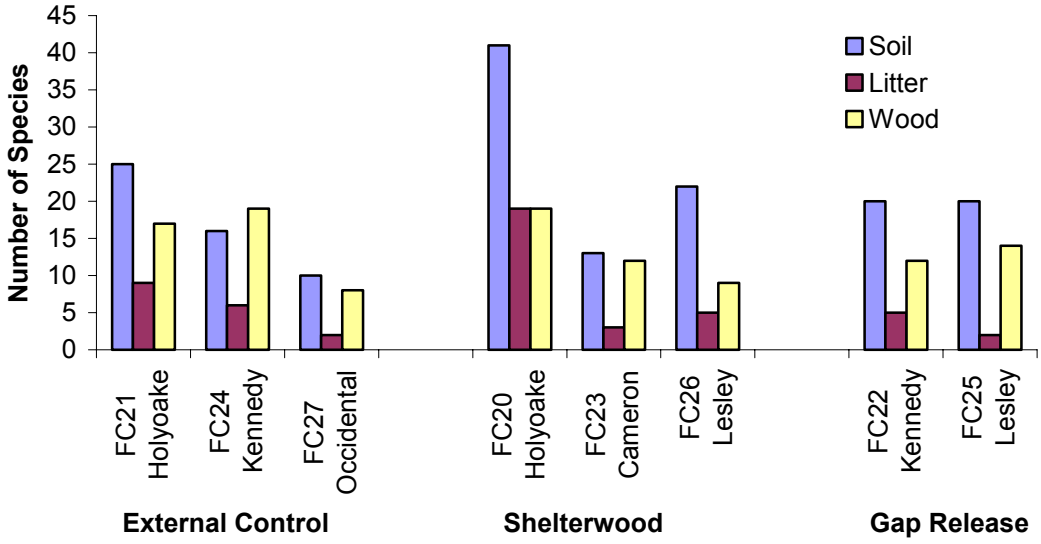


Figure 4. The number of species recorded fruiting on soil, litter and wood on the Perth Hills FORESTCHECK sites in 2004.

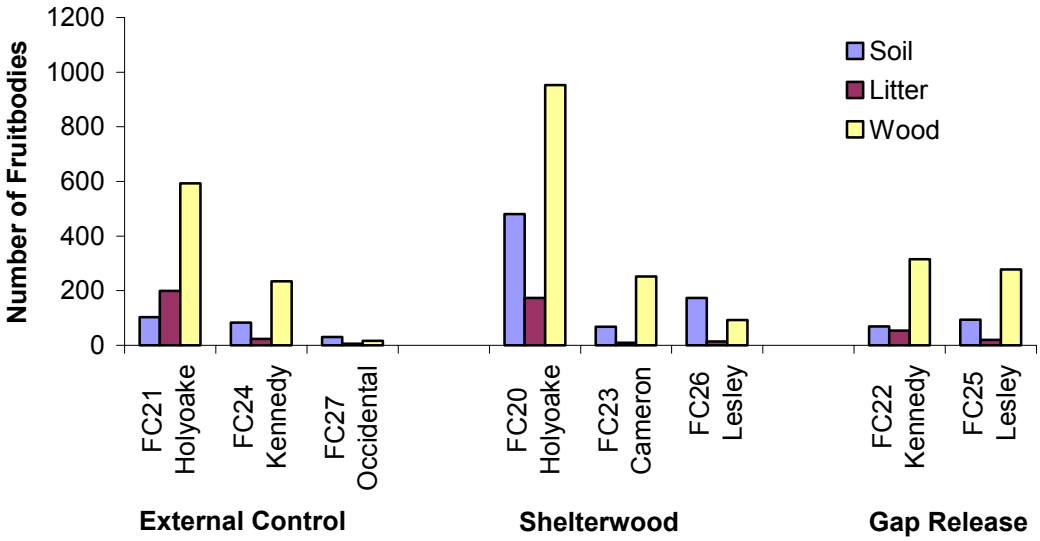


Figure 5. The number of fruitbodies recorded on litter, soil and wood in each grid on the Perth Hills FORESTCHECK sites in 2004.

Figure 6. The number of species and fruitbodies recorded on litter, soil and wood in each treatment on the Perth Hills FORESTCHECK sites in 2004 (NB. Only 2 grids in the gap release treatment).

2. DONNELLY

Monitoring

Monitoring at the Donnelly sites (installed and initially monitored in 2002) was carried out from 14-18 July 2004.

Voucher Specimens

Fifty-five voucher collections were made, representing 48 species.

Results and Discussion

A total of 179 species, and 8,290 fruitbodies were recorded across all the sites. Thirty-one species were recorded for the first time on the Donnelly sites. The overall number of species was comparable to previous years but the abundance in 2004 was considerably lower. The highest number of species and fruitbodies continued to be recorded on the gap release treatment.

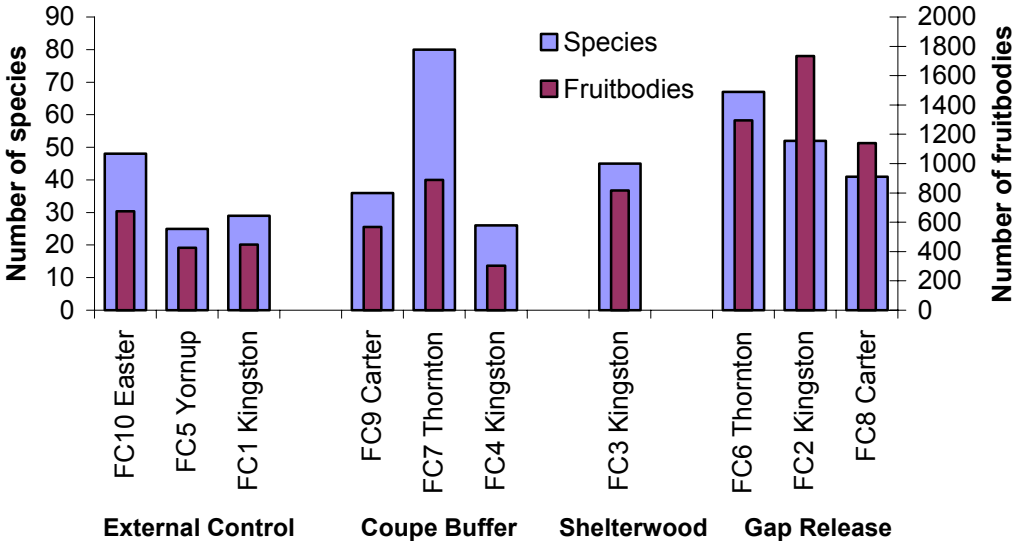


Figure 7. The total number of species and abundance recorded at the Donnelly FORESCHECK sites in 2004.

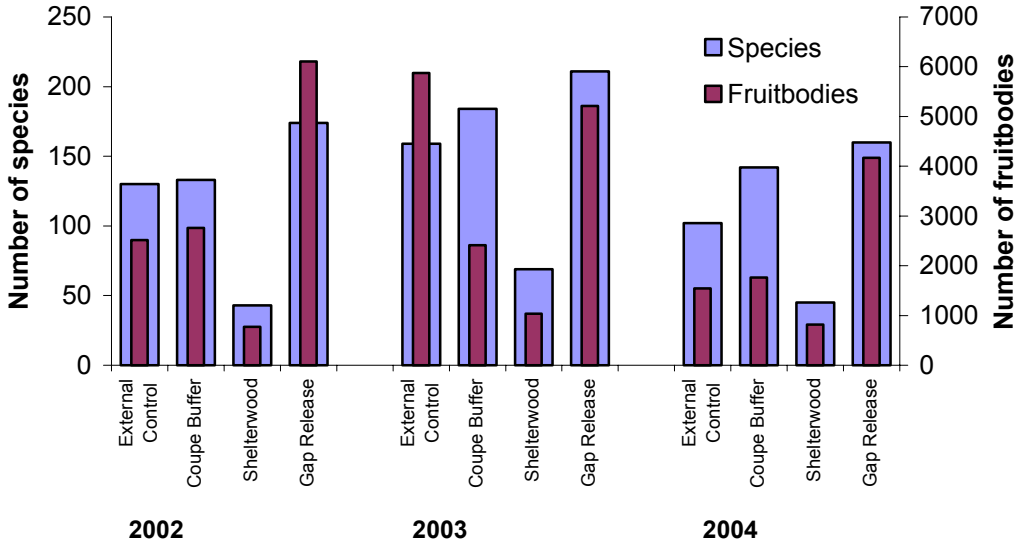


Figure 8. The total number of species and abundance recorded in each treatment in the Donnelly FORESTCHECK sites from 2002-04 (NB. Only one shelterwood site at Donnelly).

Thirty-one species were recorded at Donnelly for the first time in 2004. A planned burn was conducted on the Yornup control (FC5) in December 2003, which resulted in a number of fire associated species such as *Peziza tenacella*, *P. praetervisa*, *Pulvinula archerii*, an undescribed agaric (sp. 329) and *Mycena sanguinolenta* being abundant and recorded for the first time in 2004.

Generally, year-to-year differences at the same location(s) reflect the variation in fruiting patterns associated with annual fluctuations of local climate regimes. Such fluctuations can be alleviated to some extent with regular and long-term monitoring to ensure that all species are reliably and adequately recorded. However, disturbance and management activities such as fire also require additional monitoring in order to record species fluctuations associated with the change and the subsequent site recovery.

Conclusions

- A total of 377 species of macrofungi have so far been recorded in FORESTCHECK.
- 236 species of macrofungi were recorded in 2004 on the Donnelly and Perth Hills FORESTCHECK sites. Of these 84 species (about one-third) were recorded at both sites. Ninety-four were restricted to Donnelly and 58 were restricted to the Perth Hills. This reflects the varying environment within the Jarrah forest and indicates that a number of macrofungi are restricted in distribution within the Jarrah forest.
- Fungal species richness and abundance fluctuate from year to year.
- Timing of monitoring to capture the peak fruiting period for macrofungi is crucial.
- Monitoring for macrofungi immediately following management activities (such as fire) is needed in order to record species that respond to disturbance.

Data Management

All data has been entered onto a Microsoft Excel worksheet. Species diversity and abundance at each site and a frequency rating of 1 (rare) to 8 (very common) for each species at each site has been determined. The data includes a complete list of species recorded across all the sites, their life modes (mycorrhizal, saprotrophic, parasitic) and the substrate on which they were fruiting. Analysis is ongoing.

Issues

The addition of a third person to the team expedited the processing of voucher collections and macro-descriptions of species/specimens without compromising field data collection. However, because field work is carried out without access to the laboratory it is difficult to complete all the descriptive aspects necessary for correct identification of specimens, therefore descriptions of micro-characters for undescribed species were not completed in 2004, but can be undertaken in the future if needed.

Appendix I. The complete species list of fungi recorded in FORESTCEHCK 2002-4 and the species and number of fruitbodies recorded on the Perth Hills sites in 2004.

Sp #	Species	Life Mode[1]	Substrate[2]	Control	Shelterwood	Gap Release	TOTAL
349	Agaric "brown, brown decurrent gills"	S?	S		9		9
46	Agaric "creamy white"	S	S				
82	Agaric "Lepiota-like, cream-grey"	S	S				
156	Agaric "light brown - red scales on stem"	S	S				
18	Agaric "light brown-olive"	S	S				
97	Agaric "pure white"	?	S				
174	Agaric "red/yellow/red"	S	??				
329	Agaric "viscid buff, long stem"	M?	S				
170	Agaric "yellow brown-moist"	S	S/L				
23	Agaric ?*Clitocybe*	S	S				
240	*Agaricus* sp. "small with red brown fibrils"	S	S				
38	*Agaricus* sp. "small"	S	S				
71	*Agaricus* sp. "small, flat- red stain"	S	S				
33	*Agaricus* sp. ″yellow stainer"	S	S				
39	*Agaricus* sp."large cap, purplish scales"	S	S				
120	*Aleuria rhenana*	S	S	7	1		8
126	*Aleurina ferruginea*	S	S/MOSS		2		2
206	*Amanita ananiceps*	M	S				
186	*Amanita brunneibulbosa* "grey-brown"	M	S		1	7	8
283	*Amanita eucalypti*	M	S				
269	*Amanita ochrophylloides*	M	S				
114	*Amanita* sp. "apricot-pink margin"	M	S				
360	*Amanita* sp. "large grey-white, robust"	M	S	1			1
320	*Amanita* sp. "small robust, yellow-buff, bulbous base	M	S				
368	*Amanita* sp. "white with mealy stem"	M	S			1	1
371	*Amanita* sp. "white with saccate volva"	M	S			1	1
45	*Amanita* sp. "white, deeply rooted"	M	S				
28	*Amanita* sp. "white, stout"	M	S				
218	*Amanita* sp."powdery - long tapering base"	M	S			4	4
196	*Amanita umbrinella*	M	S	1			1
6	*Amanita xanthocephala*	M	S	1	20		21
35	*Amanita xanthocephala* forma *macalpiniana*	M	S				
338	*Anthrocobia muelleri*	S	S				
180	*Armillaria luteobubalina*	P/S	W	14		6	20
188	*Austroboletus laccunosa*	S	S				
200	*Austroboletus occidentale*	S	S		1		1
93	*Boletellus ananiceps*	S	S				
103	*Boletellus obscurecoccineus*	S	S		1	3	4
225	*Boletus* sp. "creamy pale yellow	M	S				
29	*Boletus* sp. "dull maroon"	M	S		1		1
345	*Boletus* sp. "light yellow"	M	S				
350	Boletus sp. "pink maroon cap, yellow/red stem"	M	S		2		2
49	*Boletus* sp. ″red pores and stem"	M	S				
253	*Boletus* sp. "red-brown/golden yellow - intense blue stain"	M	S				
95	*Boletus* sp. "small yellow/cream pores"	M	S				
358	*Boletus* sp. "viscid brown cap, yellow marshmallow pores"	M	S		1		1
99	*Boletus* sp. "yellow-red, stains blue"	M	S			1	1
216	*Boletus* sp."brown/yellow pores which stain blue"	M	S				

Sp #	Species	Life Mode[1]	Substrate[2]	Control	Shelterwood	Gap Release	TOTAL
210	*Boletus* sp."maroon/orange pores"	M	S				
195	*Boletus* sp."mustard brown-brown stain"	M	S				
193	*Boletus* sp."purple brown"	M	S				
284	*Boletus* sp."under Allocasuarina"	M	S				
208	*Boletus* sp."yellow-brown, cracked/white pores"	M	S				
9	*Calocera* sp. "yellow"	S	W	352	325	53	730
265	*Cheilymenia* sp. "eyelash on roo poo"	C	DUNG				
243	*Cheilymenia* sp. "orange disks on Marri nuts"	S	NUTS		8		8
364	*Chlorociboria aeruginascens*	S	W				
377	Clavaria "small lemon yellow"	S	S	4	8		12
316	*Clavaria* (*Clavulinopsis*) aff. *aurantiaca* "orange"	M?	S				
319	*Clavaria* (*Clavulinopsis*) sp. "grey-brown with black tips"	M?	S		11		11
81	*Clavulina* cf. *cinerea* "grey-brown"	S	S				
344	*Clavulina* sp. "cream, fluffy tips"	M?	S				
140	*Clavulina* sp. "pink-buff coral"	S	S	2			2
362	Clavulinopsis "grey brown, black tips"	M?	S				
261	*Clavulinopsis* sp. "cream"	S	S				
262	*Clavulinopsis* sp. "tiny white candles"	S	S				
197b	*Clitocybe semi-occulta* "large"						
14	*Clitocybe* sp.	S	S				
370	*Clitocybe* sp. "creamy beige"	S	S/L	4		16	20
324	*Clitocybe* sp. "grey robust"	S	S				
197	*Clitocybe* sp. "semi occulta"	S	W				
301	*Clitocybe* sp."dark grey with dimple"	S	S				
181	*Collybia* aff. *butracea*	S	S				
143	*Collybia* sp. "buff funnel"	S	S				
249	*Collybia* sp. "grey"	S	S				
233	*Collybia* sp. "grey/dimple"	S	S				
151	*Collybia* sp. "large"	S	S				
15	*Coltricia oblectans*	S	S	2	33	5	40
32	*Coprinus* sp.	S	S/L				
128	*Coprinus* sp. "basal hairs"	S	S				
224	*Coprinus* sp. "micaceous"	S	S				
282	*Cortinarius* sp."honey-brown dome /long stem"	M	S				
303	*Cortinarius* sp."stubby domes"	M	S				
146	*Cortinarius* (*Myxacium*) sp. "orange-brown"	M	S		5		5
125	*Cortinarius (Phlegmacium)* sp. "purple-grey"	M	S				
171b	*Cortinarius ?vinaceolamellatus "purple"*	M	S				
158	*Cortinarius* aff. *micro archerii*	M	S				
314	*Cortinarius archerii*	M	S				
207	*Cortinarius australiensis*	M	S				
173	*Cortinarius basirubescens* (red cap)	M	S		1		1
173b	*Cortinarius basirubescens*(brown cap)	M	s				
115	*Cortinarius fibrillosus*	M	S	3	0	0	3
7	*Cortinarius radicatus*	M	S				
293	*Cortinarius rotundisporus*	M	S				
357	*Cortinarius sinapicolor*	M	S/L	1	2	2	5
234	*Cortinarius* sp.	M	S				
355	*Cortinarius* sp. "brown with lavender margin and stem"	M	S			6	6
73	*Cortinarius* sp. "brown with purplish tints"	M	S				
68	*Cortinarius* sp. "brown" ?(34)	M	S				
346	*Cortinarius* sp. "brown, grey-lavender gills"	M	S				

Sp #	Species	Life Mode[1]	Substrate[2]	Control	Shelterwood	Gap Release	TOTAL
232	*Cortinarius* sp. "cf sinapicolor"	M	S				
382	*Cortinarius* sp. "chestnut with yellow margin and yellow flesh"	M	S	1			1
154	*Cortinarius* sp. "chestnut"	M	S	4	22	2	28
334	*Cortinarius* sp. "fawn brown"	M	S				
252	*Cortinarius* sp. "glutinous cap/rooting stem"	M	S	18		4	22
348	*Cortinarius* sp. "golden tan, long stem"	M	S				
374	*Cortinarius* sp. "golden-tan"	M	S		3		3
257	*Cortinarius* sp. "honey-brown"	M	S		4		4
369	*Cortinarius* sp. "large red-brown"	M	S			2	2
379	*Cortinarius* sp. "lilac-brown with yellow gills"	M	S		1		1
251	*Cortinarius* sp. "orange-brown 2"	M	S				
121	*Cortinarius* sp. "slender brown"	M	S				
131	*Cortinarius* sp. "slender lilac"	M	S				
96/259	*Cortinarius* sp. "viscid - pink"	M	S		1		1
375	*Cortinarius* sp. "yellow with brown fibrils and orange ring"	M	S	1			1
237	*Cortinarius* sp. "yellow with orange brown fibrils"	M	S	3	7	1	11
354	*Cortinarius* sp. "yellow-brown cap, lavender gills and stem"	M	S	2	6	4	12
231	*Cortinarius* sp. "yellow-brown/tan margin"	M	S				
124	*Cortinarius sp.* "yellow-olive"	M	S				
255	*Cortinarius* sp. "yellow-orange"	M	S				
279	*Cortinarius* sp."brown fibrillose"	M	S				
244	*Cortinarius* sp."brown umbonate"	M					
299	*Cortinarius* sp."chocolate brown with mustard gills"	M	S				
201	*Cortinarius* sp."cream with orange gills"	M	S	2	16		18
212	*Cortinarius* sp."orange brown"	M	S				
230	*Cortinarius* sp."orange viscid"	M	S				
223	*Cortinarius sp."orange"*	M	S				
205	*Cortinarius* sp."orange/yellow flesh/yellow gills"	M	S				
267	*Cortinarius* sp."showy chestnut"	M	S	8	4		12
270	*Cortinarius* sp."viscid, yellow-red-brown, white stem"	M	S				
273	*Cortinarius* sp."white with deep rooting stem"	M	S				
199	*Cortinarius* sp."yellow orange"	M	S				
184	*Cortinarius* spp. (unidentified)	M	S	15	37	6	58
171	*Cortinarius vinaceolamellatus*	M	S				
290	*Cortinarius violaceous*	M	S				
118	*Crepidotus* sp. "large creamy-tan"	S	W	1	11		12
323	*Crepidotus* sp. "rusty brown suede"	S	W				
61	*Crepidotus sp.* "small brown"	S	W/Bk				
83	*Crepidotus* sp. "small creamy tan"	S	Bk/W	3		8	11
21	*Crepidotus* sp. "small white"	S	W				
241	*Crepidotus variabilis*	S	T/W				
148	*Crucibulum laeve*	S	T/L	51	80		131
296	*Cyathus* sp."on roo poo"	S/C	DUNG				
307	*Cyathus* sp.	S	L		2		2
138	*Daldina concentrica*	S	W				
110	*Dermocybe* aff. *sanguinea*	M	S				
147	*Dermocybe austroveneta*	M	S		2		2
340	*Dermocybe clelandii* "mini"	M	S				
57b	*Dermocybe clelandii* "olive brown - white mycelium"	M	S		2		2

Sp #	Species	Life Mode[1]	Substrate[2]	Control	Shelterwood	Gap Release	TOTAL
57/34	*Dermocybe clelandii* (white mycelium)	M	S		1		1
172b	*Dermocybe clelandii* (yellow mycelium - glutinous cap)	M					
172	*Dermocybe clelandii* (yellow mycelium)	M	S				
328	*Dermocybe* sp. "small olive"	M	S				
168	*Dermocybe* sp. (*D. clelandii* ?) "brown with mustard yellow gills"	M	S				
40	*Dermocybe* sp."chestnut"	M	S				
310	*Dermocybe splendida*	M	S				
294	Discomycete "small yellow on *Banksia grandis* leaf"	S	L	5			5
123	Discomycete "yellow stalked"	S	S	14	14		28
31	*Entoloma* (*Leptonia*) *sp.* "blue-black"	S	S	1			1
78	*Entoloma* (*Leptonia*) sp. "grey/decurrent gills"	S	S				
153	*Entoloma* (*Leptonia*) sp. "small dark grey-brown"	S	S				
222	*Entoloma* sp. "black with grey-white gills	S	S			2	2
347	*Entoloma* sp. "brown striate cap"	S	S			1	1
227	*Entoloma* sp. "brown-black with tan gills"	S	S				
30	*Entoloma* sp. "creamy white"	S	S		4		4
167	*Entoloma* sp. "dark grey/blue gill edge"	S	S				
25	*Entoloma* sp. "grey-brown/blue stem"	S	S				
77	*Entoloma* sp. "grey-brown/brown stem"	S	S				
235	*Entoloma* sp. "grey-brown/grey stem"	S	S		8		8
135	*Entoloma* sp. "tall, grey-brown"	S	S		4	1	5
198	*Entoloma* sp."brown black/tan/blue"	S	S				
194	*Entoloma* sp."brown"	S	S				
272	*Entoloma* sp."grey-brown with dimple"	S	S				
278	*Entoloma* sp."suede grey-brown"	S	S				
274	*Entoloma viridomarginatum*	S	S				
159	*Exidia glandulosus*	S	W				
41	*Fistulina hepatica*	S	W	1	4	1	6
91	*Fistulinella mollis*	S	W				
11	*Galerina* sp. "hanging gills" and "conic"	S	S/L	35	64	3	102
111	*Galerina* sp. "large"	S	S				
42	*Galerina* sp. "small on bark"	S	Bk				
228	*Geastrum* sp.	S	S/L				
8	*Gymnopilus austrosapineus*	S	W	218	99	108	425
365	*Gymnopilus junionus*	S	W				
43	*Gymnopilus* sp.	S	W				
105	*Gymnopilus* sp. "chestnut scales, forked gills"	S	W				
26	*Gymnopilus* sp. "reddish cap, orange gills"	S	W				
85	*Gymnopilus* sp. "slender"	S	W	80	292	95	467
58	*Gymnopilus* sp. "small cap, eccentric stipe - on wood"	S	W	43	47	168	258
217	*Gyroporus* aff. *cyanescens* "yellow suede - intense blue stain"	M	S				
292	*Gyroporus* sp."beige-yellow, blue stain"	M	S				
56	*Heterotexus peziziformis*	S	W/T	55	5	12	72
275	Hydnoid "fleshy funnel"	?	S/L				
297	*Hydnum repandum*	S?	S				
380	*Hydnum* sp. "chestnut"	S?	S	1			1
381	*Hygrocybe cantharellus*	M	S	2			2
317	*Hygrocybe conica*	S	S				
281	*Hygrocybe* sp."pallid yellow"	S	S				
100	*Hypholoma australe*	S	W	52	35		87

Sp #	Species	Life Mode[1]	Substrate[2]	Control	Shelterwood	Gap Release	TOTAL
59	*Hypholoma brunneum*	S	W				
108	*Hypomyces chrysospermus*	P	BOLETE	1			1
204	*Innonotus* sp.	S	W				
1	*Inocybe australiensis*	M	S	18	177		195
203	*Inocybe geophylla*	M	S				
378	*Inocybe* sp. "chocolate umbonate"	M	S		3		3
137	*Inocybe* sp. "creamy-brown"	M	S				
48	*Inocybe* sp. "grey"	M	S	1			1
65	*Inocybe* sp. "large scaly cap"	M	S				
226	*Inocybe sp.* "orange brown"	M	S				
113	*Inocybe* sp. "radially fibrillose, pink stem"	M	S	1			1
20	*Inocybe* sp. "scaly cap" see sp. 277 Fire Fungi	M	S		2		2
169	*Inocybe* sp. "shaggy stem"	M	S				
162	*Inocybe* sp. "small light brown, fibrillose"	M	S				
53	*Inocybe* sp. "tan skirt"	M	S	18	46		64
286	*Inocybe* sp."umbonate, shaggy"	M	S		4	13	17
74	*Laccaria* aff. *masonii*	M	S	3	37	12	52
36	*Laccaria lateritia*	M	S	4	2		6
221	*Lactarius clarkii*	M	S				
142	*Lactarius eucalypti*	M	S	1		1	2
245	*Lactarius* sp. "cream yellow"	M	S				
215/220	*Lactarius* sp."cream custard"	M	S				
335	*Lentinellus* sp. "brown cap, saw-toothed gills"	S	W				
271	*Lepiota* aff. *haemorrhagica* "red stainer"	S	S				
185	*Lepiota cristata*	S	S				
264	*Lepiota* sp. "cream-grey"	S	S				
246	*Lepiota* sp. "purple-grey"	S	S	1			1
166	*Lepiota* sp."creamy-brown"	S	S				
76	*Lepiota* sp."orange with brick red scales/white gills"	S	S				
117	*Lepista* sp.	M?	S				
214	*Leucapaxillus lilacinus*	M	S				
24	*Lycoperdon* sp.	S	S		2	3	5
190	*Macrolepiota konradii*	S	S				
318	*Marasmiellus* sp."small white, on twigs & leaves"	S	L/T				
191	*Marasmiellus* sp. "white umbrella"	S	T/W				
239	*Marasmiellus* sp. "on zamia"	S	T				
55	*Marasmius crinis-equi*	S	L	11	5	12	28
183	*Marasmius elegans*	S	S				
341	*Marasmius* sp. "tiny red on twigs"	S	L/T	12			12
309	*Marasmius* sp. (see 223 Fire fungi)	S	S/L				
75	*Marasmius* sp."large brown, on Zamia stems"	S	T				
22	*Melanotus hepatocrous (Crepidotus subhaustellaris)*	S	W				
304	*Meruliopsis* sp.	S	W/T			7	7
373	*Merulius* sp "creamy yellow, on Jarrah stick'	S	W		1		1
101	*Merulius* sp.″pink-buff″	S	W/Bk	3	2		5
238	*Mycena yuulongicola*	S	W	17	1	0	18
327	*Mycena "austrocapillaris"* (bleach)	S	L				
372	*Mycena* aff. *fumosa*	S	W		7	7	14
134	*Mycena* aff. *subcapillaris*	S	L				
44	*Mycena* aff. *subgallericulata*	S	W				
80	*Mycena carmeliana*	S	W	5			5
50	*Mycena mijoii*	S	L	2			2

Sp #	Species	Life Mode[1]	Substrate[2]	Control	Shelterwood	Gap Release	TOTAL
66	*Mycena pura*	S	S/L				
144	*Mycena sanguinolenta*	S	S	5	40	6	51
163/260	*Mycena* sp. "brown-grey, on wood"	S	W		10	12	22
51	*Mycena* sp. "buff umbrella"	S	L/T	96	5	25	126
336	*Mycena* sp. "dk brown on burnt ground"	S	S				
285	*Mycena* sp. "light brown striate/white stems, on wood"	S	W				
27	*Mycena* sp. "long stem"	S	W				
376	*Mycena* sp. "small brown with decurrent gills"	S	W		6		6
326	*Mycena* sp. "small buff on wood - bleach"	S	W		1		1
352	Mycena sp. "small creamy yellow-white"	S	L/Bk			15	15
165	*Mycena* sp. "small grey - bleach"	S	S/L	2	1		3
88	*Mycena* sp. "tiny white with decurrent gills"	S	S				
64	*Mycena* sp. "tiny white, on twigs"	S	T				
308	*Mycena* sp."grey-brown,/no bleach"	S	S	1			1
302	*Mycena* sp."nipple umbrellas"	S	W				
312	*Mycena* sp."pink, bleach"	S	S/L				
295	*Mycena* sp."small buff"	S	L				
182	*Mycena* spp. (unidentified)	S	W	6	27	0	33
164	*Nidula candida*	S	L/T				
127	*Omphalina* aff. *umbellifera*	S	S		34	3	37
112	*Omphalina chromacea*	S	S/LICHEN				
122	*Omphalina* sp. "orange in moss - on log"	S	MOSS				
213	*Omphalotus nidiformis*	S	W		4	1	5
130	Orange parasite on white resupinate polypore (sp.116)	P		4			4
104	*Panellus ligulatus*	S	W				
339	*Panellus* sp. - on ground	S	S				
343	*Panellus* sp. "soft brown"	S	W				
311	*Panus fasciatus*	S	W				
356	*Paxillus* sp. "robust with bulbous base"	M	S	3			3
179	*Paxillus* sp. "yellow, brown scales"	M	S		1	2	3
291	*Paxillus* sp."orange-brown"	M	S	3	1		4
332	*Peziza "praetervisa"*	S	S				
256	*Peziza* sp. "white cup"	?	S				
330	*Peziza tenacella*	S	S				
300	*Peziza whitei*	M	S				
136	*Phellinus gilvus*	S	W	2	10	4	16
37	*Phellinus* sp. "yellow rim"	S	W	3		3	6
70	*Phellodon niger*	S	L/S	5	13		18
87	*Phellodon* sp."brown, white margin"	S	L/S		5		5
160	*Pholiota highlandensis*	S	L	16	39	19	74
119	*Pholiota multicingulata*	S	W	9	26	2	37
363	*Piptoporus australiensis*	S	W	1			1
353	*Pisolithus* sp. 'small, stalked"	M	S			1	1
192	*Plectania* sp. "black"	S	L				
133	*Pluteus attromarginata*	S	W				
248	*Pluteus cervinus*	S	W				
47	*Pluteus lutescens* "orange"	S	W				
47b	*Pluteus lutescens* "yellow-green"	S	W	0	2		2
4	*Pluteus* sp. "brown velvet"	S	S	1	1		2
157	*Podoserpula pusio*	S/M?	L/S				
277	Polypore "beige"	S	W				
13	Polypore "brown with white margin"	S	W				

Sp #	Species	Life Mode[1]	Substrate[2]	Control	Shelterwood	Gap Release	TOTAL
3	Polypore "long white shelf"	S	W				
333	Polypore "on dead waterbush"	S	W				
361	Polypore "white resupinate on twig"	S	W/T		1		1
116	Polypore "white resupinate"	S	T/W				
313	*Polyporus citreus*	S	W/T				
109	*Poria sp.*"purple splash"	S	W		3		3
145	*Poronia ericii*	C	Dung				
236/219	*Postia* (*Tyromyces*) *peliculosa*	S	W				
155	*Protubera canescens*	M?	S				
17	*Psathyrella* sp.	S	S/L				
229	*Psathyrella* sp.	S	L				
250	*Psathyrella* sp.	S	L				
337	*Psathyrella* sp.	S	S				
359	*Psathyrella* sp. "brown with white skirt"	S	S		7		7
98	*Psathyrella* sp. "very tall, slender"	S	L	14	11		25
177	*Psilocybe coprophila*	C	Dung	11	26	2	39
331	*Pulvinula archerii*	S	S				
129	*Pulvinula* sp.	S	S				
280	*Pulvinula* sp.	S	S				
176	*Pycnoporus coccineus*	S	W			10	10
366	*Pyronema* sp.	S	S				
351	*Ramaria* / *Clavulina* "creamy white"	M	S		14		14
52	*Ramaria* aff. *aurea* "yellow, flat tops"	M	S	4			4
72	*Ramaria holorubella* "purple-pink with pink tips"	M	S				
102	*Ramaria ochroceosalmonicolor*	M	S	10	29	31	70
139	*Ramaria* sp. "bright-yellow"	M	S				
242	*Ramaria* sp. "cream/flat"	M	S			2	2
247	*Ramaria* sp. "lemon yellow"	M	S		1	2	3
86	*Ramaria* sp. "orange-red, yellow stem"	M	S	1	1		2
367	*Ramaria* sp. "small yellow"	M?	S		2		2
254	*Ramaria vesatilis* "purple"	M	S				
79	*Resupinatus cineroscens*	S	T/Bk				
187	*Resupinatus* sp."veined underside"	S	W		100		100
209	*Rickinella fibula*	S	Moss				
69	*Russula adusta*	M	S				
90	*Russula* aff. *cyanoxantha*	M	S		1		1
89	*Russula clelandii* group	M	S		4	1	5
202	*Russula flocktoniae*	M	S				
92	*Russula neerimea*	M	S				
178	*Russula persanguinea* (white stem)	M	W				
107	*Russula* sp. "grey-white"	M	S				
10	*Russula* sp. "white/white/white"	S	S		1		1
276	*Russula* sp."purple-mottled"	M	S				
342	*Ryvardinia campyla*	S	W				
263	*Sarcodon* sp. "brown"	S	S				
315	*Scleroderma* sp."yellow/yellow mycelium"	M	S				
150	*Scutellina* aff. *margaritacea*	S	W/T				
12	*Simocybe* sp."olive"	S	W				
106	Slime Mould *Stemonitis herbatica*		NUTS				
306	*Sphaerobolus stellatus*	S	L				
132	*Steccherinum* sp. "creamy yellow crust"	S	W				
94	*Steccherinum* sp."tiered white shelves"	S	W		1		1
62	*Stereum hirsutum*	S	W	6	263	80	349

Sp #	Species	Life Mode[1]	Substrate[2]	Control	Shelterwood	Gap Release	TOTAL
149/141/152	*Stereum illudens*	S	W	3	3	4	10
5&84	*Stereum* sp. "grey-brown white hirsute, purple fertile layer"	S	W				
325	*Stereum* sp. "purple margin - algae"	S	W				
67	*Stropharia semiglobata*	C	DUNG		2	1	3
266	*Thelephora* sp. "terrestris"	M	S/HOST				
16	Thelephore "translucent funnels"	S	S/MOSS				
268	*Thelephore* sp."brown/yellow-orange"	M	S				
19	*Trametes lilacino-gilva*	S	W	2	5		7
63	*Trametes versicolor* (brown or grey)	S	W	100		12	112
60	*Tremella mesentericia*	S	W	1			1
287	*Tremella* sp."cloudy yellowish white"	S	W		6		6
289	*Tremella* sp."tiny yellow knobs"	S	W				
288	*Tremella* sp."yellow buttons"	S	W				
211	*Tricholoma* sp.	M	S				
161	*Tricholoma* sp. "grey-white"	M	S	3			3
54	*Tricholoma eucalypticum*	M	S	5	11	14	30
322	Truffle "black gleba"	M	S				
321	Truffle "pink gleba"	M	S				
258	Truffle "sticky"	M	S				
189	*Tubaria rufofulva*	S	W				
305	*Tylopilus* sp."yellow"	M	S				
2	*Xerula australis*	S	S				
175	*Xylaria hypoxylon*	S	W	10			10
	Number of fruitbodies			**1433**	**2214**	**830**	**4477**
377	**Number of Species**			**80**	**98**	**61**	**142**

[1] S = saprotrophic, M = mycorrhizal, P = parasitic, C = coprophilous
[2] S = soil, L = litter, T = twigs, Bk = bark, W = wood

CRYPTOGAMS

Ray Cranfield

Introduction

'Cryptogams' is the collective name for the Lichen, Moss and Liverwort flora. Some species of lichens are important indicators of ecosystem health, being sensitive to changes and disturbance in the environment in which they grow. Many colonize primary substrates such as rocks and bare organic matter and are active in the initial breakdown of these materials. Mosses also play an important role in the stabilization of bare soil. Cryptogams are a major component of the biodiversity of forest ecosystems, and many species in Western Australia are yet to be named.

The object of this component of FORESTCHECK is to:

- Record species richness and abundance in each FORESTCHECK grid and treatment
- Record species habitat and substrate preference, and
- Monitor the effect of disturbance on cryptogam communities

Monitoring

The cryptogam flora was monitored in August 2004. At each of the 8 grids, the presence and frequency of each species along with the macro and microhabitat that each species occurred on was recorded.

Voucher Specimen Processing

All specimens collected this year have been identified or phrase named for ease of redetermination. Information gained from several ongoing cryptogam studies has become available and several names used in this report reflect these changes. Once again several samples of terrestrial algae were collected and prepared for incorporation in the state collection held at the WA Herbarium.

All collections have been prepared for database entry and label generation prior to submitting these vouchers to the Herbarium. A total of 346 collections (308 lichens, 29 mosses and 8 liverworts) were made from the 8 grids in the Perth Hills. These collections represent 80 species of lichens, 8 species of moss and 4 species of liverworts, making a total of 92 species of cryptogams. A further 8 collections of terrestrial algae were collected and 4 fungal collections. It should be noted that the lateness of this collection compared to previous years shows a reduction in microscopic fungi collections but no real impact upon the other cryptogams normally sampled.

Preliminary Results and Discussion

Species and habitats

A total of 92 species of cryptogams were recorded on the grids in the Perth Hills (Table 1). The number of liverwort species recorded was relatively low. This may be a reflection of the dryness of these northern sites when monitored or the may have a naturally low occurrence. The opening up of these sites, which allows increased exposure to the hot drying elements, may also have and impact upon all species of cryptogams associated with the northern grids. However, the end effect upon liverwort species and other sensitive cryptogams is as yet unknown and is dependant

on their ability to re-establish and on the time frame required to achieve the same species levels that may have been present prior to logging.

Table 1. Presence/Absence of Cryptogam taxa located on each FORESTCHECK grid (Names in **bold text** are the nominated indicator species).

Taxa	External Control			Shelterwood			Gap Release	
Grids	FC21	FC24	FC27	FC20	FC23	FC26	FC22	FC25
Mosses (B)								
Barbula calycina	+			+		+	+	+
Campylopus Introflexus	+	+	+	+	+	+	+	+
Ceratodon purpureus *ssp.* ***convolutus***		+						
Didymodon torquatus	+		+			+	+	+
Fissidens tenellus		+						
Rhynchostegium tenuifolium var. tenuifolium	+							
Rosulabryum torquescens	+			+	+			
Sematophyllum subhumile *var.* ***contiguum***	+	+		+		+	+	
Liverworts (H)								
Austrofossombronia australis							+	
Cephaloziella exiliflora	+	+		+	+	+		
Fossombronia altiamellosa	+							
Frullania probosciphora				+				
Lichens (L)								
Buellia sp.		+	+	+	+	+	+	+
Calicium glaucellum	+	+			+			
Calicium victorianum subsp. desidiosum			+		+			
Chaenotheca brunneola					+			
Chaenothecopsis pusilla	+							
Cladia aggregata	+	+	+	+			+	+
Cladia schizopora	+	+	+	+	+	+	+	+
Cladonia cervicornis *var.* ***verticillata***					+			
Cladonia krempelhuberi	+	+	+	+	+		+	
Cladonia merochlorphaea		+		+	+		+	
Cladonia praetermissa				+				
Cladonia ramulosa				+	+		+	
Cladonia rigida	+	+	+	+	+	+	+	
Cladonia scabriuscula	+		+		+	+		
Cladonia sulcata	+		+	+		+	+	
Cladonia tessellata	+				+			
Cladonia ustulata		+						
Cladonia sp. (scraggy)								+
Collema sp.		+						
Diploschistes scruposus	+	+		+	+	+	+	+
Diploschistes strictus	+						+	
Diploschistes sp.		+	+				+	
Ephebe lanata		+					+	
Flavoparmelia ferrax					+			
Flavoparmelia haysonii						+	+	
Graphis sp. (black beans)	+							
Graphis sp. (black buns*)*						+		
***Graphis* sp. (black rays)**		+			+		+	
Graphis sp. (conglomerate)					+			

Table 1 cont.	External Control			Shelterwood			Gap Release	
Taxa								
Grids	FC21	FC24	FC27	FC20	FC23	FC26	FC22	FC25
Graphis sp. (tram lines)					+	+		
Graphis sp. (writhing mass)					+			
Hafellia disciformis					+			
Hyperphyscia sp.							+	
Hypocenomyce australis	+	+	+					
Hypocenomyce foveata		+	+	+		+		
Hypocenomyce scalaris	+	+	+	+	+		+	+
Hypogymnia subphysodes *var.* ***subphysodes***	+	+		+	+			
Leptogium sp.					+			
Menegazzia platytrema					+			
Ochrolechia subrhodotropa		+						
Ochrolechia sp. (G. Kantavilas 306/92)		+	+	+		+		
Ochrolechia sp. (cream doughnuts*)*		+						
Ochrolechia sp. (RC 20178a)			+		+			
Pannoparmelia wilsonii	+	+	+	+	+	+		
Paraporpidia glauca	+		+	+				+
Parmelina conlabrosa	+	+		+	+		+	
Ramboldia stuartii	+	+		+	+	+	+	+
Rhizocarpon geographicum						+		
Tephromela atra	+	+		+	+			
Thysanothecium hookeri		+						
Thysanothecium scutellatum	+	+	+		+	+	+	
Toninia sp.							+	
Trapeliopsis sp.			+				+	
Usnea inermis	+	+	+	+	+	+	+	
Usnea scabrida subsp. scabrida		+						
Usnea nidulifera		+						
Usnea sp. (leuco)		+						
Xanthoparmelia sp. (RC20150)			+		+	+	+	+
Genus sp (black hairy stepping stones)		+					+	
Genus sp. (blue apo)			+				+	
Genus sp. (brown apo)		+						
Genus sp. (brown patch RC20318)			+		+			
Genus sp. (cactus)						+		
Genus sp. (coral)			+				+	
Genus sp. (coral squares)			+			+		
Genus sp. (green crumbs)	+							
Genus sp. (green crust)	+	+	+	+	+	+	+	
Genus sp. (green flecks)	+						+	
Genus sp. (grey corn cobs)							+	
Genus sp. (grey crust)	+						+	
Genus sp. (grey squamules)	+	+	+					
Genus sp. (soot)							+	
Genus sp. (tan apo flake)					+			
Genus sp. (tar spot)								+
Genus sp. (yellow domes)							+	
Genus sp. (U8)								
Genus sp. (U15)							+	
Genus sp. RC20125						+		
Genus sp. RC20132						+		
Genus sp. RC20171						+		

Comparing the number of cryptogams recorded on each grid shows that treatments and environmental effects influenced the species numbers (Fig 1). On the external controls there appeared to be an influence due to the drying effect between the northern (FC25-27) and southern sites (FC20-24). In both the shelterwood and gap release grids differences in species can be attributed to effects of site age (time since treatment) and moisture availability. As may be expected the gap release showed the greatest decline in species and reflected the time since treatment. It appears that the longer the grid remained undisturbed the nearer the number of species present approached the level present in the external controls. An analysis of the species present is required to determine if the species composition in the gap release grids represents what was originally present or represents species that are in a phase of succession.

Figure 1. The number of species of cryptogams on each FORESTCHECK grid in the Perth Hills.

Generally all the grids had suitable substrates with all seven types classified present. The degree of disturbance and time since treatment is reflected in the number of species recorded on each substrate (Fig. 2), with wood (old logs) and the bark of older trees in the control grids being the most utilized substrate. Generally most sites had all of the required habitats and differences were generally dependant on the age of the substrate. For cryptogams, time after fire is important and species substitution can be observed when primary species are replaced over time by subsequent species. On the gap release sites, although required substrates were present they were not always colonized because they are not yet mature enough to be colonized.

The total number of cryptogams occurring on the available substrates was recorded for each grid along with the position they occupied within the stratal level (Fig 3). Most grids indicated that at ground level (0-30 cm) the number of species was fairly stable while at shrub level (31 cm-3 m) a higher species ratio was recorded which may be related to a moisture and thermal barrier. At tree level (>3.1 m) there were fewer species and they were recorded in lower numbers in the treated (shelterwood and gap release) grids than in the controls. Their presence is possibly linked to the age of the

regrowth trees and to the number of older trees retained in the shelterwood grids. The degree of accuracy of accessing the tree (>3.1 m) species is limited, however, and is dependant upon sampling material that occurs on fallen tree limbs. The result of this is that the number of species recorded in the tree layer may be lower than expected. A more thorough survey of canopy species should be considered where tree removal has occurred, as they may be a high-risk group.

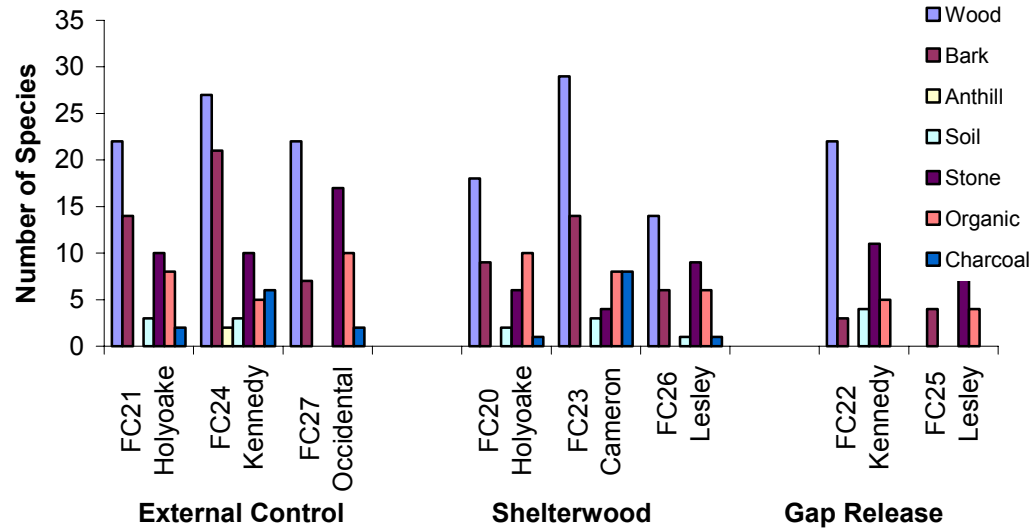


Figure 2. The number of cryptogam species colonizing the available microhabitats (substrates) on FORESTCHECK grids in the Perth Hills.

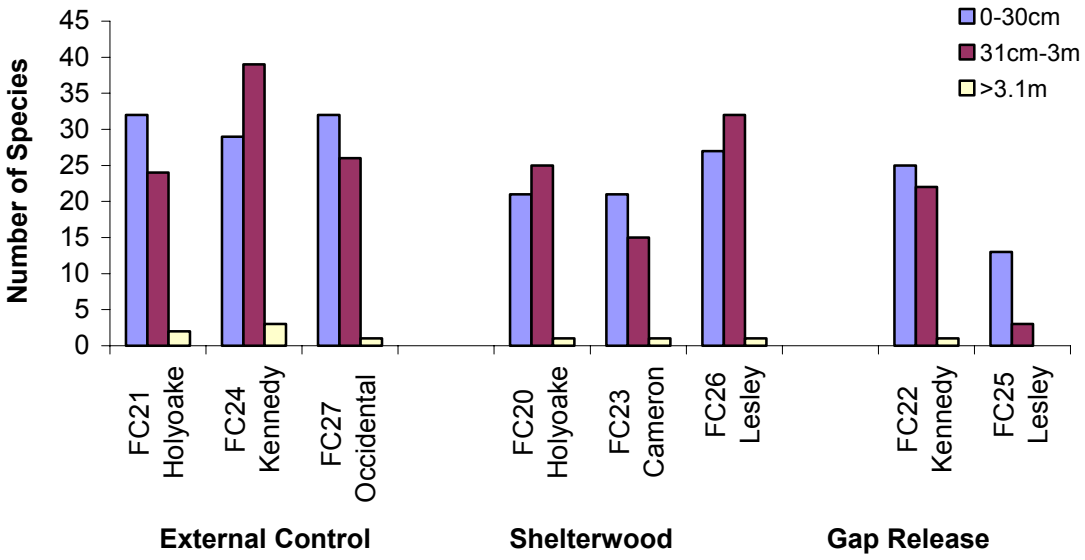


Figure 3. The number of cryptogam species recorded in three strata on FORESTCHECK grids in the Perth Hills.

An understanding of the growth requirements of individual cryptogam species and the effects of modified external influences is required to ensure the long term viability and diversity of these taxa. The number of individual species of lichens, mosses and liverworts occurring on each substrate and in each level of strata is included in Appendix II.

Indicator Species

In the 2002-3 report a list of possible indicator species was presented. In 2003-4, the use of potential indicator species continued to be investigated. At each grid the presence of each potential indicator species was noted and in most instances the list of species present was close to the possible twenty-one species listed (Fig. 4). Preliminary examination of the indicator species indicates that species not being present on a grid represents a habitat that has been lost or modified. However, the possibility that a species may have a limited geographical range cannot as yet be ruled out. FORESTCHECK includes Jarrah forest that extends over a large geographical range and as yet we do not have detailed information on the extent of the range of all the potential indicator species.

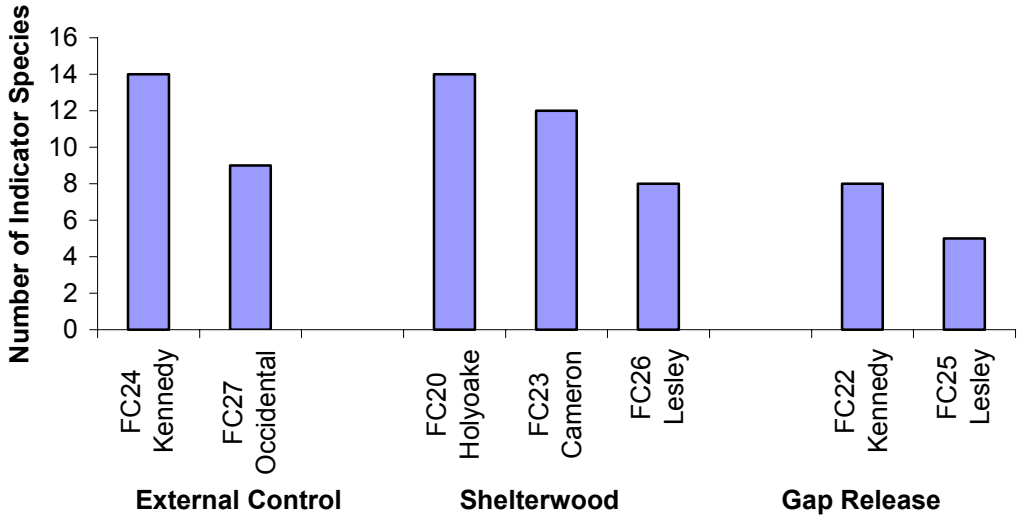


Figure 4. The number of potential indicator species (from a possible 21) recorded on each FORESTCHECK grid in the Perth Hills.

Several species on the original list have undergone taxonomic review and as a result have been subject to name changes, these changes are detailed in Table 2. An additional species that colonizes old decaying wood, *Graphis* sp. (black rays), was added to the list in 2003-4.

Other species that show up as possible indicators have been included in Table 1 (bold type). In establishing this and previous lists an attempt has been made to include species that have specific requirements of either substrate or landscape position. It is anticipated that in the final report in 2006 that a list of indicator species can be presented along with the rationale as to why they are selected and what their absence may indicate.

Table 2. Recent name changes (a) of potential FORESTCHECK Indicator Species and additional taxa (b) that were added to the list in 2003-4 (B = moss, H = liverwort and L = lichen).

Code No.	Group	Taxon	Redetermined Name
(a) Redetermined Indicator Taxa			
23	H	*Fossombronia* sp. (leafy & lettuce)	= *Fossombronia altilamellosa*
8	L	*Neuropogon* sp	= *Usnea* sp. (leuco)
10	L	*Parmotrema cooperi*	= *Remelia reticulata*
18	B	*Sematophyllum contiguum*	= *Sematophyllum subhumile* var. *contiguum*
21	B	*Ceratodon purpureus*	= *Ceratodon purpureus* subsp. *convolutes*
(b) Additional Taxa			
28	L	*Graphis* sp. (blackrays)	

Comparison of all Three FORESTCHECK Locations

A preliminary overview of all FORESTCHECK locations (Donnelly, Wellington and Perth Hills) was undertaken in an attempt to discern similarities and differences between the three areas.

Common species

Seventeen species of lichens, 3 species of moss and 2 species of liverworts were found to be common to 90% of the grids in the three FORESTCHECK locations. Many of these species appear on the proposed indicator species list. The common lichens were: *Cladia aggregata, Cladia schizopora*, *Cladonia krempelhuberi*, *Cladonia ramulosa, Cladonia rigida, Cladonia sulcata, Graphis* sp. (blackrays), *Hypocenomyce foveata, Hypocenomyce scalaris, Hypogymnia subphysodes* var. *subphysodes***,** *Ochrolechia* sp. (G. Kantavilis 306/92), *Pannoparmelia wilsonii, Paraporpidia glauca, Ramboldia stuartii, Tephromela atra, Thysanothecium scutellatum and Usnea inermis*. The common mosses were: *Barbula calycina*, *Campylopus introflexus* and *Sematophyllum subhumile* var. *contiguum* and the common liverworts: *Cephaloziella exiliflora* and *Chiloscyphus semiteres*.

External control and gap release grids

Species richness

There was some variation observed in the number of species recorded on the control grids at each location and between locations (Fig. 5). As the preferred habitat substrates for most species are represented on most grids, the variation may be the result of varying climatic conditions and vegetation densities on each grid and between locations. The lower number of liverwort species recorded at Wellington and the Perth Hills for example, may be indicative of the warmer drier conditions on these grids.

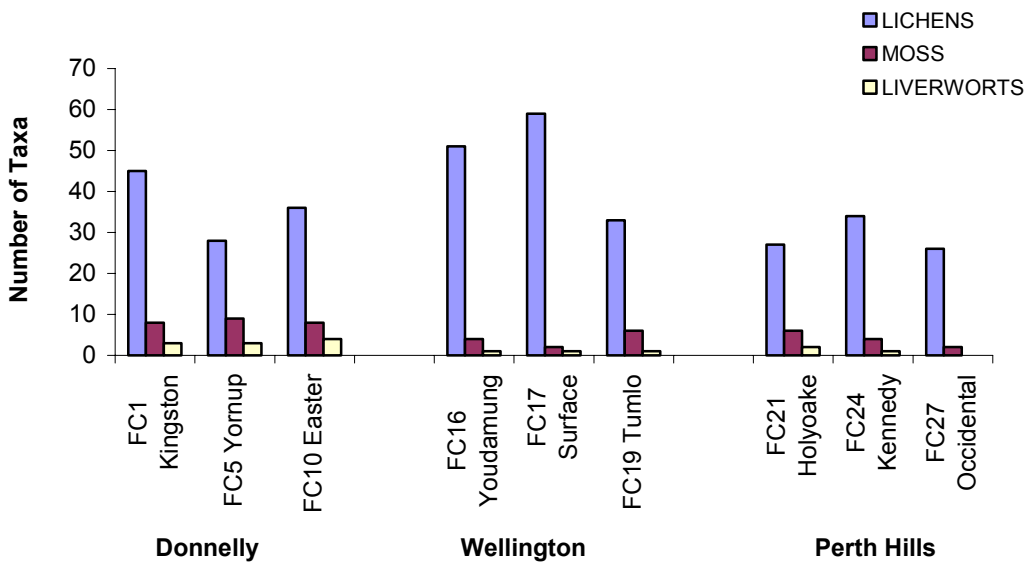


Figure 5. The number of cryptogam taxa recorded on external control sites at the Donnelly, Wellington and Perth Hills FORESTCHECK locations.

The lower number of taxa recorded on the gap release sites (Fig. 6) is a direct result of disturbance and habitat loss or by either tree harvesting or fire or both. The loss of micro climatic niches is known to impact on several cryptogam species resulting in the loss of species or reduced population sizes. The time since treatment on the gap release sites is important in the recovery of the cryptogam flora. On disturbed sites recovery is influenced directly by the increase in size and density of understorey vascular flora and by tree species densities. Early strong regrowth of tree saplings can retard the establishment of many cryptogams as a direct result of too much shading and lack of aged substrates. Further management practices, such as thinning, may have the effect of either delaying or speeding up the recovery of the cryptogam flora on these sites and further investigation is needed in order to understand what impact this intervention would entail.

Strata occupied

The use of particular levels of strata by various cryptogam flora in the external control grids varied between each location. At Donnelly and the Perth Hills the majority of species were generally recorded on the ground layer (0-30 cm) while at Wellington the shrub layer (30 cm- 3 m) was the dominant strata for the majority of species (Fig. 8). The number of species recorded in the tree layer (>3 m) was low at all three locations but noticeably lower in the Perth Hills. This variation may be a reflection of the change in moisture and temperature from north to south in the locations.

On the gap release sites (Fig. 8), the loss of older trees, and the high proportion of mature shrub cover, has reduced the level of suitable substrates for cryptogam establishment. Rapid tree re-growth, dense canopy cover, and the removal of debris by fire in the early stages appear to restrict the establishment of ground and shrub layer occupation. The ground level appears to be the desired location for most cryptogams but in most instances it is a reflection of the predominance of moss species and liverworts on these sites in the wetter areas.

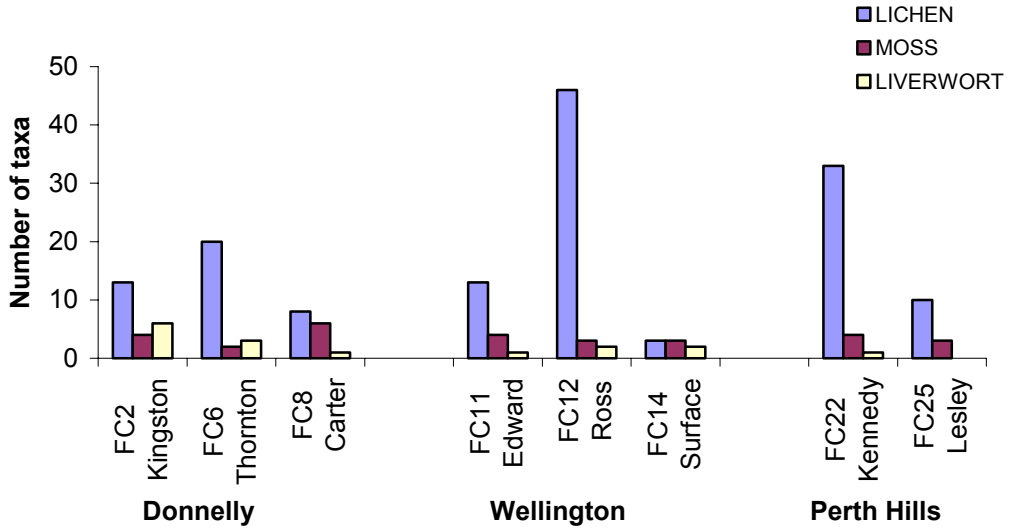


Figure 6. The number of cryptogam taxa recorded on gap release sites at the Donnelly, Wellington and Perth Hills FORESTCHECK locations

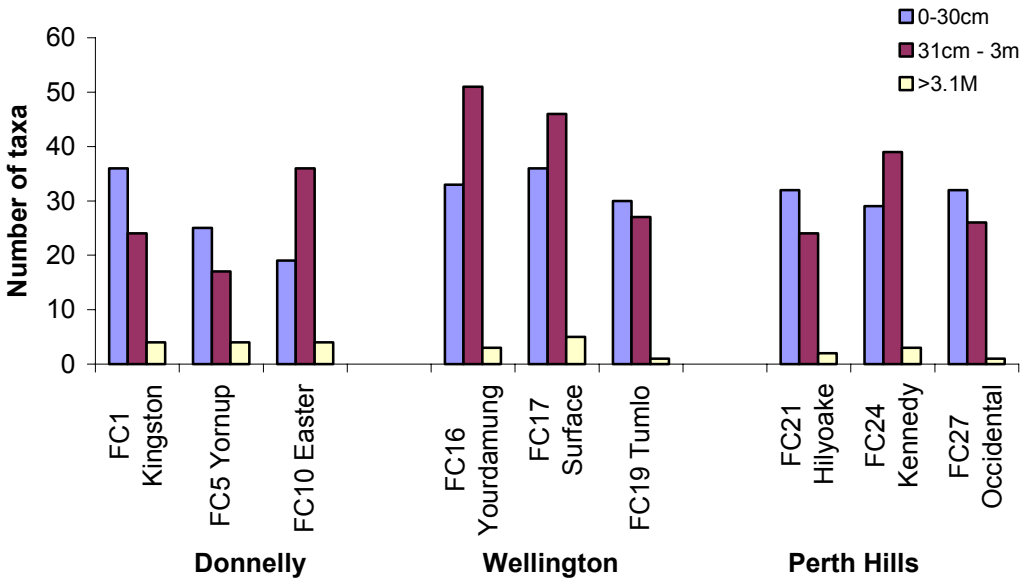


Figure 7. The number of cryptogam taxa occupying the different levels of forest strata in the control grids at the Donnelly, Wellington and Perth Hills FORESTCHECK locations.

Conclusion

As more data become available difference in treatments may be seen, but will pose many unanswered questions. In most instances the variations may be minor and when viewed in the big picture will appear insignificant. On the other hand as we are dealing with microhabitat variations any changes that appear to be small can and do have significant impact on the cryptogam flora.

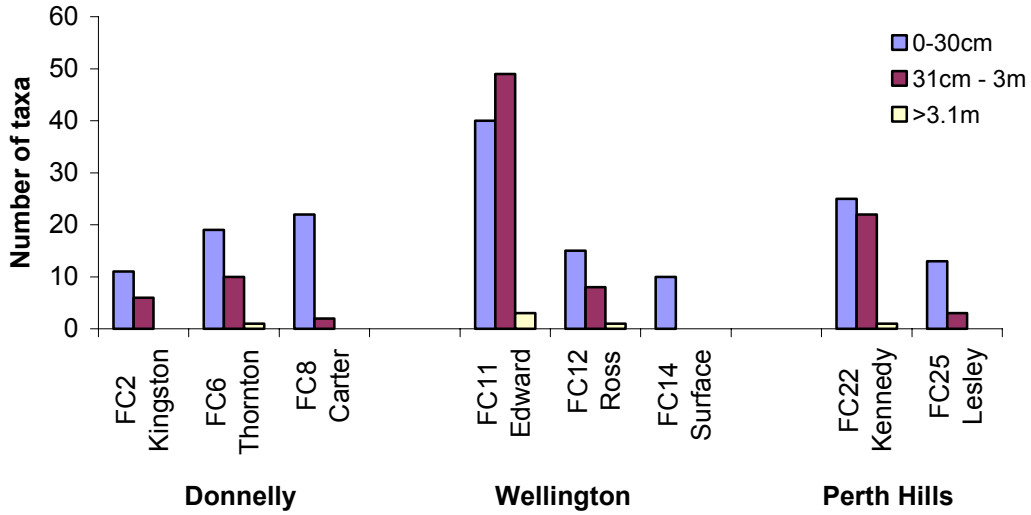


Figure 8. The number of cryptogam taxa occupying the different levels of forest strata in the gap release grids at the Donnelly, Wellington and Perth Hills FORESTCHECK locations.

The interdependence upon site variables, which may be altered or removed, may result in a changed micro flora population. The ability to rebuild these population niches might not be achievable, and if they can be re-established it may take an extended and unknown period of time. The 5-year monitoring program for these sites will help address these issues.

Appendix I. The number of cryptogams recorded in the Perth Hills FORESTCHECK grids showing groups, habitats and level of strata occupied.

		External Control			Shelterwood			Gap Release	
GRIDS		FC21	FC24	FC27	FC20	FC23	FC26	FC22	FC25
		Holyoake	Kennedy	Occidental	Holyoake	Cameron	Lesley	Kennedy	Lesley
Number of Voucher Collections		55	59	52	41	56	36	46	19
GROUPS									
	(Number of species)								
L	Lichens	27	34	26	21	34	23	33	10
B	Moss	6	4	2	4	2	4	4	3
H	Liverwort	2	1	0	2	1	1	1	0
Habitats									
	(Number of individual cryptogam records)								
1	Wood	22	27	22	18	29	14	22	0
2	Bark	14	21	7	9	14	6	3	4
3	Anthill	0	2	0	0	0	0	0	0
4	Soil	3	3	0	2	3	1	4	0
5	Stone	10	10	17	6	4	9	11	8
6	Organic Material	8	5	10	10	8	6	5	4
7	Charcoal	2	6	2	1	8	1	0	0
Stratal Position									
	(Number of individual cryptogam records)								
1	0-30 cm	32	29	32	21	21	27	25	13
2	31 cm-3 m	24	39	26	25	15	32	22	3
3	3.1 m	2	3	1	1	1	1	1	0
Indicator Species for Perth Hills sites (from a total of 21)									
		14	14	8	11	10	9	9	4

Appendix II. The number of individual cryptogam species in each group (B = moss, H = liverwort and L = lichen) recorded in the Perth Hills FORESTCHECK grids showing, habitats and level of strata occupied.

Grid / Groups		Microhabitats							Stratal Levels		
		Wood	Bark	Ant Hill	Soil	Stone	Organic	Charcoal	Ground 0-30cm	Shrub 31cm-3m	Tree 3.1m +
External Control											
FC21	L	19	12	0	1	8	6	2	23	23	2
	B	2	2	0	2	2	2	0	10	0	0
	H	1	0	0	1	0	0	0	1	1	0
FC24	L	24	19	2	0	7	2	4	22	37	3
	B	0	0	0	2	2	2	0	6	0	0
	H	1	0	0	0	0	0	0	1	1	0
FC25	L	15	6	0	0	16	7	0	24	22	2
	B	1	1	0	0	0	3	0	4	0	0
	H	0	0	0	0	0	0	0	0	0	0
Shelterwood											
FC20	L	16	9	0	0	6	6	1	17	23	1
	B	0	0	0	1	1	4	0	5	0	0
	H	2	0	0	0	0	0	0	0	2	0
FC23	L	24	14	0	0	5	4	7	19	32	1
	B	1	0	0	2	0	3	1	5	1	0
	H	1	0	0	0	0	0	0	0	1	0
FC26	L	9	5	0	1	7	1	0	14	9	3
	B	0	0	0	0	1	4	0	5	0	0
	H	1	0	0	0	0	0	0	0	1	0
Gap Release											
FC22	L	25	3	0	0	8	7	0	21	23	1
	B	1	0	0	3	0	0	0	4	0	0
	H	1	0	0	1	0	0	0	1	0	0
FC25	L	0	2	0	0	5	1	0	7	2	0
	B	0	0	0	0	0	3	0	3	0	0
	H	0	0	0	0	0	0	0	0	0	0

VASCULAR PLANTS

Bruce Ward and Ray Cranfield

Introduction

The vegetation complexes of the south-west forests are considered to be relatively stable and resilient to natural disturbances such as fire. In most circumstances, and in time, the species that were present before the disturbance, are generally present after the event, although abundances may change. Where logging is concerned, disturbance includes fire as well as physical/mechanical disturbance to the vegetation and the soil. Changes in species richness and abundance are used to determine the short term impact of logging on vascular plants. Longer term impacts, which allows for post-disturbance responses, will be assessed in subsequent monitoring of FORESTCHECK sites.

The object of this component of the FORESTCHECK program is to;

- monitor vascular plant species richness and abundance on each of the FORESTCHECK sites

This report highlights the results of the third round of FORESTCHECK monitoring.

Field and lab Work

Vegetation was monitored during October 2004. Spring was targeted as the best time to monitor understorey vascular plants as this coincides with the peak flowering time for most species. Species richness was determined using four 30m x 30m plots in each grid (32 in total) and 1 m x 1 m plots were used to analyse species abundance with 20 per plot (640 in total). 126 species were identified for the 1 m x 1 m quadrats and 188 for the 30 m x 30 m quadrats. A complete species list is attached (Appendix 1).

Results and Discussion

Species Richness

A total of 188 species were recorded from the 30 m x 30 m plots and 126 species in total from the 1 m x1 m plots, 18 of which were unique and not found in the 30 m x 30 m plots. This increased the number of species to 206 (see Table 1 for comparison of species numbers).

Species richness across the treatments has shown little variation and no apparent loss of species due to logging activities. Any loss in species would be reflected in lower species richness than was recorded for external controls. The gap release treatment has the highest number of species and this may be due to its location in the Yarragil vegetation /soil complex. This complex is in a valley floor and is evidently more diverse than the uplands associated with Dwellingup 1 and 2 vegetation/soil associations.

Table 1. The number of vascular plant species recorded at FORESTCHECK sites in the Donnelly, Wellington and Perth Hills districts.

Location and Year	Number of species		% Difference	Number of weed species
	30 m x 30 m Plots	1 m x 1 m Plots		
Donnelly 2002	203	158	78%	24
Wellington 2003	181	116	64%	10
Perth Hills 2004	206	126	61%	4

Comparing species richness for the three FORESTCHECK sites (Table 1) shows that minor differences do occur. Differences in species numbers between Donnelly and Wellington were mainly due to higher annual weeds at the Donnelly sites. The Perth Hills sites had a higher number of species mainly due to a mixture of site types. These site types have soil/vegetation complexes ranging from valley floor to uplands, and species numbers were more variable. Comparing species richness in the Perth Hills (Fig. 1) shows a similar trend across the range of treatments, with no apparent impact from logging treatments evident

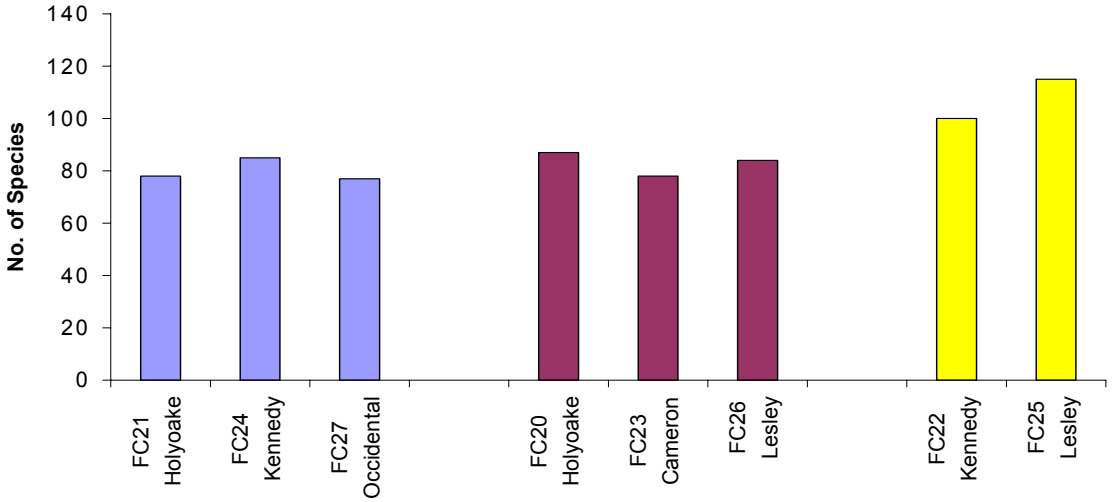


Figure 1. The number of vascular plant species recorded in each FORESTCHECK grid in the Perth Hills.

Species Abundance

Comparing species abundance across all treatments shows that there appears to be no apparent impact with logging treatments (Fig. 2, Table 2, Fig. 3).

There were 140 species common to all FORESTCHECK grids and for the external control treatment there were 23 species that were unique and not found in either the shelterwood or gap release treatments. In the shelterwood treatment, 17 were unique and not found in either the external control or gap release treatments. In the gap release treatment, 37 unique species were recorded as not being present in the other two treatments.

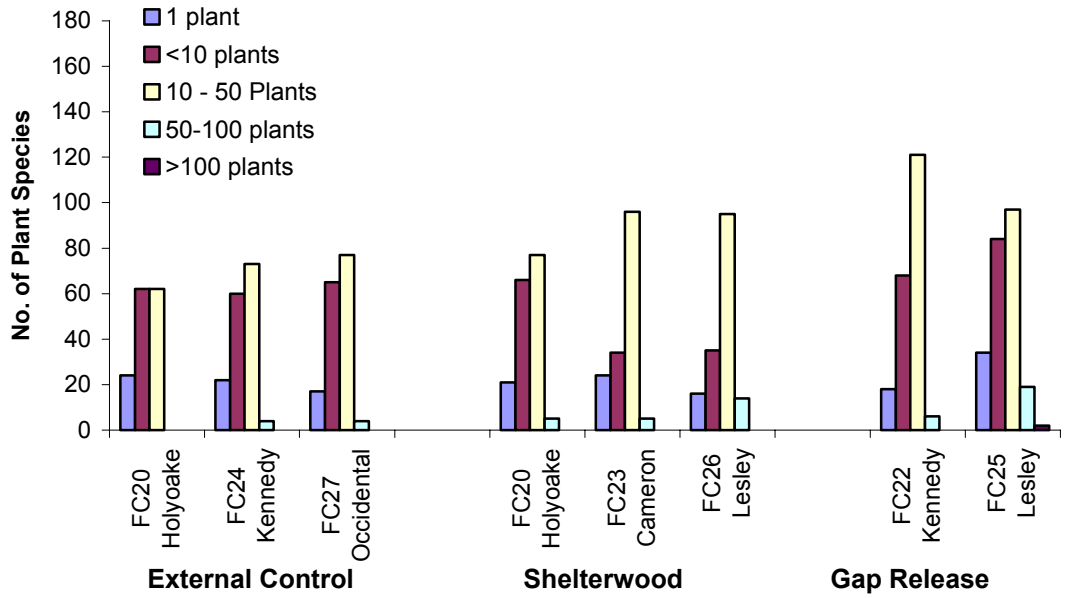


Figure 2. The number of plant species per frequency group for each FORESTCHECK grid (30 m x 30 m plots) in the Perth Hills.

Table 2. The number of plant species per frequency group for each FORESTCHECK grid (30 m x 30 m plots) in the Perth Hills.

Plant Frequency Group	**External Control**			**Shelterwood**			**Gap Release**	
	FC20 Holyoake	FC24 Kennedy	FC27 Occidental	FC21 Holyoake	FC23 Cameron	FC26 Lesley	FC22 Kennedy	FC25 Lesley
1 plant	24	22	17	21	24	16	18	34
<10 plants	62	60	65	66	34	35	68	84
10 – 50 plants	62	73	77	77	96	95	121	97
50 – 100 plants		4	4	5	5	14	6	19
>100 plants								2
Total	**148**	**159**	**163**	**169**	**159**	**160**	**213**	**236**

Species lists derived from the 1000 m^2 plots showed that 188 species were unique to these plots with an additional 18 species unique to the 1 m^2 plots. Combined, these made up the 206 species recorded for the Perth Hills FORESTCHECK sites.

Life-form composition was generally consistent across each treatment. While there appears to be no significant short term impacts due to logging, the number of small woody shrubs is higher in the gap release, but the number of geophytes is significantly lower (Fig. 4).

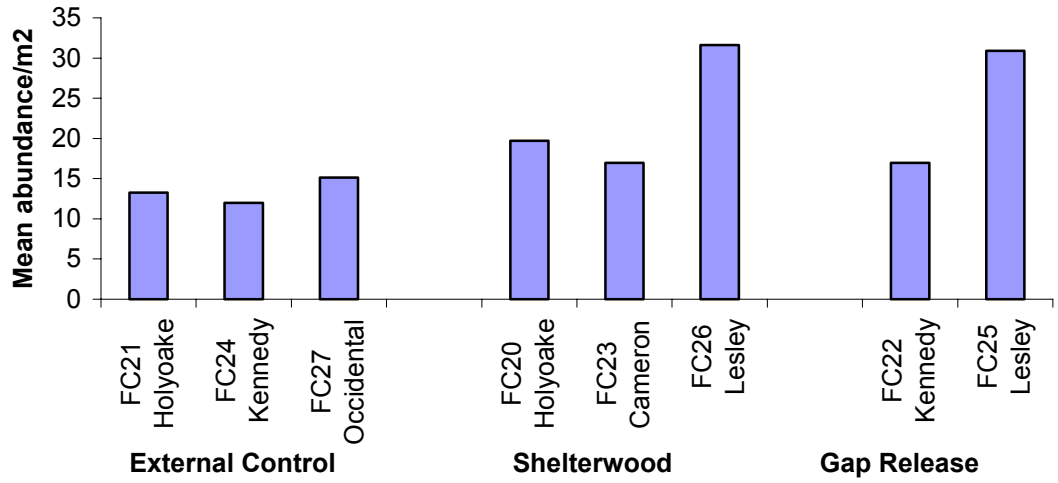


Figure 3: The mean abundance of vascular plants in each FORESTCHECK grid in the Perth Hills.

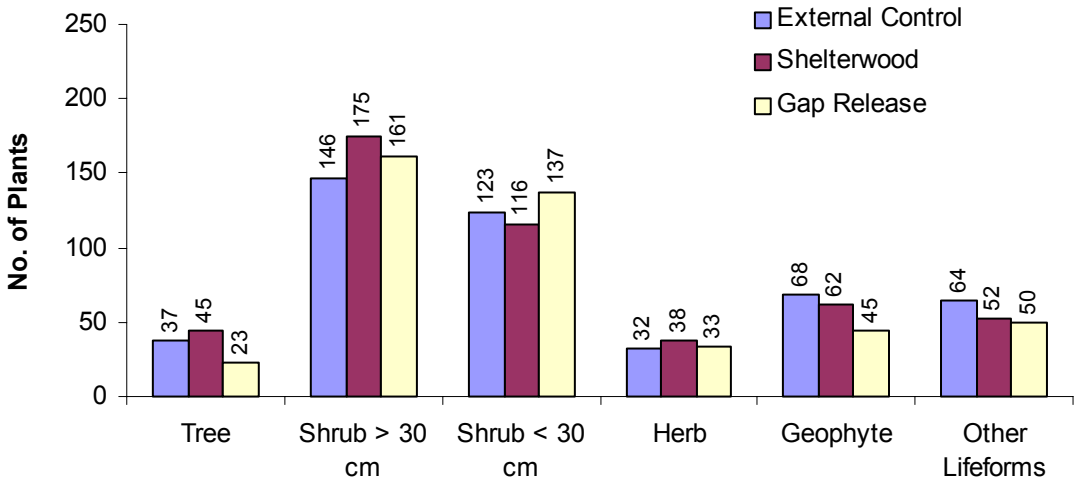


Figure 4: The number of individual plants in each life-form category for each of the logging treatments in the Perth Hills FORESTCHECK sites.

Vegetation heights were quite variable between the various grids (Fig 5). However this did not appear to be the result of time since fire and was more likely due to dominant species associated with the different soil types.

The vegetation structure in each grid appears to be dependent on the position of the grid in the landscape. For example, grids FC20, FC23 and FC24 are on ridges and the vegetation is quite low. The height and density of the vegetation increased as the position of the grid was nearer to the lower slopes (Fig. 6). The time since fire may also influence the vegetation density; however, this trend was not clear.

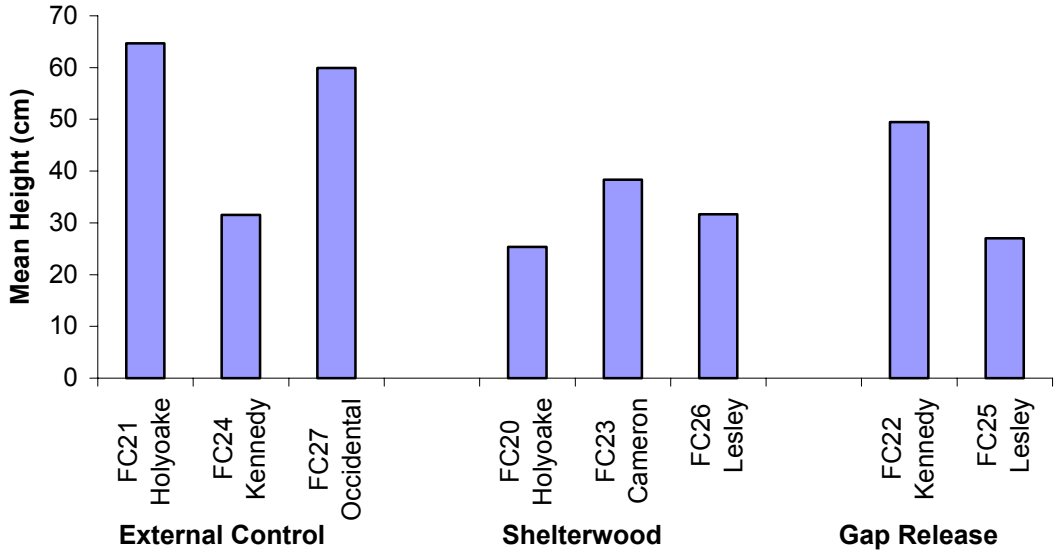


Figure 5: Mean vegetation heights in each of the Perth Hills FORESTCHECK grids.

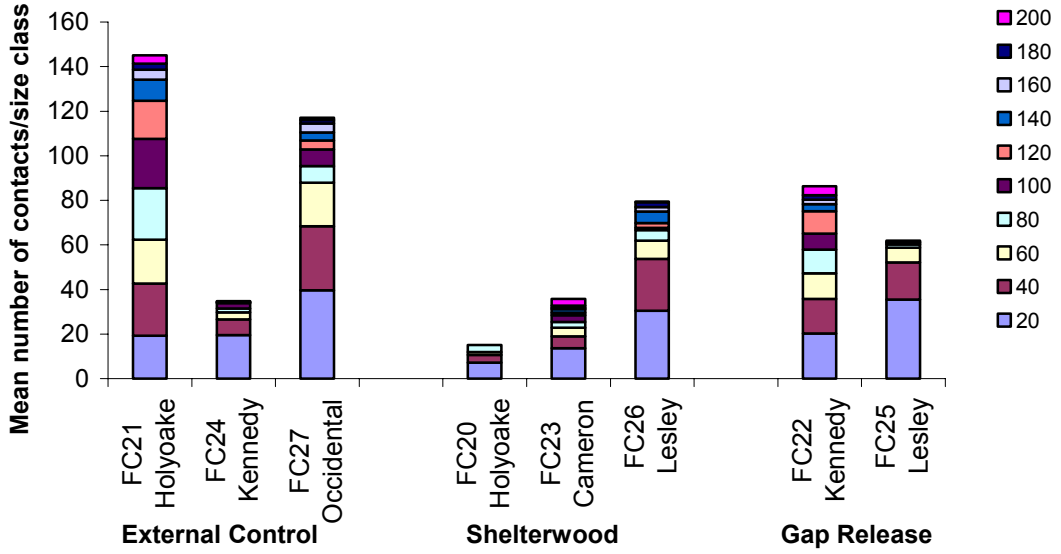


Figure 6: The vegetation structure in each grid as determined from the mean number of levy contacts in height classes up to 2m.

Specimen Processing
The area around each grid was used to search for and voucher flowering plant specimens. In total 123 vouchers were collected, representing c. 60% of the species recorded. In order to achieve a complete set of voucher specimens for this site further vouchering will need to be undertaken during the next monitoring session.

Data Base Management
Raw field data were verified and entered into the established FORESTCHECK data system where species richness and abundance information can be retrieved. Processed voucher specimens were databased in the W.A. Herbarium system under MAX system program. These data are unique and specimen information can be retrieved for each site.

Conclusions
Following three years of monitoring vascular plants in the FORESTCHECK program, preliminary analysis of the data suggests that:

- Species richness within the first three locations of FORESTCHECK (Donnelly, Wellington and Perth Hills) is similar and differences in numbers of species can be attributed to introduced weed species. There are many species common to all sites, and some unique to each site.

- Comparison of the three FORESTCHECK locations (Donnelly, Wellington and Perth Hills) has shown that harvesting treatments have not significantly affected species richness and abundance of vascular plants. However there are early indications that on some sites, some life-form groups are favoured by logging while others may be disadvantaged. Site attributes (soil type, landform, climate), soil condition and time since fire may be responsible for variations within treatments.

Issues
There is still a need to track the occurrence of priority species that may be present on monitoring sites (none located so far in the current grids).

Operating Plan Revision
There is no need for any major revision to the operating plan.

APPENDIX 1: **Total species list for Perth Hills sampling**

	Taxon Name	TaxonID	SpCode	Life Form	Life Style	Fire Response
	Acacia browniana	3247	ACABRO	S	P	A1
	Acacia browniana var. *browniana*	11731	ACABRO	S	P	A1
	Acacia celastrifolia	3254	ACACEL	S	P	A1
	Acacia drummondii	3311	ACADRU	S	P	A1
	Acacia drummondii subsp. *drummondi*i	11661	ACADRUDR	S	P	A1
	Acacia extensa	3331	ACAEXT	S	P	A1
	Acacia huegelii	3374	ACAHUE	S	P	A1
	Acacia nervosa	3454	ACANER	S	P	A1
	Acacia pulchella	3502	ACAPUL	S	P	A1
	Acacia urophylla	3591	ACAURO	S	P	A1
	Adenanthos barbiger	14970	ADEBAR	S	P	B2
	Agrostocrinum scabrum	1261	AGRSCA	G	P	B3
*	*Aira cupaniana*	185	AIRCUP	GR	A	A1
	Allocasuarina fraseriana	1728	ALLFRA	T	P	B1
	Amperea ericoides	4585	AMPERI	DS	P	B2
	Amphipogon amphipogonoides	194	AMPAMP	DS	P	B2
	Amphipogon strictus	199	AMPSTR	GR	P	B3
	Astroloma ciliatum	6323	ASTCIL	DS	P	B2
	Astroloma pallidum	6334	ASTPAL	DS	P	B2
	Austrodanthonia caespitosa	17950	AUSCAE	GR	P	B3
	Baeckea camphorosmae	5336	BAECAM	S	P	B2
	Banksia grandis	1819	BANGRA	T	P	A2
	Billardiera floribunda	3157	BILFLO	V	P	A1
	Billardiera variifolia	3165	BILVAR	V	P	A1
	Boronia crenulata	4413	BORCRE	DS	P	A1
	Boronia denticulata	4416	BORDEN	DS	P	A1
	Boronia ovata	4432	BOROVA	DS	P	A1
	Boronia spathulata	4441	BORSPA	S	P	B2
	Bossiaea aquifolium subsp. *aquifolium*	14396	BOSAQUAQ	S	P	A1
	Bossiaea eriocarpa	3710	BOSERI	S	P	A1
	Bossiaea ornata	3714	BOSORN	S	P	A1
	Brachyscome iberidifolia	7878	BRAIBE	H	A	A1
	Burchardia umbellata	1387	BURUMB	G	P	B3
	Caesia micrantha	1276	CAEMIC	G	P	B3
	Caladenia flava	1592	CALFLA	G	P	B3
	Caladenia flava subsp. *flava*	15348	CALFLAFL	G	P	B3
	Caladenia latifolia	1599	CALLAT	G	P	B3
	Caladenia reptans	1613	CALREP	G	P	B3
	Caladenia sp.	-44	CALSP.	G	P	B3
	Calytrix amethystina	5438	CALAME	G	P	B3
	Calytrix leschenaultii	5465	CALLES	S	P	A1
	Chamaescilla corymbosa	1280	CHACOR	G	P	B3
	Chorizema nanum	12765	CHONAN	DS	P	A1

Taxon Name	TaxonID	SpCode	Life Form	Life Style	Fire Response
Chorizema rhombeum	3761	CHORHO	DS	P	A1
Clematis pubescens	2929	CLEPUB	V	P	A1
Comesperma calymega	4550	COMCAL	DS	P	B2
Conostylis aculeata	1418	CONACU	DS	P	B3
Conostylis setigera	1454	CONSET	DS	P	B3
Corymbia calophylla	17104	CORCAL	T	P	A2
Corynotheca micrantha	1285	CORMIC	S	P	B3
Cyanicula gemmata	15114	CYAGEM	G	P	B3
Cyathochaeta avenacea	768	CYAAVE	Z	P	B3
Dampiera linearis	7454	DAMLIN	DS	P	A1
Daucus glochidiatus	6218	DAUGLO	H	A	A1
Daviesia decurrens	3805	DAVDEC	S	P	B2
Daviesia incrassata	3816	DAVINC	S	P	A1
Desmocladus fasciculatus	17691	DESFAS	Z	P	B3
Desmocladus flexuosus	16595	DESFLE	Z	P	B3
Dianella revoluta	1259	DIAREV	H	P	B3
Dillwynia sp.	-39	DILSP.	S	P	A1
Diuris longifolia	1635	DIULON	G	P	B3
Diuris sp.	-43	DIUSP.	G	P	B3
Drosera bulbosa	3092	DROBUL	G	P	B3
Drosera erythrorhiza	3095	DROERY	G	P	B3
Drosera huegelii	3102	DROHUE	G	P	B3
Drosera pallida	3118	DROPAL	G	P	B3
Drosera pycnoblasta	3125	DROPYC	G	P	B3
Drosera sp.	-40	DROSP.	G	P	B3
Drosera stolonifera	3131	DROSTO	G	P	B3
Dryandra lindleyana	16672	DRYLIN	S	P	B2
Dryandra sessilis	1932	DRYSES	S	P	B2
Eucalyptus marginata	5708	EUCMAR	T	P	A2
Gastrolobium spinosum	3924	GASSPI	S	P	A1
Gompholobium capitatum	3948	GOMCAP	S	P	A1
Gompholobium knightianum	3950	GOMKNI	DS	P	A1
Gompholobium marginatum	3951	GOMMAR	DS	P	A1
Gompholobium sp.	-45	GOMSP.	S	P	A1
Gompholobium tomentosum	3957	GOMTOM	S	P	A1
Grevillea pulchella	2078	GREPUL	S	P	B2
Grevillea synapheae subsp. *synapheae*	14421	GRESYNSY	S	P	B2
Grevillea wilsonii	2122	GREWIL	S	P	B2
Haemodorum paniculatum	1470	HAEPAN	H	P	B3
Hakea amplexicaulis	2128	HAKAMP	S	P	B2
Hakea lissocarpha	2175	HAKLIS	S	P	B2
Hakea ruscifolia	2203	HAKRUS	S	P	B2
Hemigenia rigida	6868	HEMRIG	DS	P	B2
Hibbertia amplexicaulis	5109	HIBAMP	S	P	B2
Hibbertia commutata	5114	HIBCOM	S	P	B2

	Taxon Name	TaxonID	SpCode	Life Form	Life Style	Fire Response
	Hibbertia hypericoides	5135	HIBHYP	S	P	B2
	Hibbertia montana	5146	HIBMON	DS	P	B2
	Hibbertia sp.	-41	HIBSP.	S	P	B2
	Hovea chorizemifolia	3964	HOVCHO	DS	P	B2
	Hovea trisperma var. *grandiflora*	12907	HOVTRIGR	S	P	A1
	Hyalosperma demissum	12742	HYADEM	H	A	A1
	Hybanthus debilissimus	5218	HYBDEB	DS	P	A1
	Hydrocotyle callicarpa	6226	HYDCAL	H	A	A1
	Hypocalymma angustifolium	5817	HYPANG	S	P	B2
*	*Hypochaeris glabra*	8086	HYPGLA	H	A	A1
	Hypoxis occidentalis	1503	HYPOCC	H	P	B3
	Isotoma hypocrateriformis	7396	ISOHYP	H	A	A1
	Kennedia coccinea	4037	KENCOC	V	P	A1
	Kennedia microphylla	4041	KENMIC	V	P	A1
	Kennedia prostrata	4044	KENPRO	V	P	A1
	Labichea punctata	3669	LABPUN	DS	P	B2
	Lagenophora huegelii	18585	LAGHUE	G	P	B3
	Lasiopetalum floribundum	5033	LASFLO	S	P	A1
	Lechenaultia biloba	7568	LECBIL	S	P	A1
	Lepidosperma leptostachyum	936	LEPLEP	Z	P	B3
	Lepidosperma squamatum	945	LEPSQU	Z	P	B3
	Leptomeria cunninghamii	2342	LEPCUN	S	P	A1
	Leucopogon capitellatus	6367	LEUCAP	S	P	B2
	Leucopogon propinquus	6436	LEUPRO	S	P	B2
	Leucopogon verticillatus	6454	LEUVER	S	P	B2
	Levenhookia pusilla	7676	LEVPUS	H	A	A1
	Logania serpyllifolia	6511	LOGSER	DS	P	B2
	Lomandra caespitosa	1223	LOMCAE	DS	P	B3
	Lomandra hermaphrodita	1228	LOMHER	DS	P	B2
	Lomandra integra	1229	LOMINT	DS	P	B3
	Lomandra purpurea	1240	LOMPUR	DS	P	B3
	Lomandra sericea	1243	LOMSER	DS	P	B3
	Lomandra sonderi	1244	LOMSON	DS	P	B3
	Lomandra sp.	-32	LOMSP.	DS	P	B3
	Lomandra spartea	1245	LOMSPA	DS	P	B3
	Lomandra suaveolens	1246	LOMSUA	DS	P	B2
	Macrozamia fraseri	18119	MACFRA	C	P	A1
	Macrozamia riedlei	85	MACRIE	C	P	B3
	Millotia tenuifolia	8106	MILTEN	H	A	A1
	Mirbelia dilatata	4090	MIRDIL	S	P	A1
	Monotaxis grandiflora	4662	MONGRA	DS	P	A1
	Neurachne alopecuroidea	492	NEUALO	GR	P	B3
	Olax benthamiana	2365	OLABEN	S	P	A1
	Opercularia hispidula	7348	OPEHIS	S	P	A1
*	*Orobanche minor*	7122	OROMIN	H	A	A1

	Taxon Name	TaxonID	SpCode	Life Form	Life Style	Fire Response
*	*Oxalis corniculata*	4349	OXACOR	G	P	B3
	Paraserianthes lophantha	3618	PARLOP	S	P	A1
	Patersonia babianoides	1542	PATBAB	G	P	B3
	Patersonia occidentalis	1550	PATOCC	DS	P	B3
	Patersonia pygmaea	1551	PATPYG	DS	P	B3
	Patersonia umbrosa	1553	PATUMB	DS	P	B3
	Pentapeltis peltigera	6245	PENPEL	S	P	B2
	Persoonia longifolia	2267	PERLON	S	P	B2
	Persoonia saccata	2273	PERSAC	S	P	B2
	Phyllangium paradoxum	16177	PHYPAR	H	A	A1
	Phyllanthus calycinus	4675	PHYCAL	DS	P	B2
	Pimelea rosea	5261	PIMROS	S	P	A1
	Pimelea sp.	-42	PIMSP.	S	P	A1
	Pimelea spectabilis	5264	PIMSPE	S	P	A1
	Pimelea suaveolens	5266	PIMSUA	S	P	B2
	Platysace commutata	6248	PLACOM	S	P	A1
	Platysace filiformis	6253	PLAFIL	S	P	A1
	Podotheca angustifolia	8182	PODANG	H	A	A1
	Poranthera microphylla	4691	PORMIC	DS	A	A1
	Pteridium esculentum	57	PTEESC	F	P	B2
	Ptilotus manglesii	2742	PTIMAN	G	P	B3
	Pyrorchis nigricans	16367	PYRNIG	G	P	B3
	Scaevola platyphylla	7636	SCAPLA	S	P	A1
	Scaevola striata	7646	SCASTR	DS	A	A1
	Senecio glomeratus	8206	SENGLO	H	A	A1
	Senecio hispidulus	8208	SENHIS	S	A	A1
	Senecio leucoglossus	8212	SENLEU	S	A	A1
	Sollya fusiformis	8922	SOLFUS	S	P	U
	Sowerbaea laxiflora	1312	SOWLAX	G	P	B3
	Sphaerolobium sp.	-33	SPHSP.	S	P	B2
	Sphaerolobium medium	4207	SPHMED	S	P	B2
	Stackhousia monogyna	4733	STAMON	S	P	B2
	Stylidium amoenum	7684	STYAMO	DS	P	A1
	Stylidium calcaratum	7696	STYCAL	H	A	A1
	Stylidium ciliatum	7702	STYCIL	DS	P	A1
	Stylidium junceum	7745	STYJUN	H	A	A1
	Stylidium luteum	7757	STYLUT	DS	P	A1
	Stylidium piliferum	7774	STYPIL	DS	P	A1
	Stylidium schoenoides	7798	STYSCH	DS	P	A1
	Stylidium sp.	-37	STYSP.	DS	P	A1
	Stylidium spathulatum	7799	STYSPA	DS	P	A2
	Styphelia tenuiflora	6476	STYTEN	S	P	A1
	Synaphea petiolaris	2324	SYNPET	S	P	B3
	Templetonia drummondii	4251	TEMDRU	DS	P	A1
	Tetraria capillaris	1034	TETCAP	S	P	B3

Taxon Name	TaxonID	SpCode	Life Form	Life Style	Fire Response
Tetraria octandra	1036	TETOCT	Z	P	B3
Tetraria sp.	-38	TETSP.	Z	P	B3
Tetrarrhena laevis	667	TETLAE	GR	P	B3
Tetratheca hirsuta	4535	TETHIR	S	P	A1
Tetratheca hispidissima	4536	TETHIS	S	P	A1
Thelymitra crinita	1705	THECRI	G	P	B3
Thomasia foliosa	5080	THOFOL	S	P	A1
Thysanotus manglesianus	1338	THYMAN	G	P	B3
Thysanotus multiflorus	1339	THYMUL	H	P	B3
Thysanotus tenellus	1354	THYTEN	H	P	B3
Trachymene pilosa	6280	TRAPIL	H	A	A1
Tremandra stelligera	4548	TRESTE	DS	P	B2
Trichocline spathulata	8251	TRISPA	G	P	B3
Tricoryne elatior	1361	TRIELA	DS	P	A1
Tricoryne humilis	1362	TRIHUM	DS	P	A1
Tripterococcus brunonis	4737	TRIBRU	DS	P	A1
Trymalium floribundum	4841	TRYFLO	S	P	A1
Trymalium ledifolium	4842	TRYLED	S	P	A1
Xanthorrhoea gracilis	1253	XANGRA	X	P	B2
Xanthorrhoea preissii	1256	XANPRE	X	P	B2
Xanthosia atkinsoniana	6283	XANATK	S	P	B2
Xanthosia candida	6284	XANCAN	DS	P	B2
Xanthosia huegelii	6289	XANHUE	DS	P	A1

* = Introduced Species

INVERTEBRATES

Janet Farr, Allan Wills and Tom Burbidge

Introduction

Invertebrates, including the class Insecta, comprise over 75% of this planet's biodiversity and therefore represent a crucial component in any ecosystem. Invertebrates play a major role in decomposition, nutrient recycling and provide an important food source for vertebrates. In addition a wide range of species are already known to be exclusive to the southwest forests of Western Australia, and some of these are Gondwanan relicts. Despite this, current knowledge of the invertebrate taxa present in the Jarrah forest is limited.

The objectives of this component of FORESTCHECK monitoring are to:

- Monitor and record the species of invertebrates in the various treatments of managed Jarrah (gap release, shelterwood) and uncut forest.
- Analyse trends in species composition, richness and abundance
- Monitor the presence of Gondwanan relic and affinity invertebrate species with respect to the above treatments
- Monitor the presence of known insect pest species.

Field and lab Work

Sampling at Perth Hills was carried out in November (spring) 2003 and March (autumn) 2004 using the protocol formerly established at Donnelly. To briefly summarize; active capture samples, involving sweeping, beating, and habitat searches of coarse woody debris (CWD) and litter were conducted once at each site for a total time of 1 person hour per capture/habitat method. Light traps were run for 3 nights simultaneously at each site (except when light trap failure occurred for sites FC20, FC22, FC23, FC25), achieving one trap night per week for three weeks; pitfall traps were opened for 10 days simultaneously at each site. Captures were bagged and labelled according to site and other capture details in the field, then transported in an insulated container back to a base camp were they were stored in a portable freezer. At the conclusion of a sampling period, specimens were then transported to the laboratory in Manjimup where they were sorted and assigned to morphospecies. This report examines invertebrate captures made in Perth Hills District and includes some comparison with the former Donnelly and Wellington samples.

Results

The Perth Hills (sampling initiated 2003) samples increased the number of morphospecies to 960 (Appendix 1). Figure 1 shows the cumulative captures for the successive sampling locations.

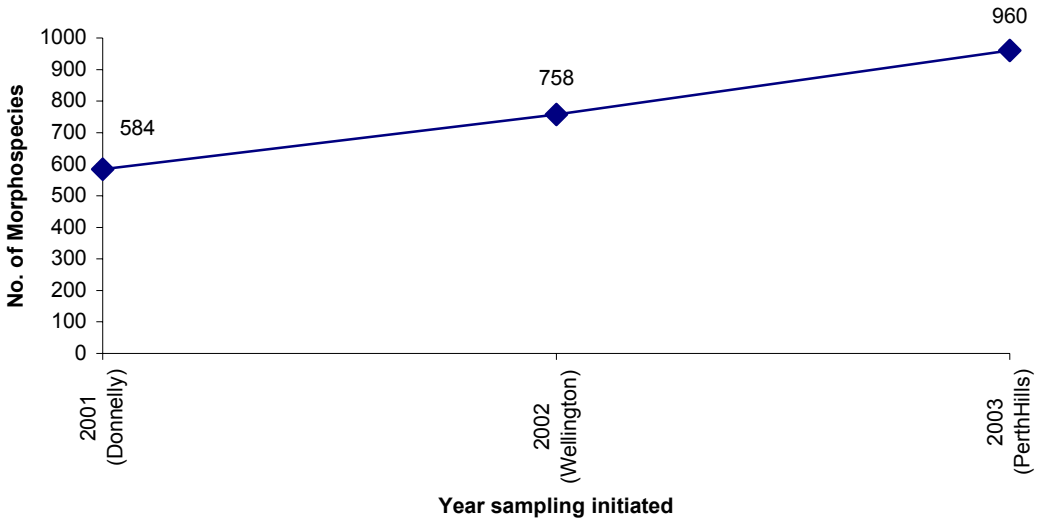


Figure 1. Cumulative number of morphospecies from 2001 (Donnelly) to 2003 (Perth Hills)

In total 450 morphospecies were collected from Perth Hills compared to 381 and 587 from Wellington and Donnelly Districts respectively (Appendix II). Of those collected from Perth Hills, 18 were considered Gondwanan relicts and a further 12 species had Gondwanan affinities, compared to 25 and 32 respectively for Donnelly. A species of *Peripatus* (Sp. 937) caught at the Cameron shelterwood (FC23) is a Pangea relict and represents the link between annelids and arthropods. The numbers of morphospecies for orders where 10 or more morphospecies have been assigned are compared for Donnelly and Wellington Districts in Figure 2.

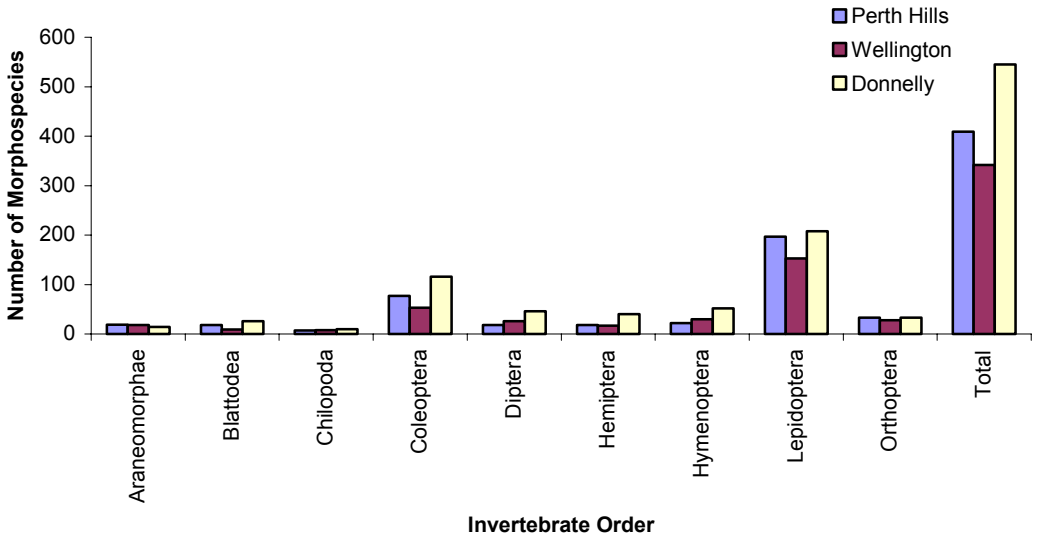


Figure 2. Comparison of Perth Hills, Donnelly and Wellington District morphospecies numbers for orders where ten or greater morphospecies have been assigned.

Overall, Perth Hills was second to Donnelly in species diversity, with this pattern repeated in Coleoptera (beetles), Diptera (flies), Hemiptera (bugs), and Hymenoptera

(wasps). Lepidoptera (moths) and Blattodea (cockroaches) had similar capture numbers for Perth Hills and Donnelly. Captures in Araneomorpha (spiders), Chilopoda (centipedes) and Orthoptera (crickets and grasshoppers) were similar at all sample districts.

Comparing capture methods

Light trapping resulted in the most abundant and diverse captures (Table 1) with a spring capture of 197 morphospecies comprising 3499 individuals. As expected, diversity and abundance for all capture methods are highest in spring.

Table 1. Number of morphospecies and specimen abundance for Perth Hills District in spring and autumn for each capture method (CWD = coarse woody debris).

Capture Method	No. of Morphospecies		Abundance	
	Spring	Autumn	Spring	Autumn
Light	198	133	3499	762
Pitfall	44	33	131	103
Sweep	42	23	100	34
Beat	27	13	113	39
CWD	14	8	24	14
Litter	25	16	35	26

Figure 3 compares the number of morphospecies for each capture method from Perth Hills, Wellington and Donnelly Districts. Abundance comparisons are shown in Figure 4. In spring, with the exception of the light trap captures, the Donnelly captures are more diverse (Fig. 3a). For autumn Donnelly appears marginally more diverse, however for sweep, beat and litter captures there is little difference between sample districts (Fig 3b).

For abundance, spring light trap captures were most abundant for Perth Hills with 3500 individuals compared to 1511 individuals for Donnelly (Fig 4a). In autumn, light trap capture abundance for Perth Hills was lower compared to Wellington and Donnelly (Fig. 4b). Coarse woody debris sample abundance was also low for Perth Hills compared to Donnelly. For the other capture techniques there were no strong differences.

Comparing sample grids and silvicultural treatments

Figure 5 shows Perth Hills grid comparisons for silvicultural treatments expressed as the total morphospecies and abundance for all capture methods and summed for spring and autumn seasons. The shelterwood treatment site of Lesley (FC26) had the greatest number of species (212). The lowest number of species was collected at two external control treatments, Holyoake (FC21) and Kennedy (FC24) where 135 and 134 species were captured respectively. The greatest number of individuals (1023) was captured at the gap release site Lesley (FC25), whilst the least abundance (303) was again found at the external control treatment Kennedy (FC24).

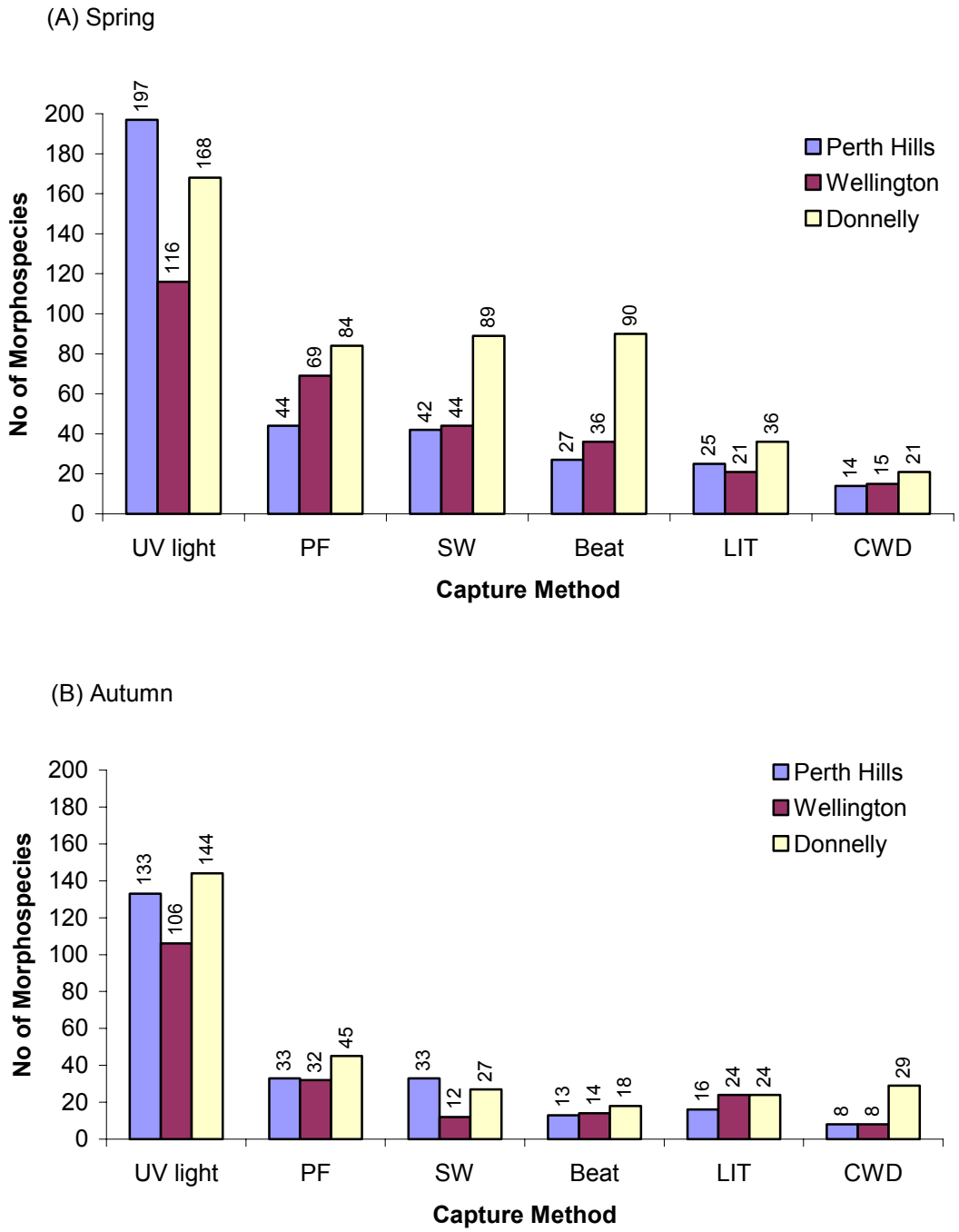


Figure 3. The number of morphospecies in spring (A) and autumn (B) for each capture method; Perth Hills, Wellington and Manjimup Districts compared. (PF= pitfall trap; SW = sweep net; Beat = beating tray; cwd = coarse woody debris search; LIT = litter search)

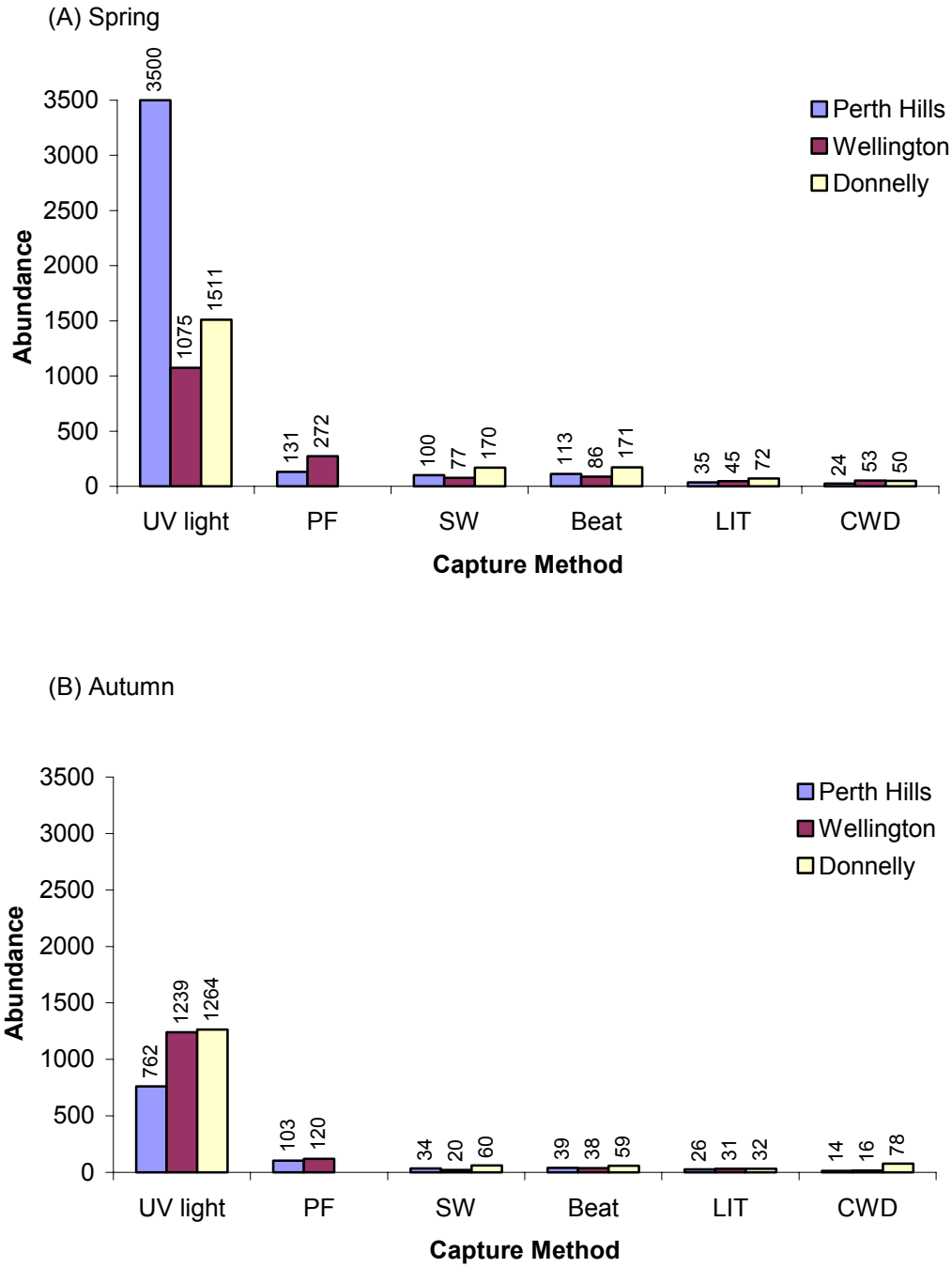


Figure 4. Abundance (measured as the number of individual specimens captured) in spring (A) and autumn (B) for each capture method, from Perth Hills, Wellington and Donnelly. (UV Light = light trap captures; PF= pitfall trap captures; SW = sweep net; Beat = beating tray; LIT = litter search; CWD = coarse woody debris search)

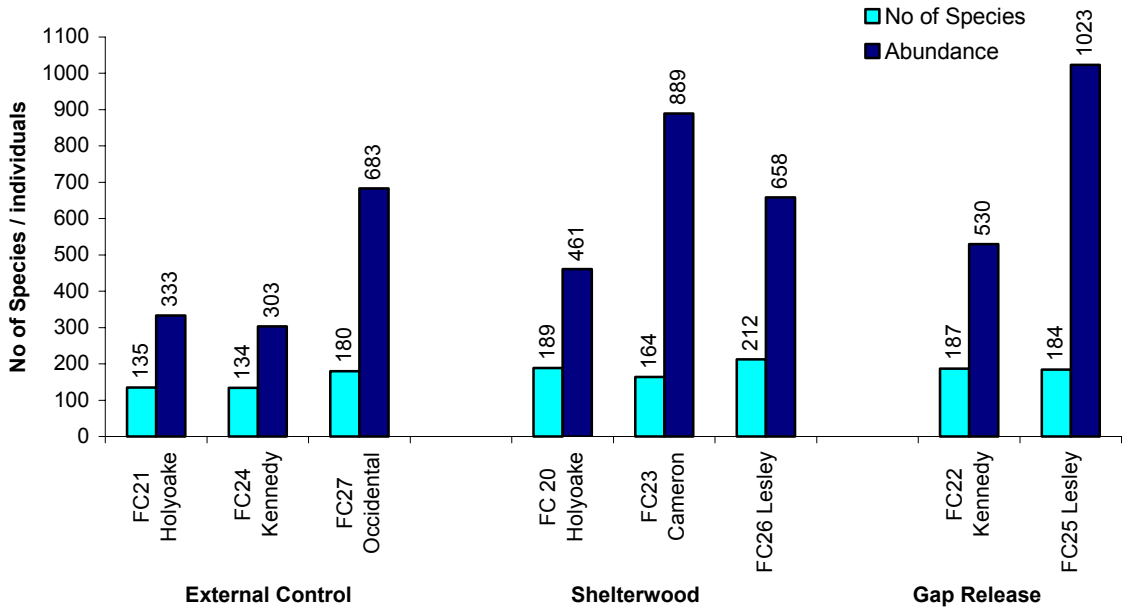


Figure 5. Comparison of individual Perth Hills treatment grids for total morphospecies (no. of species) and abundance (no. of individuals), for all capture methods, summed for both seasons.

Comparison of the means between treatments indicates the controls are less diverse and have less invertebrate abundance (Table 2). This trend, although present for number of species, in the Wellington samples is less apparent.

Table 2. Comparison of means (± SE) for number of species and abundance (number of individuals) at Perth Hills and Wellington in respect to silvicultural treatment.

Silvicultural Treatment	Perth Hills		Wellington	
	No. of Species	Abundance	No. of Species.	Abundance
External Control	149.0 ± 15.0	439.0 ± 121.8	108.0 ± 12.8	337.3 ± 31.7
Shelterwood	187.7 ± 13.9	668.7 ± 123.4	116.3 ± 0.9	329.7 ± 16.3
Gap Release	185.0 ± 1.0	776.0 ± 247.0	120.0 ± 7.2	357.0 ± 53.2

The number of morphospecies and abundance (number of individuals captured at each grid) for active (beat, sweep, coarse woody debris and litter searches), light and pitfall trap capture techniques in spring and autumn are shown in Table 3.

Figure 6 shows comparisons for silvicultural treatments for light trap captures between Perth Hills and Donnelly in spring. For Perth Hills species diversity and abundance is lowest in the control. This trend is also apparent for the active capture method but not for pit fall captures. For Donnelly there is little variation between treatments for the spring captures. However in autumn, the control site is also lowest in diversity and abundance (Fig. 7). This trend is not present in the Perth Hills autumn data with the exception of light trap abundance.

Table 3. Number of morphospecies and abundance (number of individuals captured at each grid) for active (beat, sweep, coarse woody debris, litter), light and pitfall trap capture techniques in spring and autumn for Perth Hills District.

Treatment	Site No	Location	Season	Active capture		Light trap		Pitfall trap		All capture methods	
				No. Spec	Abund.	No. Spec	Abund.	No. Spec	Abund.	No. Spec	Abund.
External Control	FC21	Holyoake	AU	12	24	15	35	8	13	35	72
External Control	FC21	Holyoake	SP	16	35	69	206	15	20	100	261
External Control	FC24	Kennedy	AU	6	7	36	87	5	6	47	100
External Control	FC24	Kennedy	SP	15	19	61	169	10	14	86	202
External Control	FC27	Occidental	AU	12	15	56	135	11	16	79	166
External Control	FC27	Occidental	SP	16	20	73	485	11	11	100	516
Shelterwood	FC20	Holyoake	AU	11	15	40	70	9	9	60	94
Shelterwood	FC20	Holyoake	SP	16	44	107	303	6	20	129	367
Shelterwood	FC23	Cameron	AU	13	14	30	76	7	14	50	104
Shelterwood	FC23	Cameron	SP	18	26	79	739	16	19	113	784
Shelterwood	FC26	Lesley	AU	10	15	68	164	10	15	88	194
Shelterwood	FC26	Lesley	SP	26	39	85	403	12	21	123	463
Gap Release	FC22	Kennedy	AU	10	12	37	90	5	6	52	108
Gap Release	FC22	Kennedy	SP	29	58	97	354	8	9	134	421
Gap Release	FC25	Lesley	AU	11	11	33	103	15	24	59	138
Gap Release	FC25	Lesley	SP	22	29	92	840	11	16	125	885

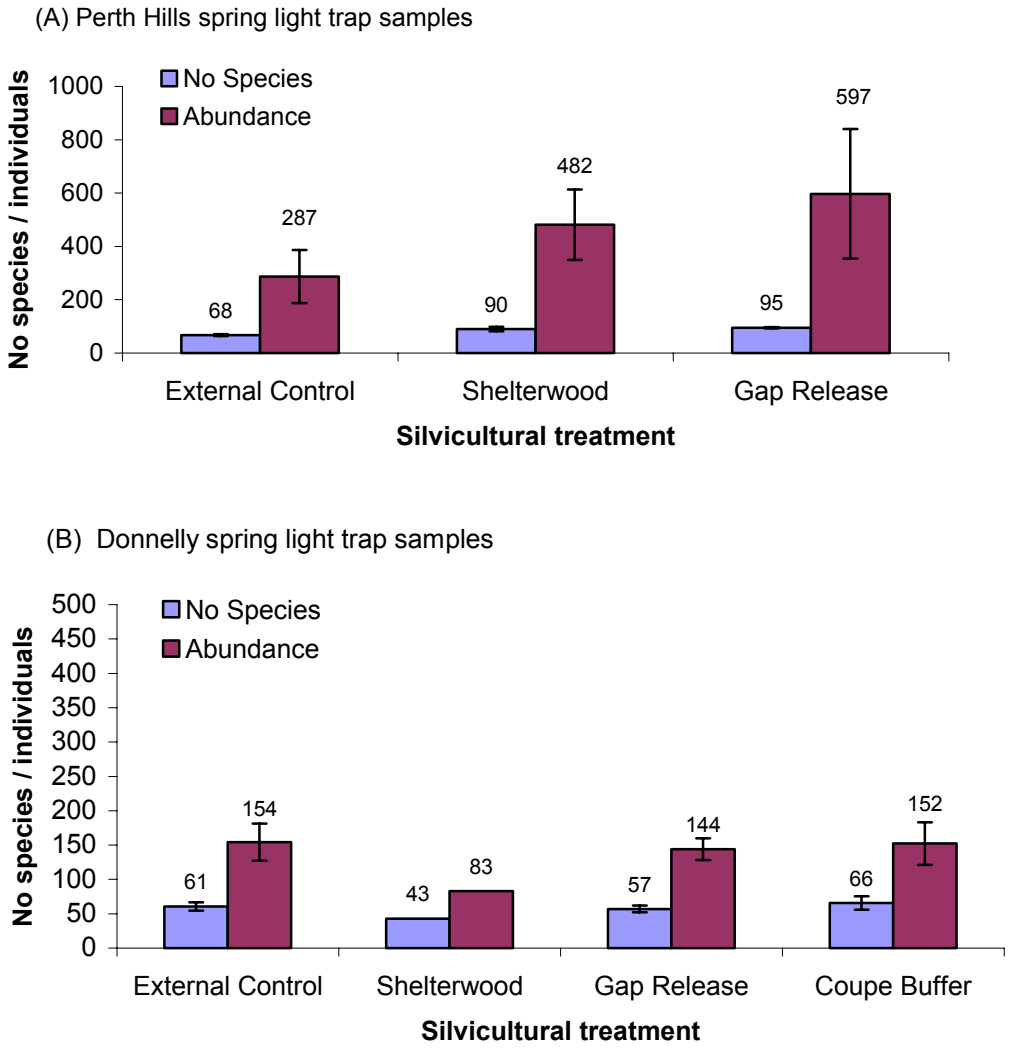
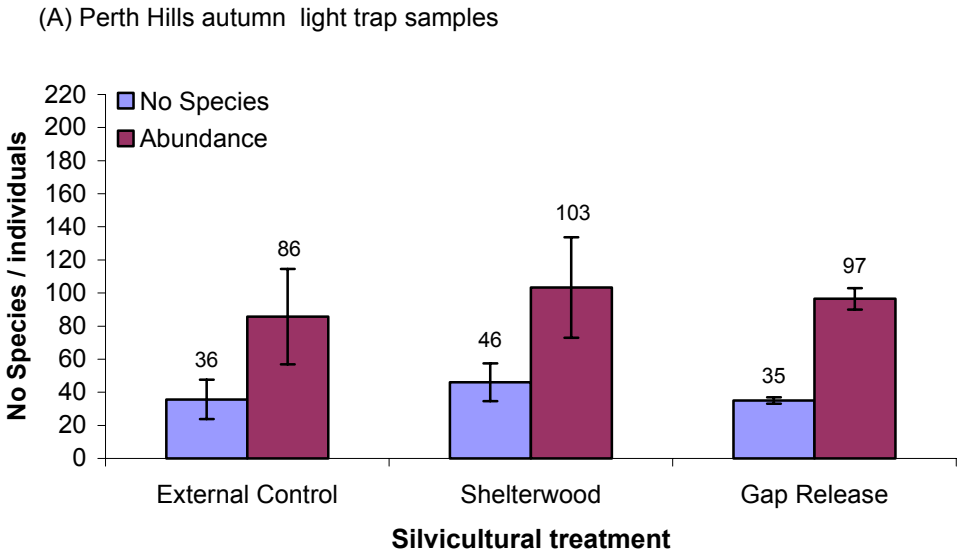


Figure 6. Mean (± SE) spring light trap captures against treatment grids for (A) Perth Hills and (B) Donnelly. (No Species = number of morphospecies; abundance = number of individuals).

Species differences

Table 4 shows the most frequent species captured for Perth Hills, Wellington and Donnelly. Trichopteran 145 was the most common species collected in Perth Hills and Wellington and also features in the 10 most common species captured in Donnelly. Species 52 (the introduced honey bee) was the only other species present in the top 10 of all sample sites. At Perth Hills scorpions and grasshoppers were more common than at the other sample sites.

There were 137 morphospecies common to Perth Hills, Wellington and Donnelly (Figure 8). Of the 960 total morphospecies, 202 were exclusive to Perth Hills (45% of the Perth Hills capture), 118 to Wellington (30% of the Wellington capture) and 299 were exclusive to Donnelly (51% of the Donnelly capture).



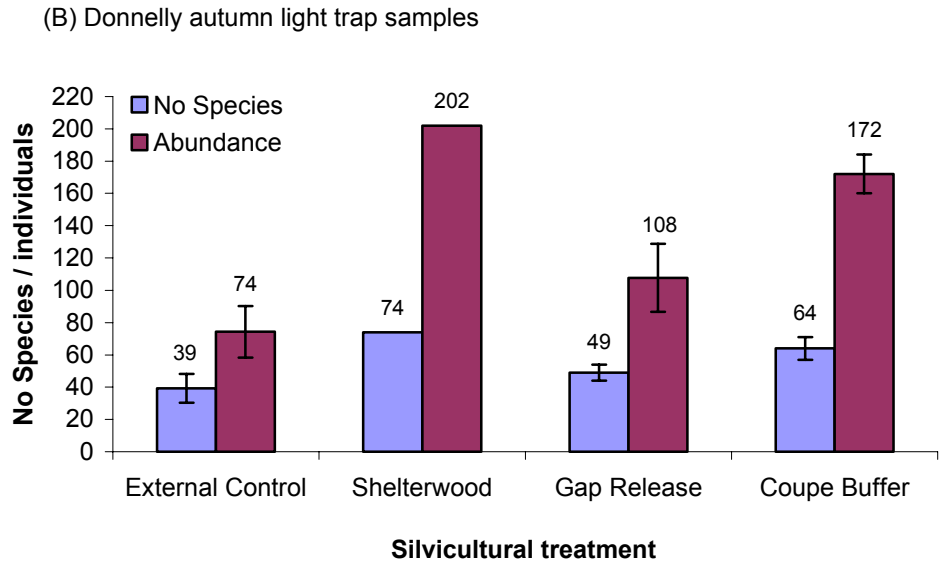


Figure 7. Mean (n = 3, ± SE) autumn light trap captures against treatment grids for (A) Perth Hills and (B) Donnelly (note: Donnelly shelterwood is for n=1). (No Species = number of morphospecies; abundance = number of individuals).

Table 4. The ten most frequent species captured for Perth Hills, Wellington and Donnelly (Capture frequency is the number of times a specimen is collected at its respective sample site and is not to be confused with abundance levels which refer to the total number of specimens collected; capture frequency ranks relate to Perth Hills samples, eg. a rank of 6 for a Wellington specimen means this species was the 6th most frequent species at Perth Hills, a rank >23 indicates single specimen only found in Perth Hills, a rank = 0 indicates no specimen captured in Perth Hills.).

Sample Site	Species no	Capture Frequency	Perth Hills Capture frequency rank	Order	Family	Genus
Perth Hills	145	32	1	Trichoptera		
	14	26	2	Coleoptera	Hydrophilidae	
	144	23	3	Trichoptera		
	39	22	4	Lepidoptera	Noctuidae	
	424	21	5	Lepidoptera	Geometridae	
	52	20	6	Hymenoptera	Apidae	*Apis* (honey bee)
	235	20	6	Orthoptera	Acrididae	
	880	19	7	Scorpionida		
	634	19	7	Lepidoptera	Geometridae	
	633	17	8	Lepidoptera	Geometridae	
	872	17	8	Orthoptera	Acrididae	*Goniaea*
	48	17	8	Lepidoptera		
Wellington	145	26	1	Trichoptera		
	11	20	22	Lepidoptera	Thaumetopoeidae	*Ochrogaster*
	1	19	21	Lepidoptera	Carthaeidae	*Carthaea*
	16	19	16	Diptera	Tipulidae	
	423	19	12	Hymenoptera	Formicidae	*Iridomyrex*
	39	18	22	Lepidoptera	Noctuidae	
	52	18	6	Hymenoptera	Apidae	*Apis* (honey bee)
	374	18	17	Lepidoptera	Notodontidae	
	326	18	17	Lepidoptera	Geometridae	
	630	17	24	Lepidoptera	Geometridae	
Donnelly	52	64	6	Hymenoptera	Apidae	*Apis* (honey bee)
	6	54	0	Lepidoptera	Arctiidae	
	235	45	6	Orthoptera	Acrididae	
	373	28	0	Lepidoptera	Hepialidae	*Abantiades*
	39	28	4	Lepidoptera	Noctuidae	
	145	26	1	Trichoptera		
	18	26	15	Lepidoptera	Noctuidae	*Agrotis*
	376	26	24	Lepidoptera		
	423	24	12	Hymenoptera	Formicidae	*Iridomyrex*
	16	23	16	Diptera	Tipulidae	

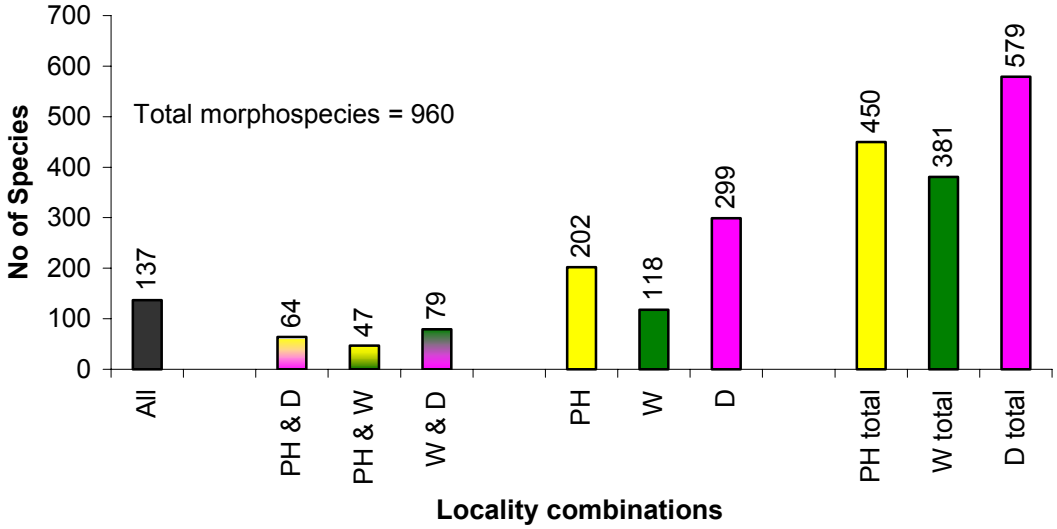


Figure 8: Number of species common and exclusive to Perth Hills (PH) Wellington (W) and Donnelly (D). (All refers to number of species common to all sites; locality combinations such as PH & D refers to the number of species common to both sites; a single locality shows the number of species exclusive to that site; location totals refer to total morphospecies for the respective site and is included for comparison)

Pest presence

The forest pests Jarrah leafminer and gumleaf skeletonizer were absent from all grid locations (Table 5). Bullseye borer was present at all sites except Lesley gap (FC25).

Table 5. Pest presence and abundance assessment at each site (JLM = Jarrah leafminer; GLS = gumleaf skeletonizer; BEB = bullseye borer; 0 = absent, 1 = present, 2 = abundant).

Treatment	Site No	Location	JLM	GLS	BEB
External Control	FC21	Holyoake	0	0	1
External Control	FC24	Kennedy	0	0	1
External Control	FC27	Occidental	0	0	1
Shelterwood	FC20	Holyoake	0	0	1
Shelterwood	FC23	Cameron	0	0	1
Shelterwood	FC26	Lesley	0	0	1
Gap Release	FC22	Kennedy	0	0	1
Gap Release	FC25	Lesley	0	0	0

Appendix I. Morphospecies list for FORESTCHECK invertebrates for June 2004. (K = assigned indicator species; GA = species with Gondwanan affinities; GR = suspected Gondwanan relic species

Spec No	Order	Family	Subfamily	Genus	Species	Status
1	Lepidoptera	Carthaeidae		*Carthaea*	*saturnioides*	K
2	Lepidoptera	Geometridae	Oenochrominae	*Arhodia*	sp..	K
3	Lepidoptera	Thaumetopoeidae		*Epicoma*	*melanosticta*	K
4	Lepidoptera	Notodontidae		*Destolmia*	*lineata*	K
5	Lepidoptera					
6	Lepidoptera	Arctiidae				K
7	Lepidoptera	Thaumetopoeidae		*Ochrogaster*	sp. 1	K
8	Lepidoptera	Thaumetopoeidae		*Ochrogaster*	sp.. 2	K
9	Lepidoptera	Thaumetopoeidae		*Ochrogaster*	sp. 3	K
10	Lepidoptera	Thaumetopoeidae		*Ochrogaster*	*lunifer*	K
11	Lepidoptera	Thaumetopoeidae		*Ochrogaster*	sp.4	K
12	Lepidoptera	Geometridae				K
13	Coleoptera	Dytiscidae				
14	Coleoptera	Hydrophilidae				
15	Coleoptera	Elateridae				
16	Diptera	Tipulidae				K
17	Coleoptera	Scarabaeidae		*Onthophagus*	*ferox*	K
18	Lepidoptera	Noctuidae		*Agrotis*	*munda*	K
19	Lepidoptera	Geometridae		*Chlorocoma*	*dicloraria*	K
20	Lepidoptera					
21	Lepidoptera					
22	Lepidoptera	Geometridae		*Chlorocoma*	sp.	K
23	Lepidoptera	Geometridae				K
24	Lepidoptera	Geometridae				K
25	Lepidoptera					
26	Coleoptera	Elateridae				
27	Blattodea	Blaberidae		*Cololampra*	sp.	K
28	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.1	
29	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.2	
30	Lepidoptera	Noctuidae		*Dasypodia*	*selenophora*	
31	Lepidoptera	Geometridae		*Parepisparis*	*excusata*	K
32	Lepidoptera	Thaumetopoeidae				K
33	Lepidoptera					
34	Lepidoptera	Lymantriidae		*Teia*	*athlophora*	K
35	Lepidoptera	Thaumetopoeidae		*Ochrogaster*	sp.5	K
36	Lepidoptera	Thaumetopoeidae		*Ochrogaster*	sp.6	K
37	Lepidoptera					K
38	Lepidoptera					
39	Lepidoptera	Noctuidae				K
40	Lepidoptera	Noctuidae		*Persectania*	sp.	K
41	Lepidoptera	Geometridae				K
42	Lepidoptera	Geometridae		*Gastrina*	*cristaria*	K
43	Lepidoptera	Pyralidae ?				K
45	Lepidoptera	Zygaenidae		*Pollanisus*	*viridipulverulenta*	K
46	Lepidoptera	Geometridae				
47	Lepidoptera	Geometridae				
48	Lepidoptera					
49	Hemiptera	Cicadidae		*Cicadetta*	sp.	
50	Lepidoptera	Geometridae				K

Spec No	Order	Family	Subfamily	Genus	Species	Status
51	Diptera	Muscoidea				
52	Hymenoptera	Apidae		*Apis*	*melifera*	K
53	Diptera	Calliphoridae		*Calliphora*		
54	Diptera	Syrphidae				
55	Coleoptera	Dytiscidae				
56	Coleoptera	Chrysomelidae				
57	Lepidoptera	Notodontidae		*Danima*	*banksiae*	K
58	Lepidoptera	Notodontidae				K
59	Lepidoptera	Geometridae				K
60	Lepidoptera					
61	Lepidoptera					
62	Lepidoptera					K
63	Lepidoptera					
64	Lepidoptera	Oecophoridae				K
65	Lepidoptera					
66	Lepidoptera	Geometridae				
67	Lepidoptera					
68	Diptera	?				
69	Trichoptera					GR
70	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.3	
71	Lepidoptera					
72	Lepidoptera	Geometridae				
73	Lepidoptera					
74	Lepidoptera	Noctuidae				
75	Lepidoptera	Noctuidae				
76	Lepidoptera					
77	Lepidoptera					
78	Lepidoptera	Zygaenidae		*Pollanisus*	*viridipulverulenta*	K
79	Lepidoptera	Geometridae	Oenochrominae	*Arhodia*	sp.	K
80	Lepidoptera					K
81	Lepidoptera	Limacodidae		*Doratifera*	sp.	K
82	Lepidoptera	Geometridae				
83	Lepidoptera	Geometridae				
84	Lepidoptera	Pyralidae		*Uresiphita*	*ornithopteralis*	K
85	Lepidoptera	Geometridae				
86	Lepidoptera	Geometridae				
87	Hymenoptera	Ichneumonidae		*Ophion*	sp.	GA
88	Diptera	Pyrgotidae				K
89	Mecoptera	Meropeidae		*Austromerope*	*poultoni*	GR
90	Lepidoptera	Limacodidae				K
91	Lepidoptera	Anthelidae		*Chenuala*	sp.	K
92	Lepidoptera	Tortricidae ?				
93	Coleoptera	Carabidae				
94	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.4	
95	Lepidoptera	Geometridae				
96	Lepidoptera	Geometridae				
97	Lepidoptera	Geometridae				
98	Coleoptera	Curculionidae	Gonipterinae	*Oxyops*	*pictipennis*	
99	Coleoptera	Lycidae		*Metriorrhynchus*	sp.	K
100	Coleoptera	Curculionoidea	Belidae			GR
101	Coleoptera	Chrysomelidae				
102	Coleoptera	Curculionidae				

Spec No	Order	Family	Subfamily	Genus	Species	Status
103	Coleoptera	Curculionidae	Aterpinae	*Rhinaria*	*aberrans* (?)	
104	Lepidoptera					
105	Hemiptera	Pentatomidae				K
106	Orthoptera	Tettigoniidae				K
107	Hemiptera					
108	Hemiptera	Membracidae				K
109	Hemiptera					
110	Hemiptera					
111	Lepidoptera					
112	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	
113	Coleoptera	Curculionidae	Entiminae	*Polyphrades*	*aesalon* (?)	
114	Coleoptera	Curculionidae				
115	Coleoptera	Chrysomelidae				
116	Coleoptera	?				
117	Hemiptera	Pentatomidae				
118	Orthoptera	Tettigoniidae				
119	Blattodea	Blaberidae		*Calolampra*	sp.1	K
120	Blattodea	Blatellidae		*Neotemnopteryx*	sp.	K
121	Blattodea	Blatellidae		*Platyzosteria*	sp.1	K
122	Blattodea	Blatellidae		*Platyzosteria*	sp.2	K
123	Dermaptera					K
125	Diptera	Drosophilidae				
126	Diptera	Tabanidae				
127	Diptera	?				
128	Diptera	Muscoidea				
129	Diptera	Syrphidae				
130	Diptera	Syrphidae				
131	Neuroptera	Hemerobeidae				GR
132	Mantodea					
133	Lepidoptera	Noctuidae				
134	Diptera	Muscoidea				
135	Coleoptera	Elateridae				
136	Diptera	Tachinidae				K
137	Lepidoptera	Noctuidae				
138	Lepidoptera					
139	Lepidoptera	Noctuidae				
140	Lepidoptera	Noctuidae				
141	Lepidoptera	Tineidae		*Moerarchis*	*australasiella*	K
142	Diptera	Therevidae				K
143	Diptera	Syrphidae				
144	Trichoptera					GR
145	Trichoptera					GR
147	Blattodea	Blaberidae		*Calolampra*	sp.2	
148	Blattodea	Blaberidae				
149	Orthoptera	Tettigoniidae				K
150	Hemiptera	Reduvidae				K
151	Trichoptera					GR
153	Hemiptera	Pentatomidae				
154	Coleoptera	Scarabaeidae	Melolonthinae	*Liparetrus*	sp.	
155	Coleoptera	Chrysomelidae				
156	Coleoptera	Curculionidae				
157	Coleoptera	Curculionidae	Aterpinae	*Rhadinosomus*	*lacordairei*	K

Spec No	Order	Family	Subfamily	Genus	Species	Status
158	Coleoptera	?				
159	Coleoptera	?				
160	Coleoptera	Curculionidae	Gonipterinae	*Gonipterus*	sp.	
161	Coleoptera	Curculionidae	Gonipterinae	*Oxyops*	*fasciata*	K
162	Coleoptera	Scarabaeidae	Melolonthinae	*Liparetrus*	*jenkinsi*	
163	Hemiptera	Reduviidae				
164	Hemiptera					
165	Diptera	Asilidae				GA
166	Hemiptera					
167	Orthoptera	Tettigoniidae				
168	Coleoptera	Belidae		*Rhinotia*	sp.	GR
169	Coleoptera	Curculionidae				
170	Hemiptera					
171	Coleoptera	Scarabaeidae	Melolonthinae	*Liparetrus*	sp.	
172	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.	
173	Coleoptera	?				
174	Orthoptera	Acrididae				K
175	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*		
176	Hemiptera	Pentatomidae				
177	Hemiptera					
178	Diptera	Tabanidae				GA
179	Diptera	Drosophilidae				
180	Orthoptera	Gryllidae				K
182	Coleoptera	Chrysomelidae				
183	Hymenoptera	Colletidae				K
184	Hymenoptera	Doryctinae				
185	Lepidoptera	Noctuidae		*Periscepta*	*polystieta*	K
186	Hymenoptera	Colletidae				K
187	Hemiptera					
188	Hemiptera					
189	Coleoptera	Scarabaeidae	Dynastinae	*Cryptodus*	sp.	K
190	Blattodea	Blatidae				K
191	Coleoptera	Phycosecidae	Phycosecis			
192	Coleoptera	Tenebrionidae	Lagriinae	*Lagria*	*aneouiobcea*	GA
193	Coleoptera	Coccinellidae		*Coccinella*	*repanda*	
194	Coleoptera	?				
195	Diptera	?				
196	Hemiptera	Reduviidae				
197	Lepidoptera					
198	Coleoptera	Lycidae				
199	Coleoptera	Curculionidae				
200	Hemiptera					
201	Coleoptera	Belidae		*Araiobelus*		GR
202	Orthoptera	Tettigoniidae				
203	Hymenoptera	Colletidae				
204	Diptera	Asilidae				GA
205	Diptera	Muscoidea				
206	Diptera	Syrphidae				
207	Hemiptera	Cicadidae		*Cicadetta*	sp..	K
208	Coleoptera	Lycidae		*Metriorrhynchus*	sp..	K
209	Coleoptera	Curculionidae				K
210	Coleoptera	Curculionidae	Entiminae	*Aesolithna*	sp..	

Spec No	Order	Family	Subfamily	Genus	Species	Status
212	Coleoptera	Scarabaeidae	Melolonthinae	*Liparetrus*	sp..	
214	Coleoptera	Curculionidae				
215	Coleoptera	?				
216	Orthoptera	Gryllidae				
217	Diptera	Asilidae				GA
218	Orthoptera	Tetigoniidae				K
219	Blattodea	Blattidae		*Platyzosteria*		K
220	Coleoptera	Elateridae				
221	Hemiptera	Pentatomidae				
222	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp..2	
223	Chilopoda					
224	Chilopoda					
225	Chilopoda					
226	Chilopoda					
227	Chilopoda					
228	Chilopoda					
229	Chilopoda					
230	Hemiptera	Pseudococcidae				
231	Orthoptera	Acrididae				K
232	Orthoptera	Acrididae		*Goniaea*	sp..	K
233	Orthoptera	Acrididae		*Goniaea*	sp..	K
235	Orthoptera	Acrididae				K
236	Lepidoptera					
237	Odonata	Zygoptera				GR
238	Lepidoptera					
239	Hemiptera					
240	Hemiptera	Pentatomidae				K
241	Hemiptera					
242	Diptera	Syrphidae				
243	Hymenoptera	Evaniidae				
244	Coleoptera	Curculionidae				K
245	Diptera	Bombyliidae				K
246	Orthoptera	Tetigoniidae				K
248	Coleoptera	Chrysomelidae	Chrysomelinae			
249	Hemiptera					
250	Mecoptera	Bittacidae		*Harpobittacus*	sp..	GR
251	Hemiptera	Pentatomidae				
252	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp..1	
253	Coleoptera	Carabidae				
254	Blattodea	Blattidae		*Platyzosteria*	sp..	
257	Dermaptera					K
258	Dermaptera					K
259	Diplopoda					
260	Diplopoda					K
261	Amphipoda					GR
262	Isopoda					GR
264	Coleoptera	Carabidae	Harpalinae	*?Cenogmus*	sp..	GA
265	Coleoptera	Carabidae	Esydrinae			GA
266	Blattodea	Blattidae		*Platyzosteria*		K
267	Chilopoda					
268	Orthoptera	Tettigoniidae				
269	Blattodea					

Spec No	Order	Family	Subfamily	Genus	Species	Status
270	Hemiptera	Reduviidae				
271	Araneomorphae					
275	Hymenoptera	Formicidae		*Iridomyrmex*	sp..3	
276	Orthoptera					
277	Chilopoda					
278	Orthoptera					
279	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp..4	
280	Coleoptera	Carabidae		*Carenum*	sp..	GA
281	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp..3	
282	Blattodea	Blattidae		*Platyzosteria*	sp..	K
283	Mygalomorphae					GR
284	Hemiptera	Reduviidae				K
285	Araneomorphae					
286	Araneomorphae	Sparassidae				
287	Coleoptera	Scarabaeidae				
288	Coleoptera	Carabidae		*Chlaenius*		GA
289	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp..	
290	Coleoptera	Curculionidae	Molytinae	*Helanotranes*	*roei*	K
291	Coleoptera	Curculionidae	Molytinae	*Tranes*	*vigorsii*	K
292	Blattodea	Blaberidae		*Laxta*		K
293	Orthoptera	Acrididae		*Phaulacridium*	*vitatum*	K
294	Orthoptera	?				
295	Hymenoptera	Pompilidae				
296	Lepidoptera	Lycinidae				K
297	Lepidoptera	Nymphalidae	Heteronympha	*Merope*	*duboulayi*	K
299	Coleoptera	Buprestidae				K
300	Coleoptera	Curculionidae	Amycterinae			K
301	Hemiptera	Membracidae				K
302	Hemiptera	Membracidae				K
303	Phasmatodea					
304	Orthoptera	Acrididae		*Goniae*		K
305	Neuroptera	Mermelontidae				GR
306	Lepidoptera	Nymphalidae		*Geitoneura*	*klugit*	K
307	Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsis*	sp.	K
308	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	K
309	Mantodea					
310	Orthoptera					
311	Hemiptera	Reduviidae				K
312	Diptera	Asilidae				GA
314	Orthoptera					
315	Lepidoptera					
316	Lepidoptera					
317	Lepidoptera	Geometridae				
318	Lepidoptera	Geometridae				
319	Lepidoptera	Tineidae		*Moerarchis*	*clathrella*	K
320	Lepidoptera	Geometridae		*Arhodia*	sp.	K
321	Lepidoptera	Geometridae				K
322	Lepidoptera	Limacodidae		*Doratifera*	*quadirguttata*	K
323	Lepidoptera	Geometridae				
324	Lepidoptera	Tineidae		*Moerarchis*	sp.	K
325	Lepidoptera	Psychidae		*Iphierga*	*euphragma*	K
326	Lepidoptera	Geometridae				

Spec No	Order	Family	Subfamily	Genus	Species	Status
327	Lepidoptera	Geometridae				
328	Lepidoptera	Saturnidae		*Opodiphthera*	*helena*	K
329	Lepidoptera	Noctuidae				K
330	Lepidoptera	Geometridae		*Crypsiphora*	*ocultaria*	K
331	Lepidoptera	Oecophoridae		*Wingia*	*aurata*	K
332	Lepidoptera	Lymacodidae		*Doratifera*	sp.	K
333	Lepidoptera	Pyralidae				
334	Lepidoptera	Geometridae		*Gastrina*	*cristarina*	K
336	Lepidoptera	Noctuidae		*Chrysodeixis*	*argentifera*	K
337	Lepidoptera					
338	Lepidoptera	Geometridae				
339	Lepidoptera	Geometridae				
340	Coleoptera	Carabidae	Chlaeniiae			
341	Lepidoptera	Pyralidae				
342	Lepidoptera	Pyralidae				
343	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp.5	
344	Lepidoptera	Noctuidae				K
345	Lepidoptera	Noctuidae				K
345	Lepidoptera	Noctuidae				K
346	Lepidoptera	Noctuidae				K
347	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*		
349	Coleoptera	Curculionidae				K
350	Lepidoptera					
351	Coleoptera	Cerambycidae		*Uracantha*	*triangularis*	K
352	Lepidoptera	Anthelidae		*Anthela*	sp.	K
353	Coleoptera	Scarabaeidae		*Colpochila*	sp.	K
354	Coleoptera	Scarabaeidae		*Cryptodus*	*dynastinae*	K
355	Lepidoptera	Geometridae				
356	Lepidoptera	Pyralidae				
357	Lepidoptera	Geometridae		*Eucyclodes*	*buprestaria*	K
358	Lepidoptera	Geometridae				
359	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*		
360	Neuroptera	Hemerobiidae				GR
361	Neuroptera	Chrysopidae		*Chrysopa*		GR
362	Lepidoptera					
363	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*		
364	Lepidoptera	Noctuidae				
365	Lepidoptera	Pyralidae				
366	Lepidoptera					
367	Lepidoptera					
368	Coleoptera	Curculionidae	Amycterinae			K
369	Lepidoptera					
370	Lepidoptera	Notodontidae		*Hylaeora*	*dilucida*	K
371	Lepidoptera	Lasiocampidae		*Entometa*	*fervens*	K
372	Lepidoptera	Hepialidae		*Abantiades*	*hydrographis*	GA
373	Lepidoptera	Hepialidae		*Abantiades*	*ocellatus*	GA
374	Lepidoptera	Notodontidae				K
375	Lepidoptera	Geometridae				K
376	Lepidoptera					
377	Lepidoptera	Geometridae		*Phallaria*	*ophiusaria*	K
379	Lepidoptera	Noctuidae		*Peripyra*	*sanguinipucta*	K
380	Lepidoptera					

Spec No	Order	Family	Subfamily	Genus	Species	Status
381	Lepidoptera	Anthelidae				K
382	Lepidoptera					
383	Lepidoptera					
384	Lepidoptera	Geometridae		*Pholodes*	sp.1	K
385	Lepidoptera	Geometridae		*Pholodes*	sp.2	K
386	Lepidoptera	Noctuidae				
387	Lepidoptera					
388	Lepidoptera	Noctuidae		*Pantydia*	sp.	
389	Lepidoptera	Geometridae				K
390	Lepidoptera	Notodontidae				K
391	Lepidoptera	Noctuidae				
392	Lepidoptera	Geometridae				K
393	Lepidoptera	Geometridae				K
394	Lepidoptera					
395	Lepidoptera	Geometridae				
396	Lepidoptera	Oecophoridae				
397	Lepidoptera	Pyralidae				
398	Lepidoptera	Limacodidae		*Doratifera*	sp.	K
399	Lepidoptera					
400	Neuroptera	Myremeleontidae				GR
401	Lepidoptera	Pyralidae				
402	Lepidoptera	Geometridae				
403	Lepidoptera	Geometridae				K
404	Lepidoptera	Thaumetopoeidae		*Oenosandra*	sp.	K
405	Lepidoptera	Noctuidae				
406	Lepidoptera					
407	Lepidoptera					
408	Hymenoptera					
409	Hymenoptera	Formicidae				
410	Blattodea	Blaberidae				K
411	Lepidoptera					
412	Lepidoptera	Noctuidae				K
413	Lepidoptera					
414	Lepidoptera					
415	Lepidoptera	Geometridae				K
416	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.	
417	Lepidoptera	Geometridae		*Gastrina*	sp.	K
418	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.	
419	Lepidoptera					
420	Lepidoptera					
421	Lepidoptera					
422	Lepidoptera					
423	Hymenoptera	Formicidae	Dolichoderinae	*Iridomyrex*	sp.2	K
424	Lepidoptera	Geometridae				K
425	Lepidoptera	Geometridae				K
426	Lepidoptera	Lasiocampidae		*Entometa*	sp.	K
427	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*		
428	Lepidoptera					
429	Lepidoptera					
430	Lepidoptera					
431	Lepidoptera					
432	Lepidoptera	Pyralidae				K

Spec No	Order	Family	Subfamily	Genus	Species	Status
433	Mantodea	Mantidae		*Archimantis*	sp.	K
434	Lepidoptera					
435	Lepidoptera	Noctuidae				K
436	Lepidoptera	Geometridae				K
437	Coleoptera	Lucanidae		*Syndesus*	sp.	K
438	Lepidoptera					
439	Coleoptera	Carabidae	Carabinae			GA
440	Coleoptera	Dytiscidae				
441	Lepidoptera					
442	Lepidoptera					
443	Lepidoptera					
444	Coleoptera	Elateridae				
445	Lepidoptera	Artctiidae	Arctiinae	*Spilosoma*	sp.	K
446	Lepidoptera					K
449	Lepidoptera	Noctuidae				K
450	Lepidoptera	Geometridae		*Thalaina*	*clara*	K
451	Lepidoptera	Geometridae				K
452	Lepidoptera					K
453	Lepidoptera					
454	Lepidoptera					
455	Lepidoptera	Geometridae		*Gastrina*	*cristaria*	
456	Lepidoptera					
457	Lepidoptera	Anthelidae				K
458	Phasmatodea					
459	Lepidoptera					
460	Lepidoptera	Pyralidae	Epipaschinae			
462	Coleoptera	Curculionidae	Gonipterinae	*Oxyops*		
463	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	K
464	Diptera	Tachinidae				K
465	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	K
466	Diptera	Tabanidae				
467	Diptera	Tabanidae				GA
468	Araneomorphae					K
469	Scorpionida				Scorpion sp2	K
470	Coleoptera	Curculionidae	Gonipterinae	*Oxyops*		
471	Coleoptera	Chrysomelidae	Paropsinae	*Chrysophtharta*		
472	Araneomorphae					
473	Diptera	Tabanidae				
475	Hemiptera	Pentatomidae				K
476	Coleoptera	Cerambycidae	Laminae			
477	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	*callima*	K
478	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp.7	K
479	Blattodea	Blaberidae				
480	Diptera	Calliphoridae		*Calliphora*		
481	Hymenoptera	Pompilidae				GA
482	Hemiptera	Reduviidae				K
483	Blattodea	Blaberidae				
484	Dermaptera					K
485	Orthoptera					
486	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp1	
487	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp.6	
488	Coleoptera	Curculionidae	Gonipterinae	*Gonipterus*		

Spec No	Order	Family	Subfamily	Genus	Species	Status
489	Hemiptera					K
490	Blattodea					
491	Dermaptera					
492	Dermaptera					
493	Hymenoptera	Braconinae				K
494	Hymenoptera	Pompilidae				
495	Diptera	Tabanidae				
496	Coleoptera	Curculionidae	Amycterinae		Acantholophus	K
497	Araneomorphae					
498	Diptera	Muscoidea				
500	Hymenoptera	Evaniidae				K
501	Orthoptera	Acrididae				K
502	Araneomorphae					
503	Hemiptera	Eurymelidae		*Pogonoscopus*	sp.	K
504	Hymenoptera					
505	Hymenoptera	Sphecidae				K
506	Diptera	Bombylidae				K
507	Blattodea					
508	Blattodea					K
509	Blattodea					
510	Hymenoptera	Formicidae				
511	Coleoptera	Scarabaeidae		*Onthophagus*		
512	Hemiptera	Reduviidae				K
513	Hemiptera	Pentatomidae				K
514	Coleoptera	Curculionidae				
515	Hymenoptera	Ichneumonidae				GA
516	Hymenoptera	Pompilidae				
517	Lepidoptera	Geometridae				
518	Lepidoptera	Noctuidae				
519	Isopoda	collective sp.				
520	Annelida	collective sp.				
521	Platyhelminthes					
522	Dermaptera					
525	Blattodea	Blattidae	******			K
526	Orthoptera	Stenopelmatidae		*Onosandrus*	sp.	K
527	Hemiptera	Gelastocoridae		*Nerthra*	sp.	
528	Coleoptera	Carabidae				K
529	Coleoptera	Carabidae				K
530	Diptera	Anthomyiidae				
531	Diptera	Tabanidae				GA
532	Diptera	Asilidae				GA
533	Hymenoptera	Ichneumonidae	Branchinae	*Australoglypta*	sp.	
534	Hymenoptera	Mutilidae				
535	Hymenoptera	Formicidae	Dolichoderinae	*Iridomyrmex*	sp1	
536	Araneomorphae	Corinnidae		*Supunna*	*albopunctata*	K
537	Araneomorphae	Corinnidae		*Supunna*	*picta* sp..1	K
538	Mygalomorphae	Nemesiidae			juvenile	GR
539	Isopoda					
540	Isopoda					
541	Diptera	Asilidae				GA
542	Hymenoptera	Formicidae	Ponerinae	*Prionopella*	sp.	
543	Hymenoptera	Formicidae	Poneri	*Rhytidoponera*	sp.	

Spec No	Order	Family	Subfamily	Genus	Species	Status
545	Hymenoptera	Colletidae	***			
546	Hymenoptera	Colletidae				
547	Blattodea	Blaberidae		*Laxta*	sp2	K
548	Orthoptera	Acrididae				
550	Coleoptera	Scarabaeidae	Melolonthinae			
552	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp1	
553	Araneomorphae	Ctenidae				
554	Araneomorphae	Lycosidae				
555	Orthoptera	Gryllidae	******			
557	Coleoptera	Carabidae	***			K
558	Coleoptera	Carabidae	Pentagonicinae	*Scapodes*	*boops*	
560	Araneomorphae	Gnaphosidae	*******			
562	Coleoptera	Scarabaeidae	Melololonthinae	*Heteronyx*	sp.	
564	Diptera	Asilidae	***			GA
565	Diptera	Syrphidae				
567	Mygalomorphae	Nemesiidae	*****	*Chenistonia*	sp1	GR
568	Scorpionida				Scorpion sp1	K
570	Blattodea	Blaberidae	***		sp4	K
571	Coleoptera	Elateridae				
573	Hemiptera	Reduviidae	****			
576	Orthoptera	Acrididae		*Cedarinia*	sp2	
577	Diptera	Tipulidae	***			
579	Diptera	Sarcophagidae	***			
580	Hymenoptera	Mutilidae				
581	Mygalomorphae	Nemesiidae		*Chenistonia*	sp2	GR
584	Hymenoptera	Tiphiidae	***			GA
585	Mygalomorphae	Nemesiidae			juvenile	GR
587	Coleoptera	Carabidae	***			K
588	Diptera	Tipulidae				
589	Lepidoptera	Noctuidae				
590	Mygalomorphae			*Nemesiidae*	juvenile	GR
591	Blattodea	Blatellidae		*Neotemnopteryx*	sp.	
592	Blattodea	Blattidae		*Polyzosteria*	sp.	
593	Lepidoptera	Hesperiidae		*Hesperilla*	*chrysotricha*	K
594	Lepidoptera	Nymphalidae		*Vanessa*	*kershawi*	K
596	Hymenoptera	Colletidae	****			
597	Araneomorphae	Miturgidae		*genus2*	sp1	
598	Lepidoptera	Noctuidae				
603	Diptera	Tabanidae	***			GA
604	Hymenoptera	Tiphiidae				GA
607	Hymenoptera	Pompilidae	***			GA
608	Orthoptera	Gryllidae				
609	Orthoptera	Gryllidae				
611	Hymenoptera	Pompilidae	***			GA
612	Hymenoptera	Pompilidae				GA
613	Orthoptera	Acrididae				
614	Hymenoptera	Tiphiidae				GA
616	Hymenoptera	Pompilidae	****			GA
617	Hymenoptera	Pompilidae				GA
618	Orthoptera	Gryllidae				
619	Hymenoptera	Pompilidae				GA
620	Araneomorphae	Trochanteridae		*Rebilus*	sp.	

Spec No	Order	Family	Subfamily	Genus	Species	Status
621	Coleoptera	Elateridae				
622	Hymenoptera	Pompilidae		*Cryptocheilus*	*fabricolor*	GA
623	Chilopoda					
628	Coleoptera	Staphylinidae	****			K
629	Scorpionida				Scorpion sp3	K
630	Lepidoptera	Geometridae				
631	Lepidoptera	Pyralidae				K
632	Lepidoptera	Geometridae				
633	Lepidoptera	Geometridae				
634	Lepidoptera	Geometridae				
635	Lepidoptera	Pyralidae				
636	Coleoptera	Elateridae				
637	Lepidoptera	Geometridae				
638	Lepidoptera	Geometridae				
639	Lepidoptera	Geometridae				
640	Lepidoptera	Noctuidae				
641	Lepidoptera	Pyralidae				
642	Lepidoptera	Noctuidae				
643	Lepidoptera	Noctuidae (?)				
644	Lepidoptera	Geometridae				
645	Lepidoptera	Pyralidae				
646	Lepidoptera	Pyralidae				
647	Lepidoptera					
648	Lepidoptera	Noctuidae				
649	Lepidoptera	Noctuidae				
650	Lepidoptera	Noctuidae				
651	Coleoptera	Dytiscidae		*Lancetes*	sp.	
652	Lepidoptera	Pyralidae (?)				
653	Neuroptera	Hemerobiidae				GR
654	Coleoptera	Cerambycidae		*Coptocercus*	*rubripes*	
655	Lepidoptera	Geometridae				
656	Lepidoptera	Noctuidae				
657	Lepidoptera					K
658	Lepidoptera	Gelechiodea				
659	Lepidoptera	Noctuidae		*Chrysodeixis*	sp.	
660	Lepidoptera					
661	Lepidoptera					
662	Lepidoptera					
663	Lepidoptera	Geometridae		*Heliomystis*	sp.	
664	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*		
665	Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsis*	sp.	K
667	Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsis*	sp.	K
669	Hemiptera	Pentatomidae				
670	Hemiptera	Pentatomidae				
671	Isopoda					
672	Orthoptera	Gryllidae				
673	Coleoptera	Cerambycidae		*Stenoderus*	*suturalis*	
674	Mantodea					
675	Diptera	Muscidae				
676	Diptera	Conopoidea	Conopidae			
677	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	
678	Hemiptera	Pentatomidae	(green)			

Spec No	Order	Family	Subfamily	Genus	Species	Status
679	Hemiptera	Lygaeidae				
680	Hemiptera	Pentatomidae				
681	Orthoptera	Acrididae	Acridinae			
682	Dermaptera	Anisolabididae	Isolabellinae			
683	Diptera	Bombylidae				K
684	Coleoptera	Cleridae				
685	Hymenoptera	Thyninae				GR
686	Lepidoptera	Noctuidae		*Uraba*	*lugens*	K
687	Neuroptera	Mantispidae				GR
688	Orthoptera					
689	Lepidoptera	Noctuidae				
690	Orthoptera	Acrididae	Catantopinae	*Cedarinia*	sp.	
691	Lepidoptera	Geometridae				
692	Lepidoptera	Thaumetopoeidae				K
693	Lepidoptera	Lasiocampidae				
694	Lepidoptera	Geometridae				
695	Coleoptera	Cleridae		*Eleale*	sp.	
696	Hymenoptera	Colletidae				
697	Hymenoptera	Gasteruptiidae				
698	Hymenoptera	Ichneumonidae				
699	Hymenoptera	Pompiilidae				
700	Hemiptera	Coreidae		*Amorbus*	*bispinus*	
701	Coleoptera	Buprestidae		*Melobasis*	sp.	
702	Coleoptera	Curculionidae		*Gonipterus*		
703	Orthoptera	Acrididae	Acridinae			
704	Hymenoptera	Colletidae				
705	Orthoptera					
706	Blattodea	Blattidae				
707	Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsis*	sp.	
708	Orthoptera					
709	Coleoptera	Curculionidae				
710	Coleoptera	Curculionidae	Entiminae			
711	Coleoptera	Tenebrionidae		*Oectosis*	sp.	K
712	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp.	
713	Orthoptera	Tetrigidae				
714	Hemiptera	Reduvidae				
715	Orthoptera					
716	Chilopoda					
717	Diplopoda					
718	Mantodea					
719	Diptera	Bombyliidae				
720	Hymenoptera	Sphecidae				
721	Mygalomorphae	Idiopidae		*?Eucytops*	sp.	GR
722	Orthoptera	Acrididae		*Cedarinia*	sp3	
723	Hymenoptera	Sphecidae				
724	Araneomorphae	Miturgidae				
725	Araneomorphae	Stiphidiidae		*?Balami*	*volucripes*	
726	Orthoptera	Acrididae		*Cedarinia*	sp2?	
727	Coleoptera	Carabidae				GA
728	Hymenoptera	Formicidae				
729	Orthoptera	Acrididae				
730	Hymenoptera	Colletidae				

Spec No	Order	Family	Subfamily	Genus	Species	Status
731	Araneomorphae	Zoridae				
732	Araneomorphae	Stiphidiidae		*Balami*	sp.	
733	Araneomorphae	Lycosidae				
734	Dermaptera					K
735	Araneomorphae	Stiphidiidae		*Balami*	*volucripes*	
736	Coleoptera	Curculionidae				
737	Hymenoptera	Formicidae		*Pachycondyla*	sp.	
738	Orthoptera	Eumasticidae				
739	Mantodea	Amorphoscelidae		*Paroxypilus*	?*tasmaniensis*	
740	Araneomorphae					
741	Araneomorphae	Lycosidae				
742	Araneomorphae	Gnaphosidae				
743	Araneomorphae	Lycosidae				
744	Coleoptera	Curculionidae	Amycterinae			K
745	Diptera	Bombyliidae				
746	Coleoptera	Carabidae				GA
747	Coleoptera	Carabidae		*?Notonomus*	sp.	GA
748	Coleoptera	Curculionidae	Amycterinae			K
749	Lepidoptera	Bombycidae				
750	Lepidoptera					
751	Diptera	Asilidae				
752	Neuroptera	Hemerobiidae				GR
753	Lepidoptera	Geometridae (?)				
754	Lepidoptera					
755	Lepidoptera	Lasiocampidae				
756	Lepidoptera	Geometridae				
757	Lepidoptera	Geometridae				
758	Lepidoptera	Geometridae				
759	Lepidoptera	Geometridae				
760	Lepidoptera					
761	Lepidoptera	Hepialidae		*Abantiades*		K
762	Coleoptera	Cerambycidae		*Phoracantha*	*semipunctata*	
764	Hemiptera	Fulgoridae				
765	Lepidoptera	Geometridae				
766	Lepidoptera	Noctuidae (?)				
767	Mantodea	Mantidae				
768	Lepidoptera	Pyralidae (?)				
769	Lepidoptera	Noctuidae				
770	Lepidoptera	Noctuidae				
771	Lepidoptera	Noctuidae				
772	Lepidoptera	Geometridae (?)				
773	Lepidoptera					
774	Coleoptera	Dytiscidae		*Eretes*		
775	Diptera	Asilidae				
776	Lepidoptera	Geometridae				
777	Blattodea	Blattidae	Michells cocky	*Polyzosteria*	*mitchelli*	K
778	Coleoptera	Tenebrionidae		*Oectosis*	sp.2	
779	Hemiptera	Pentatomidae	(nymph)			
781	Blattodea	Blaberidae		*Laxta*	sp.2	K
782	Orthoptera	Pyrgomorphidae				
783	Araneomorphae					
784	Mantodea					

Spec No	Order	Family	Subfamily	Genus	Species	Status
785	Phasmatodea	(grey stick insect)				
786	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	
787	Hemiptera	Cicadellidae				
788	Araneomorphae					
789	Mantodea					
790	Hymenoptera					
791	Orthoptera					
792	Diptera	Tipulidae				K
793	Araneomorphae					
794	Araneomorphae					
795	Coleoptera	Lycidae				
796	Hymenoptera	Tiphiidae				
797	Lepidoptera					
798	Lepidoptera					
799	Lepidoptera	Noctuidae				
800	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	
801	Hymenoptera	Tiphiidae				GR
802	Coleoptera	Lycidae		*Metriorrhynchus*	sp.	K
803	Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsis*	sp.	
804	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	
805	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	
806	Hymenoptera	Tiphiidae				GR
807	Coleoptera	Chrysomelidae	Chrysomelinae	*Chalcolampra*	sp.	K
808	Coleoptera	Chrysomelidae	Chrysomelinae	*Chrysophtharta*	sp.	
809	Orthoptera	Gryllidae				
810	Diptera	Asilidae				
811	Orthoptera	Gryllidae		*Apterogryllus*	sp2	
812	Araneomorphae	Miturgidae				
813	Hymenoptera	Pompilidae				
814	Coleoptera	Curculionidae				
815	Chilopoda					
816	Orthoptera	Eumasticidae				
817	Coleoptera	Curculionidae				
818	Diptera	Muscidae				
819	Lepidoptera	Thaumetopoeidae		*Ochrogaster*	sp5	K
820	Lepidoptera	Geometridae				
821	Lepidoptera	?				
822	Neuroptera	Chrysopidae		*Chrysopa*	sp.	GR
823	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.	
824	Coleoptera	Scarabaeidae				
825	Coleoptera	Trogidae		*Omorgus*	sp.	K
826	Coleoptera	Scarabaeidae	Melolonthinae	*Maechidius*	sp.	
827	Lepidoptera	Geometridae	prob same as 776 (battered)			
828	Lepidoptera	?				
829	Lepidoptera	?				
830	Lepidoptera	Geometridae (?)				
831	Coleoptera	Geotrupidae		*Blackbolbus*	sp.	K
832	Lepidoptera	Geometridae		*Lissomma*	sp.	
833	Lepidoptera	Noctuidae				
834	Orthoptera	Gryllidae				
835	Lepidoptera	Geometridae				

Spec No	Order	Family	Subfamily	Genus	Species	Status
836	Lepidoptera	Geometridae				
837	Lepidoptera	Pyrallidae (?)				
838	Hemiptera	Pentatomidae				
839	Coleoptera	Carabidae	?			
840	Lepidoptera	Lepidoptera	?			
841	Coleoptera	Curculionidae	?			
842	Coleoptera	Carabidae	?			
843	Coleoptera	Curculionidae	?			
844	Lepidoptera	Noctuidae		*Agrotis*	sp.	
845	Coleoptera	Scarabaeidae	Melolonthinae	*Colpochila*	*deceptor*	K
846	Coleoptera	Scarabaeidae	Melolonthinae	*Colpochila*	sp.	K
847	Lepidoptera	Noctuidae				
848	Coleoptera	Trogidae		*Omorgus*	sp.	
849	Lepidoptera	?				
850	Coleoptera	Dytiscidae		*Lancetes*	sp.	
851	Coleoptera	Carabidae				
852	Coleoptera	Curculionidae				
853	Lepidoptera	Noctuidae				
854	Mantodea	Amorphoscelidae	Paraoxypilinae			
855	Lepidoptera	?				
856	Lepidoptera	?				
857	Orthoptera	Gryllidae				
858	Lepidoptera	Geometridae				
859	Lepidoptera	Noctuidae	Mythimna (?)			
861	Lepidoptera	?				
862	Lepidoptera	Geometridae				
863	Hemiptera	Reduviidae				
864	Lepidoptera	?				
865	Coleoptera					
866	Lepidoptera	?				
867	Lepidoptera	?				
868	Orthoptera	Acrididae	Oxyinae			
869	Coleoptera	Curculionidae	Amycterinae	*Acantholophus*	sp.	K
870	Lepidoptera	Lycaenidae				
871	Orthoptera	Acrididae		*Goniaea*	sp.	K
872	Orthoptera	Acrididae		*Goniaea*	sp.	K
873	Orthoptera	Tettigoniidae				
874	Blattodea					
875	Chilopoda					
876	Diplopoda					
877	Chilopoda					
878	Blattodea					
879	Scorpionida					
880	Scorpionida					
881	Orthoptera	Tetrigidae				
882	Orthoptera	Tettigoniidae				
883	Orthoptera	Eumastacidae				
884	Diptera	Tabanidae				
885	Hemiptera	Reduviidae				
886	Hemiptera	Reduviidae				
887	Araneomorphae					
888	Hymenoptera	Formicidae				

Spec No	Order	Family	Subfamily	Genus	Species	Status
889	Hymenoptera	Formicidae				
890	Orthoptera	Acrididae		*Cedarinia*	sp.	
891	Blattodea					
892	Orthoptera	Acrididae		*Cedarinia*	sp.	
893	Hymenoptera	Apoidea	Colletidae			K
894	Hymenoptera	Vespoidea				
895	Lepidoptera	Limacodidae		*Doratifera*	sp.	
896	Lepidoptera	?				
897	Orthoptera	Tettigoniidae				
898	Coleoptera	Curculionidae		*Oxyops*	sp.	
899	Blattodea					
900	Lepidoptera	?				
901	Diptera	Tabanidae				
902	Orthoptera	Tettigoniidae				
903	Orthoptera	Tettigonidae				K
904	Coleoptera	Tenebrionidae				
905	Blattodea					
906	Coleoptera	Curculionidae	Amycterinae	*Acantholophus*	sp.	K
907	Diptera	Bombylidae				K
908	Mecoptera	Bittacidae		*Harpobittacus*	sp.	K
909	Coleoptera	Elateridae				
910	Coleoptera	Curculionidae	Amycterinae			K
911	Coleoptera	Curculionidae				
912	Coleoptera	Coccinellidae		*Parapriasus*	sp.	
913	Coleoptera	Chrysomelidae		*Paropsis*	sp.	
914	Coleoptera	Carabidae	Licininae	*Dicrochile*	sp.	
915	Lepidoptera	?				
916	Hemiptera	Cicadidae	?			
917	Lepidoptera	?				
918	Lepidoptera	?				
919	Lepidoptera	Geometridae				
920	Lepidoptera	?				
921	Lepidoptera	?				
922	Lepidoptera	Pyralidae		*Hedonota*	*recurvella*	
923	Lepidoptera	Geometridae				
924	Coleoptera	Silphidae		*Ptomaphila*	*lacrymosa*	GR
925	Lepidoptera	Geometridae				
926	Blattodea	Blaberidae				
927	Lepidoptera	Geometridae				
928	Lepidoptera	Pyralidae (?)				
929	Diptera	Tachinidae				
930	Coleoptera	Tenebrionidae		*Chalcopteroides*	sp.	K
931	Orthoptera	Tettigoniidae				
932	Araneomorphae	Zoridae				
933	Araneomorphae	Zoridae				
934	Coleoptera	Curculionidae	Amycterinae			K
935	Coleoptera	Trogidae		*Omorgus*		K
936	Blattodea					
937	Onychophora			*Peripatus*		GR
938	Araneomorphae	?				
939	Araneomorphae	?				
940	Orthoptera	Acrididae		*Goniaea*	sp.	

Spec No	Order	Family	Subfamily	Genus	Species	Status
941	Araneomorphae	Gnaphosidae				
942	Lepidoptera	Geometridae				
943	Lepidoptera	Tortricidae				
944	Lepidoptera	?				
945	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp.	
946	Lepidoptera	?				
947	Lepidoptera	?				
948	Lepidoptera	Pyralidae				
949	Neuroptera	?				GR
950	Lepidoptera	?				
951	Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*	sp.	
952	Hymenoptera	Formicidae				
953	Lepidoptera	Pyralidae				
954	Lepidoptera	?				
955	Lepidoptera	Geometridae		*Hypobapta*	*percomptaria*	K
956	Coleoptera	Carabidae		*Philophloeus*	*eucalypti*	
957	Lepidoptera	Pyralidae				
958	Lepidoptera	CANT FIND				
959	Coleoptera	Histeridae				
960	Hemiptera	Pentatomidae				
961	Blattodea					
962	Hemiptera	Pentatomidae				
963	Hemiptera					
964	Hemiptera					
965	Araneomorphae					
966	Diplopoda					
967	Blattodea	CAN'T FIND				
968	Blattodea					
969	Gastropoda					
970	Coleoptera	Curculionidae	Amycterinae			
971	Blattodea					
972	Araneomorphae	Corrinidae (?)				
973	Phasmatodea					
974	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*	sp.	
975	Araneomorphae	Gnaphosidae				
976	Lepidoptera	Geometridae	Oenochrominae			K
977	Lepidoptera	Geometridae				
978	Lepidoptera	?				
979	Lepidoptera	Pyralidae				
980	Orthoptera	Tettigoniidae				
981	Mantodea	Mantidae	Mantinae			
982	Lepidoptera	Pyralidae				
983	Lepidoptera	?				
984	Lepidoptera	?				
985	Lepidoptera	?				
986	Lepidoptera	?				
987	Lepidoptera	Arctiidae		*Utetheisa*	*pulchelloides*	
988	Orthoptera	Tettigoniidae				
989	Coleoptera	Elateridae				K
990	Hemiptera	Pentatomidae				
991	Coleoptera	Scarabaeidae	Melolonthinae			
992	Coleoptera	Carabidae				

Spec No	Order	Family	Subfamily	Genus	Species	Status
993	Coleoptera	Curculionidae				
994	Orthoptera	Tettigoniidae				
995	Coleoptera	Tenebrionidae				
996	Lepidoptera	Noctuidae				
997	Coleoptera	Elateridae				
998	Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*		
999	Dermaptera	Spongiphoridae				
1000	Coleoptera	Carabidae				
1001	Mantodea	Mantidae	Mantinae			
1002	Hymenoptera	Pompilidae				GA
1003	Lepidoptera	Noctuidae				
1004	Odonata	Zygoptera	Protoneuridae (?)			GR
1005	Odonata	Zygoptera				GR
1006	Hymenoptera		Formicidae			
1007	Araneomorphae	Zodariidae				
1008	Orthoptera	Stenoplmatidae				
1009	Orthoptera	Tettigoniidae				
1010	Orthoptera	Acrididae				
1011	Hymenoptera	Formicidae				
1012	Coleoptera	Tenebrionidae		*Helea*	sp.	K
1013	Orthoptera	Tettigoniidae				
1014	Coleoptera	Curculionidae	Amycterinae			K
1015	Araneomorphae	Zodariidae				
1016	Blattodea					
1017	Hymenoptera	Pompilidae				GA
1018	Lepidoptera	?				
1019	Lepidoptera	?				
1020	Lepidoptera	?				
1021	Coleoptera	Scarabaeidae	Dynastinae	*Semanopterus*	sp2	

BIRDS

G.L. Liddelow and Frank O'Connor

Introduction

All eight Perth Hills FORESTCHECK grids were monitored for diurnal birds in the spring of 2003. The object of recording birds in FORESTCHECK is to monitor the impacts of logging and associated burning on bird species composition and abundance. This is to be achieved by:

- Recording species richness and abundance within each treatment (control, shelterwood and gap release)
- Comparing species richness and abundance between each treatment
- Analysing trends within species between treatments

Monitoring

The Science Division did not have personnel available to undertake bird counts in 2003, therefore monitoring was contracted to Frank O'Connor, from Birds Australia, who used sight and sound to identify birds.

Preliminary Results and Discussion

Diurnal birds

Thirty-nine species of birds were recorded in the eight grids with 18 of these having 10 or more individuals (Table 1). There were no obvious differences between the treatments (shelterwood and gap release) and the controls. An average of 54 individuals and 23 species was recorded in the controls with an average of 44 individuals and 18 species and 48 individuals and 22 species recorded in the shelterwood and gap release treatments respectively (Fig. 1). The total number of species and individuals recorded in each treatment (control, shelterwood and gap release) is shown in Table 2.

Nine species were recorded as occurring in only one treatment (either control, shelterwood or gap release, see Table 1); however, none would be expected to be restricted to that treatment.

Records the Red-eared Firetail Finch *(Stagonoplura oculata)* are interesting in that in the northern forest it is largely restricted to riparian habitats, and both records of this species were adjacent to such habitats. The northern record at Lesley forest block was in the gap release grid and is near the extremity of its range (Abbott 1999). The other interesting species was the Rufous Tree-creeper *(Climactus rufa)*, which we did not record on any of the monitoring sites and according to Abbott (1999) it is "widespread but patchy and uncommon in the northern Jarrah forest". Similarly the Red-Winged Fairy-Wren *(Malurus elegans)* was recorded in the Occidental control site and provides a slight extension of its range as other records of this species are from Zamia, Reservoir and Ashendon forest blocks.

The density of the birds this year was similar to that recorded in the Kingston Study in a "low year". The Perth Hills sites had 9.9 birds/ha, and Kingston had 10.4 birds/ha. In the Wellington sites in 2002-3 15.5 birds /ha were recorded and in the Donnelly sites in 2001-2 only 5.8 birds/ha were recorded.

Table 1: Bird species and number of individuals recorded in the Perth Hills FORESTCHECK grids.

RAOU	Common Name	Scientific Name	Total	Control	Shelter-wood	Gap Release
34	Common Bronzewing	*Phaps chalcoptera*	2	2		
224	Wedge-tailed Eagle	*Aquila audax*	1			1
259	Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	1	1		
264	Forest Red-tailed Black Cockatoo	*Calyptorhynchus banksii naso*	11	7	2	2
266	Baudin's Cockatoo	*Calyptorhynchus baudinii*	2		1	1
289	Western Rosella	*Platycercus icterotis*	2	1		1
290	Red-capped Parrot	*Platycerus spurius*	11	7	4	
294	Australian Ringneck	*Platycerus zonarius*	11	5	5	1
322	Laughing Kookaburra	*Dacelo novaeguineae*	2	1	1	
326	Sacred Kingfisher	*Todiramphus sanctus*	2			2
344	Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	7	5	2	
361	Grey Fantail	*Rhipidura fuliginosa*	18	10	5	3
380	Scarlet Robin	*Petroica multicolor*	3	2	1	
394	Western Yellow Robin	*Eopsaltria griseogularis*	16	6	6	4
398	Golden Whistler	*Pachycephala pectoralis*	28	14	10	4
401	Rufous Whistler	*Pachycephala rufiventris*	4	1	2	1
408	Grey Shrike-thrush	*Colluricincla harmonica*	19	9	5	5
424	Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*	2		2	
463	Western Greygone	*Greygone fusca*	36	11	15	10
465	Weebill	*Smicrornis brevirostis*	1		1	
472	Western Thornbill	*Acanthiza inornata*	23	6	10	7
476	Broad-tailed (Inland) Thornbill	*Acanthiza apicalis*	25	8	11	6
488	White-browed Scrubwren	*Sericornis frontalis*	4	4		
532	Splendid Fairy-wren	*Malurus splendens*	2	1		1
538	Red-winged Fairy-wren	*Malurus elegans*	2	2		
549	Varied Sittella	*Daphoenositta chrysoptera*	6	5		1
565	Spotted Pardalote	*Pardalotus punctatus*	15	4	7	4
574	Silvereye	*Zosterops lateralis*	11	5	2	4
578	Western White-naped Honeyeater	*Melithreptus chloropsis*	11	4	5	2
592	Western Spinebill	*Acanthorhynchus superciliosus*	22	7	7	8
597	Brown Honeyeater	*Lichmera indistincta*	9	1	5	3
631	Yellow-winged (New Holland) honeyeater	*Phylidonyris novaehollandiae*	2	2		
638	Red Wattlebird	*Anthochaera carunculata*	10	4	3	3
651	Red-eared Firetail	*Stagonopleura oculata*	2	1		1
697	Grey Currawong	*Strepera veriscolor*	10	4	2	4
710	Western Little Wattlebird	*Anthochaera lunulata*	8	4	2	2
794	Carnaby's Cockatoo	*Calyptorhynchus latirostris*	1			1
930	Australian Raven	*Corvus coronoides*	14	8	2	4
976	Striated Pardalote	*Pardalotus striatus*	40	15	15	10
		Total Species	**39**	**33**	**27**	**28**
		Total Individuals	**396**	**167**	**133**	**96**

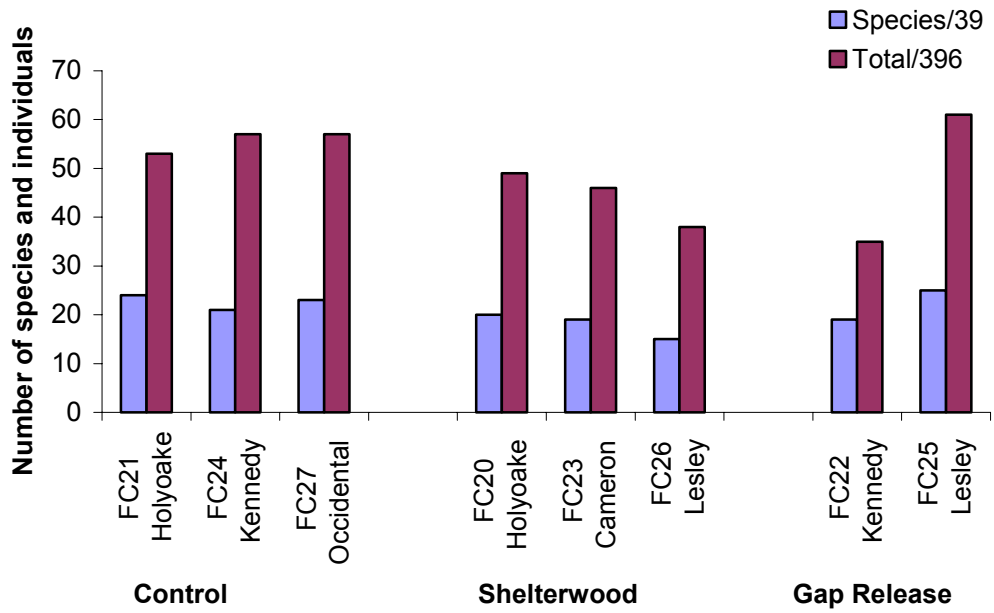


Figure 1. The number of bird species and individuals recorded in each FORESTCHECK grid in the Perth Hills.

Table 2. Total number of bird species and individuals recorded in each treatment in the Perth Hills.

	External Control	Shelterwood	Gap Release	Total
Species	33	27	28	39
Individuals	167	133	96	396

The Gray and Kingston studies have shown that bird species composition and numbers change as the understorey density and fuel age varies with time since logging and associated burning. These changes will continue for some considerable time and as we will only be monitoring these sites on a 5-6 year rotation it is important that the Gray and Kingston studies continue in order to document changes that do occur over time.

Nocturnal Birds (and mammals)

No surprises were encountered in the recording of nocturnal birds in this round of monitoring (Figs 2 and 3).

Boobook owls (*Ninox novaeseelandiae)* were recorded on all sites in both spring and autumn, as was expected for this, the true forest owl of the south-west forests. Masked owls (*Tyto novaehollandiae*) were recorded twice in autumn, in the control at Holyoake block near Dwellingup and at the Cameron block shelterwood site. These sites are similar to where Masked owls have been recorded in the other

FORESTCHECK sites at Donnelly and Wellington where farmland clearing is close by and provides a woodland type of habitat that is preferred by this species.

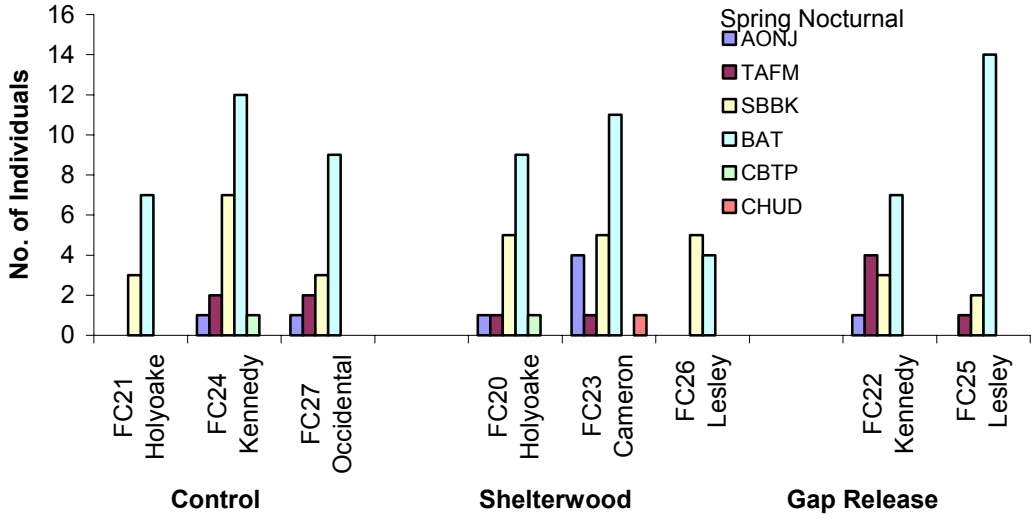


Figure 2. Nocturnal birds (and mammals) recorded in the spring on FORESTCHECK grids in the Perth Hills (AONJ = Australian owlet nightjar (*Aegotheles cristatus*), TAFM = tawny frogmouth (*Podargus strigoides*), SBBK = southern boobook owl (*Ninox novaeseelandia*), BAT = bat, CBTP = common brush tail possum (*Trichosurus vulpecular*), CHUD = chuditch (*Dasyurus geoffroii*).

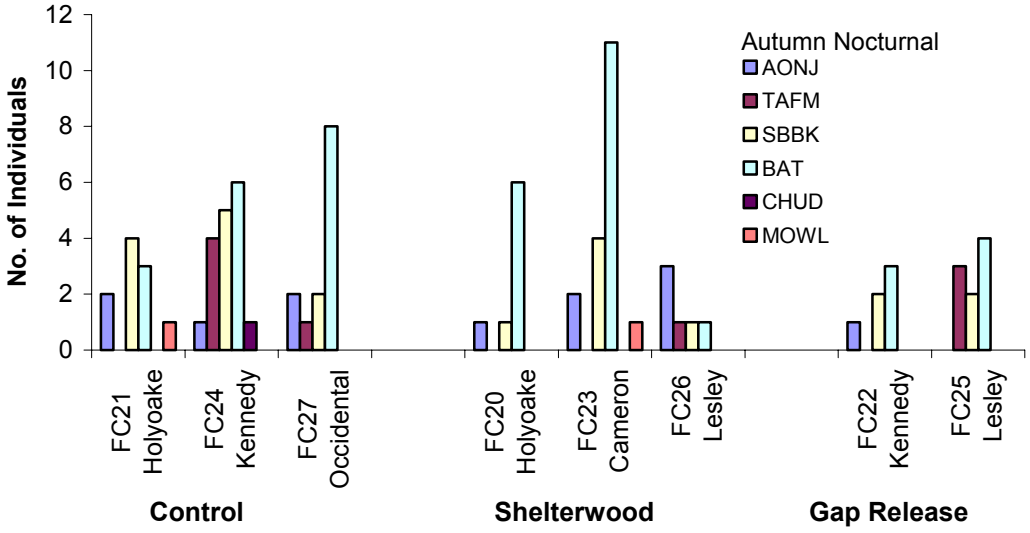


Figure 3. Nocturnal birds (and mammals) recorded in the autumn on FORESTCHECK grids in the Perth Hills (AONJ = owlet nightjar, TAFM = tawny frogmouth, SBBK = southern boobook owl, BAT = bat, CHUD = chuditch, MOWL = masked owl)

Owlet Nightjar (*Aegotheles cristatus*) and Tawny Frogmouth (*Podargus strigoides*) recording rates was similar to the other FORESTCHECK sites and are typical of the south-west forest.

Due to the large home ranges of owls it is not always possible to monitor nocturnal birds on a site basis and there is a need to monitor them on a landscape basis where treatments have taken place.

While undertaking the nocturnal bird surveys, a number of mammal species, including Chuditch, Brushtail Possum and a range of insectivorous bats, were also recorded (see Figs 2 and 3).

Specimen Processing
No bird specimens were processed in 2003-4.

Data Management
The database developed by Amanda Mellican has worked well and this keeps all FORESTCHECK bird data in the same format.

Reference

Abbott, I. (1999). The avifauna of the forests of south-west Western Australia: changes in species, composition, distribution, and abundance following anthropogenic disturbance. CALMScience Supplement 5: 1-176.

MAMMALS AND HERPETOFAUNA

G.L. Liddelow

Introduction

The object of recording mammals and herpetofauna in FORESTCHECK is to monitor the impacts of logging and associated burning on species status and abundance. This is to be achieved by:

- Trapping and recording the suite of medium- and small-sized mammals, reptiles and amphibians on each FORESTCHECK grid
- Recording the presence of small mammals in nest boxes placed within each grid
- Comparing species richness, abundance, sex ratios and trap percentages between treatments within and between FORESTCHECK sites

The species and abundance of feral animals is also recorded with the use of sand pads placed at regular intervals along pre-determined tracks and roads within each FORESTCHECK site.

Monitoring

Trapping at all eight grids was carried out in spring 2003 and autumn 2004. The program went according to plan and only one day of rain prevented checking of sand pads. The day of rain did not interfere with the pit trapping. Sheffield traps were again used in both spring and autumn and this will be the norm in the future for this program.

Voucher Specimens

45 individual specimens were lodged with the WA Museum and these included 7 species of skink, 1 snake, 2 species of gecko, 2 species of pygopod and 2 possibly 3 species of amphibians (Table 1).

Preliminary Results

Trapping

A total of 209 individuals were caught in the spring and autumn trapping sessions (Table 2) with 159 individuals being trapped in the spring and 50 in the autumn.

There were 8 mammals, 142 reptiles and 9 amphibians trapped in the spring and 15 mammals, 35 reptiles and no amphibians trapped in the autumn (Fig. 2).

The highest total number of captures occurred in the shelterwood treatement followed by the controls, with the lowest number occurring in the gap release treatment. Spring resulted in a far greater number of captures than autumn on all sites.

Table 1. Specimens from the Perth Hills FORESTCHECK grids that were lodged with the WA Museum

FC Field #	Museum #	Museum Name
FC100	154721	*Menetia greyii*
FC110	154717	*Ctenotus labillardieri*
FC111	154716	*Egernia napoleonis*
FC125	154718	*Ramphotyphlops australis*
FC126	154719	*Diplodactylus polyophthalmus*
FC127	154720	*Lerista distinguenda*
FC128	154722	*Heleioporus sp.*
FC101	154712	*Menetia greyii*
FC105	154708	*Lialis burtonis*
FC106	154709	*Morethia obscura*
FC107	154711	*Lerista distinguenda*
FC108	154703	*Hemiergis initialis*
FC109	154707	*Egernia napoleonis*
FC129	154714	*Crinia georgiana*
FC130	154715	*Crinia georgiana*
FC131	154710	*Morethia obscura*
FC102	154698	*Ramphotyphlops australis*
FC104	154700	*Christinus marmoratus*
FC112	154699	*Aprasia pulchella*
FC113	154701	*Ctenotus labillardieri*
FC114	154702	*Lerista distinguenda*
FC115	154704	*Morethia obscura*
FC116	154706	*Heleioporus inornatus*
FC132	154705	*Crinia georgiana*
FC133	154703	*Morethia obscura*
FC103		Specimen lost
FC117	154723	*Aprasia pulchella*
FC118	154724	*Diplodactylus polyophthalmus*
FC119	154727	*Hemiergis initialis*
FC120	154728	*Lerista distinguenda*
FC121	154725	*Morethia obscura*
FC134	154726	*Morethia obscura*
FC122	154697	*Lerista distinguenda*
FC123	154694	*Egernia napoleonis*
FC124	154695	*Ctenotus labillardieri*
FC135	154696	*Aprasia pulchella*
FC136	154685	*Morethia obscura*
FC137	154688	*Morethia obscura*
FC138	154687	*Lerista distinguenda*
FC139	154689	*Menetia greyii*
FC140	154686	*Egernia napoleonis*
FC141	154693	*Morethia obscura*
FC142	154690	*Ramphotyphlops australis*
FC143	154692	*Acritoscincus trilineatum*
FC144	154691	*Lerista distinguenda*

Table 2: The species and abundance of mammals, reptiles and amphibians recorded in traps on the Perth Hills FORESTCHECK sites in 2003-4.

Species	External Control		Shelterwood		Gap Release	
	Spring	Autumn	Spring	Autumn	Spring	Autumn
MAMMALS						
Antichinus flavipes				1		2
Cercartetus concinnus	1		3		1	
Dasyurus geoffroii		2		2		
Rattus rattus				1		
Trichosurus vulpecula vulpecula	3	5		2		
REPTILES[1]						
Acritoscincus trilineatum	1					
Aprasia pulchella	1		2		3	
Christinus marmoratus					2	
Ctenotus labillardieri	1		2		1	
Diplodactylus polyophthalmus	1			2		
Egernia napoleonis	3		5			
Hemiergis initialis	4		4			
Lerista distinguenda	24	2	26	6	17	3
Lialis burtonis	1					
Menetia greyii	5	5	8	7	2	2
Morethia linocellata			3		5	
Morethia obscura	5	2		1	4	1
Morethia sp.			1			
Parasuta gouldii		1				
Pogona minima	1			2		1
Ramphotyphlops australis	2		4		2	
Tiliqua rugosa			1			
Varanus rosenbergi					1	
AMPHIBIANS						
Crinia georgiana	2				2	
Heleioporus eyrei			2		1	
Heleioporus sp.			1		1	
TOTAL / 209	**55**	**17**	**62**	**24**	**42**	**9**

[1] Sightings of the common death adder (*Acanthophis antarticus*) were recorded on the Occidental control (FC27) and Lesley shelterwood (FC26) grids.

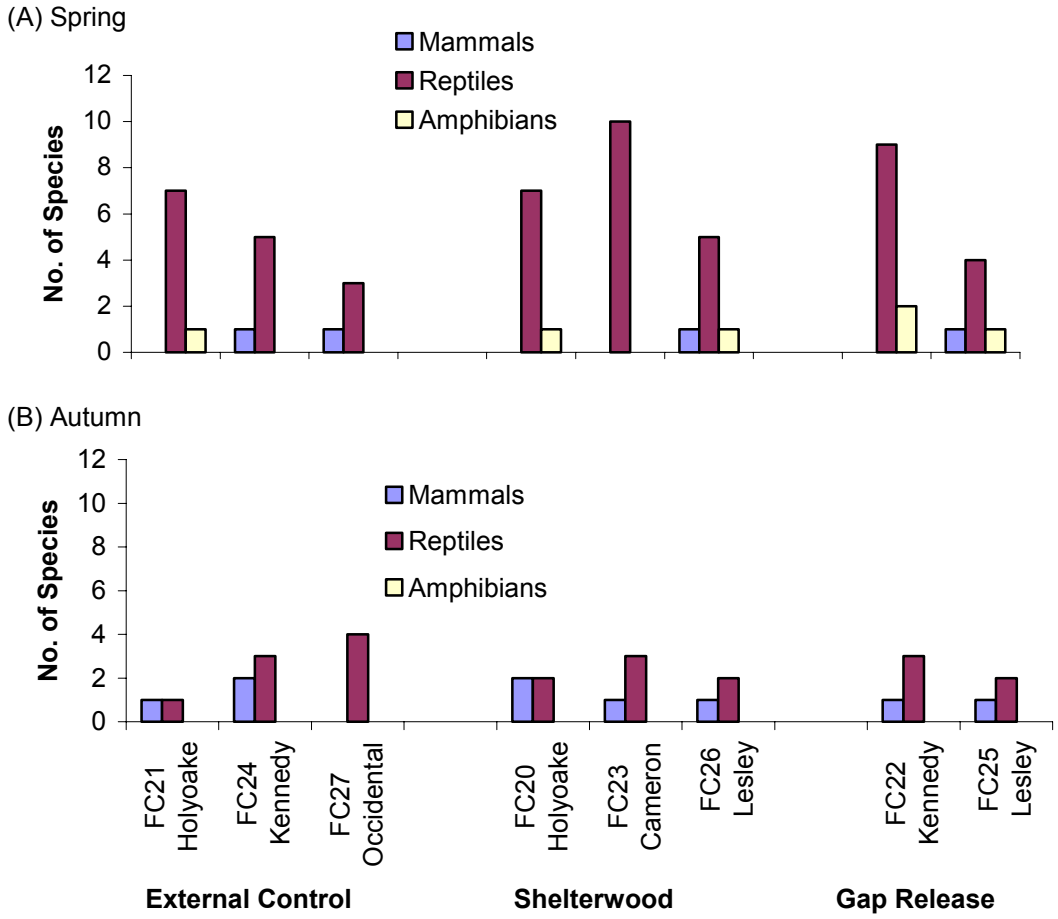


Figure 2. The number of individual mammals, reptiles and amphibians recorded in traps in spring (A) and autumn (B) on the Perth Hills FORESTCHECK sites

Pit trapping was the most successful method (Fig. 3) with all but 2 of the 177 reptiles trapped, all 9 frogs and 6 of the 23 mammals trapped in pits. Apart from 1 Mardo (*Antechinus flavipes*), all of the mammals caught in wire traps were possums and chuditch (Fig. 4).

Sandpads

As was the case last year, the sand pads were installed and monitored on a landscape scale with the pads at 1 km intervals over a distance of 52 km, and monitored in spring of 2003 and autumn 2004. This technique will be used at all future sites due the results from the first year of monitoring in Donnelly, where the pads were placed only at the grids and they did not give a true indication of activity over the area being monitored.

As we are mainly interested in monitoring the presence of feral animals on the sandpads, it was pleasing not to record any fox activity in either season. There was one dog recorded in both sessions and the presence of 4 pigs is of concern (Fig. 5).

Birds and kangaroos again accounted for the largest number of tracks recorded in both seasons and there was a large number of varanids (13) in spring (Fig. 5).

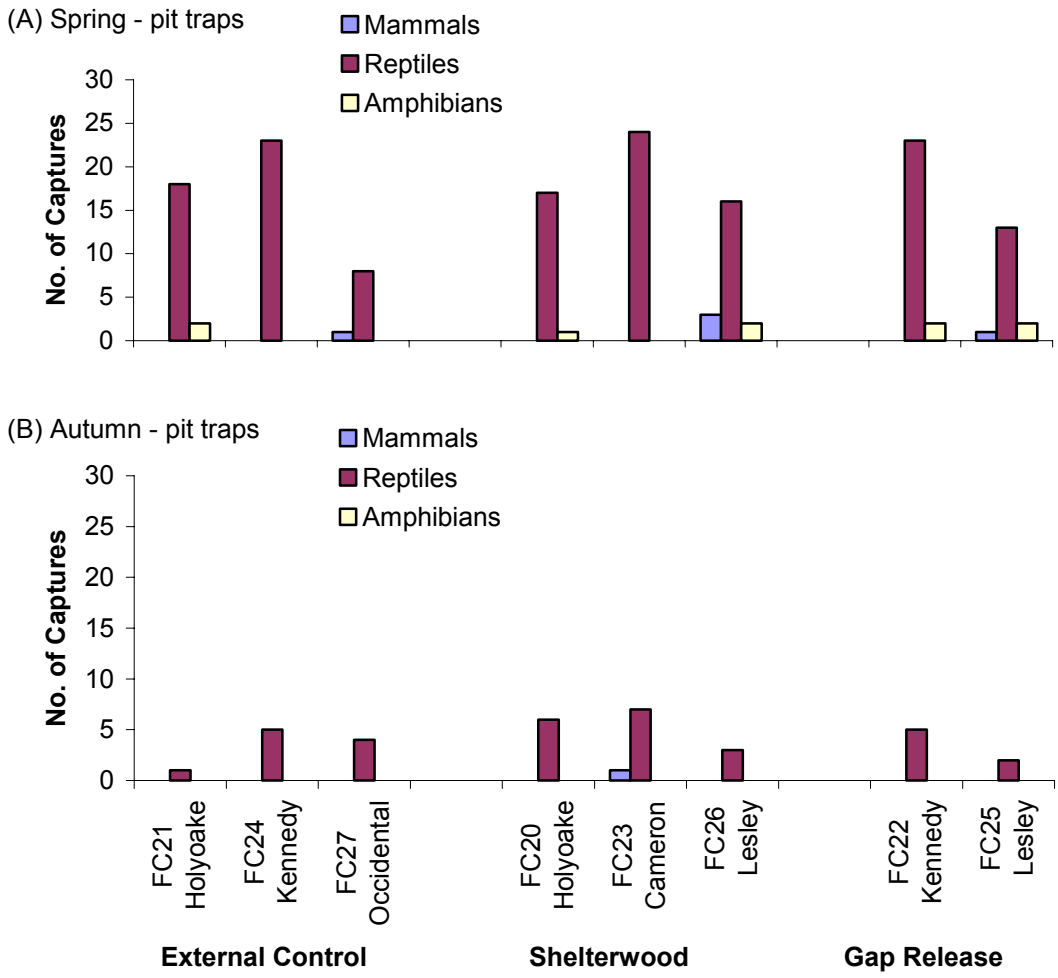


Figure 3. The number of individual mammals, reptiles and amphibians recorded in pit traps in the spring (A) and autumn (B) on the Perth Hills FORESTCHECK sites

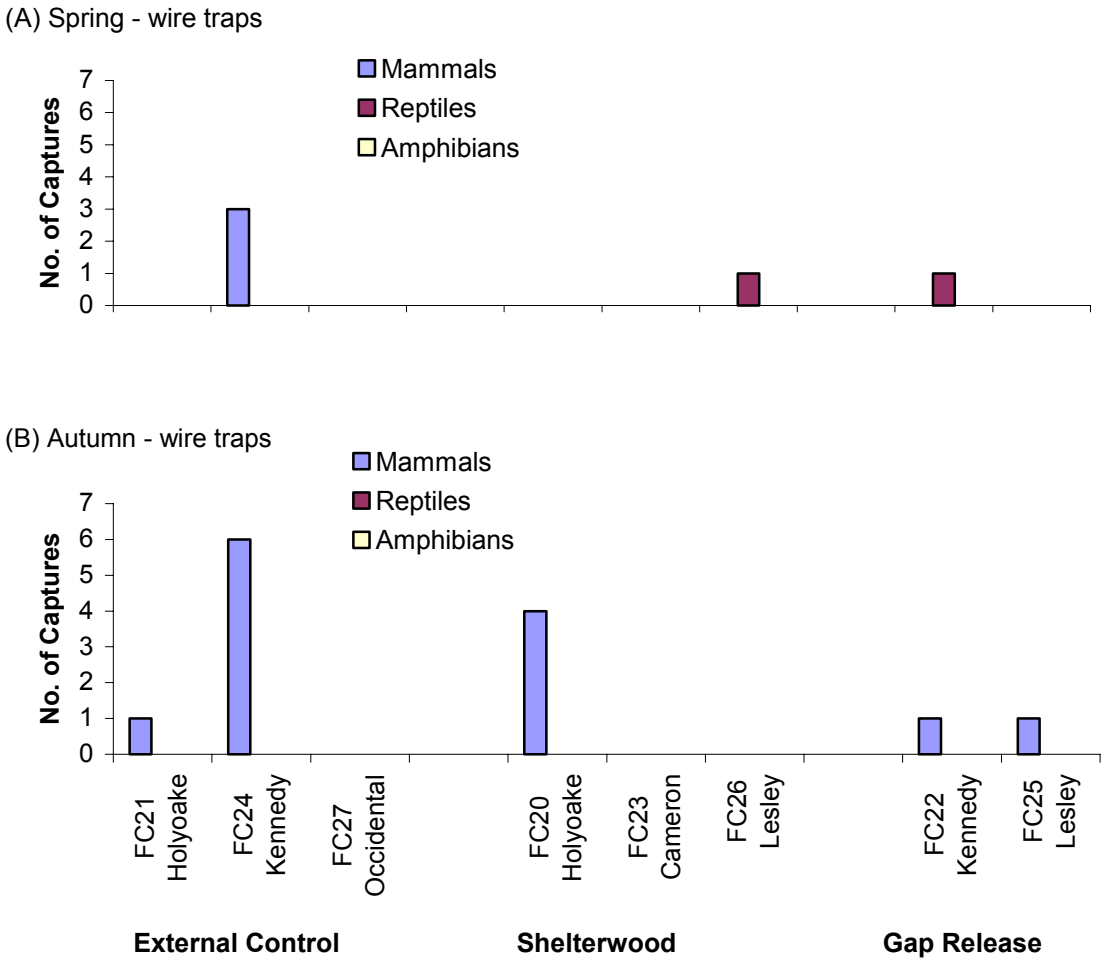


Figure 4. The number of individual mammals, reptiles and amphibians recorded in wire traps in the spring (A) and autumn (B) on the Perth Hills FORESTCHECK sites

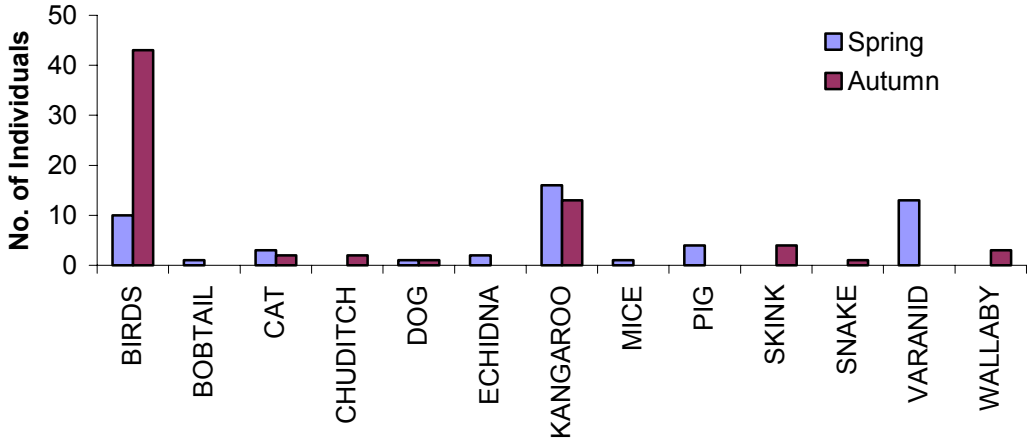


Figure 5. The number of individual animals, recorded on sandpads in the Perth Hills FORESTCHECK sites

Road Survey

The road surveys of macrovertebrates were undertaken on a landscape basis, with emphasis on differences between treatments combined and controls. The distance covered was approximately 50 km.

Figure 6 shows that Western Grey Kangaroos (*Macropus fuliginosus*) dominated the counts, with the treatments having a higher number recorded than in the controls. This is not surprising as the younger regrowth of the understorey plants provide a food base. If the controls were of a younger fire successional stage these numbers should be similar.

Western Brush Wallaby (*Macropus irma*) numbers were low, but this seems to be constant in the northern Jarrah forest. The numbers are too low to draw any conclusions about treatments and controls.

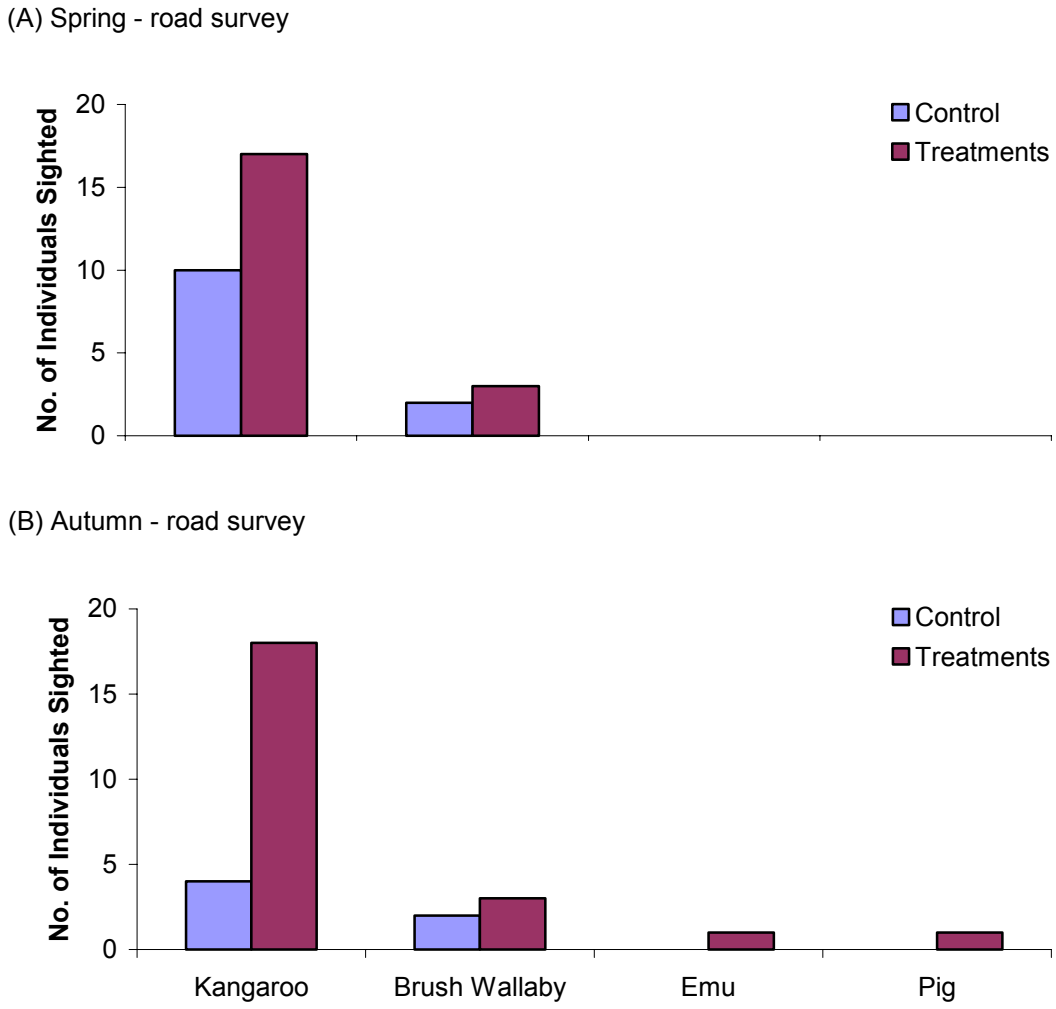


Figure 6. The number of individual animals, recorded during road surveys in the spring (A) and autumn (B) within the Perth Hills FORESTCHECK sites

Spotlighting

Except in Kingston and the Perup forest in the south or Batalling forest east of Collie, spotlight surveys result in few records. The surveys in this year's monitoring area were no different. A total of 4 Brushtail Possums were seen in the two seasons, along with 4 Kangaroos and 2 Tawny Frogmouths (Fig. 7). We know from trapping and the Nocturnal Bird Surveys that other species are present but were not located during this survey technique. A combination of techniques is necessary to ensure recording of all species present within a forest area.

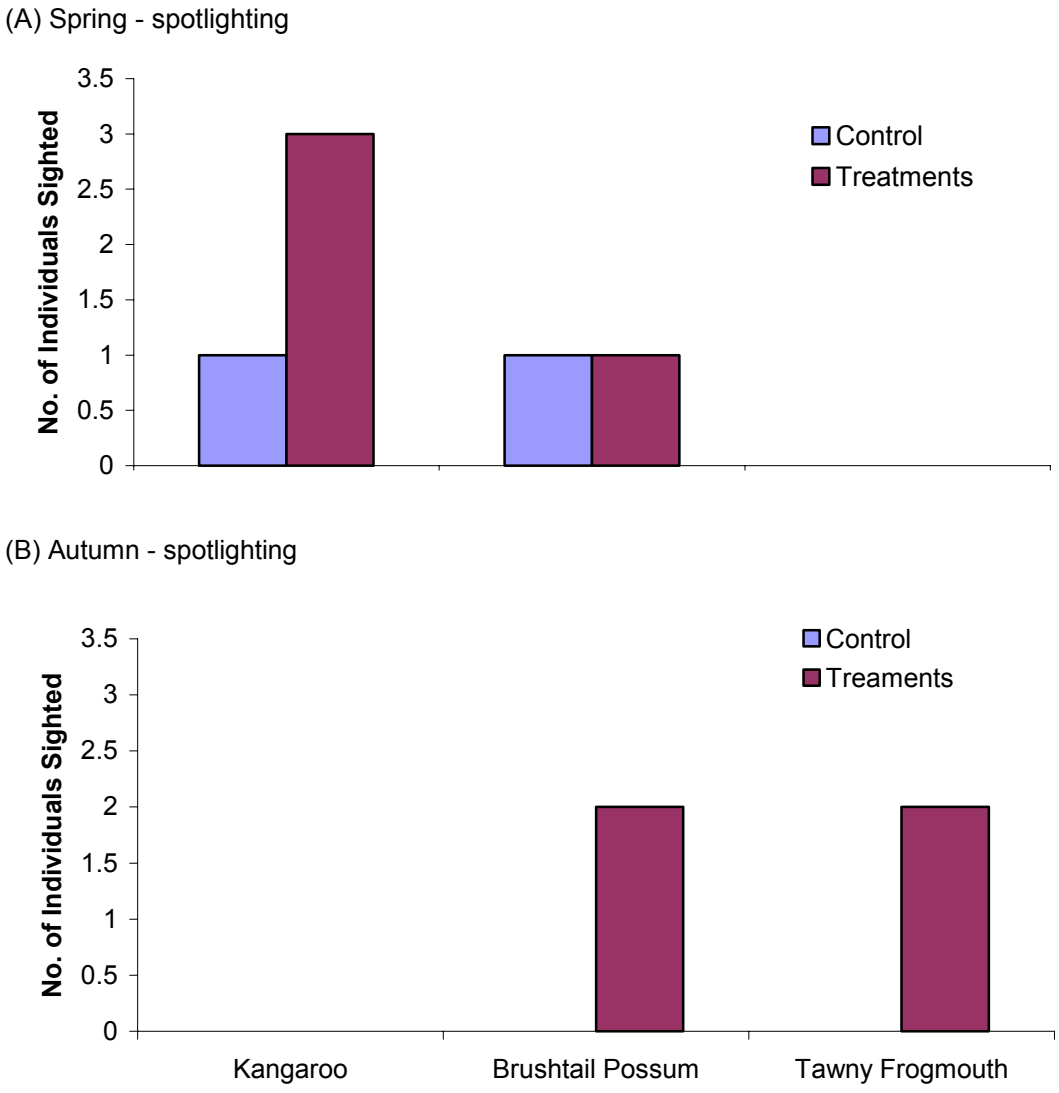


Figure 7. The number of individual animals, recorded during spotlight surveys in the spring (A) and autumn (B) within the Perth Hills FORESTCHECK sites.

Issues

No sampling method issues were encountered. All techniques are now finalized and no further alterations to the Operating Plan are foreseen.

DATA MANAGEMENT AND STORAGE

Amanda Mellican and Verna Tunsell

Introduction

We are responsible for entering the collected data into electronic format for Macro Vertebrates, Diurnal Birds, Nocturnals, Mammals and Herpetofauna, Vascular Plants, Fungi and Cryptogams, and the collected voucher specimens (Flora, Cryptogams and Fungi), and obtaining the electronic data from the remaining groups.

Data Entry

An excel program applying Visual Basic was developed for each of the survey sheets. There are two parts in the program: Data entry and Data correction. The aim is to save time and to reduce typing errors during the data entry process.

As an example, in the Trapping Field Data Sheet, there are 12 fields for the data entry (Location, Treatment, Personnel, Date, Trap point, Species, Weight, Tag #1, Tag #2, Sex, Breeding Condition and Comments). Places of location, names of treatment, names of personnel and gender are known and they are created as drop-down lists. As for the species, common species name was pre-listed in the program. Date as in Day, Month and Year (from 2001 to 2010) was also created as drop down lists. Thus, location, treatment and personnel are only entered once for all the records for a particular data sheet. If there was nothing to comment on, then the program will automatically record in the Comments section as "No comment". If any one of the fields is missing or left as blank, an error message is given and the data would not be inserted into data file until all the fields are selected or filled. Species code, scientific name and common name are also automatically recorded into the data file depending upon the selected common species. Record number is automatically written into the data file.

To date all the survey sheets have been completed by Verna Tunsell. A Metadata form as shown in Appendix A is also completed.

Data Validation

Amanda Mellican validates the data for all the groups that we are responsible for. The validation date will be recorded in the metadata form. Then a DESCRIPTIONS file (which indicates the lists of an individual field, and codes and descriptions of an individual field), and the validated DATA file will be sent to the leader of the individual group.

Data Storage

All the individual sampling data will be saved and backed up as individual files on the network drive. The data are saved and secured since the network drive is backed up at COB everyday. The final version of the validated data will be printed and kept in a filing cabinet and eventually archived with the library at the completion of the project.

Collected Specimens
The 209 Vascular Plants, 185 Fungi and 411 Cryptogam specimens collected during the period, have been identified (as far as possible), prepared, and lodged at the WA Herbarium. The fungi collection is housed at the Tony Annels Herbarium in Manjimup to enable further work to be carried out.

Each specimen is allocated its own barcode so that each is unique and is readily located by electronic means or by physical means as required.

Vascular plant specimens are pressed and dried, then mounted, with specialized herbarium tape, on card, and placed in separate folders.

Cryptogams are dried (friable specimens are stabilised with emulsion), placed on a card with adhesive to keep the specimen together (Mosses are washed prior to drying to remove debris). The specimens are then secured in cardboard boxes to prevent damage.

Fungi specimens are also dried and placed into greaseproof paper, then into zip lock bags, those small enough then go into similar boxes to cryptogams, the larger remain unboxed.

The specimens that have been lodged at the WA Herbarium have also been data based on the Max system and submitted electronically. Max was developed by Simon Woodman and Paul Gioia and is used as the primary means of submitting specimen information to the Herbarium. There are many facets to Max; the sections used for FORESTCHECK are the collecting book, specimen tables and reporting facilities. (Examples attached, see Appendix B).

Appendix A – Example of Metadata Form

Group Name →

Leader →

Contact Officer →

No	File Name	File Size (KB)	File Type	Date (completed)	Name of Data Entry Person	Validated Date

Appendix B: Example of Flora Labels generated in MAX

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Diuris aff. ***corymbosa*** Lindl.

Orchidaceae

Identified by:

Tuberous perennial dwarf shrub, height to 40 cm, width to 5 cm: flowers yellow/red-brown. State forest; hill slope: brown to grey clayey sand with 2% laterite outcrops. Soil pH 6-6.5 Occasional. Forest with associated Eucalyptus marginata, Banksia grandis and Allocasuarina fraseriana. Population flowering: 20%

Loc.: Plot FC26 Lesley forest block, W of Poison Gully, N off Brookton Highway,

Lat. 32° 9' 8"S **Long.** 116° 13' 15"E (WGS84)

Coll. R J Cranfield FC462 **Date:** 06/10/2003

Voucher: Forestcheck monitoring program.

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Trymalium ledifolium Fenzl

Rhamnaceae

Identified by:

Open-compact erect perennial dward shrub, Height 40 cm Width 35 cm; flowers cream. State forest; hill slope: brown to grey clayey sand with 2% laterite outcrops. Soil pH 6-6.5 Locally abundant. Forest with associated Eucalyptus marginata, Banksia grandis and Allocasuarina fraseriana. Population flowering: 70%.

Loc.: Plot FC26 Lesley forest block, W of Poison Gully, N off Brookton Highway,

Lat. 32° 9' 8"S **Long.** 116° 13' 15"E (WGS84)

Coll. R J Cranfield FC464 **Date:** 06/10/2003

Voucher: Forestcheck monitoring program.

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Kennedia coccinea Vent.

Papilionaceae

Identified by:

Climbing perennial shrub, flowers red. State forest; hill slope: brown to grey clayey sand with 2% laterite outcrops. Soil pH 6-6.5 Frequent. Forest with associated Eucalyptus marginata, Banksia grandis and Allocasuarina fraseriana. Population flowering: 50%.

Loc.: Plot FC26 Lesley forest block, W of Poison Gully, N off Brookton Highway,

Lat. 32° 9' 8"S **Long.** 116° 13' 15"E (WGS84)

Coll. R J Cranfield FC463 **Date:** 06/10/2003

Voucher: Forestcheck monitoring program.

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Lechenaultia biloba Lindl.

Goodeniaceae

Identified by:

Open erect perennial dwarf shrub, height 30 cm, width 40 cm; flowers blue. State forest; hill slope: brown to grey clayey sand with 2% laterite outcrops. Soil pH 6-6.5 Frequent Forest with associated Eucalyptus marginata, Banksia grandis and Allocasuarina fraseriana. Population flowering: 30%

Loc.: Plot FC26 Lesley forest block, W of Poison Gully, N off Brookton Highway,

Lat. 32° 9' 8"S **Long.** 116° 13' 15"E (WGS84)

Coll. R J Cranfield FC465 **Date:** 06/10/2003

Voucher: Forestcheck monitoring program.

Appendix C: Example of Cryptogam Label generated in Max

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Xanthoparmelia sp.

Parmeliaceae

Identified by: R.J. Cranfield 18/08/2004

Lichen: active growth phase; thallus foliose, grey green; growing in exposed and sheltered wet positions on stone on ground layer. Chemistry: Cortex K+ yellow; Medulla K-. Hill; bare to littered gravelly moist sandy clay soil over laterite with 1-2 cm of new litter; contour range 300; erosion present due to logging. Frequent on occasional sites. Forest with three life form density classes, with associated vegetation Eucalyptus marginata, Allocasuarina fraseriana and Banksia grandis. Floristic richness 51-100 species with few to moderately abundant seedlings and saplings.

Loc.: Forest monitoring plot 25, Lesley forest block, approximately 400 m N from Brookton Highway,

Lat. 32° 10' 51.1"S **Long.** 116° 15' 17.1"E (WGS84)

Coll. R.J. Cranfield 20080 **Date:** 26/07/2004

Voucher: Forestcheck Monitoring Program.

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Genus sp.(algae)

Algae

Identified by: R.J. Cranfield 17/08/2004

Algae: active growth phase; red; growing in wet positions on dead and decaying wood in shrub layer. Hill; bare to littered gravelly moist sandy clay soil over laterite with 1-2 cm of new litter; contour range 300; erosion present due to logging. Occasional on isolated sites. Forest with three life form density classes, with associated vegetation Eucalyptus marginata, Allocasuarina fraseriana and Banksia grandis. Floristic richness 51-100 species with few to moderately abundant seedlings and saplings.

Loc.: Forest monitoring plot 25, Lesley forest block, approximately 400 m N from Brookton Highway,

Lat. 32° 10' 51.1"S **Long.** 116° 15' 17.1"E (WGS84)

Coll. R.J. Cranfield 20081 **Date:** 26/07/2004

Voucher: Forestcheck Monitoring Program.

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Campylopus introflexus

Dicranaceae

Identified by: R.J. Cranfield 23/08/2004

Moss: active growth phase; growing in exposed and sheltered wet positions on organic material in ground layer. Hill; bare to littered gravelly moist sandy clay soil over laterite with 1-2 cm of new litter; contour range 300; erosion present due to logging. Numerous on frequent sites. Forest with three life form density classes, with associated vegetation Eucalyptus marginata, Allocasuarina fraseriana and Banksia grandis. Floristic richness 51-100 species with few to moderately abundant seedlings and saplings.

Loc.: Forest monitoring plot 25, Lesley forest block, approximately 400 m N from Brookton Highway,

Lat. 32° 10' 51.1"S **Long.** 116° 15' 17.1"E (WGS84)

Coll. R.J. Cranfield 20082 **Date:** 26/07/2004

Voucher: Forestcheck Monitoring Program.

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Genus sp.(algae)

Algae

Identified by: R.J. Cranfield 18/08/2004

Algae: active growth phase; green terrestrial; growing in sheltered wet positions on decaying wood in ground and shrub layer. Hill; bare to littered gravelly moist sandy clay soil over laterite with 1-2 cm of new litter; contour range 300; erosion present due to logging. Frequent on occasional sites. Forest with three life form density classes, with associated vegetation Eucalyptus marginata, Allocasuarina fraseriana and Banksia grandis. Floristic richness 51-100 species with few to moderately abundant seedlings and saplings.

Loc.: Forest monitoring plot 25, Lesley forest block, approximately 400 m N from Brookton Highway,

Lat. 32° 10' 51.1"S **Long.** 116° 15' 17.1"E (WGS84)

Coll. R.J. Cranfield 20083 **Date:** 26/07/2004

Voucher: Forestcheck Monitoring Program.

Appendix D: Example of Fungi label generated in Max

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Amanita sp. "small robust, yellow-buff, bulbous base"

Amanitaceae

Identified by:

Fruiting on soil in litter.
Cap: to 4.6 cm, planar-convex, pale cinnamon, surface slightly tacky. Margin curves inwards. Raggedly appendiculate. Margin smooth. White scraps of universal veil.
Gills: cream, convex, margin fimbriate (x10), close, two sets of lamellulae. Gills under hang cap margin.
Stipe: slender, sturdy, 6 mm wide at apex to 1 cm at base (bases at start of volva), to 6.6 long including volva (to 2.8 cm long x 1.4 cm wide) white to creamy. Fragile ring high up under gills, zone of powdery scales beneath ring. Volva marginate, bulbous with scraps of tissue at margin.
Odour: hot, peppery. Plain: bare gravelly moist loose weedy brown clay loam over laterite with 2% outcropping; new litter to 5 cm deep.

Loc.:

Lat. 34° 5' 20"S **Long.** 116° 22' 0"E (WGS84)

Coll. R.M. Robinson, R.H. Smith FC592 **Date:** 14/06/2004

Voucher:

PERTH 6640184

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Marasmius crinisequi

Tricholomataceae

Identified by:

Fruiting on leaves. Plain: bare gravelly moist loose weedy brown clay loam over laterite with 2% outcropping; new litter to 5 cm deep. Forest (shelterwood) with associated Eucalyptus marginata, Corymbia calophylla, Pteridium esculentum, Macrozamia riedlei, and Persoonia longifolia.

Loc.: Forest Check Monitoring Plot 3, Tinkers Flat Road, 800 m S of Kingston Road, Kingston Forest Block,

Lat. 34° 5' 20"S **Long.** 116° 22' 0"E (WGS84)

Coll. R.M. Robinson, L. McGurk. FC593 **Date:** 14/06/2004

Voucher: Forestcheck Monitoring Program.

PERTH 6640176

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Postia peliculosa

Fungi

Identified by:

Fruiting on Eucalyptus marginata. Plain: bare gravelly moist loose weedy brown clay loam over laterite with 2% outcropping; new litter to 5 cm deep. Forest (shelterwood) with associated Eucalyptus marginata, Corymbia calophylla, Pteridium esculentum, Macrozamia riedlei, and Persoonia longifolia.

Loc.: Forest Check Monitoring Plot 3, Tinkers Flat Road, 800 m S of Kingston Road, Kingston Forest Block,

Lat. 34° 5' 20"S **Long.** 116° 22' 0"E (WGS84)

Coll. R.M. Robinson, L. McGurk. FC594 **Date:** 14/06/2004

Voucher: Forestcheck Monitoring Program.

PERTH 6640168

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Dermocybe clelandii (yellow mycelium, glutinous cap)

Cortinariaceae

Identified by:

Fruiting in litter on ground. Plain: bare gravelly moist loose weedy brown clay loam over laterite with 2% outcropping; new litter to 5 cm deep. Forest (shelterwood) with associated Eucalyptus marginata, Corymbia calophylla, Pteridium esculentum, Macrozamia riedlei, and Persoonia longifolia.

Loc.: Forest Check Monitoring Plot 3, Tinkers Flat Road, 800 m S of Kingston Road, Kingston Forest Block,

Lat. 34° 5' 20"S **Long.** 116° 22' 0"E (WGS84)

Coll. R.M. Robinson, L. McGurk. FC595 **Date:** 14/06/2004

Voucher: Forestcheck Monitoring Program.

PERTH 6640141

Appendix E: Example of Specimen Table generated in Max

28/10/2004 **2004 Vegetation List**

Taxon Name	TaxonID	SpCode	Life Form	Life Style	Fire Respo
Adenanthos barbiger	14970	ADEBAR	S	P	B2
Acacia browniana	3247	ACABRO	S	P	A1
Acacia browniana var. *browniana*	11731	ACABROBR	S	P	A1
Acacia celastrifolia	3254	ACACEL	S	P	A1
Acacia drummondii	3311	ACADRU	S	P	A1
Acacia drummondii subsp. *drummondii*	11661	ACADRUDR	S	P	A1
Acacia extensa	3331	ACAEXT	S	P	A1
Acacia huegelii	3374	ACAHUE	S	P	A1
Acacia nervosa	3454	ACANER	S	P	A1
Acacia pulchella	3502	ACAPUL	S	P	A1
Acacia urophylla	3591	ACAURO	S	P	A1
Adenanthos barbiger	14970	ADEBAR	S	P	B2
Agrostocrinum scabrum	1261	AGRSCA	G	P	B3
* *Aira cupaniana*	185	AIRCUP	GR	A	A1
Allocasuarina fraseriana	1728	ALLFRA	T	P	B1
Amphipogon amphipogonoides	194	AMPAMP	DS	P	B2
Amperea ericoides	4585	AMPERI	DS	P	B2
Amphipogon strictus	199	AMPSTR	GR	P	B3
Astroloma ciliatum	6323	ASTCIL	DS	P	B2
Astroloma pallidum	6334	ASTPAL	DS	P	B2
Austrodanthonia caespitosa	17950	AUSCAE	GR	P	B3
Baeckea camphorosmae	5336	BAECAM	S	P	B2
Banksia grandis	1819	BANGRA	T	P	A2
Billardiera floribunda	3157	BILFLO	V	P	A1
Billardiera variifolia	3165	BILVAR	V	P	A1
Boronia crenulata	4413	BORCRE	DS	P	A1
Boronia denticulata	4416	BORDEN	DS	P	A1
Boronia ovata	4432	BOROVA	DS	P	A1
Boronia spathulata	4441	BORSPA	S	P	B2
Bossiaea aquifolium subsp. *aquifolium*	14396	BOSAQUAQ	S	P	A1
Bossiaea eriocarpa	3710	BOSERI	S	P	A1
Bossiaea ornata	3714	BOSORN	S	P	A1
Brachyscome iberidifolia	7878	BRAIBE	H	A	A1
Burchardia umbellata	1387	BURUMB	G	P	B3
Caesia micrantha	1276	CAEMIC	G	P	B3
Calytrix amethystina	5438	CALAME	G	P	B3
Caladenia flava	1592	CALFLA	G	P	B3
Caladenia flava subsp. *flava*	15348	CALFLAFL	G	P	B3
Caladenia latifolia	1599	CALLAT	G	P	B3
Calytrix leschenaultii	5465	CALLES	S	P	A1
Caladenia reptans	1613	CALREP	G	P	B3
	-44	CALSP.	G	P	B3
Chamaescilla corymbosa	1280	CHACOR	G	P	B3
Chorizema nanum	12765	CHONAN	DS	P	A1
Chorizema rhombeum	3761	CHORHO	DS	P	A1
Clematis pubescens	2929	CLEPUB	V	P	A1
Comesperma calymega	4550	COMCAL	DS	P	B2
Conostylis aculeata	1418	CONACU	DS	P	B3
Conostylis setigera	1454	CONSET	DS	P	B3
Corymbia calophylla	17104	CORCAL	T	P	A2
Corynotheca micrantha	1285	CORMIC	S	P	B3
Cyathochaeta avenacea	768	CYAAVE	Z	P	B3
Cyanicula gemmata	15114	CYAGEM	G	P	B3

* = Alien species

Appendix F: Example of File Report generated in Max showing unique bar code allocated to each specimen**.**

Example of Fungi report showing unique barcode number

COLLECT_NO	SHEETNO	FAMILY	GENUS	SPECIES
FC592	6640184	Amanitaceae	Amanita	sp. "small robust, yellow-buff, bulbous base"
FC593	6640176	Tricholomataceae	Marasmius	crinisequi
FC594	6640168	Fungi	Postia	peliculosa
FC595	6640141	Cortinariaceae	Dermocybe	clelandii (yellow mycelium, glutinous cap)
FC596	6640133	Fungi	Truffle	"pink gleba"
FC597	6640125	Fungi	Truffle	"black gleba"
FC598	6640117	Cortinariaceae	Cortinarius	sp. "viscid - pink"
FC599	6640109	Crepidotaceae	Crepidotus	sp. "rusty brown suede"
FC600	6640265	Tricholomataceae	Clitocybe	sp. "grey robust"
FC601	6640257	Cortinariaceae	Cortinarius	sp."glutinous cap/rooting stem"
FC602	6640249	Cortinariaceae	Cortinarius	sp."yellow with orange brown fibrils"
FC603	6640230	Tricholomataceae	Mycena	sp."light brown striate/white stems, on wood"
FC604	6640222	Pluteaceae	Pluteus	lutescens
FC605	6640214	Boletaceae	Boletus	sp."bown/yellow pores which stain blue"
FC606	6640206	Stereaceae	Stereum	illudens
FC607	6640192	Stereaceae	Stereum	sp. "purple margin - algae"
FC608	6640362	Crepidotaceae	Crepidotus	sp."small brown"
FC609	6640354	Tricholomataceae	Resupinatus	cinerascens
FC610	6640346	Tricholomataceae	Mycena	sp. "small buff on wood - bleach"
FC611	6640338	Fungi	Polypore	"white resupinate"
FC612	6640311	Tricholomataceae	Mycena	"austrocapillaris" (bleach)
FC613	6640303	Cortinariaceae	Dermocybe	sp. "small olive"
FC614	6640281	Tricholomataceae	Mycena	sp. "brown-grey, on wood"
FC615	6640273	Boletaceae	Boletus	sp."red-brown/golden yellow - intense blue stain"
FC616	6640443	Cortinariaceae	Dermocybe	clelandii (yellow mycelium)
FC617	6640435	Cortinariaceae	Cortinarius	sp."orange yellow"
FC618	6640427	Ramariaceae	Ramaria	sp. "orange-red, yellow stems"
FC619	6640419	Fungi	Agaric	"viscid buff, long stem"
FC620	6640397	Pezizaceae	Peziza	tenacela
FC621	6640389	Otideaceae	Pulvinula	archerii
FC622	6640370	Pezizaceae	Peziza	"praetervisa"
FC623	6640532	Strobilomycetaceae	Tylopilus	sp."yellow"
FC624	6640524	Clavariaceae	Clavulinopsis	sp. "grey-brown"
FC625	6640516	Tricholomataceae	Panellus	sp. "soft brown"
FC626	6640508	Fungi	Polypore	"small on waterbush"
FC627	6640494	Fungi	Agaric	"yellow brown - moist"
FC628	6640486	Strobilomycetaceae	Tylopilus	sp."yellow"
FC629	6640478	Fungi	Agaric	"yellow brown - moist"
FC630	6640451	Strobilomycetaceae	Tylopilus	sp."yellow"
FC631	6640613	Cortinariaceae	Cortinarius	sp. "fawn brown"
FC632	6640605	Cortinariaceae	Cortinarius	fibrillosus
FC633	6640591	Russulaceae	Russula	persanguinea (white stem)
FC634	6640583	Entolomataceae	Entoloma	sp. "tall, grey-brown"
FC635	6640575	Lentinellaceae	Lentinellus	sp. "brown cap, saw-toothed gills"
FC636	6640567	Tricholomataceae	Clitocybe	semi occulta "large"
FC637	6640559	Tricholomataceae	Mycena	sp. "dark brown on burnt ground"
FC638	6640540	Pezizaceae	Peziza	tenacela
FC639	6640702	Coprinaceae	Psathyrella	sp.
FC640	6640699	Pezizaceae	Peziza	"praetervisa"
FC641	6640680	Otideaceae	Anthracobia	muelleri
FC642	6640672	Fistulinaceae	Fistulina	hepatica

* = Alien species