REPORT OF PROGRESS 2008-09

FOREST CHECK

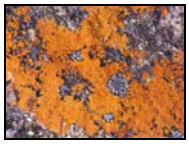
Department of Environment and Conservation

Science Division


Reptiles


Fungi


Invertebrates


Lichens


Mammals


Birds


Flora

Cover photos: *Main photo*: veteran jarrah tree at the Tumlo external control, *above right*: examining fungi in the field and *centre right*: an un-named species of *Lepiota*.

Produced by the Department of Environment and Conservation, Kensington, Western Australia, January 2010

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This report highlights preliminary results for FORESTCHECK monitoring, determined by basic analysis and field observation, for the year 2008-09. This and previous FORESTCHECK Annual Reports should not be quoted or used as final results for the FORESTCHECK program. Publications based on detailed analyses using comprehensive statistical methods are published on a 5-year basis. All FORESTCHECK publications and reports are available on the DEC web site at www.dec.wa.gov.au .

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EXECUTIVE SUMMARY

The first round of monitoring all 48 FORESTCHECK grids was completed in 2006. The second round of monitoring commenced in 2008 and this report covers the second session of monitoring at the nine Wellington grids located in jarrah forest approximately 20 km north of Collie. These grids were initially established in 2002 and monitored in 2002-03. This report, and previous reports, can be viewed and downloaded from the Department of Environment and Conservation website at www.dec.wa.gov.au .

The monitoring grids at Wellington are all located in the Dwellingup 1 vegetation complexes in the central region of the jarrah north-west ecosystem. Dwellingup 1 is characterised by an open forest dominated by *Eucalyptus marginata* sub sp. *marginata* and *Corymbia calophylla* located on lateritic uplands in mainly humid and sub-humid zones. The external reference grids are situated in uncut forest located in national park and state forest, the shelterwood and gap release treatment grids are in forest that was harvested during the period 1992 to 1997.

Knowledge regarding jarrah forest biodiversity and ecology continues to increase as the second round of FORESTCHECK monitoring proceeds. While the results presented here are from a preliminary analysis, highlights from the 2008-09 results and observations from comparisons with data from the same grids in 2002-03 include:

- Fire is an important agent of disturbance in jarrah forest and tree fall following prescribed fires had a significant effect on the basal area of some grids.
- Mean annual increments in the three gap release grids at Wellington were similar to those reported for gap release grids in Donnelly District, providing further evidence that gap release harvesting has generally resulted in stands that are well stocked and have good tree growth potential.
- Coarse woody debris (CWD) volume increases with the intensity of the most recent harvest, with the most intensive harvest treatment (gap release) having the highest volumes of CWD. A substantial proportion (34%) of CWD on the recently harvested treatments is residue from timber harvesting.
- Important and common mycorrhizal fungi species were either not recorded or under represented at Wellington in 2009 compared to 2003 and this was reflected in the mean species richness and abundance of macrofungi recorded on soil being markedly less in 2009 than in 2003.
- Some successional trends are becoming evident within the cryptogam flora.
- Species richness and abundance of plants has not been affected by silvicultural treatments.
- Sixty eight percent of invertebrate species recorded in 2008-09 were not captured in the previous 2002-03 sample. A significant increase in Isopods and Helena gum moth abundance was recorded in 2008-09. This is attributed to seasonal (weather) variation.
- An increase in the density of understory vegetation with time since regeneration and fire is likely responsible for the decrease in numbers of splendid fairy-wren and western thornbill and an increase in red-winged fairy-wren and white-breasted robin records in 2008 compared to 2003.
- Despite the area being bated under the Western Shield program, mammal numbers were down at all sites in 2008 compared to 2003.
- The number of undescribed species, especially macrofungi and invertabrates, recorded in FORESTCHECK monitoring continued to increase in 2008-09.

The commitment and professionalism of the FORESTCHECK team is to be commended. In 2009-10 monitoring is being conducted in grids established in 2003 in the Perth Hills district.

Dr Neil Burrows
Director, Science Division

January 2010

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 monitoring activities completed in the central north-west jarrah forest in the Wellington District during the 2008-09 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 provides funding for FORESTCHECK that is only 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[1] and is included as an operational program in the current Forest Management Plan 2004-2013[2]. 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 and adaptive management is recognized as an appropriate strategy for managing under conditions of uncertainty and change.

The Science Division of the Department of Environment and Conservation 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 Environment and Conservation, 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 the Department's website at www.dec.wa.gov.au .

Monitoring strategy

Between 1995 and 2004 timber harvesting in jarrah forests was 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.

[1] Codd, M. 1999. Forest management Plans 1994-2003: Mid-Term EPA Report on Compliance
[2] Conservation Commission of Western Australia.2004. Forest management plan 2004-2013. Conservation Commission of Western Australia. 144p + maps.

Silvicultural guidelines were revised in conjunction with the preparation of the Forest Management Plan (2004-2013) and are now available as SFM Guideline No. 1(CALM 2004[3]).

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.

FORESTCHECK sites have been established at a number of locations throughout the jarrah forest, stratified according to recognized ecological gradients of rainfall, evapo-transpiration and soil fertility. Forest ecosystem mapping (Mattiske and Havel 1998[4], 2000[5]) 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 have been established in forest subject to the following treatments:

(1) gap release,
(2) shelterwood (or selective cut),
(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.

At each location, grids are 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 are always present in the one locality and occasionally, external reference forest has been located some distance from their harvested counterparts. Also, 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.

Methodology

Monitoring of biodiversity is based on a sampling grid (see Fig. 1). The main grid is 200 m x 100 m, with a central area of 100 m x 100 m. Four 30 m x 30 m vegetation sample plots are located external to and adjacent each corner of the central area.

A range of ecosystem attributes are monitored on each grid 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

[3] CALM 2004. Silvicultural practice in the jarrah forest. Dept. CALM, SFM guideline No. 1.
[4] Mattiske, E.M. and Havel, J.J. 1998. Regional Forest Agreement Vegetation Complexes, Collie, Western Australia [cartographic material – scale 1:250,000]. WA Department of Conservation and Land Management.
[5] Mattiske, E.M. and Havel, J.J 2000. Vegetation Mapping in the South West of Western Australia. CALM, Perth.

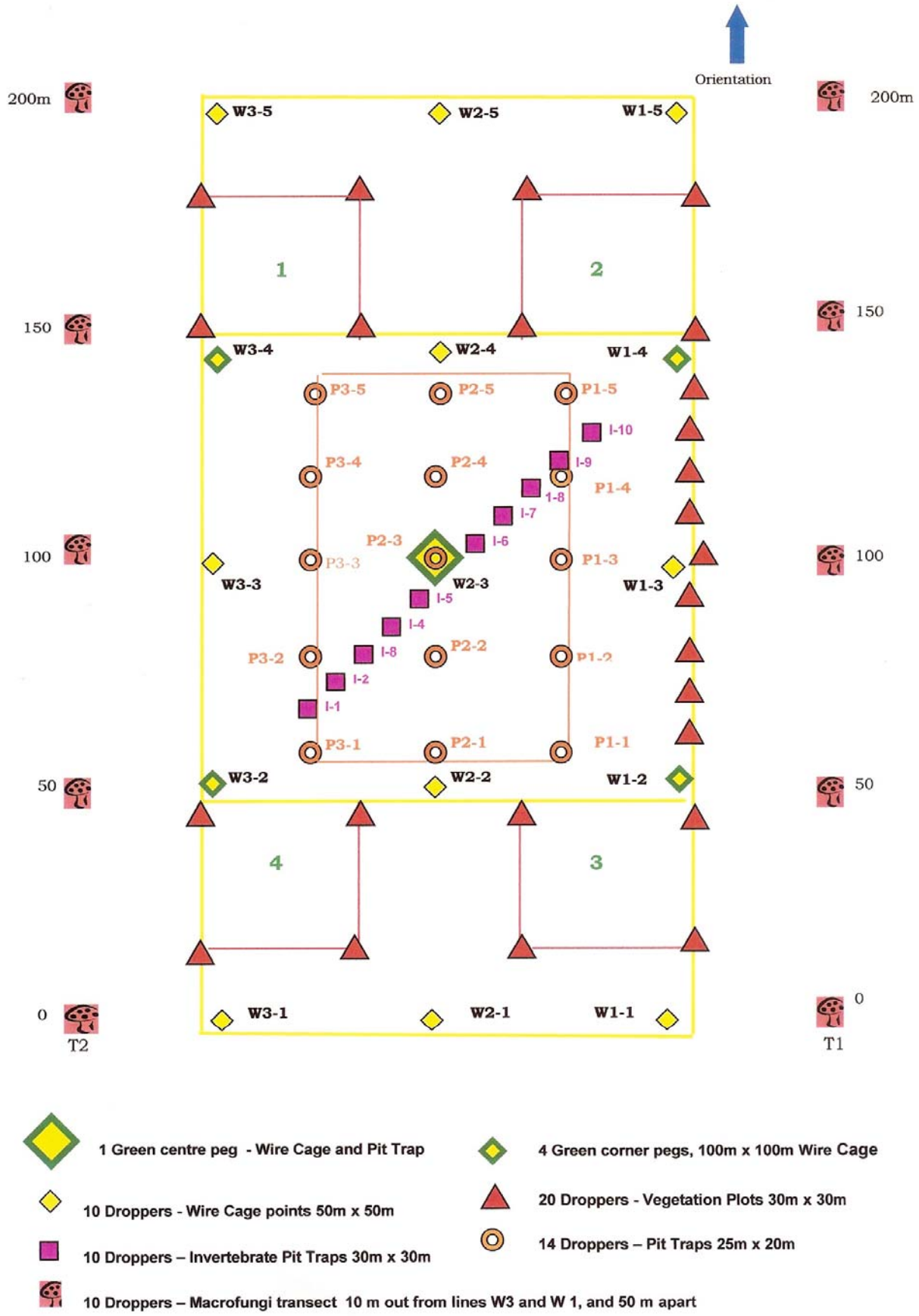

Figure 1. FORESTCHECK grid layout

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 at Wellington 2008-09

Nine FORESTCHECK monitoring grids were established in the Wellington District in 2002 (Table 1). Grids were established in Edward, Ross, Surface, Chalk, Yourdamung & Tumlo forest blocks (Fig. 2). Harvested sites (shelterwood and gap release) were matched to 1992, 1994 & 1997 harvest activities. All external reference blocks were established in uncut forest (Fig. 3-X). They were initially monitored in spring 2002 and autumn 2003 and this second round of monitoring was conducted in spring 2008 and autumn 2009. All grids are located within the Dwellingup 1 vegetation complex which is described as being open forest of *Eucalyptus marginata* sub sp. *marginata – Corymbia calophylla* on lateritic uplands in mainly humid and sub-humid zones (Mattiske and Havel 1998). Two of the external reference grids are situated in National Park (FC17 & FC17), but the Tumlo external reference (FC19) is in state forest. The range of time since the last fire was 6 months to 17 years, and three grids had been burnt since the initial monitoring in 2002-03, FC12 & FC16 in the prescribed burn program and FC18 by wildfire (Table 1).

Table 1. Forest block location and site attributes of each FORESTCHECK grid at Wellington in 2008-09.

Treatment/Grid/Location	**Burnt**		**Logged**		**Vegetation Complex** [2]
	Year [1]	Years since	Year	Years since	
Gap Release					
F11 Edward	Sp 1995 (regen release)	13	1994	14	Dwellingup 1
FC12 Ross	Sp 2006* (prescribed)	2	1992	16	Dwellingup 1
FC14 Surface	Sp 1998 (regen release)	10	1997	11	Dwellingup 1
Shelterwood					
FC13 Ross	Sp 1991 (advance)	17	1992	16	Dwellingup 1
FC15 Surface	Sp 1998 (establishment)	10	1997	11	Dwellingup 1
FC18 Chalk	Su 2004* (wildfire)	4	1992	16	Dwellingup 1
External Reference					
FC16 Yourdamung (NP)	Sp 2005* (prescribed)	3	Uncut		Dwellingup 1
FC17 Surface (NP)	Sp 2008* (prescribed)	10/0.5	Uncut		Dwellingup 1
FC19 Tumlo	Sp 1996 (prescribed)	12	Uncut		Dwellingup 1

NP indicates the grid was established in national park

[1] Sp= silvicultural burn carried out in the spring, Su = summer

* refers to sites that were burnt since they were first monitored in 2002-03. The Surface external reference was burnt in December 2008, between the spring and autumn sampling periods.

[2] Dwellingup 1 is described as being open forest of *Eucalyptus marginata* sub sp. *marginata – Corymbia calophylla* on lateritic uplands in mainly humid and sub-humid zones (Mattiske & Havel 1998).

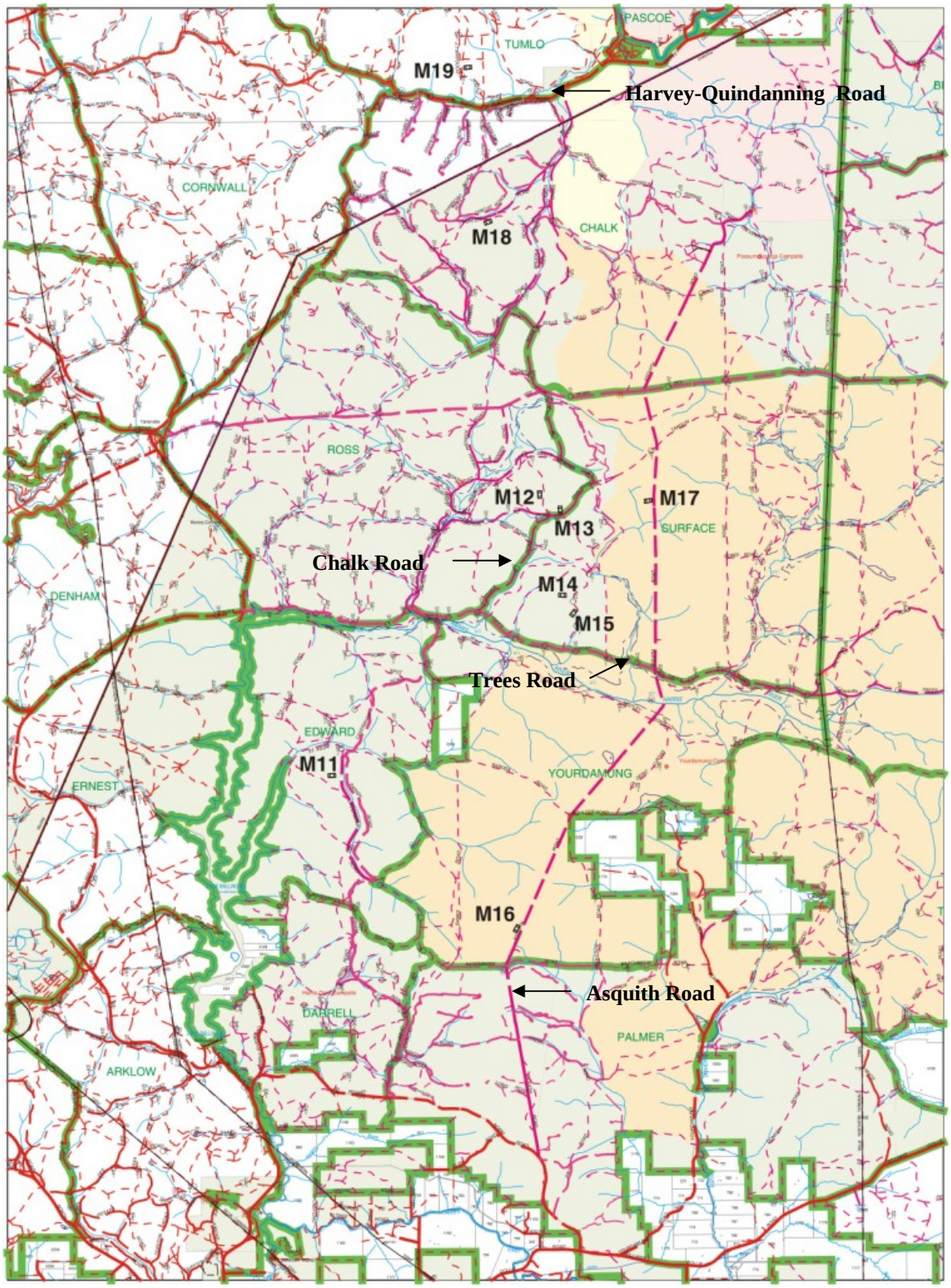

Figure 2. Location of FORESTCHECK grids in the Wellington District.

Reference photographs of each grid were initially taken in 2002 and presented in the FORESTCHECK Report of Progress 2002-2003 (available at www.dec.wa.gov.au). In 2009, reference photos were taken from a standard photo point at peg W2-1 looking towards the centre peg (W2-3) (see Fig. 1), which will allow more accurate changes in vegetation structure and condition to be observed in each subsequent photograph (Figs. 5-13).

Figure 5. FC16 Yourdamung external reference in 2003 (left) and 2009 (right).

Figure 6. FC17 Surface external reference in 2003 (left) and 2009 (right).

Figure 7. FC19 Tumlo external reference in 2003 (left) and 2009 (right).

Figure 8. FC13 Ross shelterwood in 2003 (left) and 2009 (right).

Figure 9. FC15 Surface shelterwood in 2003 (left) and 2009 (right).

Figure 10. F18 Chalk shelterwood in 2003 (left) and 2009 (right).

Figure 11. FC11 Edward gap release in 2003 (left) and 2009 (right).

Figure 12. FC12 Ross gap release in 2003 (left) and 2009 (right).

Figure 13. F14 Surface gap release

The budget and expenditure for the 2008-09 FORESTCHECK program is detailed in Table 2. Funding for the program is provided by the DEC's Sustainable Forest Management Division via a works agreement with the Forest Products Commission for $225,000.

Table 2. Budget for maintenance and monitoring of FORESTCHECK sites at Wellington for 2008-09

Task/Activity	OIC	Total Operating
OPERATIONAL		
Grid maintenance	McCaw	10 000
Forest structure and regeneration	McCaw	7 000
Soil and foliar nutrients	McCaw	Nil
Soils disturbance	Whitford	Nil
Coarse woody debris	Whitford	20 000
Macrofungi / Litter	Robinson	15 000
Vascular flora	Ward	10 000
Cryptogams	Cranfield	10 000
Invertebrates	Farr	15 000
Birds (diurnal)	Liddelow	3 000
Birds (nocturnal)	Liddelow	3 000
Fauna (grid trapping)	Liddelow	10 000
Spotlight Road surveys (vertebrate)	Liddelow	5 000
OTHER		
Administration and overheads	McCaw	41 214
Data base management	McCaw	63 050
Directorate		12 736
SUB TOTAL		**225 000**
SALARY		191 000
TOTAL		**416 000**

2009-10 Activities

In spring of 2009 and autumn 2010 monitoring will be undertaken on eight grids (FC20 – FC27) established in the Perth Hills District in 2003, and initially monitored in 2003-04. Five grids are located north-east of Dwellingup in the Holyoake, Kennedy and Cameron

forest blocks and three north east of Jarrahdale on the northern side of the Brookton Hwy Occidental and Lesley forest blocks between the 1100 mm and 1300 mm annual isohyets.

FOREST STRUCTURE AND REGENERATION STOCKING

Lachlan McCaw

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 recognised as a Category A indicator (Commonwealth of Australia 1998) 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 stands, there is a need to consider existing stand structure and whether there is sufficient sapling and advance growth present for re-establishment following harvesting. Under the current silvicultural guidelines for jarrah-marri forest, the decision as to whether the stand should be cut to gap release or shelterwood is determined by the density of existing lignotuberous advance growth (CALM 2004).

Forest managers also require information about growth rate and species composition 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.

A total of 48 FORESTCHECK monitoring grids were established between 2001-02 and 2005-06 across the geographic range of the jarrah forest. The distribution of grids stratified according to DEC administrative boundaries and forest ecosystems mapped for the Regional Forest Agreement (Mattiske and Havel 2000), and is as follows:

- Donnelly District (jarrah south), 10 grids;
- Wellington District (jarrah north west - central), 9 grids;
- Perth Hills District (jarrah north west - north), 8 grids;
- Wellington District (jarrah north east), 10 grids; and
- Blackwood District (jarrah Blackwood Plateau), 11 grids.

Nine monitoring grids established in Wellington District in 2003 were re-assessed in 2009 with the objective of describing changes in stand structure, species composition and developmental stage of tree species present over the previous six years.

Monitoring

Sampling techniques were the same as in March 2003, except that cut stumps were not re-measured and triangular tessellation assessment of regeneration stocking was not repeated. All trees taller than 2 m were measured in transects 100 m long by 4 m wide located between marker pegs 1-2 to 1-4 and 3-2 to 3-4. To improve the reliability of long

term measurements of tree growth, mortality and tree fall all stems ≥20 cm diameter at breast height were identified with a numbered tag. The height and species of regeneration was assessed at four locations on each grid to indicate the rate of regrowth.

Project foliage cover was recorded in spring 2008 as part of the vegetation cover assessment during vascular plant surveys. Intercepts with foliage above 2 m in height were recorded at 240 points around the perimeter of the four 30 m x 30 m vegetation quadrats using a vertical periscope fitted with a fine crosshair. Intercepts were recorded as foliage present or absent.

Data management

Stem diameter measurements from 2009 were entered into the FORESTCHECK stand database and used to calculate current basal area and basal area increment for the period 2003-2009. A small number of errors in the initial measurement data were detected and corrected. These resulted from:

- incorrect calculation of individual tree basal areas following the initial measurement in 2003;
- inclusion of an additional large jarrah tree on FC19 that had not been measured in 2003 but was definitely within the measurement transect area. The database was adjusted to account for the additional basal area contributed by this tree in 2003 but the tree was not assigned any increment for the period 2003-2009.

Permanent tagging of trees >20 cm diameter will minimize potential for errors of this kind during subsequent measurements.

Preliminary results

Stand structure and species composition

Basal area and basal area increment of jarrah and marri are summarised in Table 1 and stem diameter distribution by 10 cm classes is presented for each grid in Figures 1, 2 & 3.

External reference grids FC16 and FC17 had been burnt in the period since 2003. As a result of burning through at the base, jarrah trees of 40 cm diameter and 74 cm had fallen in grids FC16 and FC17 respectively causing basal area to decline between 2003 and 2009. The number of saplings <10 cm diameter had increased by more than two-fold in FC17 prior to the grid being burnt, indicating that substantial recruitment was occurring. Most of these saplings had re-sprouted following the low intensity fire in November 2008. The stand structure of external reference grid FC19 exhibited little change between 2003 and 2009 with the mean annual increment of 0.13 m^2 ha^{-1} $year^{-1}$ resulting from growth of established trees.

Basal area increments in grids cut to shelterwood ranged from 0.25 to 0.76 m^2 ha^{-1} $year^{-1}$ comprised predominantly of jarrah, although marri was more numerous than jarrah in the sapling size classes <20 cm diameter (Fig. 2). The stand structure of grids FC13 or FC18 changed little between 2003 and 2009, but grid FC15 showed extensive recruitment of jarrah and marri saplings, reflecting dynamic growth of established lignotuberous ground coppice that was less than 2 m tall when measured in 2003.

The two gap release grids that had not been burnt had increments in the range 1.0-1.6 m^2 ha^{-1} $year^{-1}$ with between 25 and 40 per cent of increment contributed by jarrah. The stand structure of gap release grids changed as a result of saplings growing into the 10-20 cm diameter size classes, with some mortality of smaller saplings (Fig. 3).

Table 1. Basal area in 2009 and basal area increment of live eucalypts >2 m tall over the period autumn 2003-2009 for nine FORESTCHECK grids in Wellington District.

Treatment	Grid	Basal area 2009 (m^2 ha^{-1})			Basal area increment (m^2 ha^{-1})		Mean annual increment (m^2 ha^{-1} $year^{-1}$)
		jarrah	marri	total	jarrah	marri	
External control	FC16	26.69	8.90	38.59	0.25	-1.79	-0.26
	FC17	26.93	3.06	29.99	-4.21	0.94	-0.55
	FC19	48.34	0.28	48.62	0.67	0.13	0.13
Shelterwood	FC13	8.20	3.41	11.61	1.07	0.40	0.25
	FC15	5.13	5.33	10.46	1.32	3.23	0.76
	FC18	11.48	5.16	16.64	0.26	1.48	0.29
Gap release	FC11	9.88	5.35	15.23	2.64	3.39	1.01
	FC12	5.00	3.64	8.64	-0.84	-0.59	-0.24
	FC14	20.70	15.60	36.30	2.25	7.35	1.60

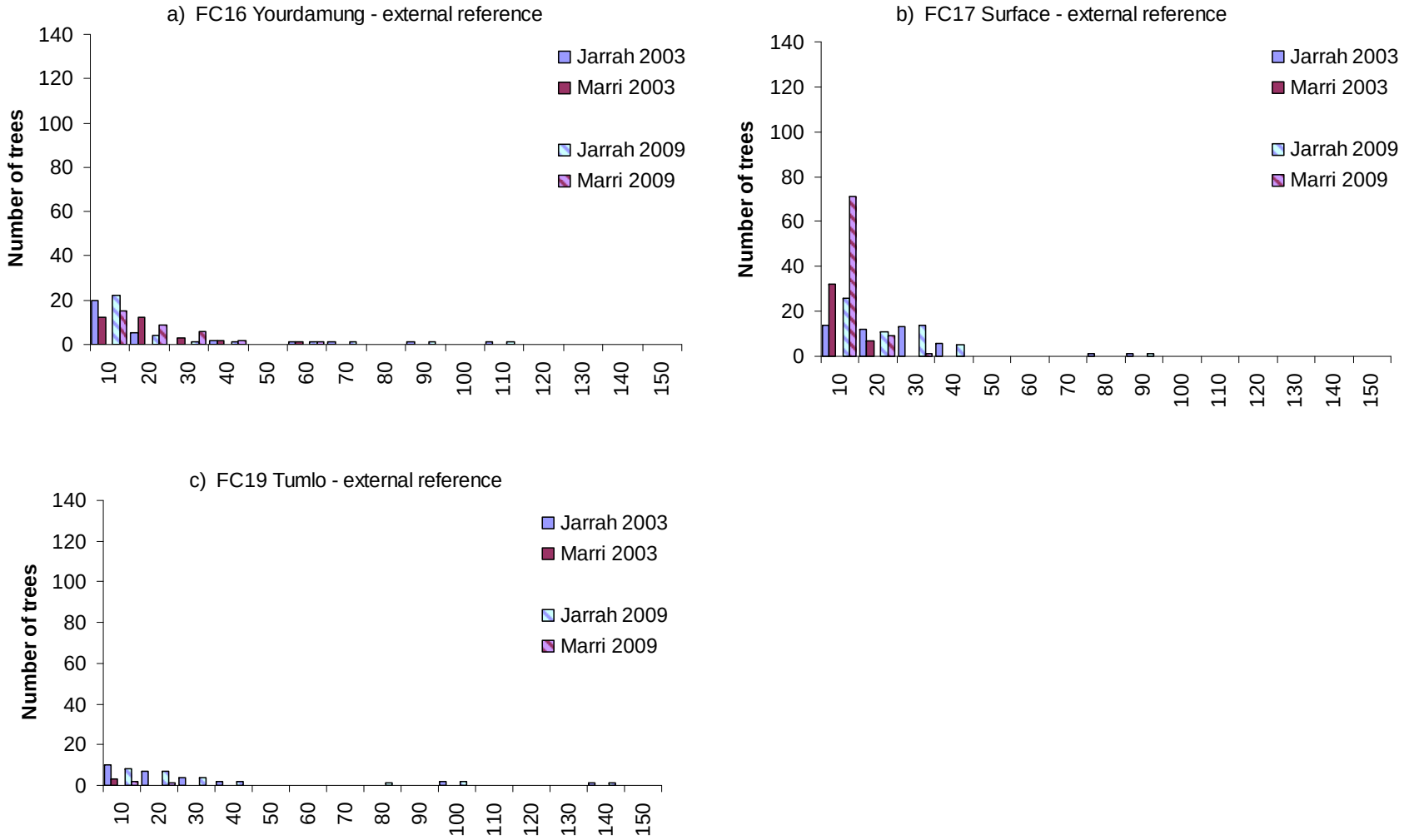

Figure 1. Stem diameter distribution by 10 cm classes for each external control grid in classes 0-9 cm, 10-19 cm etc.

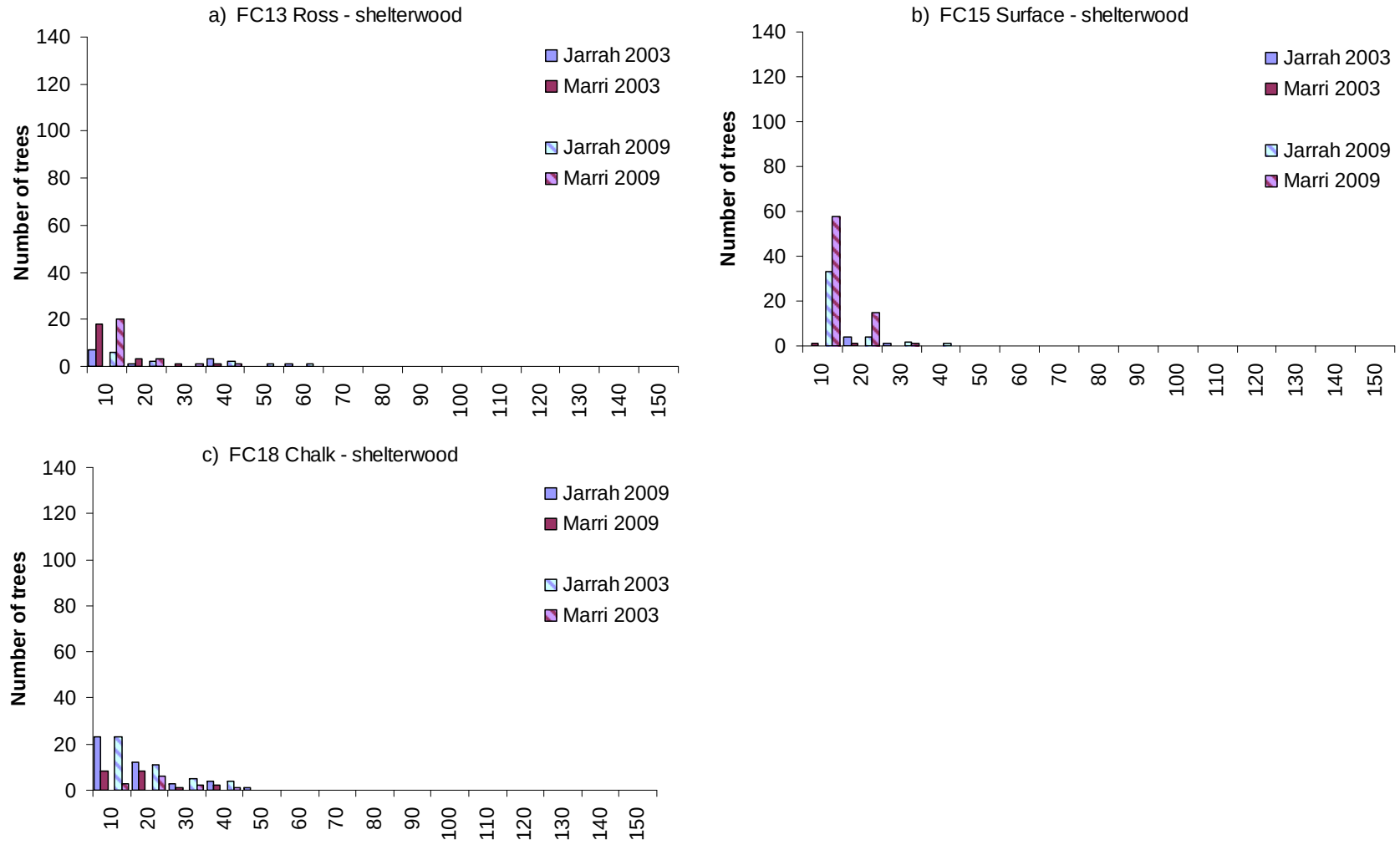

Figure 2. Stem diameter distribution by 10 cm classes for each shelterwood grid in classes 0-9 cm, 10-19 cm etc.

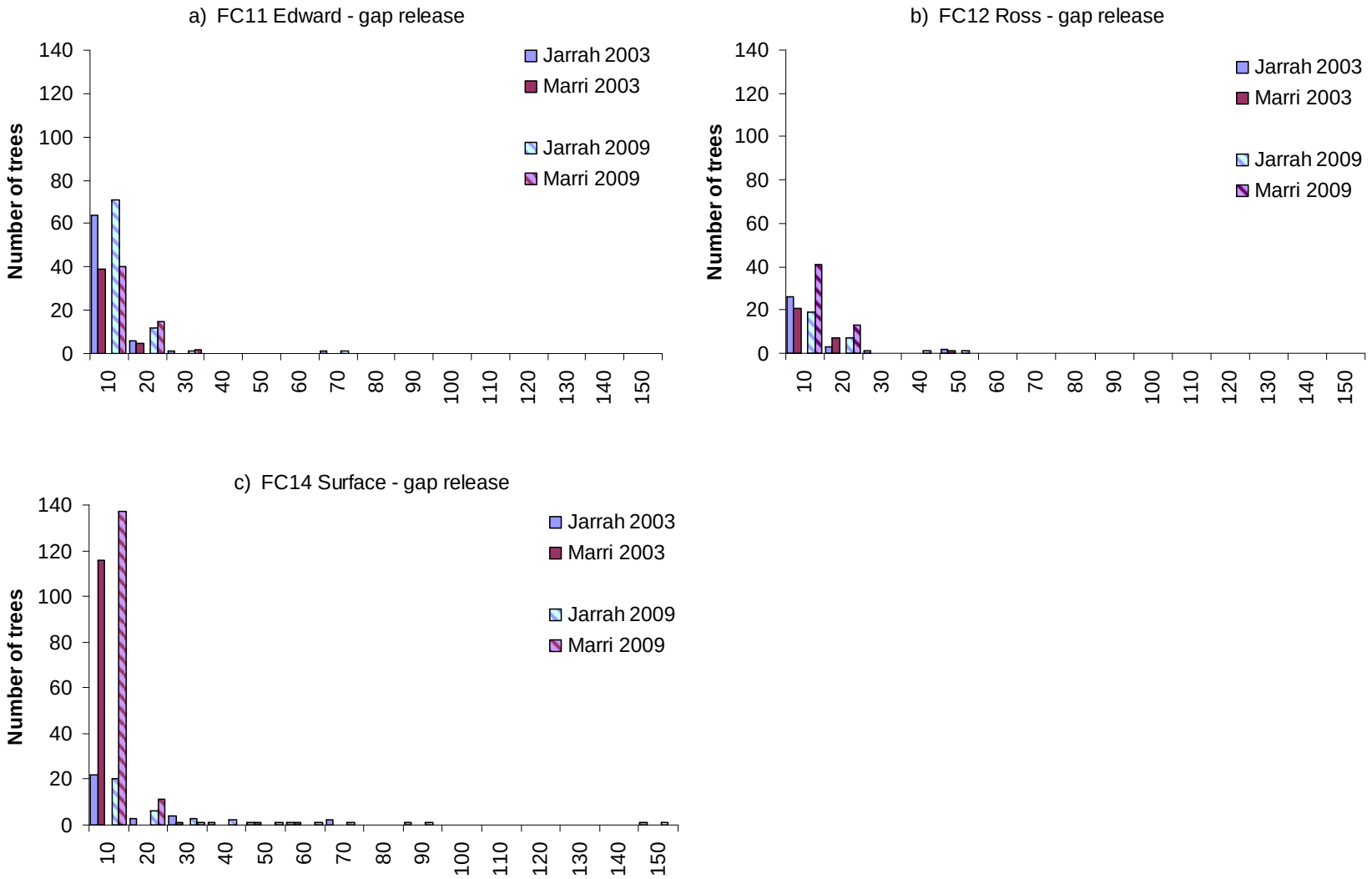

Figure 3. Stem diameter distribution by 10 cm classes for each gap release grid in classes 0-9 cm, 10-19 cm etc.

Projected foliage cover remained relatively constant in external reference grids FC16 and FC17 but declined in FC19 (Fig. 4); this decline could not be attributed to loss of standing trees and may therefore reflect an overall decline in foliage density. Foliage cover increased by 10-15 per cent for all three shelterwood grids. Trends in foliage cover were variable in gap release grids with a substantial (30 per cent) increase at Ross (FC12), a small increase at Surface (FC14) and an 8 per cent reduction at Edward (FC11).

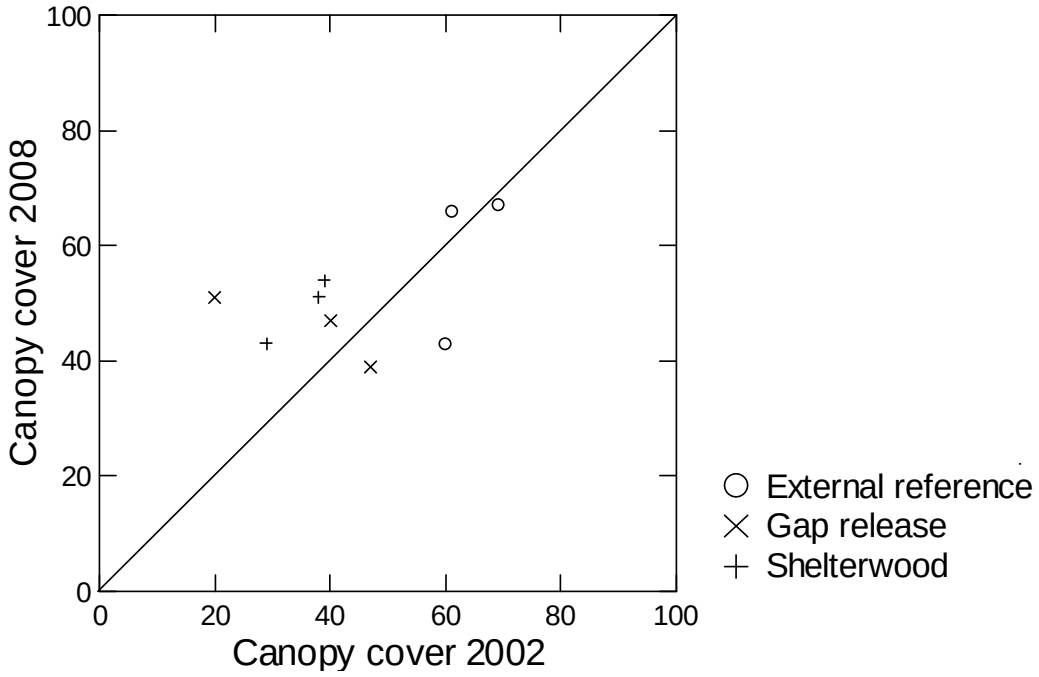

Figure 4. Scatter plot of canopy cover measurements made on each grid in 2002 and 2008. The line indicates 1:1 agreement between measurements in different years.

Discussion

Tree fall following prescribed fires had a significant effect on the basal area of three of the grids in Wellington District, leading to reduction in basal area over the six year period between measurements. Fire is an important agent of disturbance in the forests of south-west Western Australia and can influence the rate of mature tree fall, leading in turn to recruitment of seedlings and to stimulation of dynamic growth in existing lignotuberous advance growth. Fire also affects the quantity and condition of coarse woody debris on the forest floor by consuming ground logs, and by causing standing trees to fall and provide an ongoing source of woody debris.

Mean annual increments in the three gap release grids at Wellington were similar to those reported for gap release grids in Donnelly District, providing further evidence to show that gap release harvesting has generally resulted in stands that are well stocked and have good growth potential. Increment in shelterwood grids was lower than in gaps, but still

above the mean increment for the jarrah forest suggested by Abbott and Loneragan (1983). As there was only one shelterwood grid in Donnelly the basis for comparison with shelterwood grids in Wellington is limited.

Grid FC17 had been disturbed by illegal firewood harvesting at some stage during 2006, and during a brief plot inspection in November 2006 I noted that a standing dead jarrah tree and a sheoak had been felled, with much of the jarrah log removed from the site. The illegal activity was reported to staff at Wellington District in Collie. Observations of significant natural and man-caused disturbance events at FORESTCHECK grids will be systematically documented as they have the potential to provide a useful insight into the incidence and extent of such events across the forest estate.

References

Abbott, I. and Loneragan, O.W. 1983. Growth rate of jarrah (*Eucalyptus marginata*) in relation to site quality in cut-over forest, Western Australia. Australian Forestry 46, 91-102.

CALM 2004. Silvicultural practice in the jarrah forest. Dept. CALM, SFM Guideline No. 1.

Commonwealth of Australia 1998. A framework of regional (sub-national) level criteria and indicators of sustainable forest management in Australia. Department of primary Industries and Energy, Canberra, ACT.

Mattiske, E.M. and Havel, J.J 2000. Vegetation Mapping in the South West of Western Australia. CALM, Perth.

COARSE WOODY DEBRIS, SMALL WOOD AND TWIGS, AND LITTER

Kim Whitford, Lachie McCaw, Richard Robinson, Deb Feeniks

Introduction

Wood and leaf debris on the forest floor provides habitat for many fungi, invertebrates, small reptiles, and mammals. The litter layer also affects soil moisture, and in conjunction with micro-organisms, influences soil structure. Consequently coarse woody debris (CWD), small wood and twigs (SWT) and litter are important structural and biological components of forest ecosystems. Disturbances such as logging and burning affect the volumes and types of debris that occur in forests. This part of the FORESTCHECK monitoring program determines the amount of debris on each of the FORESTCHECK grids and monitors various attributes of this debris.

This component of FORESTCHECK is intended to:

- Measure and record the amount of litter, small wood and twigs, and coarse woody debris on the ground in the various managed jarrah forest treatments (i.e. gap release and shelterwood) and in uncut forest.
- Analyse trends within and between the treatments over time.
- Provide data for analysis of distribution patterns of other organisms such as invertebrates, small mammals, fungi and cryptogams.

No new FORESTCHECK grids were added for this assessment year. The 2008-09 assessment was used to collect additional data on CWD on the existing 48 monitoring grids. The additional field work and data collection:

- Increased the length of the transects used for CWD assessment on each grid from 100 m to 200 m to improve the precision of the estimate of CWD debris.
- Increased the number of transects from two to three per grid to provide an increase from the previous total of 200 m of transect per grid to a total of 600 m of transect per grid.
- Provided data on the decay status of the CWD as this had not previously been collected and is known to greatly influence the habitat value, combustibility, and density of CWD.
- Provided additional assessments of log attributes related to the combustibility of individual CWD pieces.
- Provided assessments of attributes related to the rates of decay of individual CWD pieces.
- Provided assessments of attributes related to the habitat quality of individual CWD pieces.
- Recorded the location of each piece of CWD and tagged each piece with a diameter greater than 20 cm at the point that it was intersected by the transect. This will facilitate the identification and remeasurement of CWD after fires.

The revised procedure now used to assess CWD is detailed in Whitford *et al*. (2008).

Field and Laboratory Monitoring

Small wood and twigs (SWT) is defined as woody material that is 1 cm to 2.5 cm in diameter, CWD is defined as material that is larger than 2.5 cm in diameter and litter is dead leaves and other dead fine vegetative material less than 1 cm in diameter. The 48 plots were reassessed for of CWD between 8-26 May and SWT and litter assessments were conducted on the Wellington grids (FC11-19) from 26-30 October 2009. Litter and small wood and twig samples were oven dried, weighed in grams and then converted to tonnes per hectare (t ha^{-1}). The volume of coarse woody debris was determined using the line intersect method (Van Wagner 1968) and calculated to cubic metres per hectare (m^3 ha^{-1}).

Results and Discussion

Litter weights

In 2009, litter weights on the treatment grids were generally variable. Four grids had been burnt since the 2003 measurements, but not all grids had loads reflecting time since the last burn (Fig. 1). A number of grids including the Tumlo external reference (FC19), Ross shelterwood (FC13) and Edward gap release (FC11) had lower litter loads than recorded in 2003 despite a further five years of accumulation. In contrast, the Chalk shelterwood (FC18) carried almost half as much litter again as recorded in 2003, despite being burnt only four years previously compared to nine years of accumulation in 2003. Litter accumulation is influenced by a variety of factors including stand structure and density, the extent of fuel consumption during previous fires, and reduction in canopy density by defoliating insects.

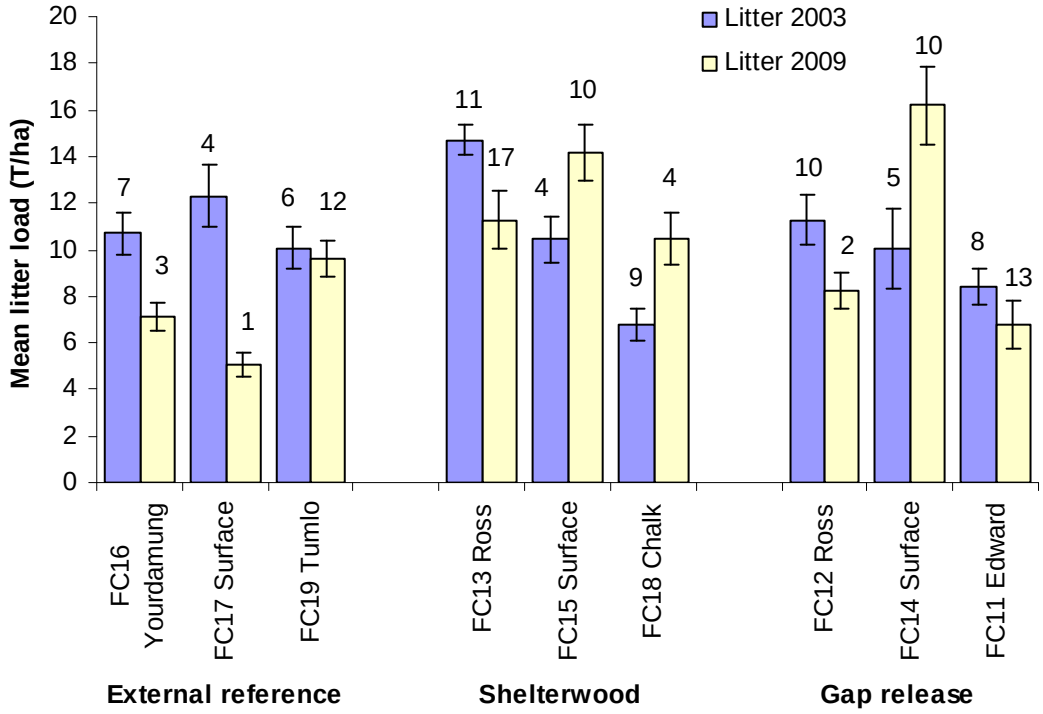

Figure 1. Mean litter loads (t ha^{-1} ± se) calculated at each FORESTCHECK grid at Wellington in 2003 and 2009. Numbers above columns indicate years since burnt.

Small wood and twigs

The amount of small wood and twigs on all sites was small (Fig. 2) compared to that of the litter (Fig. 1). Generally twig loads increased on sites that had not been burnt since the 2003 measurement, but as with the litter, the twig loading at the Tumlo control grid (FC19) was lower than the 2003 measurement. The grids that had been recently burnt, Yourdamung control (FC16), Surface control (FC17) Chalk shelterwood (FC18) all had similar loads to those measured in 2003, despite shorter accumulation times. Notably, the 2009 Ross gap release (FC12) twig load from only two years of accumulation was almost twice that measured in 2003 from 10 years of accumulation.

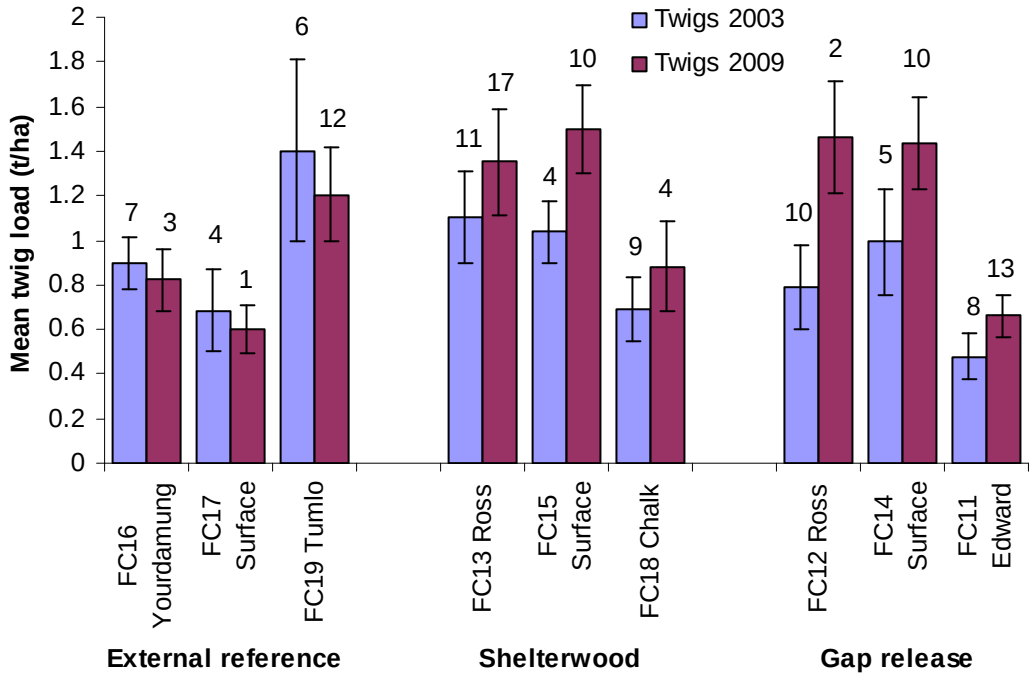

Figure 2. The average weights (t ha^{-1}) of small wood and twigs measured at each FORESTCHECK grid at Wellington in 2003 and 2009. The numbers above the columns indicate years since burnt.

Coarse woody debris volumes

All 48 FORESTCHECK grids were reassessed (Whitford *et al*. 2008) for coarse wood debris (CWD) volume and condition. Two x 200 m transects were assessed on grids FC1-10 and three on grids FC11-48 (the third transect on grids FC1-10 will be assessed in 2010). The CWD volumes determined so far for all grids are given in Table 1. CWD volume was highly variable across grids but some clear differences emerged between the treatment groupings (Fig. 3). Volumes on external reference treatments that had never been harvested (76 ± 21 m^3 ha^{-1}) were relatively low compared to all of the harvested treatments (Fig. 4). CWD volume increased with the intensity of the most recent harvest, with the most intensive harvest treatment, (gap release) having the highest volumes of CWD (161 ± 26 m^3 ha^{-1}). Loadings of CWD in shelterwood (121 ± 16 m^3 ha^{-1}) and

selectively harvested grids (127 ± 30 m^3 ha^{-1}) were not significantly different from one another and were less than in gap release treatments (Fig. 4). The volume of CWD on previously harvested external reference and coupe buffer treatments (100 ± 17 m^3 ha^{-1}) was intermediate between those of the recently harvested and the never harvested treatments.

Table 1. The 48 FORESTCHECK grids reassessed in 2008 and 2009 for coarse wood debris (CWD) volume and condition.

Location	Treatment	Year of grid establishment	Year of most recent harvest	No. of cuts	Mean CWD volume (m^3 ha^{-1} ± se)
Winnejup	External reference	2001	Uncut	1	124 ± 35
Yornup	External reference	2001	Uncut	1	99 ± 7
Easter	External reference	2001	Uncut	0	219 ± 37
Yourdamung	External reference	2002	Uncut	0	31 ± 7
Surface	External reference	2002	Uncut	0	55 ± 24
Tumlo	External reference	2002	Uncut	0	128 ± 28
Holyoake	External reference	2003	Uncut	1	45 ± 8
Kennedy	External reference	2003	Uncut	2	91 ± 7
Occidental	External reference	2003	Uncut	2	26 ± 10
Nalyerin	External reference	2004	Uncut	0	58 ± 29
Stockyard	External reference	2004	Uncut	1	59 ± 12
Bell	External reference	2004	Uncut	0	27 ± 6
Barrabup	External reference	2005	Uncut	0	39 ± 14
St John	External reference	2006	Uncut	0	46 ± 4
Layman	External reference	2005	Uncut	0	80 ± 30
Kingston	Coupe buffer	2001	Uncut	2	168 ± 89
Thornton	Coupe buffer	2001	Uncut	1	154 ± 13
Carter	Coupe buffer	2001	Uncut	1	172 ± 42
Godfrey	Coupe buffer	2004	Uncut	1	64 ± 10
Barrabup	Selective cut	2005	2002	2	163 ± 34
Cambray	Selective cut	2005	1995	2	67 ± 15
Butler	Selective cut	2005	1998	2	150 ± 50
Kingston	Shelterwood	2001	1996	3	86 ± 13
Ross	Shelterwood	2002	1992	2	150 ± 38
Surface	Shelterwood	2002	1997	2	141 ± 18
Chalk	Shelterwood	2002	1992	2 or 3	239 ± 41
Holyoake	Shelterwood	2003	1995	2	110 ± 32
Cameron	Shelterwood	2003	1989	2	182 ± 31
Lesley	Shelterwood	2003	1997	2	71 ± 26
Godfrey	Shelterwood	2004	2000	3	49 ± 8
Stockyard	Shelterwood	2004	1998	2	114 ± 10
Bell	Shelterwood	2004	1996	1	45 ± 20
Barrabup	Shelterwood	2005	2002	2	155 ± 10

Location	Treatment	Year of grid establishment	Year of most recent harvest	No. of cuts	Mean CWD volume (m^3 ha^{-1} ± se)
Cambray	Shelterwood	2005	1995	2	109 ± 30
Kingston	Gap release	2001	1996	3	254 ± 127
Thornton	Gap release	2001	1991	2	407 ± 45
Carter	Gap release	2001	1995	2	218 ± 53
Edward	Gap release	2002	1994	2	113 ± 14
Ross	Gap release	2002	1992	2	111 ± 34
Surface	Gap release	2002	1997	2	107 ± 7
Kennedy	Gap release	2003	1988	3	252 ± 39
Lesley	Gap release	2003	1997	2	94 ± 14
Godfrey	Gap release	2004	2000	2	61 ± 15
Stockyard	Gap release	2004	1998	2	74 ± 15
Bell	Gap release	2004	1996	1	67 ± 12
Barrabup	Gap release	2005	2002	2	156 ± 63
Cambray	Gap release	2005	1996	2	112 ± 39

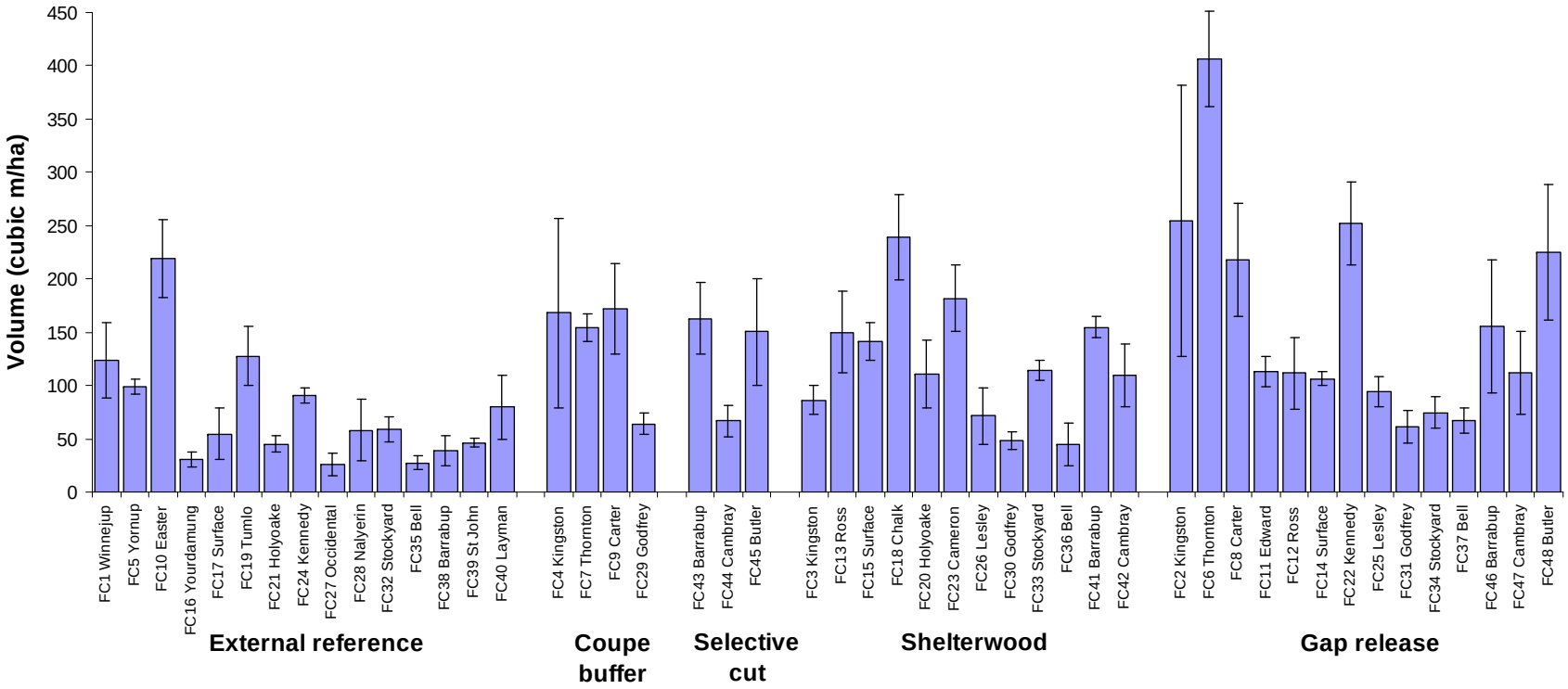

Figure 3. The volume (m^3 ha^{-1} ± se) of coarse woody debris measured at all FORESTCHECK grids in 2008 and 2009 using three 200 m transects on all grids except FC1 to FC10 which had only two transects

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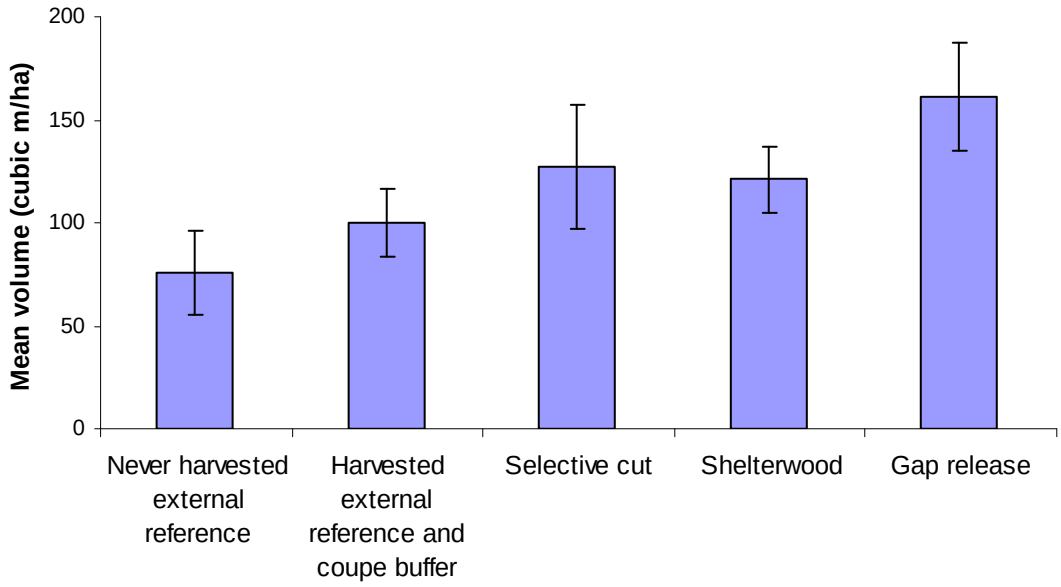


Figure 4. Treatment means for the volume (m^3 ha^{-1} ± se) of coarse woody debris on harvested and never harvested treatments measured across all 48 FORESTCHECK grids in 2008 and 2009.

Factors affecting coarse woody debris

A substantial proportion of CWD on the recently harvested treatments is derived from harvesting (34%). This material derived from harvesting predominantly impacts the volume of CWD between 10 to 50 cm in diameter (the 20 and 40 cm diameter classes, Fig.5).

Although some external reference and coupe buffer grids have been harvested previously, this harvesting took place prior to 1960 and much of the smaller material resulting from the harvest has decayed and or burnt away. Much of the woody debris produced in harvesting is small diameter material which decays and is consumed by fire sooner than larger diameter material.

Historical and recent harvesting has also increased the volume of CWD in the low to moderate log decay classes (classes 2 to 5). This is material that has been on the ground for approximately 10 to 60 years (Fig.6).

The volume of coarse woody debris on a site generally increases as the number of times that site has been harvested increases (Fig. 7). Over the longer term (100 years) CWD volume tends to decline with time since harvest.

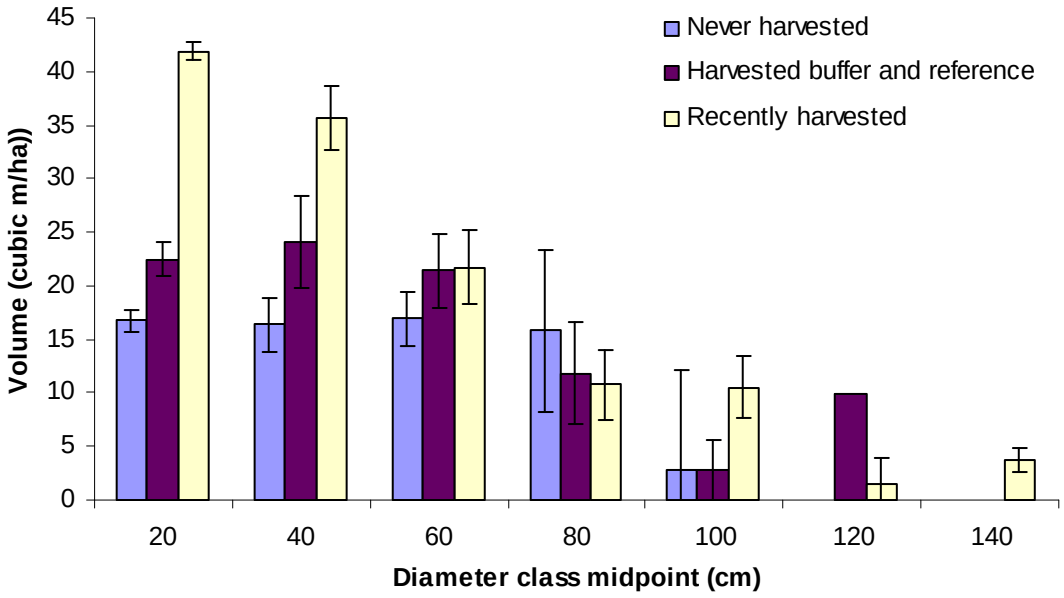


Figure 5. Means for the volume (m^3 ha^{-1} ± se) of coarse woody debris on never harvested, previously harvested coupe buffers and reference treatments, and recently harvested treatments. Mean volumes in each treatment were: never harvested, 76 m^3 ha^{-1}; previously harvested coupe buffers and reference treatments, 100 m^3 ha^{-1}; and recently harvested treatments, 136 m^3 ha^{-1}.

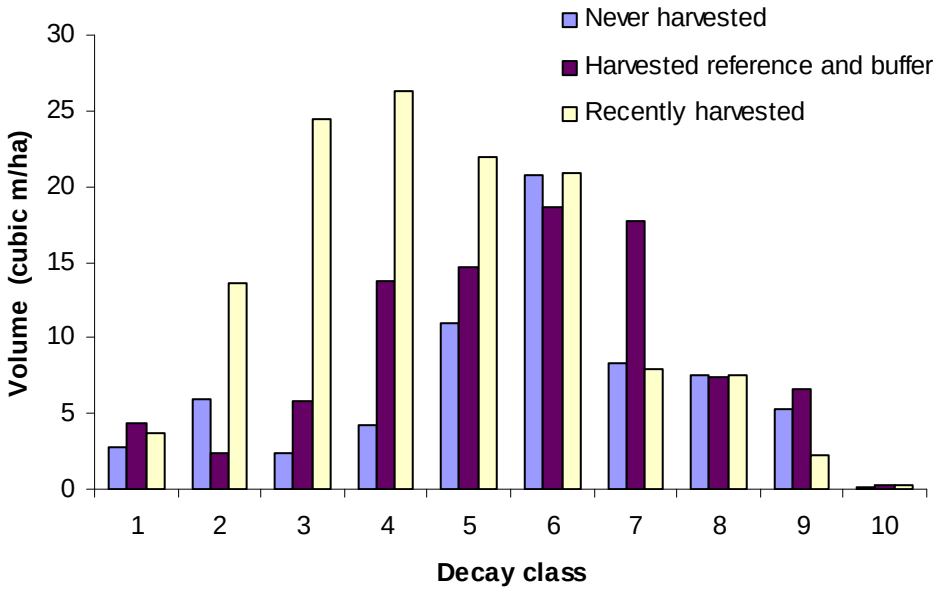


Figure 6. The volume (m^3 ha^{-1} ± se) of coarse woody debris in each of the 10 log decay classes. Treatments are never harvested, previously harvested coupe buffers and reference treatments, and recently harvested treatments. Total volumes in each treatment were: never harvested, 76 m^3 ha^{-1}; previously harvested coupe buffers and reference treatments, 100 m^3 ha^{-1}; and recently harvested treatments, 136 m^3 ha^{-1}.

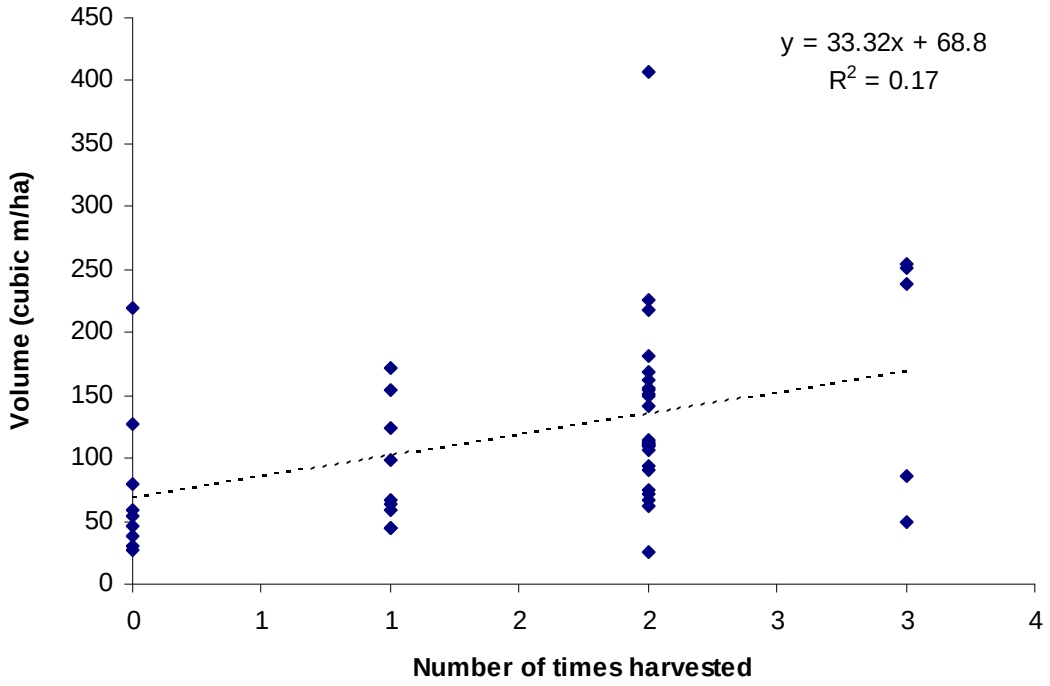


Figure 7. The relationship between the number of times a site is harvested and the volume of coarse woody debris on the site.

Fire also greatly affects the amount and decay status of CWD. Fire is difficult to characterize but it is most likely that fire frequency has the greatest affect on CWD. Our observations are that small logs burn away more readily than large logs which are more likely to char rather than burn away once ignited. Logs that are decayed or have internal faults such as rot or hollowing are also more likely to sustain fire and burn away. Smaller logs are also more likely to ignite and sustain fire, and also decay at a greater rate than large logs (Brown et al., 1996), and are thus less likely to persist on the ground over the longer term and reach advanced stages of decay.

Conclusions

- Forty-eight FC grids have now been reassessed for CWD. However, the Donnelly grids (FC1-10) all need to have the third 200 m transect measured to complete the data set.
- CWD loads are high, ranging from a mean of 140 tonnes ha^{-1} on harvested treatments to 76 tonnes ha^{-1} on never harvested treatments.
- CWD volume increases with the intensity of the most recent harvest, with the most intensive harvest treatment (gap release) having the highest volumes of CWD. External reference grids that have never been harvested have the lowest load of CWD.
- CWD volume also tends to increase with the total number of historical harvests.
- Over the longer term (100 years) CWD volume declines with time since harvest.

- A substantial proportion of CWD on the recently harvested treatments is derived from harvesting (34%).
- Most of the difference in CWD volume between 'recently harvested' and 'never harvested' occurs in the 20 and 40 cm diameter classes (diameter range 10 to 50 cm).
- Historical and recent harvesting increase the volume of CWD in the low to moderate decay classes (classes 2 to 5).
- CWD load most likely also influenced by fire frequency and site factors such as stand density, shading and site moisture levels. These and other factors will be considered in subsequent analyses once the entire data set is compiled.

Acknowledgements
Thank you to Elisa Gurske and Janine Dombrowski for field assistance with litter and twig sampling.

References

Brown, S., Mo, J., McPherson, J. K. and Bell, D. T. 1996. Decomposition of woody debris in Western Australian forests. Canadian Journal of Forest Research 26: 954 - 966.

Van Wagner, C.E. 1968. The line intersect method in forest fuel sampling. Forest Science 17: 20-26

Whitford, K., Guja, L. and Phelan, G. 2008. Forestcheck coarse woody debris assessment procedure. Internal report. Department of Conservation and Land Management. 22pp.

Woldendorp, G., Keenan R. J., Barry, S. and Spencer, R. D. 2004. Analysis of sampling methods for coarse woody debris. Forest Ecology and Management 198: 133-148.

MACROFUNGI

Richard Robinson, Katrina Syme & Jon Mccalmont

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.

Recent research on fungi in Western Australia's southern forests has shown that fungal communities respond to fire and forest management activities. 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 (shelterwood, selective cut and gap release) and in uncut forest.
- Analyse trends in species composition, richness and abundance and substrate utilization over time.
- To generate detailed descriptions of unknown or unnamed species.

Field Survey

Nine FORESTCHECK grids, including three external reference grids (FC16, FC17, FC19), three shelterwood (FC13, FC15, FC18) and three gap release treatments (FC11, FC12, FC14), were installed in the central jarrah north-west forest ecosystem in the Wellington District in 2002. These plots were initially monitored for macrofungi in autumn 2003.

In 2008-09, a second round of FORESTCHECK monitoring was conducted on the Wellington grids. Macrofungal monitoring was undertaken from 25 June – 1 July and again from 8-14 July 2008. Surveys were delayed in 2009 due to the late arrival of autumn rains. April and May were unseasonally dry but consistent rains in June increased the moisture level of soil, litter and logs resulting in an SDI of about 50 at the start and 0 at the end of the first survey in June. During the second survey in July, the SDI fluctuated between 0 and 10 (Fig 1). This is consistent with favourable conditions for macrofungal fruit body development and with conditions in previous FORESTCHECK surveys.

During each survey, all nine grids were monitored. All macrofungal species and their abundance were recorded along 2 x 200 m transects on each grid. All new or previously unrecorded taxa were photographed *in situ* and vouchers collected.

Laboratory – voucher specimen examination and processing

In the laboratory, voucher specimens were kept in a refrigerator at 5ºC. Processing of each voucher was completed on the day of collection or the next day. Detailed

descriptions of the macroscopic characters of the fresh specimens were compiled for each voucher collection that represented a putative new species or represented noticeable variation in species concepts already determined. All collections were then air dried at 35º C. At the completion of the field surveys, dried specimens were examined microscopically and detailed measurements of basidia, spore and hyphal structure were undertaken to aid in verifying the identity of a number of species and to confirm a number of unnamed species. A species list has been compiled. In total, 97 voucher collections were made representing 66 species. A total of 43 taxa were determined to be new records for FORESTCHECK. Voucher specimens are currently being entered onto the PERTH (WA Herbarium) database and are housed in the Tony Annells Herbarium at the Manjimup Research Centre.

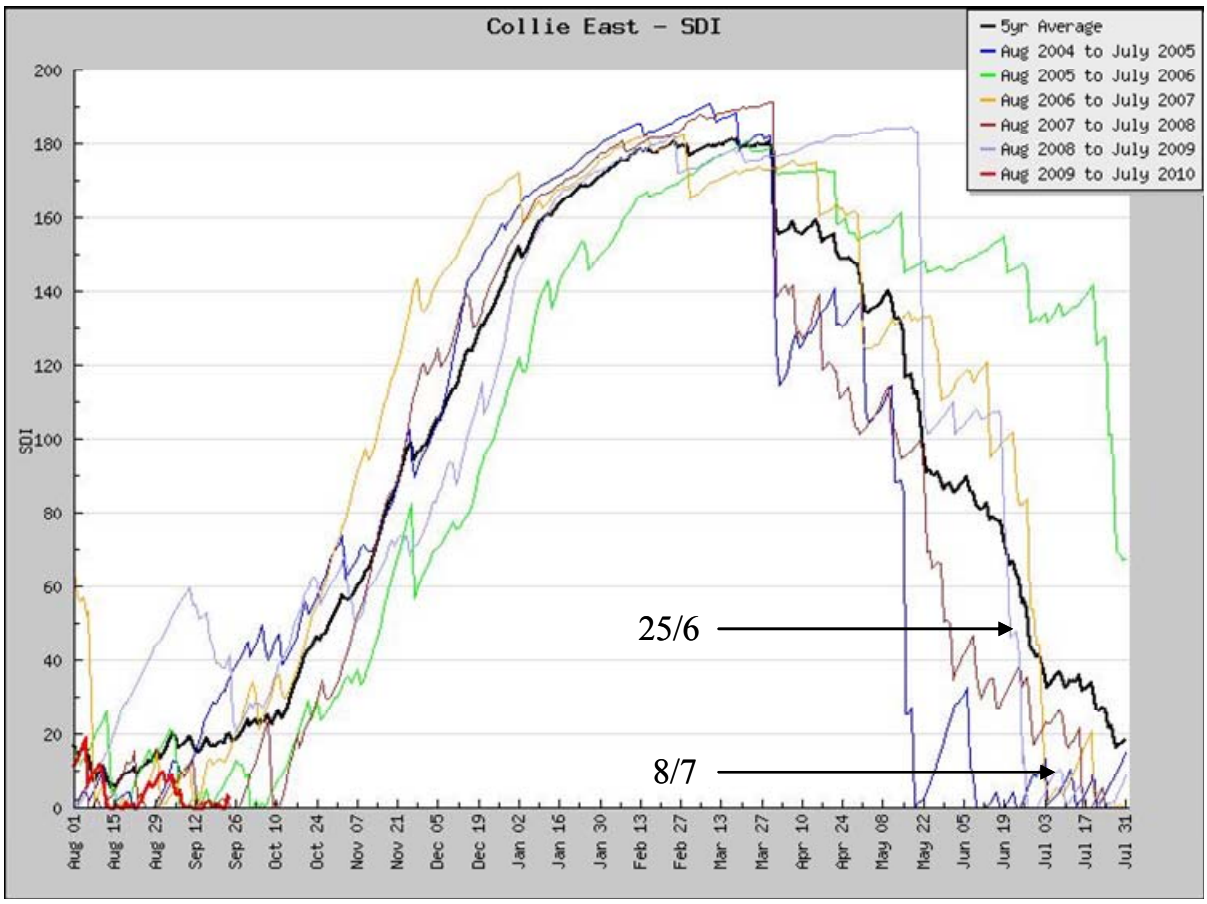


Figure 1. Daily soil dryness index (SDI) from Collie East automatic weather station during the period August 2004 to September 2009 (Bureau of Meteorology). The SDI at the start of each FORESTCHECK macrofungi monitoring period in 2009 is indicated by the black arrows.

Preliminary Results and Discussion

A total of 188 species of fungi and 13,579 fruit bodies were recorded on the Wellington monitoring grids (Appendix 1). Of these, 43 species (22.8%) were recorded for the first time in FORESTCHECK. In the June survey, 114 species were recorded and in the June survey 143 were recorded. Sixty nine species (36.7%) were recorded in both surveys, with 74 and 45 restricted to the June and July surveys respectively (Fig. 2).

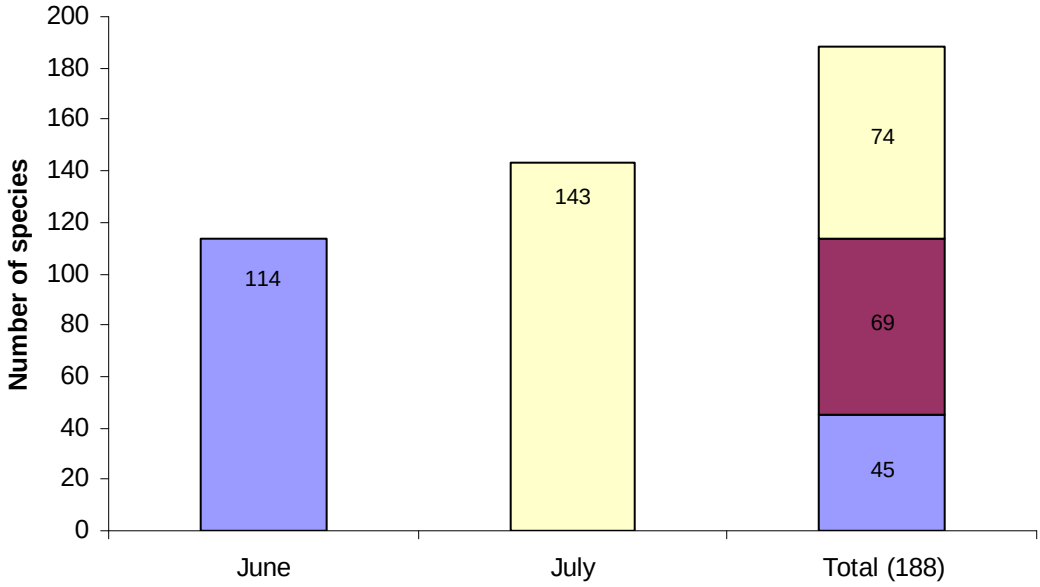


Figure 2. The total number of species recorded in June and July surveys on the Wellington FORESTCHECK monitoring grids in 2009.

Overall the shelterwood grids were the most consistent in terms of numbers of species. There was wide variation within the gap release grids, due mainly to the low number of species recorded in the Edward grid (FC11). Generally the number of species was low in the external reference grids, with the recently burnt Surface grid (FC17) having the least number of species (Fig. 3). The shelterwood treatment recorded the most number of species (118), followed by the gap release treatment (102) then the external reference treatment (95) (Fig. 3).

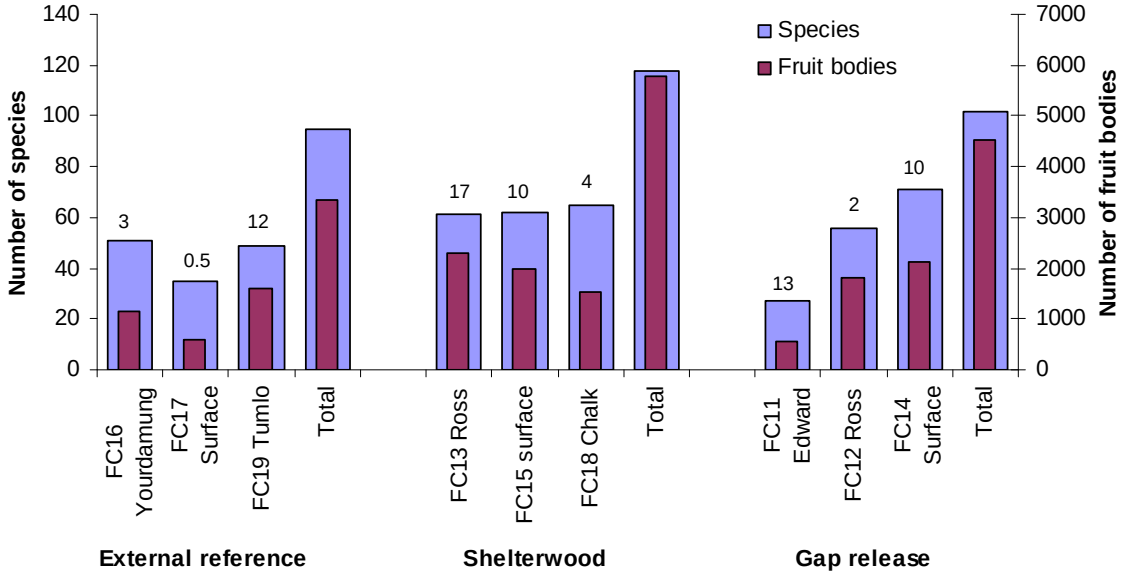


Figure 3. The total number of species recorded on each FORESTCHECK monitoring grid at Wellington in 2009. Numbers above columns indicate the years since the last fire.

The mean species richness and abundance per treatment and the mean number of species fruiting on the various substrates (soil, litter and wood) will be discussed in the following section.

Comparison with previous monitoring at Wellington and other regions

Here the 2009 results from monitoring at Wellington are compared and the initial monitoring results from 2003 as well as those from other regions (Donnelly 2002, 2008, Perth Hills 2004, Wellington East 2005 and Blackwood Plateau 2006) where FORESTCHECK grids are established.

Species richness and abundance

A total of 305 species have been recorded on the Wellington grids, 203 in 2003 and 118 in 2009 (Fig. 4). Only 31% were common to both monitoring sessions. Mean species richness was similar in all treatments in 2003, but varied between treatments in 2009. Overall there appears to be no difference between treatments (Fig. 5). In 2003, the gap release treatment recorded the highest mean number of fruit bodies per grid, followed by the shelterwood. The external control had the lowest mean number of fruit bodies and appeared to be significantly lower than the gap release treatment (Fig. 6). In 2009, the shelterwood treatment had the highest mean number of fruit bodies and the external control was again the lowest, this time significantly lower than the shelterwood. The trend for 2009 is reflected in the overall (total) figures for Wellington (Fig. 6).

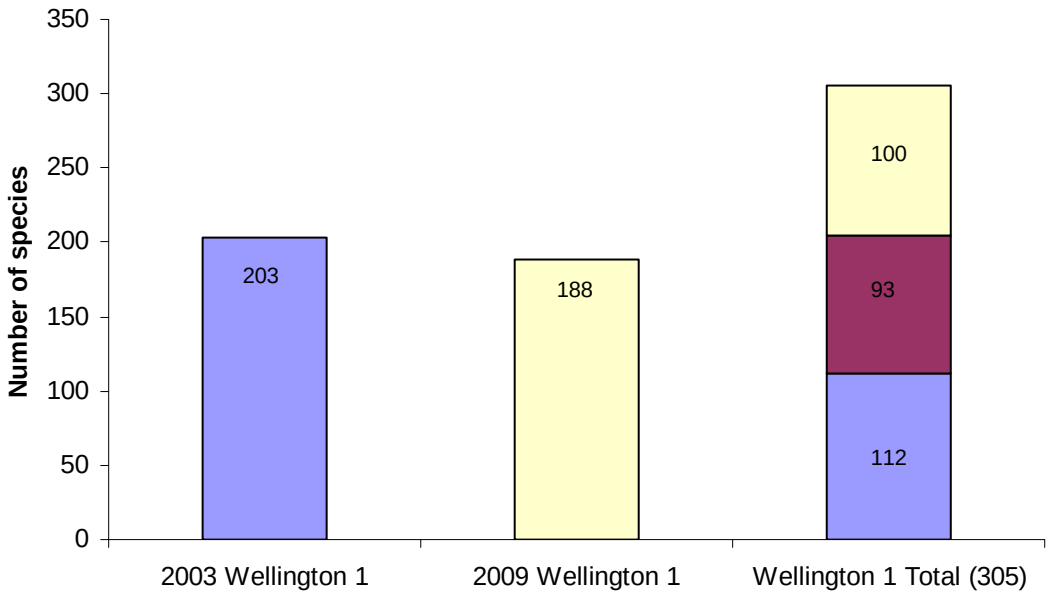


Figure 4. The number of species of macrofungi in FORESTCHECK monitoring at Wellington in 2003 and 2009.

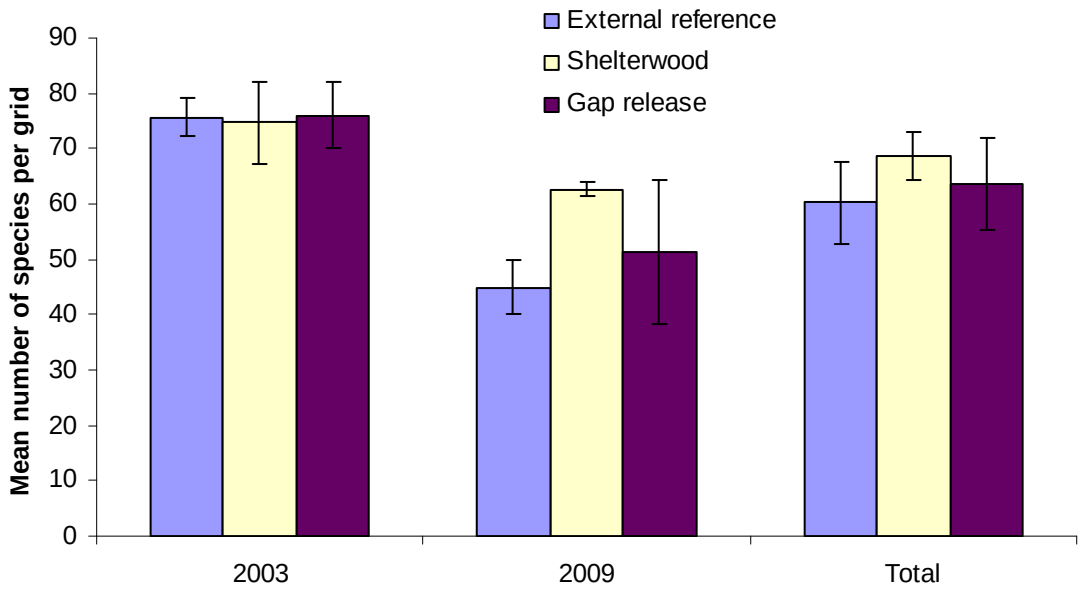


Figure 5. The mean number of species per grid in each treatment at Wellington in 2003 and 2009.

Generally, Wellington appears to be less species rich in macrofungi than other FORESTCHECK locations, except for the Perth Hills, which is generally a drier environment (NB. Donnelly was low in 2002, but only one survey was conducted in that the initial year of FORESTCHECK, compared to the two undertaken in subsequent years) (Fig. 7). Donnelly appears to be the most species rich location, followed by the dry Wellington East location and the wet Blackwood Plateau where similar numbers of fungi were recorded in 2005 and 2006 respectively. Generally abundance has reflected species richness, except at Wellington in 2003, where abundance appeared to be higher in relation to the number of species recorded.

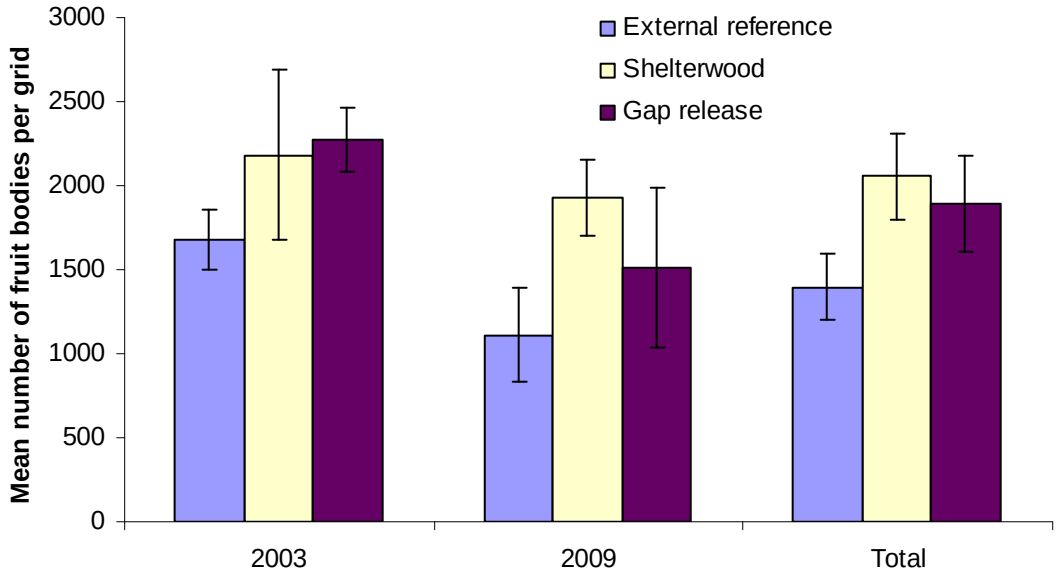


Figure 6. The mean number of fruit bodies per grid in each treatment at Wellington in 2003 and 2009.

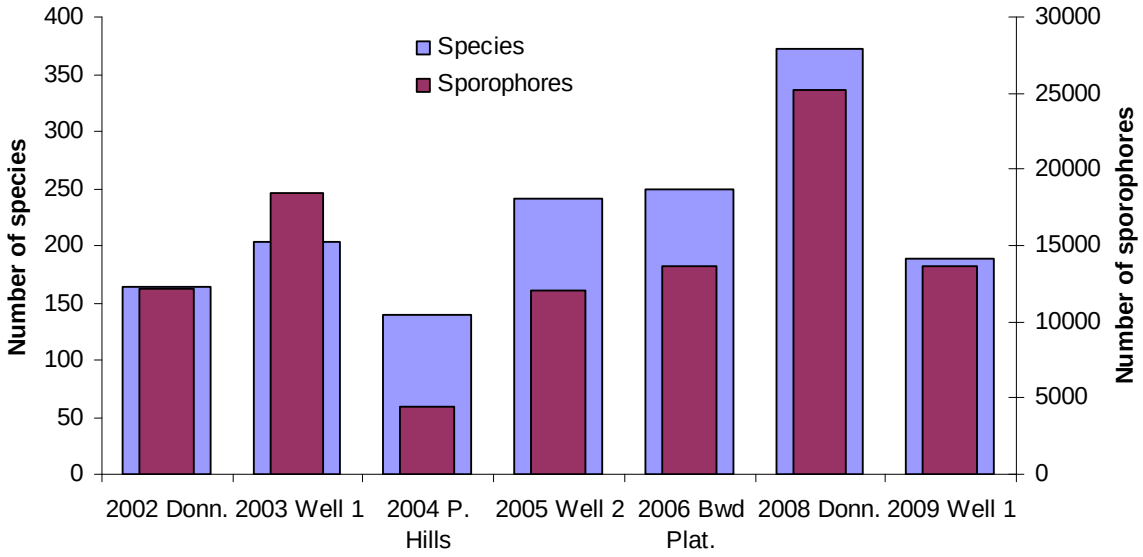


Figure 7. The total number of species and fruit bodies recorded at each Forestcheck location from 2002–2009.

The three major habitats for fungi are soil, litter and wood. In each treatment at Wellington in 2003, the majority of species were recorded fruiting on soil and in 2009 there were markedly fewer species fruiting on soil and numbers were similar to that recorded on wood (Fig. 8). In both years and overall, litter appeared to be the least species rich substrate with no obvious difference in mean species richness per grid between treatments. Mean species richness per grid recorded on wood was lowest on the external reference grids in both years and overall (total), with no difference between gap release and shelterwood treatments. The difference in total species recorded between 2003 and 2009 (21 species) would appear to be accounted for within those species fruiting on soil, and this is also reflected in the mean number of fruit bodies per grid recorded in 2009 (Fig. 9). In 2003, the gap release treatments recorded the highest mean number of fruit bodies on soil and the external grids the lowest. In 2009, the highest mean number of fruit bodies was recorded on wood in all treatments and soil the lowest. The overall (total) mean abundance of fruit bodies was similar on soil and wood and lowest on litter in both the gap release and shelterwood treatments. In the external control all treatments had a similar mean abundance.

A number of mycorrhizal genera were conspicuously absent in 2009. No species of *Russula* or *Lactarius* were recorded in 2009, but in 2003 eight species of *Russula* and four species of *Lactarius* were recorded and they produced a total of 587 fruit bodies. Similarly nine species of *Inocybe* contributed 837 fruit bodies in 2003, but in 2009 only four species of *Inocybe* were recorded and produced only 33 fruit bodies (see Appendix 1). It is not clear why this should be, perhaps it reflects the difference in weather patterns between the two years as *Russula* and *Lactarius* spp. are generally considered early season species and in 2009 the season was very late and perhaps their fruiting patterns were disrupted. However, other common species from usually well represented genera also appeared to be affected. *Cortinarius*, another important

mycorrhizal genera was also less represented in 2009. In 2003, 29 species and 496 fruit bodies were recorded and in 2009 only 19 species and 451 fruit bodies. *Entoloma* is a common saprotrophic genera that fruits on soil, decaying dead organic material in the duff and upper soil horizon. In 2003, 10 species of *Entoloma* and 349 fruit bodies were recorded and in 2003 only one species and eight fruit bodies were recorded. On the other hand, although 25 more species were recorded in 2003, 100 species recorded in 2009 were not recorded in 2003.

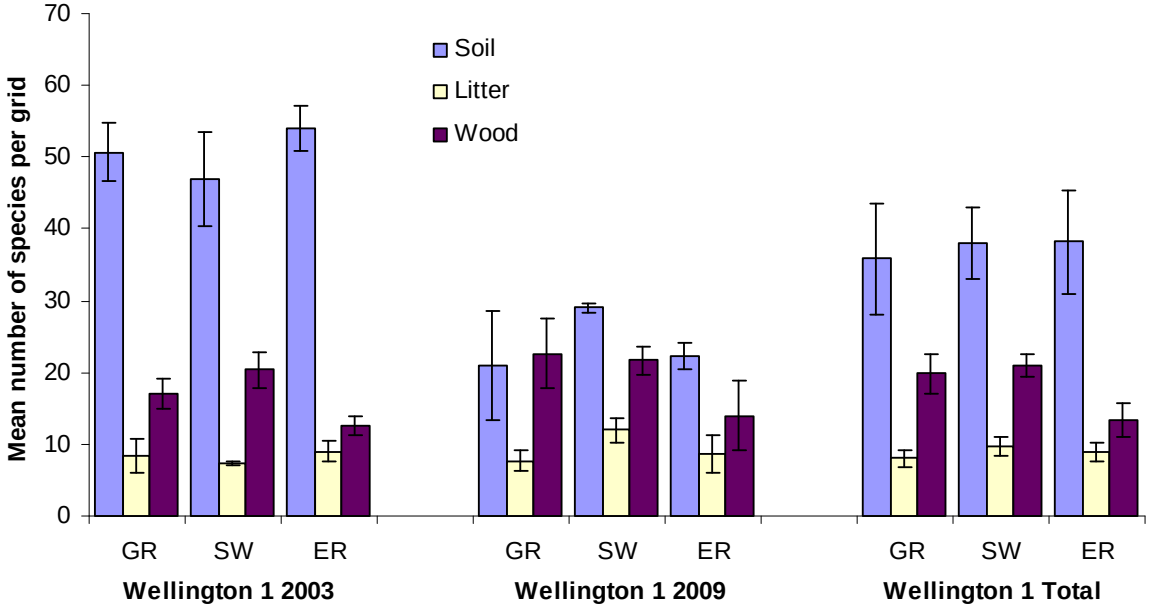


Figure 8. The mean number of species per grid recorded fruiting on soil, litter and wood on the Wellington FORESTCHECK grids in 2003 and 2009.

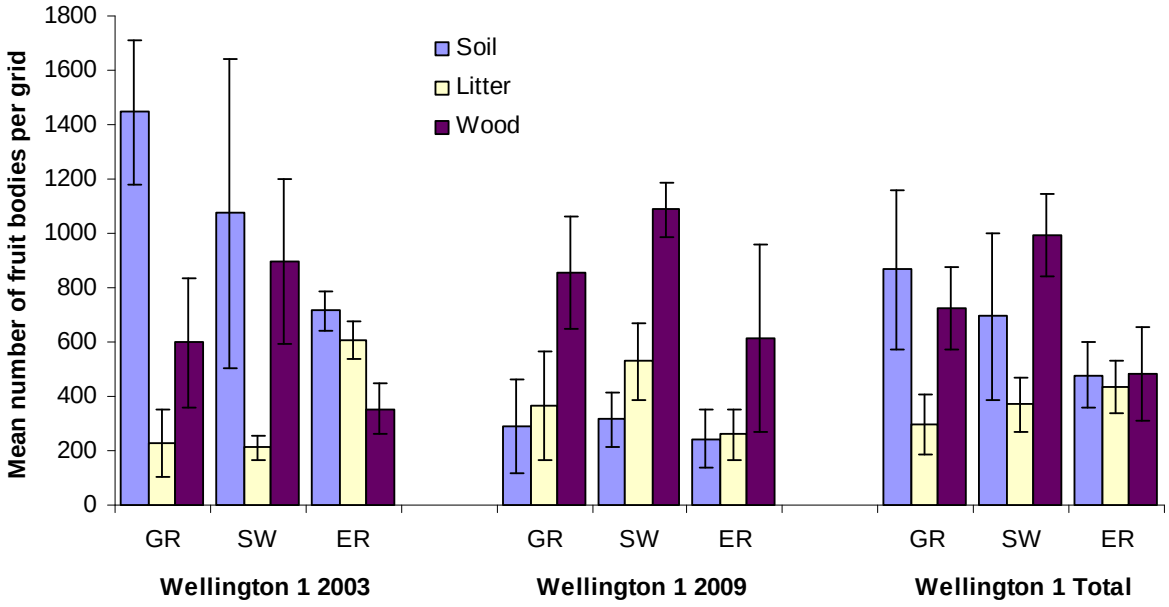


Figure 9. The mean number of fruit bodies per grid recorded fruiting on soil, litter and wood on the Wellington FORESTCHECK grids in 2003 and 2009.

Species accumulation across all locations

The total number of species of macrofungi recorded in FORESTCHECK from 2002-09 is 606. The number of species has steadily increased from 160 by an average of 73 species per year (ranging between 37 and 113). The largest increase was 113 from 2006-08, and the lowest was 37 from 2003-04 (Fig. 10).

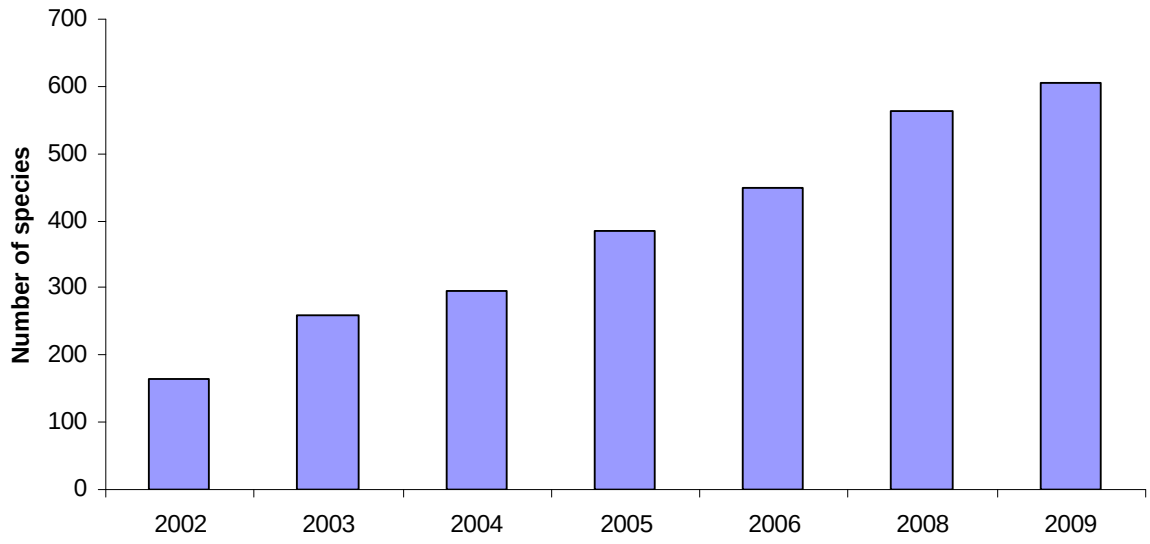


Figure 10. Species accumulation for macrofungi recorded on FORESTCHECK grids from 2002-2009.

Conclusions

The main observations made following monitoring of macrofungi in the southern jarrah at Wellington were:

- A total of 606 species of macrofungi have so far been recorded in FORESTCHECK
- 188 species were recorded at Wellington in 2008, 25 less than in 2003. Of these 100 were not recorded in 2003 and 43 were recorded for the first time in FORESTCHECK.
- In 2009, the highest mean species richness and abundance was recorded in the shelterwood treatment and the lowest was recorded in the external controls.
- The mean species richness and abundance recorded on soil in 2009 was markedly less than in 2003.
- Important and common mycorrhizal species were under represented in 2009 compared to 2003.
- Overall at the Wellington location (2003 and 2009 combined) there appears to be no difference in species richness between treatments, but species abundance is lower in the external reference treatment.
- The number of new species continues to accumulate in each year of FORESTCHECK monitoring.

Data Management

All data has been entered onto a Microsoft Excel worksheet. Species diversity and abundance on each grid and a frequency rating of 1 (rare) to 8 (very common) for each species on each grid 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

APPENDIX 1. A list of species of macrofungi recorded at Wellington 1 in 2009 and 2003

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
46	Agaric creamy white	2	2		4	
0	Agaric unidentified		1		1	
329	Agaric viscid buff, long stem			33	33	
39	*Agaricus austrovinaceous* Grgur. & T.W.May					1
38	*Agaricus* sp. small (R.M. Robinson & R.H. Smith FC42)		1		1	
71	*Agaricus* sp. small flat red stain (R.M. Robinson & R.H. Smith FC123)		1		1	1
240	*Agaricus* sp. small with red brown fibrils (R.M. Robinson & R.H. Smith FC407)	4			4	3
120	*Aleuria rhenana* Fuckel		25		25	42
126	*Aleurina ferruginea* (W. Phillips) W.Y. Zhuang & Korf					113
536	*Aleurodiscus* sp. apricot on B. grandis cone		115	140	255	
206	*Amanita ananiceps* (Berk.) Sacc.					6
186	*Amanita brunneibulbosa* O.K.Mill.					7
283	*Amanita eucalypti* O.K.Mill.					1
269	*Amanita ochrophylloides*	1			1	
788	*Amanita* sp. light brown cap, yellow veil, bulbous base FC1524		6		6	
218	*Amanita* sp. powdery cap and stem with long tapering base (R.M. Robinson, R.H. Smith & K. Pearce FC360)					5
784	*Amanita* sp. small brown, saccate base FC1496	1		3	4	
45	*Amanita* sp. white deeply rooted (R.M. Robinson, R.H. Smith & K. Pearce FC377)					3
531	*Amanita* spp. unidentified	2	1		3	
196	*Amanita umbrinella* E.J.Gilbert & Cleland	47	35		82	17
6	*Amanita xanthocephala* (Berk.) D.A.Reid & R.N.Hilton	6	3		9	98
180	*Armillaria luteobubalina* Watling & Kile		12		12	80
275	*Auriscalpium* sp. fleshy funnel (R.M. Robinson, R.H. Smith & K. Pearce FC503)					11
188	*Austroboletus laccunosus* (Kuntze) T.W.May & A.E.Wood					4
200	*Austroboletus occidentalis* Watling & N.M.Greg.					4
635	*Austrogautieria manjimupana* Trappe & E.L.Stewart BFF0007		10	1	11	
522	*Austropaxillus* aff. *infundibuliformis* (Cleland) Bresinsky & M.Jarosch			1	1	
179	*Austropaxillus macnabbii* (Singer, J. García & L.D. Gómez) Jarosch	8	1	1	10	10
291	*Austropaxillus* sp. orange-brown (R.M. Robinson, R.H. Smith & K. Pearce FC 546)	8	2		10	35
773	Black stereum with purple brown merulioid hymenium FC1458	112			112	
93	*Boletellus ananiceps* (Berk.) Singer					2
103	*Boletellus obscurecoccineus* (Höhn.) Singer		1	1	2	12
29	*Boletus* sp. Boletus speciosa group - dull maroon, light stain (R.M. Robinson & R.H. Smith FC28)					1
253	*Boletus* sp. Boletus speciosa group - intense blue stain (R.M. Robinson & R.H. Smith FC439)	2			2	6
210	*Boletus* sp. Boletus speciosa group - orange pores (R.M. Robinson, R.H. Smith & K. Pearce FC344)					1
216	*Boletus* sp. brown cap yellow pores which stain blue (R.M. Robinson, R.H. Smith & K. Pearce FC356)					2
225	*Boletus* sp. creamy pale yellow (R.M. Robinson, R.H. Smith & K. Pearce FC373)					1
774	*Boletus* sp. light brown cap yellow pores which stain blue FC1463	3		1	4	
195	*Boletus* sp. mustard brown cap with brown staining flesh (R.M. Robinson FC320)					1
193	*Boletus* sp. purple brown (R.M. Robinson FC315)					2
49	*Boletus* sp. red pores and stem		1		1	
607	*Boletus* sp. yellow brown, stains blue		4		4	
208	*Boletus* sp. yellow-brown cracked cap with white pores (R.M. Robinson, R.H. Smith & K. Pearce FC370)					3
99	*Boletus* sp. yellow-red with blue staining flesh (R.M. Robinson & R.H. Smith FC398)	4	3		7	17
503	*Botryobasidium* sp. creamy grey crust on charcoal and leaves (R.M. Robinson & R.H. Smith FC923)			10	10	
304	*Byssomerulius corium* (Pers. : Fr.) Parmasto	113			113	7
9	*Calocera guepinioides* Berk.	782	1170	921	2873	1758
187	*Campanella gregaria* Bougher		150	20	170	105
364	*Chlorociboria aeruginascens* subsp. *australis* P.R. Johnst., FC1227		13		13	
81	*Clavulina* aff. *cinerea* (Bull. : Fr.) J.Schröt.					181
344	*Clavulina* sp. cream, fluffy tips			2	2	
140	*Clavulina* sp. pink-buff coral (R.M. Robinson & R.H. Smith FC212)					285
197	*Clitocybe semi-occulta* "large"		1		1	57
197	*Clitocybe semiocculta* Cleland	3			3	
170	*Clitocybula* sp. moist yellow brown (R.M. Robinson, R.H. Smith & K. Pearce FC554)					13

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
15	*Coltricia cinnamomea* (Jacq.) Murrill	16		2	18	182
532	*Coltriciella dependens* (Berk. & M.A.Curtis) Murrill	12	5	70	87	
32	*Coprinus* sp. (R.M. Robinson & R.H. Smith FC33)					6
394	*Coprinus* sp. roo poo		1		1	
757	Corticioid blue grey crust WFM420	17	34	60	111	
615	Corticioid creamy grey maze	3			3	
454	Corticioid creamy jagged ridged crust (R.M. Robinson, R.H. Smith & K. Syme FC795)		18		18	
787	Corticioid creamy yellow flat merulioid crust FC1510	10			10	
373	Corticioid creamy yellow merulioid skin on jarrah stick (R.M. Robinson FC1530)			6	6	
776	Corticioid grey pink lumps on jarrah stick FC1475			30	30	
678	Corticioid khaki crust FC1220		2		2	
779	Corticioid olive pinkish grey crust FC1482		10		10	
683	Corticioid thin creamy maze BFF0065 (Sp. 454a) FC1250		15		15	
775	Corticioid yellow ochre tuberculate crust on B. grandis cone FC1474		50	5	55	
158	*Cortinarius* aff. *microarcherii* Cleland					7
207	*Cortinarius australiensis* (Cleland & Cheel) E.Horak		2	8	10	10
173	*Cortinarius basirubescens* (large brown) Cleland & J.R.Harris	1		1	2	33
173	*Cortinarius basirubescens* (red cap) Cleland & J.R.Harris					28
293	*Cortinarius rotundisporus* Cleland & Cheel					11
357	*Cortinarius sinapicolor* Cleland		2		2	
771	*Cortinarius* sp. bright lavender gills FC1446	6			6	
421	*Cortinarius* sp. brown cap with lilac white stem (R.M. Robinson & J. Fielder FC1095)		3		3	
279	*Cortinarius* sp. brown fibrillose (R.M. Robinson, R.H. Smith & K. Pearce FC521)					37
244	*Cortinarius* sp. brown umbonate (R.M. Robinson & R.H. Smith FC416)					
346	*Cortinarius* sp. brown with grey-lavender gills					
73	*Cortinarius* sp. brown with purplish tints (R.M. Robinson & R.H. Smith FC434)					31
466	*Cortinarius* sp. brown with white margin (R.M. Robinson, R.H. Smith & K. Syme FC835)					
154	*Cortinarius* sp. chestnut (R.M. Robinson & J. Fielder FC 1050)					
382	*Cortinarius* sp. chestnut cap with yellow margin and yellow flesh (R.M. Robinson & R.H. Smith FC774)					
500	*Cortinarius* sp. chestnut large (R.M. Robinson & R.H. Smith FC918)					
597	*Cortinarius* sp. chestnut with banded stem					
299	*Cortinarius* sp. chocolate brown with mustard gills (R.M. Robinson & K. Pearce FC578)					14
201	*Cortinarius* sp. cream cap with orange gills (R.M. Robinson FC327)	50	14	27	91	16
485	*Cortinarius* sp. creamy white with veil on stem (R.M. Robinson, R.H. Smith & K. Syme FC884)		2		2	
453	*Cortinarius* sp. decurrent gills and deep stem with double ring (R.M. Robinson, R.H. Smith & K. Syme FC790)					
611	*Cortinarius* sp. dry, purple grey					
334	*Cortinarius* sp. fawn brown					
689	*Cortinarius* sp. FC1247					
252	*Cortinarius* sp. glutinous cap with rooting stem (R.M. Robinson & R.H. Smith FC431)					11
374	*Cortinarius* sp. golden tan (R.M. Robinson & R.H. Smith FC748)					
348	*Cortinarius* sp. golden tan cap with long stem (R.M. Robinson & J.E.Neal FC669)	18	30		48	
257	*Cortinarius* sp. honey brown (R.M. Robinson & R.H. Smith FC454)					2
282	*Cortinarius* sp. honey brown domed cap with long stem (R.M. Robinson, R.H. Smith & K. Pearce FC529)					23
675	*Cortinarius* sp. large brown scaly BFF89					
707	*Cortinarius* sp. large brown-orange, banded stem BFF130a&b					
369	*Cortinarius* sp. large red brown (R.M. Robinson & R.H. Smith FC738)					
646	*Cortinarius* sp. light brown, frosty BFF0058					
379	*Cortinarius* sp. lilac brown cap with yellow gills (R.M. Robinson & R.H. Smith FC767)					
146	*Cortinarius* sp. Myxacium orange-brown viscid cap (R.M. Robinson & R.H. Smith FC223)					1
223	*Cortinarius* sp. orange					
223	*Cortinarius* sp. orange (R.M. Robinson & J. Fielder FC1187)	5			5	
212	*Cortinarius* sp. orange brown (R.M. Robinson, R.H. Smith & K. Pearce FC371)					13
205	*Cortinarius* sp. orange cap with yellow flesh and yellow gills (R.M. Robinson FC331)					9
404	*Cortinarius* sp. orange cap, with white floccose stem (R.M. Robinson & K. Syme WFM45)					
230	*Cortinarius* sp. orange viscid					
251	*Cortinarius* sp. orange-brown 2					
125	*Cortinarius* sp. Phlegmacium purple-grey (R.M. Robinson & R.H. Smith FC183)					6

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
596	*Cortinarius* sp. pink brown cap with apressed fibrils (R.M. Robinson & J. Fielder FC1052)					
423	*Cortinarius* sp. pink-brown cap with sticky white stem					
778	*Cortinarius* sp. pinkish brown, pale stem FC1480/1483		13		13	
98	*Cortinarius* sp. pointy cap (R.M. Robinson & R.H. Smith FC134)	2			2	8
627	*Cortinarius* sp. purple brown with glutinous stem (R.M. Robinson & J. Fielder FC1183)					
515	*Cortinarius* sp. red brown cap with slender lavender stem (R.M. Robinson, R.H. Smith & K. Syme FC952)					
626	*Cortinarius* sp. red brown pointy cap (R.M. Robinson & J. Fielder FC1181)					
579	*Cortinarius* sp. red brown, mauve stem					
754	*Cortinarius* sp. robust yellow WFM411					
121	*Cortinarius* sp. slender brown (R.M. Robinson & R.H. Smith FC179)					
131	*Cortinarius* sp. slender lilac (R.M. Robinson & R.H. Smith FC194)					5
670	*Cortinarius* sp. small fibrillose in moss BFF 84					
232	*Cortinarius* sp. small orange viscid cap (R.M. Robinson & R.H. Smith FC390)					1
609	*Cortinarius* sp. small purple umbonate cap (R.M. Robinson & J. Fielder FC1114)					
673	*Cortinarius* sp. small red-brown with tan margin BFF117					
267	*Cortinarius* sp. snowy chestnut (R.M. Robinson & R.H. Smith FC478)					107
608	*Cortinarius* sp. sticky creamy beige					
303	*Cortinarius* sp. stubby domes (R.M. Robinson & K. Pearce FC585)					4
432	*Cortinarius* sp. tan cap with chocolate gills (R.M. Robinson & K. Syme WFM110)					
772	*Cortinarius* sp. tiny cream FC1453	4			4	
171	*Cortinarius* sp. vinaceous lilac (R.M. Robinson, R.H. Smith & K. Pearce FC543)		9		9	
605	*Cortinarius* sp. viscid orange cap, yellow stem					
96	*Cortinarius* sp. viscid pink (R.M. Robinson & R.H. Smith FC457)	1	7		8	32
648	*Cortinarius* sp. viscid purple-brown WFM310					
270	*Cortinarius* sp. viscid red brown cap with white stem (R.M. Robinson & R.H. Smith FC487)					
789	*Cortinarius* sp. viscid violet cap FC1529			2	2	
273	*Cortinarius* sp. white with deep rooting stem (R.M. Robinson, R.H. Smith & K. Pearce FC498)					4
738	*Cortinarius* sp. wrinkled witches hat FC1371					
780	*Cortinarius* sp. yellow and lavender FC1485	4	8	15	27	
231	*Cortinarius* sp. yellow brown cap with tan margin (R.M. Robinson & R.H. Smith FC389)					4
492	*Cortinarius* sp. yellow cap with yellow stem (R.M. Robinson, R.H. Smith & K. Syme FC889)					
199	*Cortinarius* sp. yellow orange (R.M. Robinson FC325)					12
237	*Cortinarius* sp. yellow with orange brown fibrils (R.M. Robinson & R.H. Smith FC403)	115	3	3	121	4
785	*Cortinarius* sp. yellow, yellow-orange gills, yellow stem FC1490			8	8	
354	*Cortinarius* sp. yellow-brown cap with lavender gills and stem (R.M. Robinson & R.H. Smith FC698)		6		6	
255	*Cortinarius* sp. yellow-orange					
184	*Cortinarius* spp. (unidentified)	1	8	7	16	69
7	*Cortinarius sublargus* Cleland					11
584	*Cortinarius symeae* (Bougher, Fuhrer & E.Horak) Peintner					
171	*Cortinarius vinaceolamellatus* Cleland					10
290	*Cortinarius violaceus* (L. : Fr.) Gray					5
696	*Cortinarius walpolensis* Francis & Bougher (Truffle) FC1289					
676	*Cortinarui*saff. *lavendulensis* Cleland BFF92					
16	*Cotylidia undulata* (Fr.) P. Karst.					4
118	*Crepidotus nephrodes* (Berk. & M.A.Curtis) Sacc.	87	85		172	69
619	*Crepidotus* sp. ginger with white margin and gills FC1146					
323	*Crepidotus* sp. rusty brown suede (R.M. Robinson & L. McGurk FC599)	201	1	3	205	
83	*Crepidotus* sp. small creamy tan (R.M. Robinson & R.H. Smith FC99)					
21	*Crepidotus* sp. small white					
439	*Crepidotus* sp. tiny ginger-white cap with white gills see sp. 619		100		100	
686	*Crepidotus* sp. white gelatinised FC1239		30	1	31	
241	*Crepidotus variabilis* (Pers. : Fr.) P.Kumm.	175	214	10	399	
148	*Crucibulum laeve* (Huds. : Pers.) Kambly	5	6	42	53	49
307	*Cyathus* sp. (R.M. Robinson & K. Pearce FC591)					19
296	*Cyathus* sp. roo poo (R.M. Robinson & K. Pearce FC559)					6
625	aff *Cyphella* sp. tiny white cups - on marri nut FC1174					
570	aff. *Cystoderma* sp. small brown suede cap					

Sp #	Species	Treatment (2009) GR	SW	ER	2009 Total	2003 Total
672	*Cystolepiota* sp. alba BFF116					
289	*Dacrymyces capitatus* Schwein.					144
138	*Daldinia concentrica* (Bolton) Ces. & De Not. (D. childiea?)	9			9	
721	Dendritic mycelium BFF180					
147	*Dermocybe austroveneta* (Cleland) M.M.Moser & E.Horak					
340	*Dermocybe clelandii* "mini" (A.H.Sm.) Grgur.					
57	*Dermocybe clelandii* "olive brown"		14		14	25
57	*Dermocybe clelandii* (white mycelium) (A.H.Sm.) Grgur.	2	24	29	55	
172	*Dermocybe clelandii* (yellow mycelium - glutinous cap) (A.H.Sm.) Grgur.	11			11	33
172	*Dermocybe clelandii* (yellow mycelium) (A.H.Sm.) Grgur.	24	30	9	63	
340	*Dermocybe clelandii* 'mini, yellow mycelium'					
781	*Dermocybe clelendii* yellow mycelium, citrus gills FC1487	15	1	11	27	
768	*Dermocybe erethyrocephala* WFM466					
110	*Dermocybe kula* Grgur.		50		50	
168	*Dermocybe* sp. jarrah (R.M. Robinson & R.H. Smith FC301)					
769	*Dermocybe* sp. small maroon WFM467					
328	*Dermocybe* sp. small olive					
486	*Dermocybe* sp. yellow stipe with yellow mycelium (R.M. Robinson, R.H. Smith & K. Syme FC881)					
124	*Dermocybe* sp. yellow-olive (R.M. Robinson & R.H. Smith FC182)		1	1	2	
40	*Dermocybe* sp.chestnut					
310	*Dermocybe splendida* E.Horak					2
449	*Descolea maculata* Bougher					
123	*Discinella terrestris* (Berk. & Broome) Denni					672
622	*Discinella terrestris* (Berk. & Broome) Denni white form (R.M. Robinson & R. Wittkuhn BFF107)	10			10	
724	Discomycete blue-green flat discs					
729	Discomycete light brown FC1349					
243	Discomycete orange discs on marri nuts (R.M. Robinson & R.H. Smith FC798)		80		80	
294	Discomycete small yellow on *Banksia grandis* leaves (R.M. Robinson, R.H. Smith & K. Pearce FC557)		22	5	27	170
644	Discomycete tiny bright yellow on nuts and twigs BFF0047					
508	*Discomycete* tiny cream disks on leaves					
462	Discomycete tiny white on marri nut					
528	Discomycete yellow discs on Emu poo					
681	Discomycete yellow stalked on marri nuts FC1218					
409	*Entoloma incanum* (Fr. : Fr.) Hesler					
31	*Entoloma moongum* Grgur.					4
410	*Entoloma* sp. blue-black, marginate gills (R.M. Robinson & K. Syme WFM53)					
194	*Entoloma* sp. brown (R.M. Robinson FC318)					83
198	*Entoloma* sp. brown black cap tan gills blue stem (R.M. Robinson FC323)					4
530	*Entoloma* sp. brown black cap with marginate gills and bluish grey stem (R.M. Robinson, R.H. Smith & K. Syme FC1001)					
227	*Entoloma* sp. brown black cap with tan gills (R.M. Robinson, R.H. Smith & K. Pearce FC378)					
222	*Entoloma* sp. brown black with grey white gills (R.M. Robinson, R.H. Smith & K. Pearce FC374)					
347	*Entoloma* sp. brown striate cap (R.M. Robinson & J.E.Neal FC666)					
471	*Entoloma* sp. buff with dimple					
406	*Entoloma* sp. conical, brown					
30	*Entoloma* sp. creamy white (R.M. Robinson & R.H. Smith FC29)	2	4	2	8	137
167	*Entoloma* sp. dark grey cap with blue gill edge (R.M. Robinson & R.H. Smith FC410)					14
699	*Entoloma* sp. fawn scurfy cap FC1285					
235	*Entoloma* sp. grey brown cap with grey stem (R.M. Robinson & R.H. Smith FC399)					55
556	*Entoloma* sp. grey brown pixie					
272	*Entoloma* sp. grey brown with dimple (R.M. Robinson, R.H. Smith & K. Pearce FC497)					29
77	*Entoloma* sp. grey-brown with brown stem (R.M. Robinson & R.H. Smith FC92)					
641	*Entoloma* sp. grey-brown with silver-blue stem BFF0031					
25	*Entoloma* sp. grey-brown/blue stem (R.M. Robinson & R.H. Smith FC23)					
583	*Entoloma* sp. khaki brown cap with white stem (R.M. Robinson & J. Fielder FC1025)					
430	*Entoloma* sp. lilac					
568	*Entoloma* sp. long rooting stem, on burnt ground					
741	*Entoloma* sp. orange green FC1451					

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
97	*Entoloma* sp. pure white (R.M. Robinson & R.H. Smith FC133)					
407	*Entoloma* sp. rosy - not an Entoloma (non angular spores) WFM58					
555	*Entoloma* sp. small olive brown					
278	*Entoloma* sp. suede grey brown cap with dimple (R.M. Robinson, R.H. Smith & K. Syme FC996)					3
606	*Entoloma* sp. tall velvet grey brown cap					
589	*Entoloma* sp. tall grey conical (R.M. Robinson & J. Fielder FC1042)					
135	*Entoloma* sp. tall, grey-brown (R.M. Robinson & R.H. Smith FC207)					17
514	*Entoloma* sp. very large brown grey (R.M. Robinson, R.H. Smith & K. Syme FC951)					
654	*Entoloma* sp. WFM327					
604	*Entoloma* sp.FC1092		3		3	
274	*Entoloma viridomarginatum* (Cleland) E.Horak					3
159	*Exidia glandulosus* (Bull. : Fr.) Fr.	53	15	3	71	20
41	*Fistulina spiculifera* (Cooke) D.A.Reid	7	1	4	12	9
91	*Fistulinella mollis* Watling					
19	*Fomitopsis lilacinogilva* (Berk.) J.E.Wright & J.R.Deschamps	20	22	5	47	1
434	*Fuligo septica* (L.) F.H.Wigg.					
136	*Fuscoporia gilva* (Schwein.) T.Wagner & M.Fisch.	9	2		11	7
11	*Galerina* sp. hanging gills and conic (R.M. Robinson & R.H. Smith FC11)	337	131	23	491	853
58	*Galerina* sp. small cap, eccentric stipe - on wood (R.M. Robinson & R.H. Smith FC63)	33	67	81	181	368
42	*Galerina* sp. small on bark					
630	*Galerina* sp. tiny tan (R.M. Robinson & J. Fielder FC1192)					
228	*Geastrum* sp.					
546	*Geastrum* sp.					
533	*Geoglossum* aff. *umbratile* Sacc. FC997					
442	*Geopora* (*Sepultaria*) sp. hollow spheres (R.M. Robinson WFM126)					
742	*Geopyxis* sp. tan spheres BFF186					
8	*Gymnopilus allantopus* (Berk.) Pegler	91	116	70	277	1065
690	*Gymnopilus ferruginosus* B.J.Rees					
365	*Gymnopilus junonius* (Fr. : Fr.) P.D.Orton					
43	*Gymnopilus* sp.					
400	*Gymnopilus* sp. (R.M. Robinson WFM43)					
663	*Gymnopilus* sp. big gym					
105	*Gymnopilus* sp. chestnut cap with forked gills (R.M. Robinson & R.H. Smith FC147)					
591	*Gymnopilus* sp. purple maroon (R.M. Robinson & J. Fielder FC1078)					
517	*Gymnopilus* sp. red cap with yellow gills and yellow stem (R.M. Robinson, R.H. Smith & K. Syme FC957)					
174	*Gymnopilus* sp. red cap yellow gills red stem (R.M. Robinson, R.H. Smith & K. Pearce FC314)					
26	*Gymnopilus* sp. reddish cap, orange gills (R.M. Robinson & R.H. Smith FC487)					
85	*Gymnopilus* sp. slender (R.M. Robinson & R.H. Smith FC110)	411	277	72	760	567
633	*Gymnopus dryophilus* (Bull. : Fr.) Murrill		1		1	
217	*Gyroporus* aff. *cyanescens* (Bull. : Fr.) Quél.					1
292	*Gyroporus variabilis* sensu Bougher & Syme					1
600	*Hebeloma aminophilum* R.N.Hilton & O.K.Mill.					
498	*Hebeloma* sp. small (R.M. Robinson & R.H. Smith FC922)					
433	*Hebeloma westraliensis* Bougher, Tommerup & Malajczuk					
56	*Heterotexus peziziformis* (Berk.) Lloyd	134	380	292	806	124
422	*Hohenbuehelia bingarra* Grgur.	285		32	317	
339	*Hohenbuehelia petaloides (*Bull. : Fr.) Schulzer - on ground (check against H. carbonaria) FC647					
645	*Hohenbuehelia* sp. BFF0051		2		2	
541	*Hohenbuehelia* sp. dark brown					
343	*Hohenbuehelia* sp. soft brown					
480	*Hydnellum* sp. orange tipped spines (R.M. Robinson, R.H. Smith & K. Syme FC829)					
87	*Hydnellum* sp. red brown (R.M. Robinson & R.H. Smith FC113)					19
704	*Hydnellum* sp. rubber FC1310					
698	Hydnoid "mouldy marshmallow" FC1284					
539	Hydnoid creamy white resupinate (R.M. Robinson & K. Syme WFM160)					
300	*Hydnoplicata convoluta* (McAlpine) Trappe & Claridge					3
297	*Hydnum repandum* L. : Fr.					13

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
380	*Hydnum* sp. chestnut (R.M. Robinson & J. Fielder FC1158)					
476	*Hygrocybe* aff. *astatogala*					
381	*Hygrocybe cantharellus* (Schwein. : Fr.) Murrill					
317	*Hygrocybe conica* (Schaeff. : Fr.) P.Kumm.					
744	*Hygrocybe miniata* (Fr. : Fr) P.Kumm. BFF218					
445	*Hygrocybe polychroma* Bougher & A.M.Young					
734	*Hygrocybe* sp. chrome yellow - large FC1403					
408	*Hygrocybe* sp. chrome yellow WFM 59					
613	*Hygrocybe* sp. dry, orange brown					
599	*Hygrocybe* sp. olive yellow (R.M. Robinson & J. Fielder FC1058)					
732	*Hygrocybe* sp. pallid with orange stem FC1426 - H. virguinea var. virginea?					
656	*Hygrocybe* sp. steel grey, dries green/yellow WFM369					
548	*Hygrocybe* sp. translucent white WFM175 - echinate spores					
616	*Hygrocybe* sp. viscid, red, purple stem					
564	*Hygrocybe* sp. yellow red					
631	*Hygrocybe* sp. yellow with orange stem (R.M. Robinson & J. Fielder FC1196)					
122	*Hygrocybe* sp. yellow-orange (R.M. Robinson & R.H. Smith FC858)					
281	*Hygrocybe virginea*(Wulfen : Fr.) P.D. Orton & Watling var. *virginea*					2
416	*Hymenochaete semistupposa* Petch					
758	*Hymenochaete* sp. brown with yellow margin WFM421					
711	*Hymenochaete* sp. chocolate BFF140		4		4	
680	*Hymenochaete* sp. chocolate brown FC1224					
691	*Hyphodontia barba-jovis* (Bull.) J. Erikss. FC1265		31		31	
100	*Hypholoma australe* O.K.Mill.	31	37		68	166
595	*Hypholoma sublateritium* (Fr.) Quél. sp. H. aurantiaea?? (R.M. Robinson & J. Fielder FC1049)					
419	*Hypocrea gelatinosa* (Tode) Fr.			10	10	
130	*Hypomyces* cf. *aurantius* (Pers.) Fuckel (*Cladobotryum varium*)					
108	*Hypomyces chrysospermus* Tul. & C. Tul.	4	1		5	22
640	*Hypomyces* sp - on *Lactarius* sp (*L. clarkeae*) BFF0027					
697	*Hypomyces* sp. - on *Ramaria* sp. FCxxxx					
268	*Hypomyces* sp. brown/yellow-orange (on *C. cinnamoni*) FC483					
726	*Hypomyces* sp. creamy pimples on Coltricia FC1329					
713	*Hypomyces* sp. magenta on skin fungus (sp. 714) BFF146					
730	*Hypomyces* sp. on Crepidotus FC1388					
750	*Hypomyces* sp. on *Pisolithus* WFM385					
581	*Hysterangium inflatum* Rodway 'olive gleba' BFF199					
592	*Hysterangium* sp. olive gleba (R.M. Robinson & J. Fielder FC1077)			1	1	
516	*Ileodictyon gracile* Berk.					
1	*Inocybe australiensis* Cleland & Cheel					
115	*Inocybe austrofibrillosa* Grgur.					26
487	*Inocybe* sp. brown fibrillose cap with yellow gills (R.M. Robinson, R.H. Smith & K. Syme FC883)					
378	*Inocybe* sp. chocolate umbonate (R.M. Robinson & R.H. Smith FC764)					
137	*Inocybe* sp. creamy-brown (R.M. Robinson & R.H. Smith FC209)					
487	*Inocybe* sp. fibrillose cap, pink stem (R.M. Robinson & K. Syme FC1498)			13	13	
48	*Inocybe* sp. grey (R.M. Robinson & R.H. Smith FC52)					11
444	*Inocybe* sp. large orange-brown scaly cap					
65	*Inocybe* sp. large scaly cap (R.M. Robinson & R.H. Smith FC74)			2	2	7
398	*Inocybe* sp. large scaly umbonate cap (R.M. Robinson & K. Syme WFM36)					
484	*Inocybe* sp. large umbonate firillosecap with yellow-tan gills (R.M. Robinson, R.H. Smith & K. Syme FC880)					
226	*Inocybe sp.* orange brown Not an Inocybe, no cystidia					
113	*Inocybe* sp. radially fibrillose with pink stem (R.M. Robinson & R.H. Smith FC162)			5	5	10
20	*Inocybe* sp. scaly cap (R.M. Robinson, R.H. Smith & K. Pearce FC334)					267
169	*Inocybe* sp. shaggy stem (R.M. Robinson & R.H. Smith FC306)					
162	*Inocybe* sp. small light brown, fibrillose (R.M. Robinson & R.H. Smith FC261)					3
53	*Inocybe* sp. tan skirt (R.M. Robinson & R.H. Smith FC60)					484
722	*Inocybe* sp. tan square cap BFF181					
286	*Inocybe* sp. umbonate, shaggy (R.M. Robinson & K. Pearce FC576)			13	13	28

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
399	*Inocybe* sp. very large fibrillose cap					
203	*Inocybe violaceocaulis* Matheny & Bougher					1
719	*Isaria* sp. yellow clubs BFF160					
74	*Laccaria* aff. *masoniae* G.Stev.	24	170	9	203	2881
36	*Laccaria lateritia* Malençon	12	85		97	56
765	*Laccaria* sp. burnt orange WFM460			154	154	
384	*Laccocephalum basilapiloides* McAlpine & Tepper					
542	*Laccocephalum sclerotinium* (Rodway) Núñez & Ryvarden					
383	*Laccocephalum tumulosum* (Cooke) Núñez & Ryvarden					
221	*Lactarius clarkeae* Cleland					10
142	*Lactarius eucalypti* O.K.Mill. & R.N.Hilton					6
215	*Lactarius* sp. cream custard (R.M. Robinson, R.H. Smith & K. Pearce FC365)					36
245	*Lactarius* sp. creamy yellow (R.M. Robinson & R.H. Smith FC417)					140
478	*Laetiporus potentosus* (Berk.) Rajchenb.					
737	*Lanzia lanaripes* (Dennis) Spooner FC1369					
335	*Lentinellus* sp. brown cap, saw-toothed gills					
457	*Lentinellus* sp. brown fan, white saw-gills					
468	*Lentinellus* sp. brown lobed, hirsute, brown gills					
764	*Lentinellus* sp. stalked on burnt ground WFM456		14		14	
185	*Lepiota* aff. *cristata* (Alb. & Schwein. : Fr.) P.Kumm.		2		2	
76	*Lepiota alopochroa* (Berk. & Broome) Sacc.	1		2	3	2
475	*Lepiota aspera* (Pers. : Fr.) Quél. Agaric creamy brown scaly cap, white bifurcate gills					
271	*Lepiota haemorrhagica* Cleland					7
735	*Lepiota* sp. amber drops FC1398	12			12	
82	*Lepiota* sp. cream-grey (R.M. Robinson & R.H. Smith FC98)					
264	*Lepiota* sp. creamy grey (R.M. Robinson & R.H. Smith FC471)					22
760	*Lepiota* sp. creamy grey no ring WFM448					
603	*Lepiota* sp. creamy pink					
246	*Lepiota* sp. purple grey (R.M. Robinson & R.H. Smith FC419)					6
728	*Lepiota* sp. red-brown FC1337					
166	*Lepiota subcristata* Cleland	7	2	7	16	39
214	*Leucopaxillus lilacinus* Bougher					6
112	*Lichenomphalia chromacea* (Cleland) Redhead, Lutzoni, Moncalvo & Vilgalys		3	11	14	
461	*Lichenomphalia* sp. (R.M. Robinson & F. Tovar FC1347)					
127	*Lichenomphalia umbellifera* (L.) Redhead, Lutzoni, Moncalvo & Vilgalys					193
24	*Lycoperdon* sp. (R.M. Robinson & R.H. Smith FC22)	1	3		4	67
777	*Lyophyllum* sp. dark brown FC1477		15		15	
731	*Macowanites luteiroseus*? Bougher (Truffle) FC1420					
610	*Macowanites* sp.					
190	*Macrolepiota clelandii* Grgur.					
390	*Macrotyphula juncea* (Fr. : Fr.) Berthier					
318	*Marasmellis* sp. small white cap on twigs and leaves (R.M. Robinson & J.E.Neal FC667)					
191	*Marasmiellis* sp. "white umbrella"					
671	*Marasmiellus* sp. on *Anarthria scabra* leaves BFF114	6			6	
239	*Marasmiellus* sp. on zamia					
55	*Marasmius crinisequi* F.Muell.	182	37		219	168
183	*Marasmius elegans* (Cleland) Grgur.			4	4	
618	*Marasmius sp.*					
309	*Marasmius* sp. 223 (R.M. Robinson FF664)					56
720	*Marasmius* sp. garlic BFF179					
75	*Marasmius* sp. large brown, on *Macrozamia riedlii* stems					
443	*Marasmius* sp. small tan (R.M. Robinson FF770)	3			3	
341	*Marasmius* sp. tny red on twigs (R.M. Robinson & L. McGurk FC652) - Gloiocephala sp?					
507	*Meiorganum curtisii* (Berk.) Singer, Garcia & Gomez					
23	*Melanoleuca* sp. (R.M. Robinson & R.H. Smith FC21)					
529	*Melanoleuca* sp. grey brown cap with white gills and stem (R.M. Robinson, R.H. Smith & K. Syme FC994)					
151	*Melanoleuca* sp. large (R.M. Robinson & R.H. Smith FC472)					

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
489	*Melanoleuca* sp. large brown cap with tan gills (R.M. Robinson, R.H. Smith & K. Syme FC894)					
612	*Melanophyllum haematospermum* (Bull. : Fr.) Kreisel					
22	*Melanotus hepatochrous* (Berk.) Singer					6
61	*Melanotus hepatochrous* (Berk.) Singer	25			25	
643	*Merulius* sp. on leaves' BFF0039					
637	*Mesophellia* sp. olive powdery spores, brown core BFF0012					
298	*Micromphale* sp. *g*arlic (R.M. Robinson & K. Syme WFM11)		18		18	
262	*Multiclavula* aff. *coronilla* (G.W. Martin) R.H. Petersen,"tiny white candles" WFM 88					
64	*Mycena adscendens* (Lasch) Maas. Geest.			6	6	
477	*Mycena* aff. *adonis* (Bull.) Gray					
44	*Mycena* aff. *atrata* Grgur. & A.A.Holland. ex Grgur.			15	15	12
327	*Mycena* aff. *maldea* Grgur.					
134	*Mycena albidocapillaris* Grgur. & T.W.May	28	4	3	35	423
80	*Mycena carmeliana* Grgur.	8	144	71	223	112
312	*Mycena fuhreri* Grgur.			18	18	10
372	*Mycena fumosa* Grgur.					
144	*Mycena kuurkaceae*Grgur.	4	1	118	123	95
50	*Mycena mijoi* Grgur.	155	41	1	197	284
66	*Mycena pura* (Pers. : Fr.) P.Kumm.	2		3	5	15
491	*Mycena* sp. brown pointy cap (R.M. Robinson, R.H. Smith & K. Syme FC897)					
521	*Mycena* sp. brown pura-like (R.M. Robinson & R.H. Smith FC963)					
523	*Mycena* sp. brown striate cap with dark umbo (R.M. Robinson & R.H. Smith FC966)					
706	Mycena sp. brown with white spots BFF128					
336	*Mycena* sp. dark brown on burnt ground					
574	*Mycena* sp. dry grey, creamy white gills WFM262					
701	*Mycena* sp. dusty purple conic FC1298					
308	*Mycena* sp. grey brown cap no bleach (R.M. Robinson & J. Fielder FC1038)		8	2	10	14
590	*Mycena* sp. grey brown with creamy brown margin (R.M. Robinson & J. Fielder FC1068)					
285	*Mycena* sp. light brown striate cap with white stem - on wood (R.M. Robinson, R.H. Smith & K. Pearce FC495)	1			1	60
18	*Mycena* sp. light brown-olive (R.M. Robinson & R.H. Smith FC86)					2
27	*Mycena* sp. long stem					
650	*Mycena* sp. maroon or red gills WFM320					
677	*Mycena* sp. mini epipterygia					
302	*Mycena* sp. nippled umbrellas (R.M. Robinson & K. Pearce FC584)					12
658	*Mycena* sp. orange striate cap, dimpled WFM352					
756	*Mycena* sp. orange striate on litter WFM424		27	4	31	
571	*Mycena* sp. ? radicating stem					
565	*Mycena* sp. red gills (R.M. Robinson & K. Syme WFM233)					
664	*Mycena* sp. rosy cap with olive stem WFM362					
437	*Mycena* sp. rosy maroon cap with marginate decurrent gills					
376	*Mycena* sp. small brown with decurrent gills (R.M. Robinson & R.H. Smith FC757)					
295	*Mycena* sp. small buff (R.M. Robinson & K. Pearce FC558)					247
326	*Mycena* sp. small buff on wood - bleach (R.M. Robinson & L. McGurk FC610)					
352	*Mycena* sp. small creamy yellow white (R.M. Robinson & R.H. Smith FC695)					
165	*Mycena* sp. small grey - bleach (R.M. Robinson & R.H. Smith FC394)	21	34	9	64	43
544	*Mycena* sp. split stem, bleach					
502	*Mycena* sp. striate cap with decurrent gills, on burnt ground (R.M. Robinson & R.H. Smith FC932)					
386	*Mycena* sp. tiny white sticky cap (R.M. Robinson & K. Syme WFM006)					
88	*Mycena* sp. tiny white with decurrent gills					
456	*Mycena* sp. viscid with brown grey conic cap (R.M. Robinson & R.H. Smith FC801)					
182	*Mycena* spp. (unidentified)		4		4	44
163	*Mycena subgallericulata* Cleland	68	47	34	149	
51	*Mycena yirukensis* Grgur.	225	847	267	1339	1457
238	*Mycena yuulongicola* Grgur.	36	20		56	138
709	*Mycoacia* sp. brown BFF133					
510	*Mycoacia subceracea* (Wakef.) G.Cunn.					
703	*Nectria* aff. *cinnabarina* (Tode) Fr. FC1305	30			30	

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
164	*Nidula niveotomentosa* (Henn.) Lloyd					
413	*Nidularia deformis* (Willd. : Pers.) Fr.					
441	*Nothocastorium* sp.					
535	*Nothojafnea thaxterii* (Cash) Gamundí					
601	*Octavianina* sp. orange (R.M. Robinson & J. Fielder FC1086)					
431	*Omphalina* sp. orange brown					
425	*Omphalina* sp. salmon pink					
415	*Omphalina* sp. short tan					
213	*Omphalotus nidiformis* (Berk.) O.K.Mill.	24			24	2
762	*Otidia* sp. Large brown on burnt ground WFM453					
558	*Paecilomyces tenuipes* (Peck) Samson					
705	*Panaeolus sp. Cortinarius* sp delicate brown bells FC1314					
104	*Panellus ligulatus* E.Horak					
311	*Panus fasciatus* (Berk.) Pegler	2		4	6	12
393	*Perenniporia ochroleuca* Polypore bracket on B. grandis cone					
277	Perenniporia sp. beige (R.M. Robinson, R.H. Smith & K. Pearce FC510)	1			1	2
332	*Peziza praetervisa* Bres.					
661	*Peziza* sp. black WF358					
455	*Peziza* sp. brown (R.M. Robinson & R.H. Smith FC799)					
499	*Peziza* sp. dark brown burgandy cup with tan underside (R.M. Robinson & R.H. Smith FC930)					
501	*Peziza* sp. flat black (R.M. Robinson & R.H. Smith FC936)					
527	*Peziza* sp. smooth dark brown cup (R.M. Robinson & R.H. Smith FC982)					
256	*Peziza* sp. white cup					
330	*Peziza tenacella* W. Phillips					
524	*Peziza thozetii* Berk.					
488	*Phaeocollybia ratticauda* E.Horak					
749	*Phaeocollybia* sp - on burnt ground WFM 384					
598	*Phaeocollybia tasmanica* B.J.Rees & A.E.Wood					
37	*Phellinus* sp. yellow rim (R.M. Robinson, R.H. Smith & K. Pearce FC515)					2
70	*Phellodon* aff. *niger* (Fr. : Fr.) P.Karst.					16
479	*Phellodon* sp. black brown (R.M. Robinson & R.H. Smith FC844)			1	1	
84	*Phellodon* sp. black slender (R.M. Robinson & J. Fielder FC1189)					
621	*Phellodon* sp. black with silvery margin and brown grey spines (R.M. Robinson & J. Fielder FC1159)					
435	*Phellodon* sp. brown (R.M. Robinson, R.H. Smith & K. Syme FC827)					
716	*Phellodon* sp. feathery black-purple BFF148					
634	*Phellodon* sp. flimsy silver grey (R.M. Robinson & J. Fielder FC1204)					
563	*Phellodon* sp. olive brown spines					
717	*Phellodon* sp. silver BFF152					
447	*Phellodon* sp. silver-blue					
101	*Phlebia rufa* (Pers. : Fr.) M.P.Christ.		6		6	
101	*Phlebia rufa* 'blonde' WFM329					
614	*Phlebia* sp. Orange					
160	*Pholiota highlandensis* (Peck) Quadr./*P. communis*(Cleland & Cheel) Grgur.	36	28	9	73	891
119	*Pholiota multicingulata* E.Horak	20	58	24	102	112
156	*Pholiota* sp. light brown cap with red scales on stem (R.M. Robinson & R.H. Smith FC252)					
506	*Pholiota* sp. water soaked gills					
636	*Phylloporus* sp. BFF0010					
481	*Phylloporus* sp. (R.M. Robinson, R.H. Smith & K. Syme FC876)					
363	*Piptoporus australiensis* (Wakef.) G.Cunn.			2	2	
403	*Pisolithu arhizus* (Scop. : Pers.) Rauschert					
401	*Pisolithus mamoratus* (Berk.) E.Fisch.					
353	*Pisolithus* sp. small stalked (R.M. Robinson & R.H. Smith FC697)					
192	*Plectania platensis* (Speg.) Rifai					
469	*Pleuroflammula* sp.1 chestnut with fringed margin FC842					
133	*Pluteus atromarginatus* (Konrad) Kühner					3
248	*Pluteus cervinus*					
47	*Pluteus flammilipes* E.Horak var. *depauperatus* E.Horak					8

		Treatment (2009)			2009	2003
Sp #	**Species**	**GR**	**SW**	**ER**	**Total**	**Total**
47	*Pluteus lutescens* (Fr.) Bres.	2		1	3	
659	*Pluteus nanus* (Pers. : Fr.) P.Kumm. WFM354					
4	*Pluteus* sp. brown velvet (R.M. Robinson & R.H. Smith FC4 (BFF150))					
157	*Podoserpula pusio* (Berk.) D.A.Reid					
321	*Pogiesperma* sp. pink gleba (R.M. Robinson & L. McGurk FC596)					
204	Polypore beige resupinate, stains brown (R.M. Robinson FF369)					1
649	Polypore bullich WFM311					
3	Polypore long white shelf					
333	Polypore on dead waterbush (R.M. Robinson & R.H. Smith FC626)					
743	Polypore salmon resupinate BFF174					
746	Polypore shelving tiers BFF223					
474	Polypore soft pored bracket					
647	Polypore soft, angular pored bracket BFF0059					
424	Polypore soft, small brown bracket					
639	Polypore thick white resupinate on twigs BFF0023					
782	Polypore thin white-sanguine resupinate FC1507	7			7	
585	Polypore white floccose resupinate (R.M. Robinson & J. Fielder FC1027)	4			4	
116	Polypore white resupinate (R.M. Robinson & J. Fielder FC1197)			6	6	1
361	Polypore white resupinate on twig (R.M. Robinson & R.H. Smith FC708)			2	2	
783	Polypore white resupinate under burnt wood FC1493			25	25	
668	Polypore white resupinate with yellow margin BFF 83					
494	*Polyporus* sp. brown stalked (R.M. Robinson & R.H. Smith FC901)					
388	*Polyporus* sp. small stalked					
145	*Poronia erici* Lohmeyer & Benkert					2
632	*Porostereum crassum* (Lév.) Hjortstam & Ryvarden	28			28	
505	*Postia caesia* (Schrad. : Fr.) P.Karst					
236	*Postia peliculosa* (Berk.) Rajchenb.	2	1		3	2
155	*Protubera canescens* G.W.Beaton & Malajczuk					
59	*Psathyrella echinata* (Cleland) Grgur.					
250	*Psathyrella* sp.					
337	*Psathyrella* sp.	1			1	
17	*Psathyrella* sp. (R.M. Robinson & R.H. Smith FC15)			1	1	
229	*Psathyrella* sp. (R.M. Robinson & R.H. Smith FC386)					3
414	*Psathyrella* sp. brown cap, white fibrillose stem					
359	*Psathyrella* sp. brown with white skirt (R.M. Robinson & R.H. Smith FC707)					
763	*Psathyrella* sp. burnt ground WFM455					
727	*Psathyrella* sp. FC1330			4	4	
682	*Psathyrella* sp. grey, delicate fibrillose FC1219					
177	*Psilocybe coprophila* (Bull. : Fr.) P.Kumm.	9	16	24	49	127
349	*Psilocybe musci* Cleland & Cheel					
331	*Pulvinula archerii* (Berk.) Rifai					
280	*Pulvinula* sp. (R.M. Robinson, R.H. Smith & K. Pearce FC526)					42
129	*Pulvinula tetraspora* (Hansf.) Rifai					
176	*Pycnoporus coccineus* (Fr.) Bondartsev & Singer	4		10	14	139
366	*Pyronema omphalodes* (Bull.) Fuckel					
72	*Ramaria australiana* (Cleland) R.H.Petersen					3
52	*Ramaria capitata* (Lloyd) Corner					2
52	*Ramaria capitata* 'burnt'					
377	*Ramaria lorithamnus* (Berk.) R.H.Petersen			1	1	
102	*Ramaria ochroceosalmonicolor* (Cleland) Corner	23	42	27	92	211
242	*Ramaria* sp. cream (R.M. Robinson & R.H. Smith FC414)					
624	*Ramaria* sp. golden orange					
247	*Ramaria* sp. lemon yellow (R.M. Robinson & R.H. Smith FC420)					32
86	*Ramaria* sp. orange-red with yellow stem (R.M. Robinson & R.H. Smith FC112)					10
490	*Ramaria* sp. tan, in *Allocasuarina* litter (R.M. Robinson, R.H. Smith & K. Syme FC896)					
767	*Ramaria* sp. yellow flat (burnt ground) WFM464			22	22	
254	*Ramaria versatilis* Quél.					4

Sp #	Species	Treatment (2009) GR	SW	ER	2009 Total	2003 Total
534	*Ramariopsis pulchella* (Boud.) Corner					
79	*Resupinatus cinerescens* (Cleland) Grgur.		32	165	197	2
452	*Rhizopogon* sp. FC789					
181	*Rhodocollybia butyracea* (Bull. : Fr.) Lennox	6	10	6	22	5
397	*Rhodocybe* sp. grey (R.M. Robinson & K. Syme WFM35)					
209	*Rickenella fibula* (Bull. & Vent. : Fr.) Raithelh.					1
69	*Russula adusta* (Pers. : Fr.) Fr.					11
552	*Russula* aff. *albonigra* (Krombh.) Fr.					
89	*Russula clelandii* complex O.K.Mill. & R.N.Hilton					
89	*Russula clelandii* group 'brown' FC1389					77
202	*Russula flocktoniae* Cleland & Cheel					192
90	*Russula kalimna* Grgur.					5
92	*Russula neerimea* Grgur.					51
178	*Russula persanguinea* Cleland					
107	*Russula* sp. grey-white (R.M. Robinson & R.H. Smith FC168)					1
692	*Russula sp.* grey-white FC1267					
559	*Russula* sp. peaches and cream (R.M. Robinson & K. Syme WFM186)					
276	*Russula* sp. purple mottled (R.M. Robinson, R.H. Smith & K. Pearce FC505)					3
10	*Russula* sp. small white-white-white RR921WA					55
10	*Russula* sp. white white white (R.M. Robinson & R.H. Smith FC8)					
752	Rust on *Acacia saligna* WFM400					
342	*Ryvardenia campyla* (Berk.) Rajchenb					
263	*Sarcodon* sp. brown					
786	*Schizophyllum commune* FC1509	23			23	
315	*Scleroderma cepa*Pers. : Pers.					
322	*Scleroderma* sp. black gleba FC597					
150	*Scutellinia* aff. m*argaritacea* (Berk.) Kuntze (*sensu* Bougher & Syme)					
12	*Simocybe tabacina* E. Horak	1	10		11	7
306	*Sphaerobolus stellatus* Tode : Pers.					17
132	*Steccherinum* sp. creamy yellow crust (R.M. Robinson & J. Fielder FC1080)					1
94	*Steccherinum* sp. tiered white shelves (R.M. Robinson & R.H. Smith FC128)					
652	*Steccherinum* sp. tiers WFM324					
106	*Stemonitis herbatica*Peck					
723	*Stephanospora* sp. (Truffle) BFF 172					
62	*Stereum hirsutum* (Willd. : Fr.) Pers.	33	234	10	277	74
149	*Stereum illudens* Berk.	32	38	6	76	36
5	*Stereum* sp. grey brown, hirsute, white margin, purple fertile layer (R.M. Robinson & R.H. Smith FC468)		9		9	
325	*Stereum* sp. purple margin - algae					
748	*Steruem illudens* -grey-white fertile layer FC1317 (*Punctularia strigoszonata*)					
67	*Stropharia semiglobata* (Batsch : Fr.) Quél.	1	15	1	17	5
451	*Stropharia* sp. shaggy stem, on roo poo					
575	*Stropharia* sp. Yellow					
402	*Tephrocybe* ? sp. brown - burn					
78	*Tephrocybe = sp 153 Entoloma* sp. grey with decurrent gills (R.M. Robinson & R.H. Smith FC93)					3
537	*Tephrocybe* sp.			8	8	
301	*Tephrocybe* sp. cark grey with dimpled cap (R.M. Robinson & K. Pearce FC580)					13
587	*Tephrocybe* sp. dark brown with grey brown gills (R.M. Robinson & J. Fielder FC1036)					
513	*Tephrocybe* sp. dark grey brown convex (R.M. Robinson, R.H. Smith & K. Syme FC948) -check with sp.512					
554	*Tephrocybe* sp. decurrent funnel WFM204					
249	*Tephrocybe* sp. grey (R.M. Robinson & R.H. Smith FC423)					
233	*Tephrocybe sp.* grey brown dimpled cap (R.M. Robinson & R.H. Smith FC 391)					4
153	*Tephrocybe* sp. small dark grey-brown (R.M. Robinson & R.H. Smith FC242)					
512	*Tephrocybe* sp. small grey brown (R.M. Robinson, R.H. Smith & K. Syme FC945)					
569	*Tephrocybe* sp. small mycenoid, decurrent gills					
429	*Thelephora* aff. *terrestris* Ehrh. ex Willd. : Fr.					
761	*Thelephora* sp. creamy yellow WFM450					
549	*Thelephora* sp. small rosette (R.M. Robinson & K. Syme WFM176)*					

Sp #	Species	Treatment (2009) GR	SW	ER	2009 Total	2003 Total
427	*Thelephora* sp. white coral					
759	*Thelephora* sp. white coral WFM442					
266	*Thelephora* sp. white with orange margin (R.M. Robinson & R.H. Smith FC476)		1		1	3
586	Thelephore brown feathers (R.M. Robinson & J. Fielder FC1034)					
482	*Torrendia* sp. (R.M. Robinson, R.H. Smith & K. Syme FC877)					
688	*Trametes* sp. beige FC1245					
669	*Trametes velutina* (Pers. : Fr.) G.Cunn. BFF NC					
13	*Trametes velutina* (Pers.: Fr.) G.Cunn.					
63	*Trametes versicolor* (L. : Fr.) Lloyd	37	146	36	219	66
287	*Tremella globispora* D.A.Reid	15			15	15
685	*Tremella globispora* D.A.Reid "translucent white" FC1231	10	10		20	
60	*Tremella mesenterica* Retz. : Fr.	3			3	4
288	*Tremella* sp. yellow buttons (R.M. Robinson, R.H. Smith & K. Pearce FC540)	20			20	150
109	*Trichaptum byssogenum* (Jungh.) Ryvarden		3		3	1
446	*Tricholoma* aff. *austrocollossum* Grgur.					
54	*Tricholoma eucalypticum* A.Pearson	8	42	7	57	45
211	*Tricholoma* sp. (R.M. Robinson, R.H. Smith & K. Pearce FC346)					1
483	*Tricholoma* sp. (R.M. Robinson, R.H. Smith & K. Syme FC878) check with Sp. 674					
411	*Tricholoma* sp. cream pink-buff, large					
594	*Tricholoma* sp. creamy brown (R.M. Robinson & J. Fielder FC1063)					
736	*Tricholoma* sp. creamy tan FC1422					
733	*Tricholoma* sp. olive green FC 1427					
375	*Tricholoma* sp. orange cap with orange ring on stem (R.M. Robinson & R.H. Smith FC 753)					
495	*Tricholoma* sp. orange with white stem (R.M. Robinson & R.H. Smith FC903)					
674	*Tricholoma* sp. salmon viscid BFF87					
560	*Tricholoma* sp. tan gills, ring					
161	*Tricholoma virgatum* (Fr.) Gillet					1
747	Truffle - unknown BFF225		2		2	
418	Truffle citrus		2		2	
687	Truffle *Cystangium* sp. FC1241					
572	Truffle grey spore mass, orange core					
417	Truffle light brown with grey-brown gleba					
666	Truffle light yellow - Boletoid (Hymenogasteraceae) BFF 74					
712	Truffle *Mesophellia* sp .NC					
464	Truffle pale yellow					
766	Truffle Russuloid FC1420b					
258	Truffle sticky					
189	*Tubaria rufofulva* (Cleland) D.A.Reid & E.Horak					
111	*Tubaria serrulata* (Cleland) Bougher & Matheny		12		12	11
602	*Tubifera fuliginosa*					
305	*Tylopilus* sp. yellow (R.M. Robinson & J. Fielder FC1015)		1		1	1
567	Unknown fluffy salmon buttons (on *Podocarpus* fruits)					
725	Unknown orange pustules-fluffy on Macrozamia seed FC1326					
667	Unknown rusty nuts BFF 80					
651	Unknown white mycelium on bark and litter WFM323					
538	White mycelium on burnt soil/charcoal					
440	White mycelium on roo poo (R.M. Robinson & K. Syme WFM118)					
2	*Xerula mundroola* (Grgur.) R.H.Petersen		1	3	4	1
175	*Xylaria hypoxylon* (L.) Grev.					
428	*Xylaria polymorpha* (Pers.) Grev.					
459	*Xylaria* sp. black and white spears					
543	*Xylaria* sp. flat antlers WFM168					
426	*Xylaria* sp. pink tips					
	Total number of species	**102**	**118**	**95**	**188**	**203**
	Total number of fruit bodies	**4522**	**5797**	**3260**	**13579**	**18389**

CRYPTOGAMS

Ray Cranfield, Richard Robinson and Verna Tunsell

Introduction

Lichens, mosses and liverworts are collectively known as cryptogams. Some species of lichens are important indicators of ecosystem health, being sensitive to changes and disturbance in the environment in which they grow. Many colonise primary substrates such as rocks, soil, living bark and organic litter and are active in the initial breakdown of these materials. Mosses also play an important role in the stabilization of bare soil, localised moisture retention and habitat for many invertebrates. Lichens, mosses and liverworts are a major component of the biodiversity of forest ecosystems, and most species in Western Australia have poorly known distributions and many are yet to be named.

The object of this component of FORESTCHECK is to:

- Record species richness in each FORESTCHECK grid and treatment
- Record species habitat and substrate preference, and
- Monitor the effect of disturbance on cryptogam communities
- Record the presence of 35 monitoring (or indicator) species
- Determine successional trends within communities and life-form categories

Additional information is collected to:

- Monitor the availability and usage of suitable substrates and strata levels
- Determine the relationship of cryptogam presence with litter cover

Monitoring

Nine FORESTCHECK grids, including three external reference grids (FC16, FC17, FC19), three shelterwood (FC13, FC15, FC18) and three gap release treatments (FC11, FC12, FC14), were established in the central jarrah north-west forest ecosystem in the Wellington District in 2002. These plots were initially surveyed for cryptogams in spring 2002.

Following a review of the 2002-06 data, modified survey methods were employed in 2007-08 (see 2007-08 FORESTCHECK report). Twenty 1x1 m plots were installed (Fig. 1) and used to assess substrate and strata availability and usage, cryptogam life-forms present and the presence of 35 selected monitoring species. In 2008-09, the methods were again reviewed and modified. In addition to the 1x1 m plots, a 200 m transect was added to improve the assessment of species richness on each grid. The new transect ran from post W1-4 to W3-4 then from W3-4 to W3-2 (Fig. 1). To assess the impact of litter on the presence of cryptogams, litter coverage was scored as either none, scarce (0-25% coverage), moderate (26-75% coverage) or dense (>75% coverage) in each of the 20 1x1 m plots.

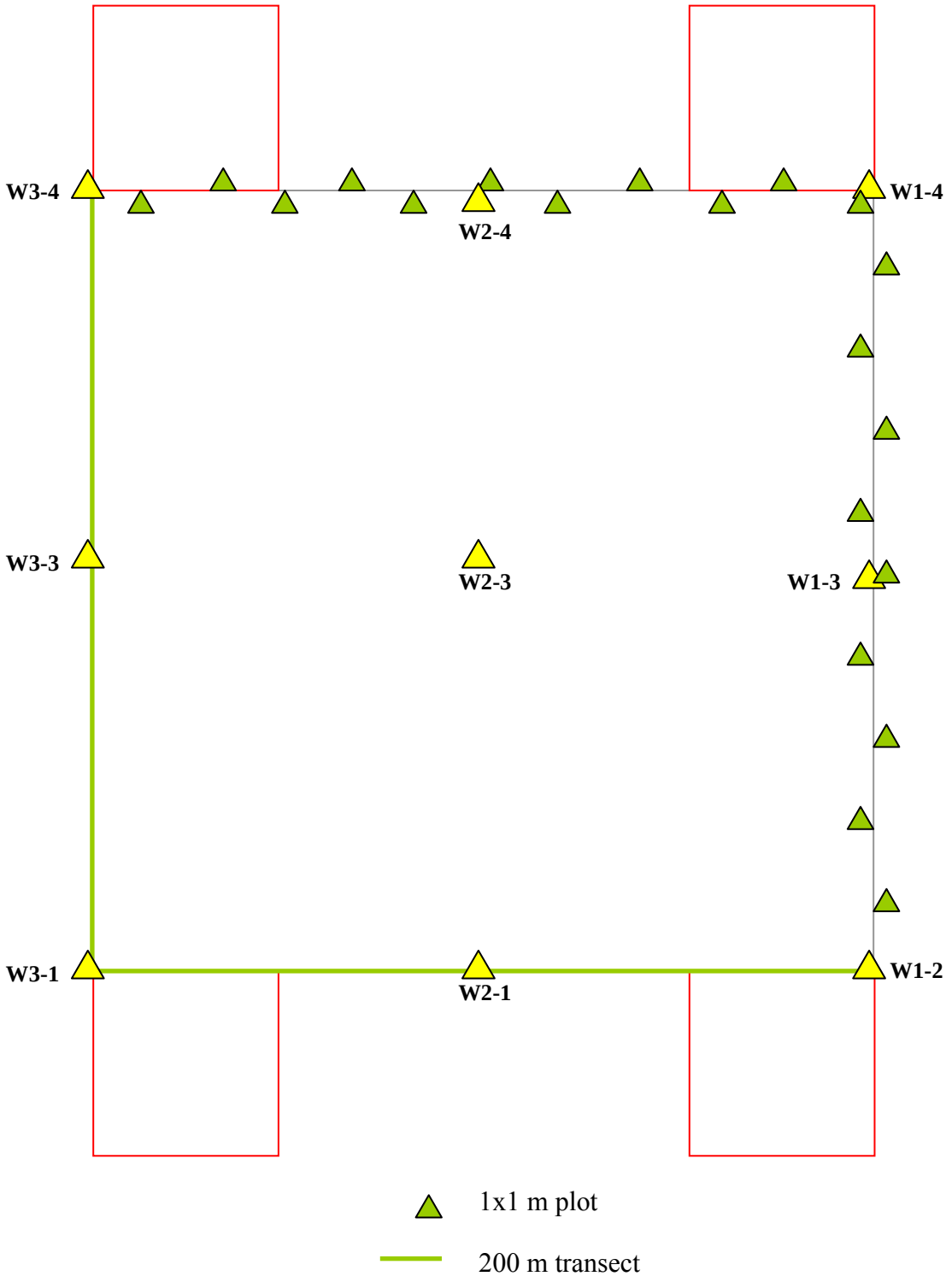


Figure 1. Central region of FORESTCHECK monitoring grid showing plots and transects for surveying cryptogams (see Fig. 1 on p. 4 in Introduction for full details of grid layout).

Monitoring of the 1x1 m plots was conducted in spring 2008, from 9-18 September and the new transect was surveyed from 29-30 June 2009. Similar transects were also surveyed on the Donnelly grids (FC1-FC10) in March 2009, but will not be reported further here. In each of the 20 1x1 m plot at Wellington, the following data was recorded:

- The total number of cryptogam species present
- The number of lichen, moss and liverwort life forms present
- The presence of any of the selected "monitoring" species
- The presence and use (colonisation) of cryptogam substrates
- The level within the strata that cryptogams occurred
- Litter coverage

Along the 200 m transect, the presence of all cryptogam species was recorded in each 50m section of the transect. An illustrated monitoring species booklet was used to facilitate the recognition of species in the field.

Voucher Specimen Processing

Vouchers for species were extensively collected in 2003. In 2008, specimen vouchering was restricted to a small number of samples that represented material needed to confirm identification and to voucher new species records. All specimens collected in 2008 have been identified or phrase named for ease of re-determination. Recently name changes have been updated on the FORESTCHECK and PERTH herbarium databases. All new collections have been prepared for database entry and label generation prior to submitting these vouchers to PERTH.

Preliminary Results and Discussion

The 2003 survey at Wellington was undertaken in autumn and the 2008 survey in spring. Generally cryptogams actively grow in the wetter autumn and winter period, however, their nature allows their continued presence over extended periods throughout the year, independent of rain. Although they are fragile when desiccated, and easily damaged, they are still readily recognised. However, when comparing the 2003 and 2008 Wellington results it needs to be noted that survey methods were reviewed and updated in 2006 (see 2007-08 FORESTCHECK report).

Preliminary results for 2008 showed that a further four to six species may need to be included in the field guide as they appear to be more widespread than previously thought. They are undescribed genera, but reasonably well known and readily recognised; an attempt to identify them is underway in collaboration with external experts.

Transect surveys

Lichen, moss and liverwort richness

A total of 58 species of cryptogams were recorded from transects; 46 lichens, nine mosses and three liverworts. On all grids, lichens were the most species rich followed by mosses. Liverworts were always in low numbers or absent (Fig. 2). There was no difference in the mean species richness of moss or liverwort species between treatments but lichen richness appeared to be lower on shelterwood compared to external reference grids (Fig. 3).

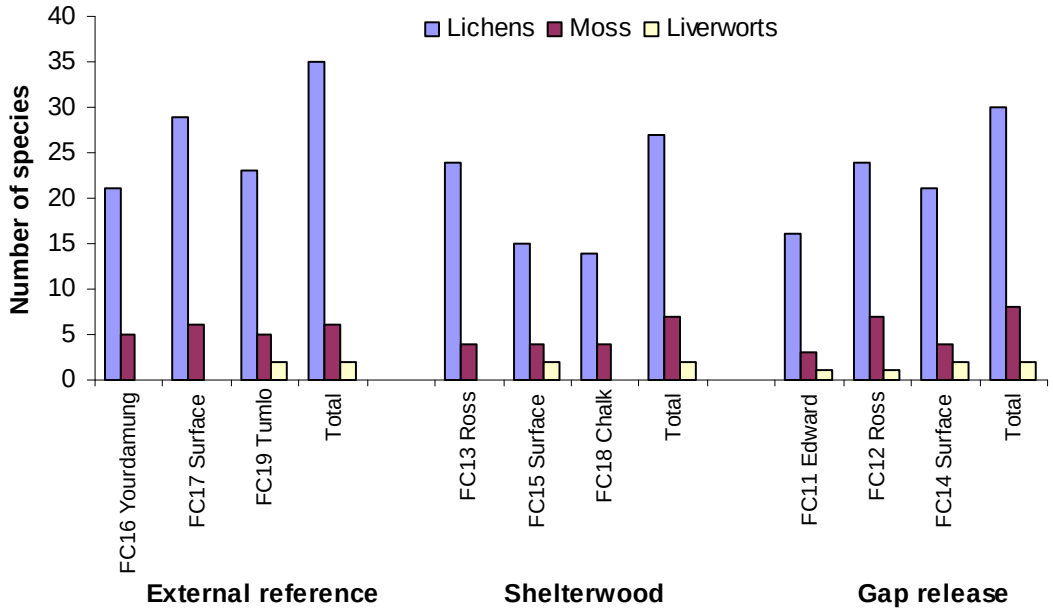


Figure 2. The total number of lichen, moss and liverwort species recorded from transects on each grid and in each treatment at Wellington in 2009.

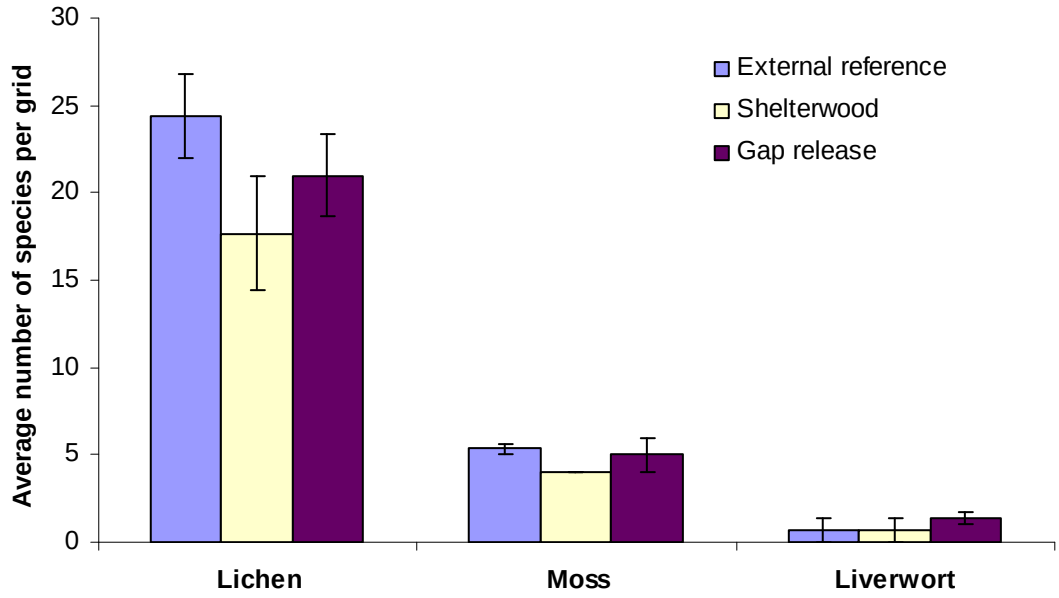


Figure 3. The mean (± se) number of lichen, moss and liverwort species per grid recorded from transects in each treatment at Wellington in 2008.

In 2003 a total of 113 cryptogams, 101 lichens, nine mosses and three liverworts, were recorded (Fig. 4). In 2008 only 100 m of transect was surveyed compared to a 'foray-type' survey covering about 400 m in 2003. In 2009, the number of lichens recorded was approximately one-half that recorded in 2003; the same number of mosses and liverworts were recorded in 2003 and 2009. In future, an additional 200 m of transect will be surveyed on each grid, running from W1.2 to W1.4 to W 3.4 (see Fig. 1). Both the Donnelly (surveyed in 2007-08) and Wellington grids will be re

surveyed in the next year in order to increase the survey effort and provide a total of 400 m of transect.

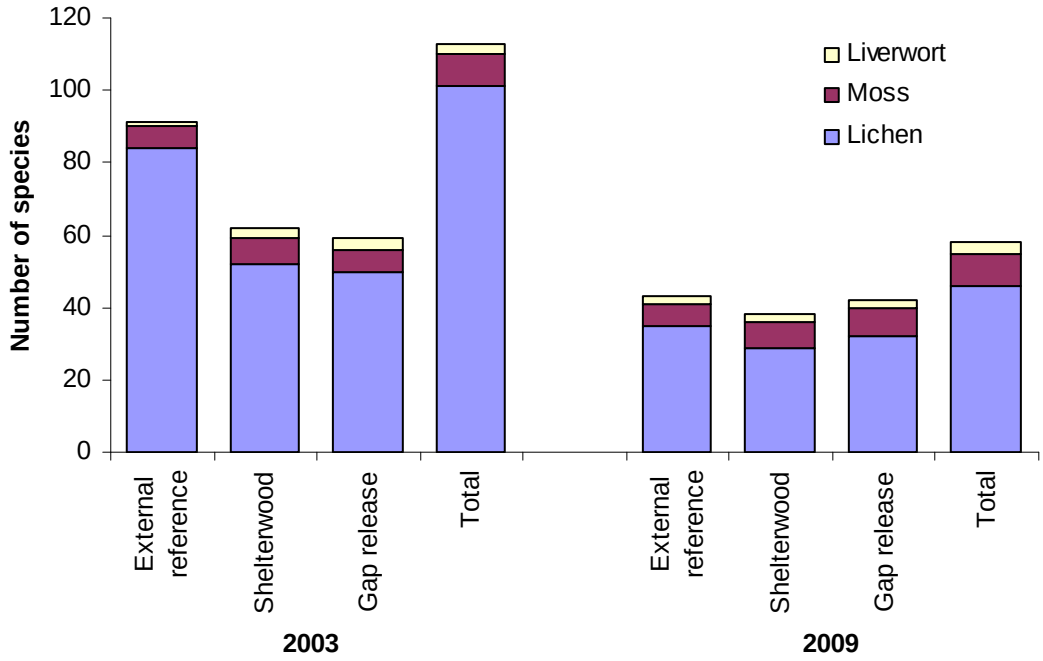


Figure 4. The total number of cryptogams recorded in each treatment at Wellington FORESTCHECK grids in 2003 and 2009.

Plot surveys

Substrate availability and usage

Survey results indicated that on most grids all substrates needed for the establishment and maintenance of cryptogams were available, but not always fully utilised (Fig. 5). On the external reference grids, soil and organic material were the most utilised habitats then stone and wood. On shelterwood grids wood and soil were the preferred habitat with stone and organic material next. On gap release grids organic material was the most utilised substrates followed by soil and stone. It appears that the time since treatment has an influence on the condition of substrates and their consequent colonisation by cryptogams.

Strata layers and cryptogam colonisation

The presence of cryptogams at different levels in the strata depends on the availability of suitable substrates at each level. Of the three strata layers investigated, the ground layer (0-30 cm) was the most utilised strata in every plot (Fig. 6). Colonisation of the shrub layer (31cm-3m) was variable within and between treatments. The epiphytic tree layer (over 3 m) is difficult to examine and surveys depend on recording material which has fallen from tree crowns, and as such the results may not reflect the true extent of tree crown colonisation.

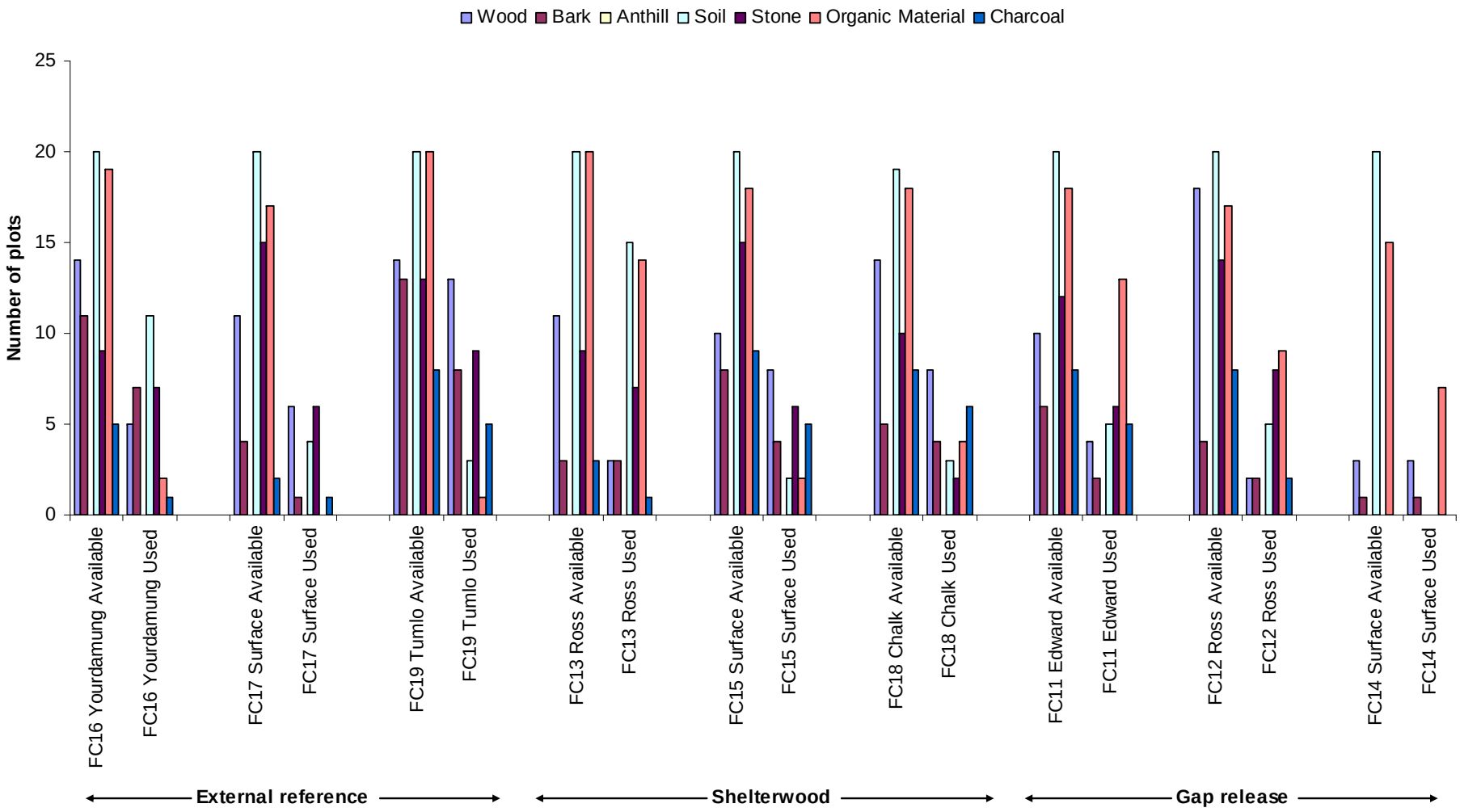


Figure 5. The number of plots with substrates available for colonization and their utilization by cryptogams on each Wellington FORESTCHECK grid in 2009.

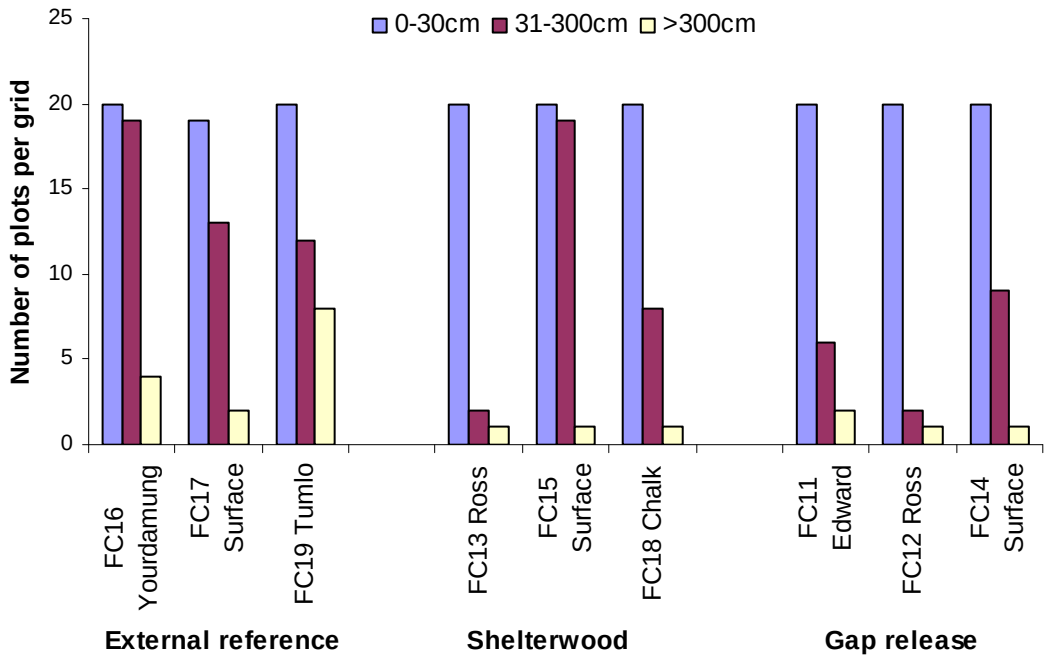


Figure 6. The number of 1x1 m plots with different strata levels occupied by cryptogams on each Wellington FORESTCHECK grid in 2009.

Life forms and population structure

To simplify their identification, cryptogams can be artificially grouped according to their morphology. Lichens are foliose, crustose or fruticose, mosses are creeping or tufted and liverworts are thallose or leafy. These groups are referred to as life forms, as species in each of these groups have similar life strategies. Crustose and fruticose lichens and tufted mosses were the most common, being recorded in the highest number of plots on each grid (Fig. 7 & 8). Creeping mosses were only recorded in low numbers of plots in three grids, one in the external reference and two in the shelterwood treatments. Thallose liverworts were absent in all treatments and no liverworts were recorded in plots in the gap release treatment (Fig. 8) (although a small number were recorded from the transect survey – see Appendix 1).

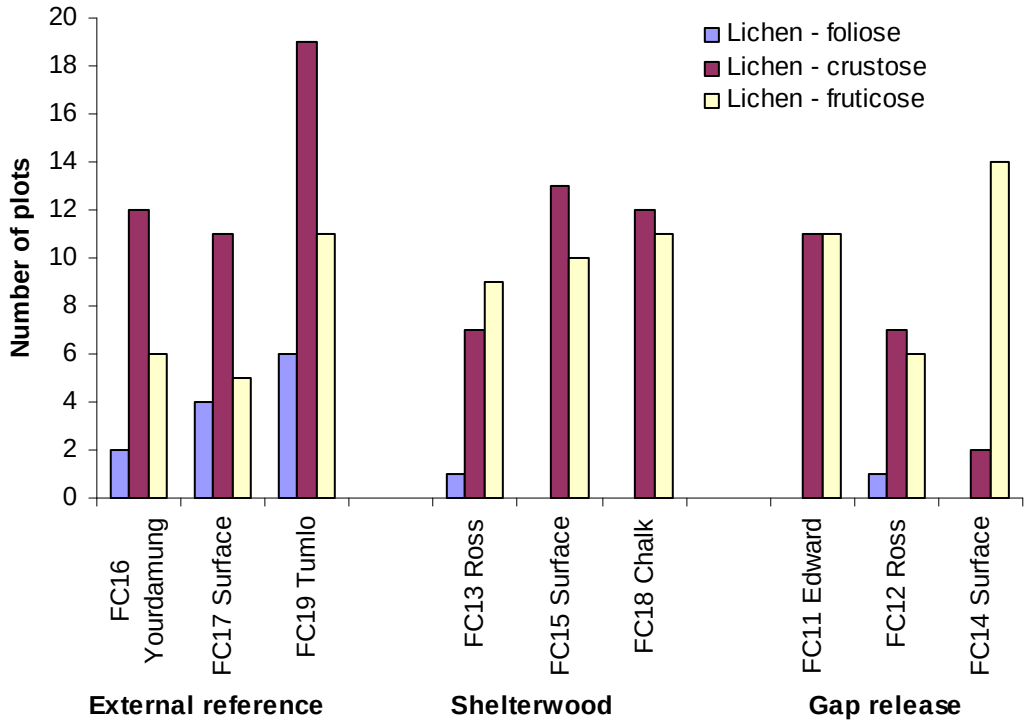


Figure 7. The number of 1x1 m plots in which each lichen life form was recorded on each Wellington FORESTCHECK grid in 2009.

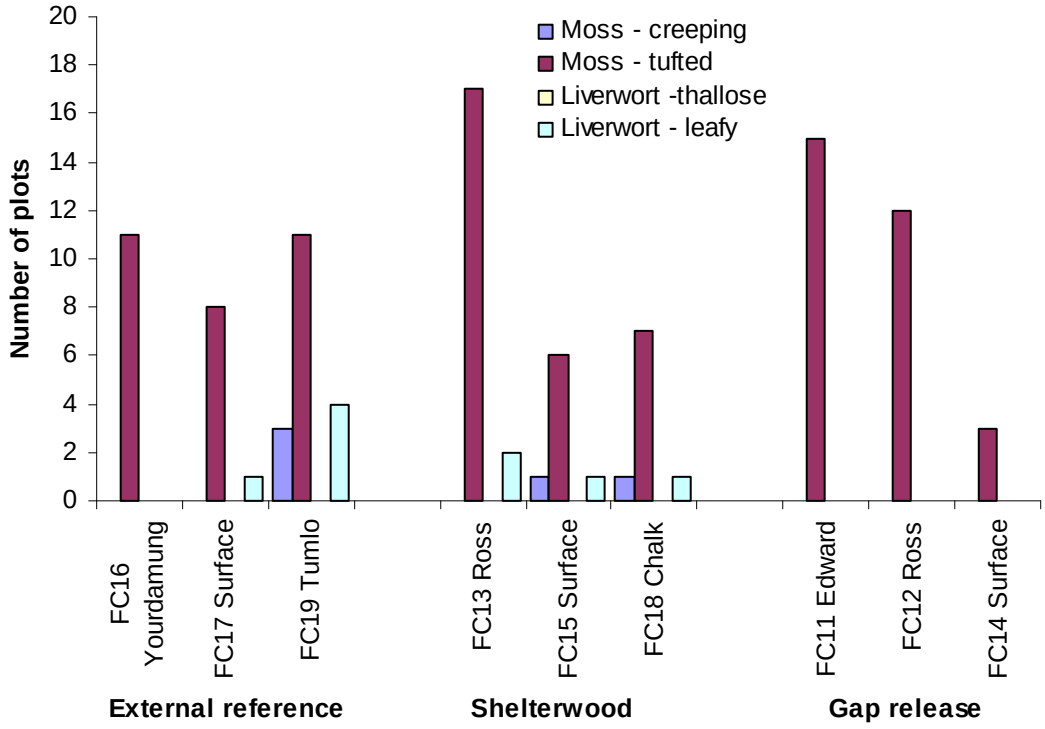


Figure 8. The number of 1x1 m plots in which each moss and liverwort life form was recorded on each Wellington FORESTCHECK grid in 2009.

Litter cover on individual 1x1 m plots

In previous years it was noted that litter cover appeared to affect the presence and growth of a number of cryptogams. Lichens growing on soil or stones may rapidly decline when covered by litter. However, in areas where litter is temporary or able to be moved by wind and not become trapped, cryptogams may be able to withstand short periods of covering without total exclusion occurring. Since 2008, a visual estimate of litter cover has been determined for each 1 x 1 m plot on each grid (Fig. 9). Overall, and on each grid, the majority of plots had a moderate (26-75% cover) to dense (>75% cover) cover of litter, especially at FC14, the Surface gap release. Both moss and liverwort species and ground dwelling lichens tended to be excluded or dramatically reduced in numbers on plots with dense litter cover.

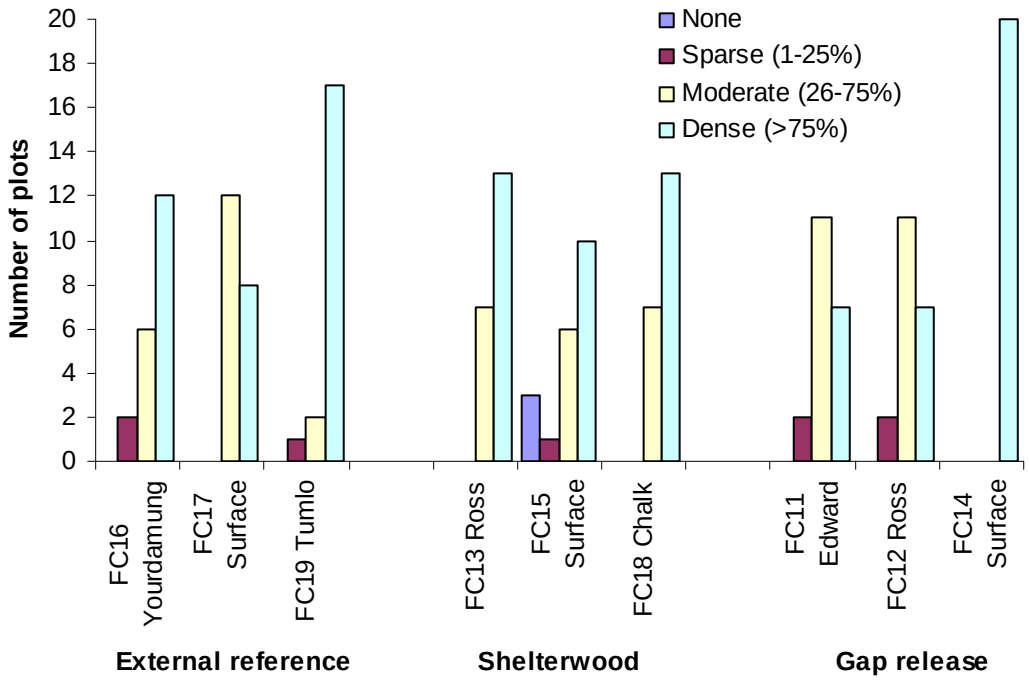


Figure 9. The number of 1x1 m plots with sparse, moderate and dense litter cover on each wellington FORESTCHECK grid in 2009.

Monitoring species recorded on grids and in treatments

Thirty five taxa have been selected as monitoring species (Table 1). Species were selected on the basis of the substrates and strata layers they occupied and on their perceived resilience and response to environment and physical changes. Their presence is recorded on each 1x1 m plot and in each 50 m section of the 200 m transect on each FORESTCHECK monitoring grid. Results from each method will be compared to test the most efficient method of monitoring them.

The lichens *Cladia aggregata*, *Cladia schizopora*, *Cladonia krempelhuberi*, *Cladonia rigida* and *Thysanothecium scutellatatum* were recorded in all treatments using both plot and transect surveys, but the only species recorded on all the grids was *T. scutellatatum*. *Thysanothecium hookerii*, a common termite mound specialist, was not

recorded due to no termite mounds being recorded in 1x1 m plots (Fig. 1 – note although termite mounds were observed on some grids, *T. hookerii* was also absent from transect surveys). There were some differences in the results from plots and transects. *Paraporpidida glauca, Menegazzia platytrema* and *Flavoparmelia haysomii* were notable in that they were not recorded in plots but were regularly recorded on transects. *Cladonia sulcata* and *Diploschistes strictus* were recorded in all treatments from plots (*D. strictus* was in fact recorded in plots on all grids except FC11, the Surface gap release) but both failed to be recorded using transects (Table 1).

Campylopus introflexus was the only moss recorded by both survey methods in all treatments (Table 1). *Dicranoloma diaphanoneum* was only recorded on the Tumlo external control; it is probably scarce in the Wellington district as it prefers the wetter and cooler environments that occur further south.

Liverworts are more common in the wetter southern regions of the jarrah forest and were rarely recorded in Wellington, except for *Cephaloziella exiliflora* which was recorded in all treatments (Table 1).

To test the dependability of using monitoring species to pick up trends or differences between treatments, and to test whether plots or transects offer the best method for survey the mean number of monitoring species per grid was determined for each method in each treatment (Figs 10 & 11). More monitoring species were detected using transects and plots failed to detect liverworts in the gap release treatment. Transect results suggest there are no differences in monitoring species richness between treatments, but plot results suggest that there are fewer lichens and liverworts in the gap release treatment. However, species composition needs to be investigated as some species show definite preferences for specific treatments (associated with the disturbance and stage of recovery) (Table 1).

Because of the large area of jarrah forest and the variety of ecosystem types represented by the five established FORESTCHECK locations (Donnelly, Wellington, Perth Hills, Wellington east and Blackwood plateau) several monitoring species do not naturally occur in all localities. The suitability of the list of monitoring species will be further tested as the other FORESTCHECK locations are monitored over the next three years.

Table 1. The number of 1x1m plots that monitoring species were recorded in for each treatment at Wellington FORESTCHECK grids in 2009.

Monitoring number	Species Name	Group[1]	Life form	Number of 1x1 m plots the species was recorded in (max score = 60)			Number of 50m sections of transect the species was recorded in (max score = 12)		
				External reference	Shelter-wood	Gap release	External reference	Shelter-wood	Gap release
1	*Cladia aggregata*	L	Fruticose	1	7	6	2	9	10
2	*Cladia schizopora*	L	Fruticose	2	2	1	8	7	1
3	*Cladonia cervicornis* var. *verticellata*	L	Fruticose	4	1		1		
4	*Cladonia krempelhuberi*	L	Fruticose	3	3	3	10	6	6
5	*Cladonia rigida*	L	Fruticose	9	12	1	12	7	4
6	*Cladonia sulcata*	L	Fruticose	1	7	5			
7	*Calicium glaucellum*	L	Crustose		2			1	2
8	*Diploschistes strictus*	L	Crustose	15	10	12			
9	*Flavoparmelia haysonii*	L	Foliose				6	2	3
10	*Hypocenomyce foveata*	L	Crustose			1	5	1	
11	*Hypocenomyce scalaris*	L	Crustose	2	3		6	5	7
12	*Hypogymnia subphysodes* var. *subphysodes*	L	Foliose	6		1	10	3	6
13	*Menegazzia platytrema*	L	Foliose				1	2	
14	*Opegrapha* sp.	L	Crustose	5	3		1	2	4
15	*Ochrolechia* sp. (G. Kantavilis 306/92)	L	Crustose	3	4		6	1	3
16	*Pannoparmelia wilsonii*	L	Foliose	3	1		5	3	5
17	*Paraporpidia glauca*	L	Crustose				7	10	11
18	*Parmotrema reticulatum*	L	Foliose						
19	*Ramboldia stuartii*	L	Crustose		1		4	6	8
20	*Tephromela atra*	L	Crustose		2		2		
21	*Thysanothecium hookeri*	L	Fruticose.						
22	*Thysanothecium scutellatum*	L	Fruticose.	8	15	18	10	12	11
23	*Usnea inermis*	L	Fruticose	9		3	12	5	10
24	*Usnea* sp. (leuco)	L	Fruticose					1	1
25	*Xanthoparmelia isidiigera*	L	Foliose						3

Monitoring number	Species Name	Group[1]	Life form	Number of 1x1 m plots the species was recorded in (max score = 60)			Number of 50m sections of transect the species was recorded in (max score = 12)		
				External reference	Shelter-wood	Gap release	External reference	Shelter-wood	Gap release
26	*Xanthoparmelia notata*	L	Foliose	2					
27	*Cephaloziella exiliflora*	H	Leafy	6	4		1	2	4
28	*Chiloscyphus semiteres*	H	Leafy		1				
29	*Fossombronia intestinalis*	H	Thallose				1		
30	*Frullania prohosciphora*	H	Leafy						
31	*Barbula calycina*	B	Tufted	1	4		8	4	6
32	*Campylopus introflexus*	B	Tufted	23	19	17	12	11	8
33	*Dicranoloma diaphanoneum*	B	Tufted	2					
34	*Funaria hygrometrica*	B	Tufted		8	16	7	8	8
35	*Sematophyllum subhumile* var. *contiguum*	B	Creeping	6			4	1	3
	Total number of species			20	20	12	24	23	22

[1] L = lichen, B = bryophyte (moss) and H = Heptophyte (liverwort)

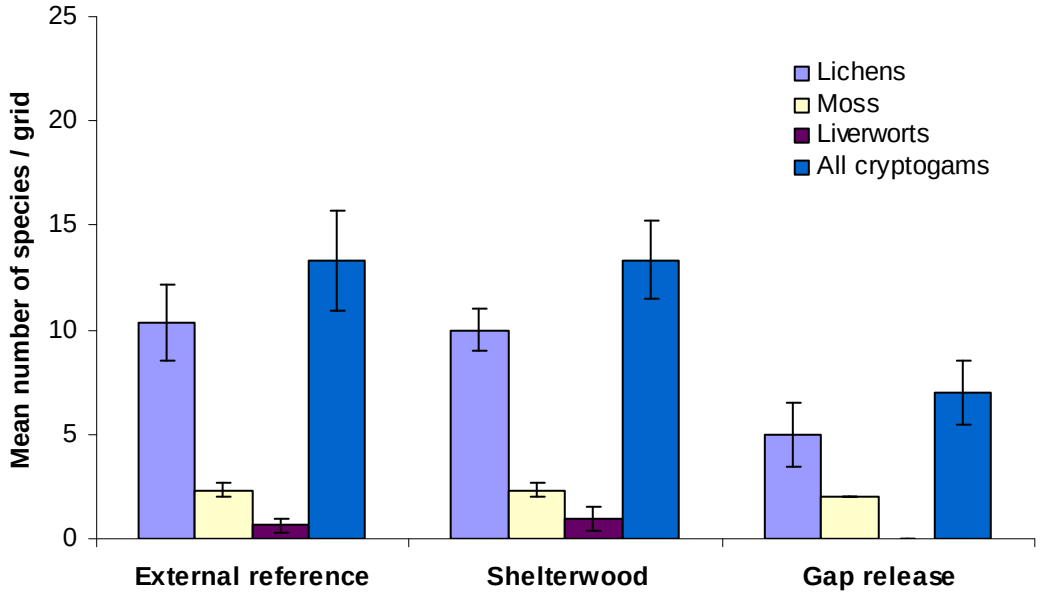


Figure 10. Mean number of cryptogam monitoring species per grid recorded from the 1x1 m plots in each treatment on Wellington FORESTCHECK grids in 2009.

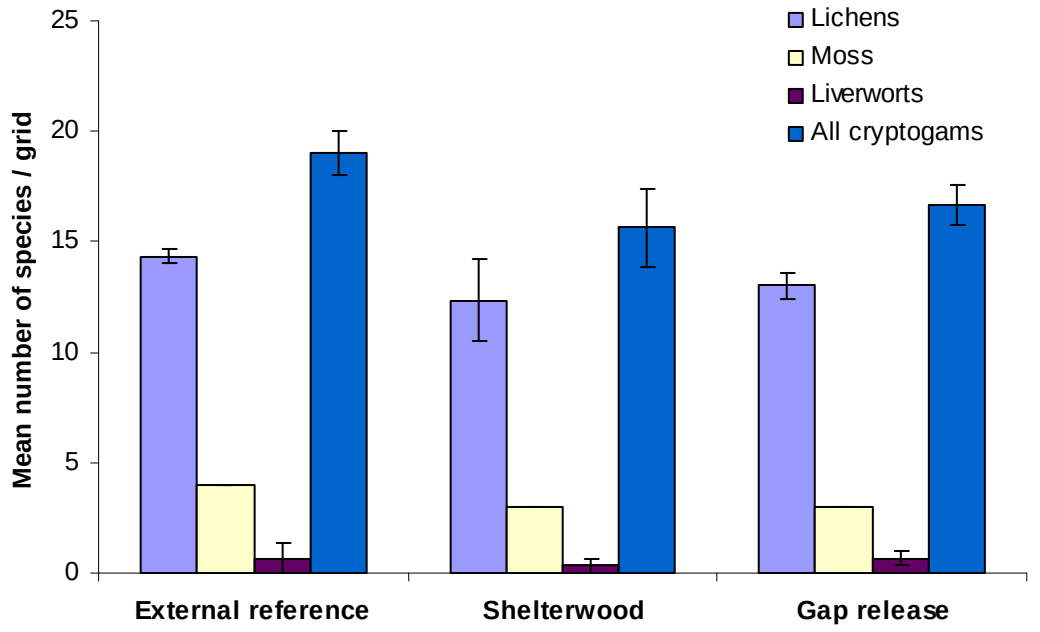


Figure 11. Mean number of cryptogam monitoring species per grid recorded from transect surveys in each treatment on Wellington FORESTCHECK grids in 2009.

Conclusions

The new survey techniques failed to record many species of lichens that were recorded in 2003. During the next year, both the Wellington and Donnelly grids will have an additional 200 m of transect surveyed. In 2009-10, the Perth Hills grids will also be monitored and 400 m of transect will be surveyed to monitor species richness. The results will be analysed to determine if this change needs to be permanent.

Some trends observed in 2009 were:

- Transects were more successful than plots in recording the presence of monitoring species.
- Lichen numbers were low in the shelterwood treatment.
- The mosses *Barbula calycina* and/or *Campylopus introflexus* appear to be replacing the early coloniser *Funaria hygrometrica* (fire moss) in gap release sites.
- *Hypocenomyce scalaris* acts as a primary coloniser on charred bark, and within the shrub layer on a number of grids it is being replaced by either *Hypogymnia subphysodes* or *Pannoparmelia wilsonii*.

General observations on other (monitoring) species are:

- *Opegraphia* sp. (black rays) appears to indicate an early to moderate stage of wood decay (it is not present on wood in an advanced stage of decay) was not common in these grids.
- *Cladonia rigida* is a common species with a high preference for decaying wood.
- *Cladia aggregata* is not common at Wellington. It occurred mainly on the ground, and suffers from being covered by litter.

Acknowledgements
Thank you to Bruce Ward for assistance with surveys.

Appendix 1. Cryptogam species recorded from transects at the Wellington FORESTCHECK grids in 2009 (numbers in treatment columns indicate the number of 50 m sections (max. = 12 in each treatment) that each species was recorded in. All 35 monitoring species are listed in bold font.

Species #	Indicator #	Taxon	Life-form [1]	Gap release	Shelterwood	External reference
2	**31**	***Barbula calycina***	B	6	4	8
9		*Campylopus bicolor*	B	4	1	
10	**32**	***Campylopus introflexus***	B	8	11	12
39	**33**	***Dicranoloma diaphanoneuron***	B			
44		*Fissidens tenellus* var. *tenellus*	B	1	1	
50	**34**	***Funaria hygrometrica***	B	8	8	7
40		*Othodontium lineare*	B	3		5
243		*Rhynchostegium tenuifolium* var. *tenuifolium*	B		2	
336		*Rosulabryum capillare*	B	1		1
128	**35**	***Sematophyllum subhumile* var. *contiguum***	B	3	1	4
12	**27**	***Cephaloziella exiliflora***	H	4	2	1
15	**28**	***Chiloscyphus semiteres***	H			
45	**29**	***Fossombronia intestinalis* (leafy*)***	H			1
46		*Fossombronia pusilla*	H	2	3	
49	**30**	***Frullania probosciphora***	H			
190		*Buellia disciformis*	L	1	2	1
145		*Buellia* sp. (R.J. Cranfield 19106)	L		1	
4		*Buellia stellulata*	L	1		5
5	**7**	***Calicium glaucellum***	L	2	1	
149		*Caloplaca elixii* (*C.* sp. (R.J. Cranfield 19144))	L	3	3	
16	**1**	***Cladia aggregata***	L	10	9	2
314		*Cladia inflata*	L	3		3
17	**2**	***Cladia schizopora***	L	1	7	8
152		*Cladonia calyciformis*	L		1	
23	**3**	***Cladonia cervicornis* var. *verticellata***	L			1
25		*Cladonia humilis* var. *humilis*	L	3		1
26	**4**	***Cladonia krempelhuberi***	L	6	6	10
30	**5**	***Cladonia rigida***	L	4	7	12
37	**6**	***Cladonia sulcata***	L			
157		*Cladonia sulcata* var. *sulcata*	L	10	8	3
38		*Cladonia tessellata*	L	3		
94		*Dictyographa* sp. brown lips (R.J. Cranfield 17791)	L			1
220		*Diploschistes scruposus*	L			2
221	**8**	***Diploschistes strictus***	L			
142	**9**	***Flavoparmelia haysomii***	L	3	2	6
347		*Genus* sp. brown spots	L			2

Species #	Indicator #	Taxon	Life-form [1]	Gap release	Shelterwood	External reference
344		*Genus* sp. grey green slick	L	11	9	7
345		*Genus* sp. mustard	L	1	1	5
61	**10**	***Hypocenomyce foveata***	L		1	5
78	**11**	***Hypocenomyce scalaris***	L	7	5	6
103	**12**	***Hypogymnia subphysodes var. subphysodes***	L	6	3	10
346		*Lecidea* sp.	L		2	2
107	**13**	***Menegazzia platytrema***	L		2	1
291		*Notocladonia cochleata*	L			
115	**15**	***Ochrolechia* sp. (G.S. Kantvilis 306/92)**	L	3	1	6
111		*Ochrolechia subrhodotropa*	L		2	1
93	**14**	***Opegrapha* sp. blackrays (R.J. Cranfield 17893)**	L	4	2	1
118	**16**	***Pannoparmelia wilsonii***	L	5	3	5
119	**17**	***Paraporpidia glauca***	L	11	10	7
293	**18**	***Parmotrema reticulatum***	L			
196		*Pertusaria trachyspora*	L			1
52	**19**	***Ramboldia stuartii***	L	8	6	4
242		*Rhizocarpon geographicum*	L			
127		*Rhizocarpon* sp. grey (R.J. Cranfield 17914)	L	2		5
79	**20**	***Tephromela atra***	L			2
64	**21**	***Thysanothecium hookeri***	L			
132	**22**	***Thysanothecium scutellatum***	L	11	12	10
178		*Trapelia coarctata*	L	4	1	3
136	**23**	***Usnea inermis***	L	10	5	12
246		*Usnea nidulifera*	L		4	
208	**24**	***Usnea* sp. leuco (R.J. Cranfield 20195)**	L	1	1	
134		*Usnea subalpina*	L	1		
140		*Usnea subeciliata*	L	1		
211		*Xanthoparmelia exillima*	L	1		
212	**25**	***Xanthoparmelia isidiigera***	L	3		
213		*Xanthoparmelia mougeotina*	L	4		5
355	**26**	***Xanthoparmelia notata***	L			
141		*Xanthoparmelia* sp. coral (R.J. Cranfield 18782)	L			2
		Total species = 58		**42**	**38**	**43**
		Lichen (46)[2]		32	29	35
		Moss (9)		8	7	6
		Liverworts (3)		2	2	2

Species #	Indicator #	Taxon	Life-form [1]	Gap release	Shelterwood	External reference
		Total monitoring species = 35				
		All cryptogams (27)		**22**	**23**	**24**
		Lichen (21)		17	18	18
		Moss (4)		4	4	4
		Liverwort (2)		1	1	2

[1] B = bryophyte (moss), H = hepatophyte (liverwort), L = lichen
[2] Numbers in brackets indicate the total number of lichen, moss and liverwort species recorded at Wellington in 2009.

VASCULAR PLANTS

Bruce Ward and Ray Cranfield

Introduction

When timber is harvested in native forests, disturbance might include soil movement, mixing and compaction in addition to the removal of overstorey and damage to understorey vegetation. This disturbance may impact more severely and cause a loss in diversity either through a decrease in species richness or a shift in species abundance. Understorey plants are key organisms for monitoring impacts of commercial timber harvesting in jarrah (*Eucalyptus marginata*) forest. FORESTCHECK utilises data on species richness and abundance to determine impacts across silvicultural harvesting treatments.

One of the strengths of this monitoring is that it was applied at an operational scale under standard industry conditions which means that the results are representative of the forest management practices. The vegetation complexes of the southwest jarrah forest 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. When analysing species richness data from harvest treatment sites it is important to also consider time since fire as observed differences may be due to succession following fire rather than a direct impact of timber harvesting.

The specific aim of monitoring vascular plants on FORESTCHECK monitoring grids is to:

- Determine species richness and abundance in the various silvicultural treatments of managed jarrah forest (shelterwood, selective cut and gap release) and in uncut reference forest
- Compare species richness, abundance and composition recorded within and between silvicultural treatment grids to those in uncut reference grids, and
- Compare results from Wellington in 2002 with those from 2008.

Revision of survey methods

Recent analysis of the first five years of FORESTCHECK monitoring (2001-06) revealed that the four 1000 m^2 plot locations picked up heterogeneous variation within the grids and that the 20 x 1 m^2 plots were compromised by edge effects. The analysis also showed that there were insufficient numbers of small (1 m^2) plots to pick up the entire plant community on each grid and many more would be required to do so. To overcome the shortcoming of plot arrangement, two additional 1000 m^2 plots were added so that a diagonal line of plots were aligned across the survey area (Fig. 1). This increased the survey area of each monitoring grid from 20% to 30%. However, in 2007 (Donnelly) and 2008 (Wellington), the 20 x 1^2 m plots were included in monitoring surveys as a further check against the additional 1000 m^2 but in the future they will be discontinued in favour of the two additional larger plots. Survey methods for the 1000^2 m plots are outlined in the FORESTCHECK Operations Plan (viewed at www.dec.wa.gov.au).

Monitoring
Flora surveys on the Wellington FORESTCHECK grids were undertaken in the spring of 2008, coinciding with the peak flowering time for most plants. Species richness and understorey vegetation structure was determined, by recording each species, estimating its area of cover, frequency of occurrence and measuring its position in the understorey strata in six 1000 m^2 plots in each grid. Species density was also measured by recording species occurrence and abundance in 20 x 1m^2 plots in each grid. Vegetation structure is determined from levy contact data at various height categories in the understorey (Levy and Madden 1933). The area around each grid was used to search and voucher flowering plant specimens to aid in or confirm their identification.

Sampling issues
A further sampling issue was detected with the measurements of canopy cover which utilises a periscope set on a pole at eye level to look vertically. Canopy is then rated as present Y/N with canopy cover calculated as a percentage of contacts with a 'yes' (Y) rating from the total number of contacts. The problem with this method is that a slight movement of the pole can alter the rating and we have found that subsequent measurements of the same site can be up or down due to operator bias. To resolve this issue we have decided to increase the sampling effort by additional measurements around the two additional 1000m^2 plots. This should reduce the variability and tighten up the cover result. The cover rating was also split into mid and upper storey ratings. The mid storey will be further split into eucalypt and other species. This will enable the structure of the developing stand to be tracked as it develops from saplings into poles and from poles to mature trees.

Specimen processing
The area surrounding each grid was used to search and voucher flowering plant specimens. In the first assessment at Wellington (2003) only 11% of the plant species were vouchered due to time taken over site selection and plot establishment. This meant that vegetation assessment could not be undertaken till late into the spring season and most species had progressed beyond their peak flowering period. Unfortunately, few species were flowering at the time of survey in 2008 and no additional vouchers were added. Additional collections will be added opportunistically during future monitoring surveys.

Data base management
Three data base files have been established to record vegetation data; vegbook1 contains data from the 1000m^2 plots, vegbook2 has the 1x1m plot data and vegbook3 has levy structural measurements. All measurements are entered directly into an excel data file which contains macros and file links which can track and verify data.

Voucher specimens are entered into the herbarium system using the MAX system program. All FORESTCHECK voucher specimens are given a unique bar code which identifies it as a type specimen for that plot and grid. Often there is more than one specimen collected for each species, especially if there is morphological variation within the species. The specimens are housed within the main collection of the WA state Herbarium.

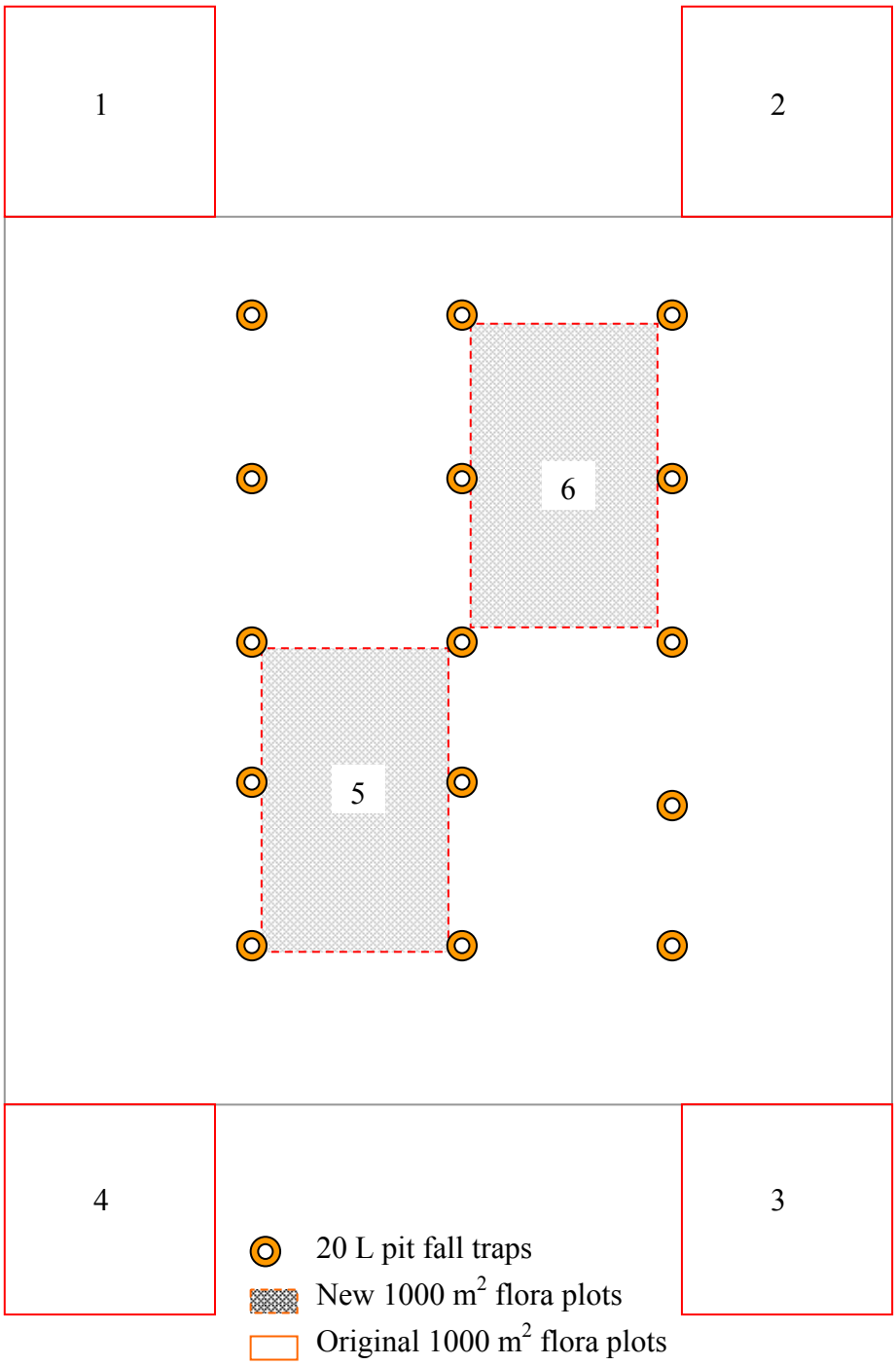


Figure 1. Two new 1000m^2 plots (numbered 5 and 6) added to the assessment in favour of the 20 1x1m^2/grid quadrats. The new plots utilised pegs already established for pit trapping and with the addition of these plots 20% of the area is now sampled. See p. 4 in Introduction for full details of grid layout.

Preliminary results

Species Richness

A total of 174 species were recorded from the 1000m^2 plots and 111 from the 1m^2 plots in 2008 (see Table 1 for comparison of specie numbers). A complete species list is attached (appendix 1).

Table 1. Total numbers of plant species recorded in each treatment and in each type of plot on the FORESTCHECK monitoring grids at Wellington in 2003 and 2008.

Number of species	Wellington 2003				Wellington 2008			
	Ref	SW	GR	Total	Ref	SW	GR	Total
Total	123	116	137	181	124	115	123	174
Unique to treatment	23	12	9		30	9	21	
Common to all				86				75
Total in 1000 m^2 plots*	123	116	137	181	124	115	123	174
Total in 1 m^2 plots	73	88	86	116	103	63	39	111
% difference	41	24	37	36	17	45	68	37
Weeds				10				5

* Six 1000 m^2 plots were monitored in 2008 and four in 2003.

Comparison in species richness between the two Wellington monitoring sessions showed a drop by 7 species from the 2003 sampling. This may be due to either a reduction in weed species or because timing of sampling was different. In 2008, surveys were conducted in early spring (Sept) as opposed to late spring (November) in 2003 and some annuals have not have developed or vegetation has developed to a point where recovery has crowded plants and out-competed the weed species. Either way a reduction in weed species accounts for most of the decline while the rest may be due to the plant communities on treatment grids developing a further six years, or to the re-establishment of species following fire that occurred on some grids between the two monitoring periods. The overall species richness shows no apparent difference due to the harvesting treatments (Fig. 2) and variations within treatments is likely due to variation in succession within plant communities at different time since treatments such as fire as well as other edaphic factors such as soil types.

Only five species of weeds were recorded in 2008, down from 10 in 2003. The highest number of weed species in any grid was four. This demonstrates that recovery of the native vegetation is occurring at a sufficient rate to out-compete and reduce the number and abundance of weeds.

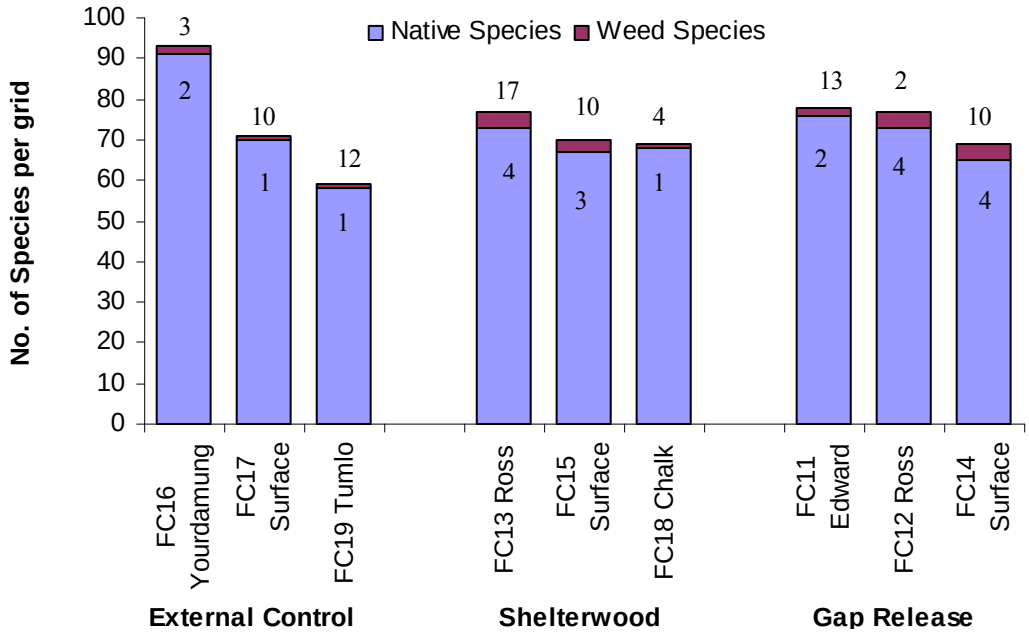


Figure 2. Total numbers of native plant and weed species in each grid at Wellington in 2008. Numbers above the bars indicate the time since fire in years, and numbers inside bars indicate the number of weeds.

Plant density

Plant density appears to show a combined effect of time since fire and spatial separation with a north-south gradient. The Yourdamung (FC16) and Tumlo control (FC19) grids are geographically separated by 23 km and time since fire ranges from 3 years at Yourdemung to 12 years at Tumlo (Fig. 3). The shelterwood and gap treatments show a similar trend with the north- south gradient and changes in structural development over time since fire being evident in plant density, except at the Edward gap release (FC11) where plant density appeared to be high despite having been burnt 13 years previously.

Combined effect

To determine the importance that each species contributes to the plant assemblage, relative values were calculated for ratings of cover, frequency and distribution to determine an overall importance value. The mean total importance value for each grid was plotted (Fig. 4). This shows an inverted view of the species richness and indicates that species richness or species density on their own, do not explain the differences within plant communities. The summing of the three parameters has the effect of increasing the difference between the same species among stands of similar species composition. That is two stands may contain the same species with the same frequency but a different cover value. This renders a disparity between the two stands which continues to widen with each additional species. For example the Tumlo control grid (FC19) has the lowest species richness but when frequency and cover are taken into account the existing species take on a higher importance (Fig. 4).

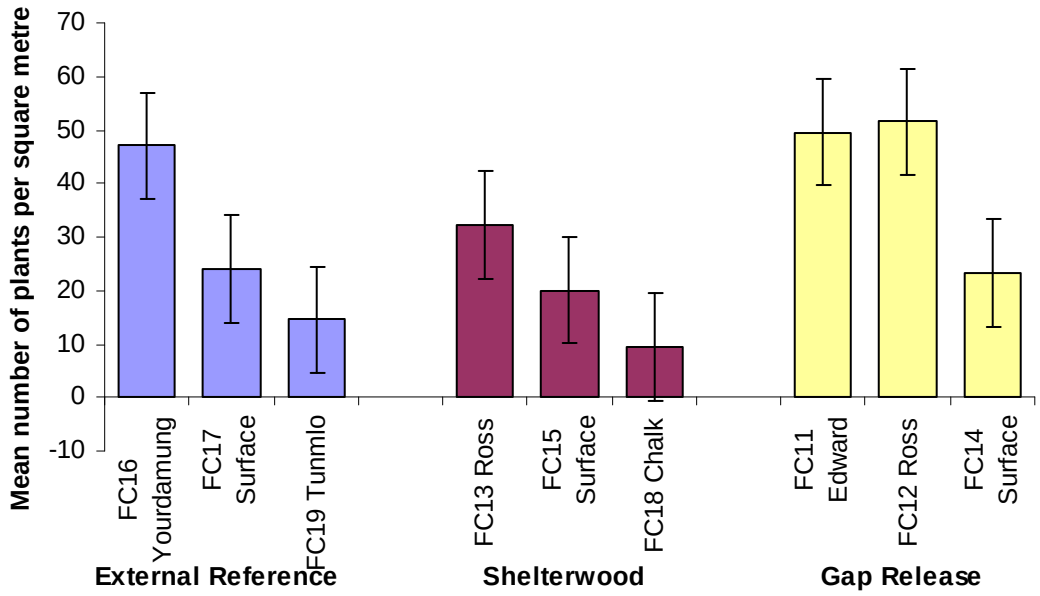


Figure 3. Mean plant density (plants m^{-2}) in each of the Wellington grids in 2008.

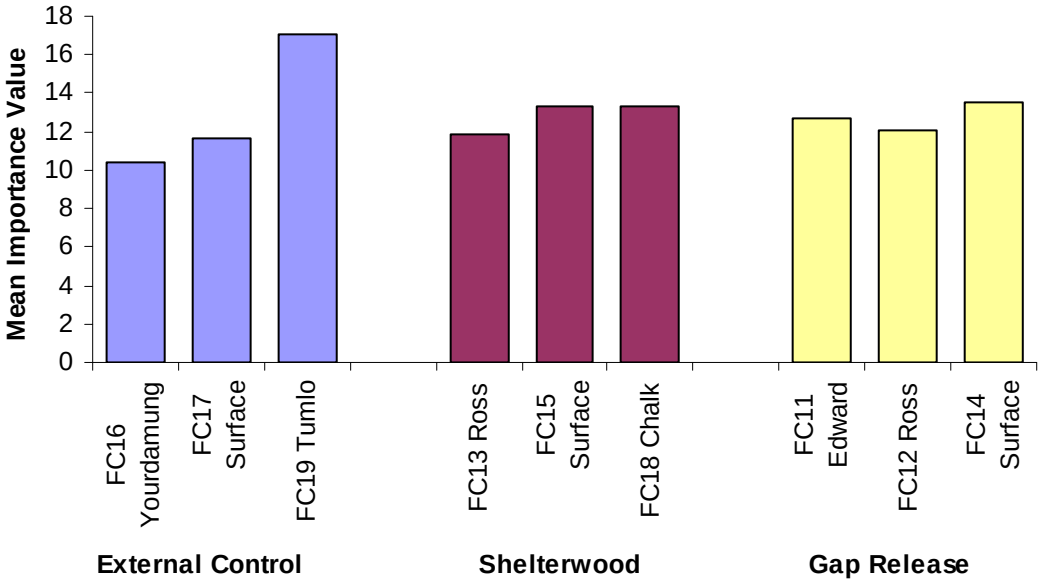


Figure 4. Mean importance values, calculated from the sum of relative cover, density and distribution data, for each grid

Life forms and fire response

Regeneration of fire-adapted plants following fire is either from seed or by re-sprouting from rootstock or an underground organ. The proportion of seeders and re-sprouters in 2008 was 40% and 60% respectively. This has not altered from the first monitoring surveys from 2003.

In vegetation ecology, plants have been grouped into life-form or growth-form classes on the basis of their similarity in structure and function. A life form group is a growth form that displays an obvious relationship to environmental factors and is usually constant. We grouped the plant species according to their life form group to see if logging has favoured or impacted any particular group (Fig. 5). Results show that in general the shelterwood treatment has 2-3 species less then the reference and gap release treatments for all life form groups with the exception of trees. This is likely the result of a deliberate scarification treatment to promote the development of jarrah advance growth. The scarification formed part of the prescription for shelterwood in the older plots and recent changes to the prescription may have eliminated this problem. The gap treatment has favoured some groups such as the large shrubs and herbs which may have come at the expense of other groups.

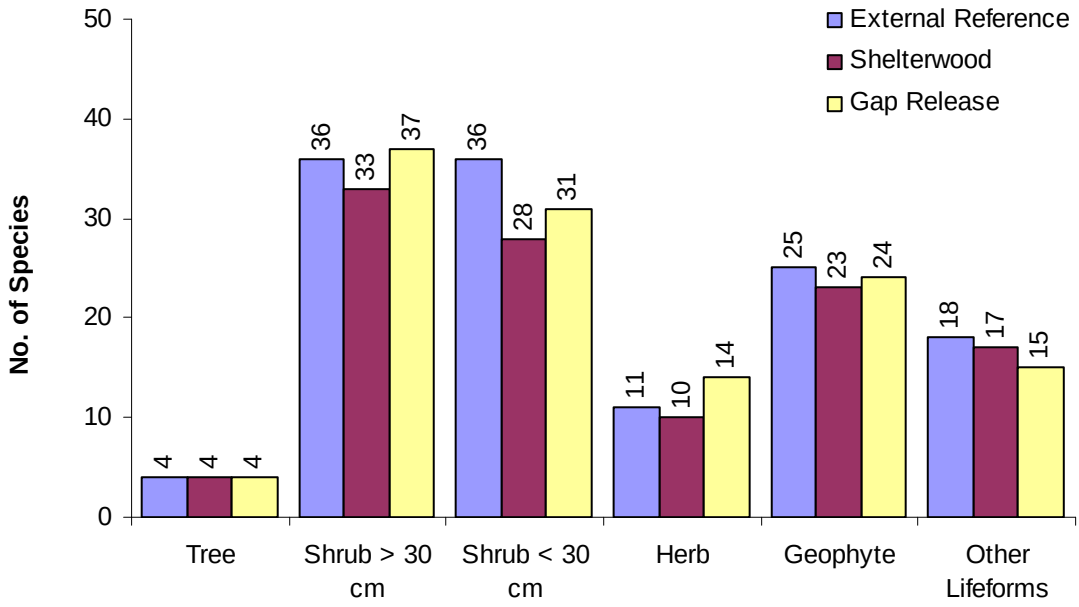


Figure 5. The life form composition in each of the treatments at Wellington in 2008.

Vegetation structure

Height and strata density are used to show a vertical profile of the vegetation within each grid (Fig. 6). The dominant plant species and site factors have had the largest influence on plant structure. For example, the Surface shelterwood (FC15) and gap release (FC14) grids are dominated by dense stands of netic (*Bossiaea aquifolium* subsp. *aquifolium*) with a mean top height of 1.5 m where as the Ross shelterwood (FC13) and gap release (FC12) grids, only 2-3 kilometres away, have an open stand of assorted low woody shrubs less than 30 cm. The Ross gap release was prescribe burnt only 2 years previously and the other three were all burnt more than 10 years previously. This demonstrates that fire also has a short term impact on vegetation structure.

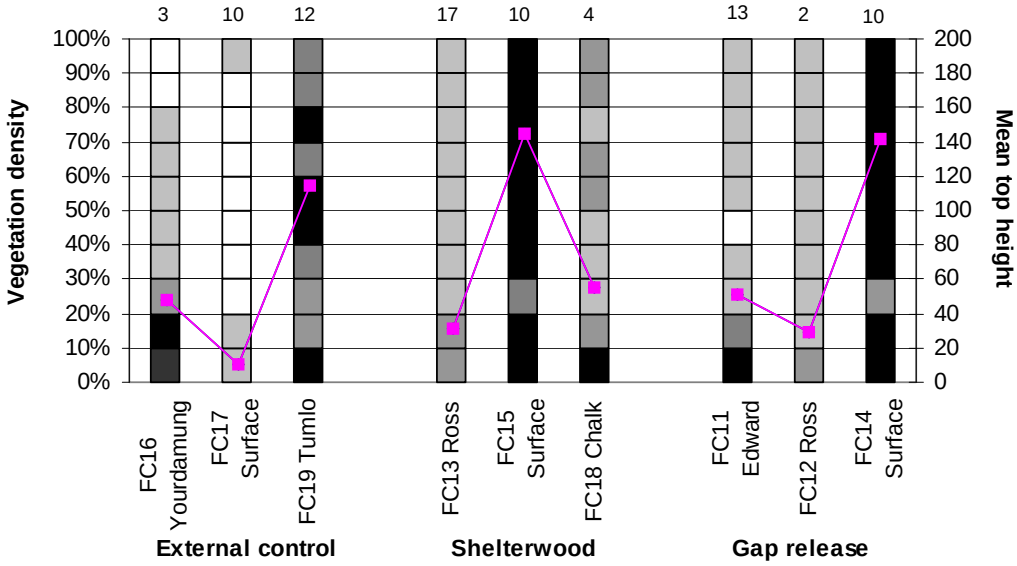


Figure 6. Profile diagram of the vegetation structure from ground level to 2 m in the Wellington grids in 2008. The bars showing the cover density varies from black being the densest to white being no plants (white = 0 contacts, light grey = 1-25 contacts, mid-grey = 26-40 contacts, dark grey = 41-60 contacts and black = >60 contacts). The line profiles across each treatment indicate mean top height of the vegetation stand in each grid. Numbers above the bars indicate the years since fire.

Conclusions

- Species richness and abundance of plants has not shown any obvious adverse effects due to silvicultural treatments associated with harvesting. Variation between grids is most likely due to other edaphic and climatic factors which effect plant establishment and growth, and are often responsible for variation in plant dominance and distribution.
- The shelterwood treatment showed a reduction in species numbers that may be attributed to scarification of the sites as part of the prescription. Recent revision of the prescription to reduce these effects is now in practice but the older plots are still recovering from this treatment.

Operating Plan revision

Methods for monitoring vascular flora will be updated in the Operating Plan to cover the current revisions to the method for sampling vegetation and canopy cover.

APPENDIX 1. **A list of all plant species recorded on the Wellington Forestcheck grids in 2008**

Weed	Species code	Species name	Life form[1]	Life style[2]	Fire response[3]
	ACABRO	*Acacia browniana*	S	P	A1
	ACACEL	*Acacia celastrifolia*	S	P	A1
	ACADRU	*Acacia drummondii*	S	P	A1
	ACAEXT	*Acacia extensa*	S	P	A1
	ACAMYR	*Acacia myrifolia*	S	P	A1
	ACAPRE	*Acacia preissiana*	DS	P	A1
	ACAPUL	*Acacia pulchella*	S	P	A1
	ACAURO	*Acacia urophylla*	S	P	A1
	AGRSCA	*Agrostocrinum scabrum*	GP	P	B3
*	AIRCUP	*Aira cupaniana*	GR	A	A1
	ALLFRA	*Allocasuarina fraseriana*	T	P	B1
	AMPAMP	*Amphipogon amphipogonoides*	DS	P	B2
	AMPERI	*Amperea ericoides*	DS	P	B2
	ASTCIL	*Astroloma ciliatum*	DS	P	B2
	ASTDRU	*Astroloma drummondii*	DS	P	B2
	ASTPAL	*Astroloma pallidum*	DS	P	B2
	AUSCAE	*Austrodanthonia caespitosa*	GR	P	B3
	BAECAM	*Baeckea camphorosmae*	S	P	B2
	BANBIP	*Banksia bipinnatifida*	DS	P	B2
	BANBIP	*Banksia bipinnatifida*	S	P	B2
	BANDAL	*Banksia dallanneyi*	S	P	B2
	BANGRA	*Banksia grandis*	T	P	A2
	BANSESSES	*Banksia sessilis var. sessilis*	S	P	A1
	BILHET	*Billardiera heterophylla*	S	P	U
	BILVAR	*Billardiera variifolia*	V	P	A1
	BORSPA	*Boronia spathulata*	S	P	B2
	BOSAQUAQU	*Bossiaea aquifolium* subsp. *aquifolium*	S	P	A1
	BOSORN	*Bossiaea ornata*	S	P	B2
*	BRIMIN	*Briza minor*	GR	A	A1
	BURCON	*Burchardia congesta*	GP	P	B3
	CALFLA	*Caladenia flava*	GP	P	B3
	CALREP	*Caladenia reptans*	GP	P	B3
	CALSP.	*Caladenia sp.*	GP	P	B3
	CASRAC	*Cassytha racemosa*	P	P	A1
*	CENERY	*Centaurium erythraea*	H	A	A1
	CHACOR	*Chamaescilla corymbosa*	GP	P	B3
	CLEPUB	*Clematis pubescens*	V	P	A1
	COMCON	*Comesperma confertum*	S	P	A1
	CONACU	*Conostylis aculeata*	DS	P	B3
	CONCAP	*Conospermum capitatum*	S	P	B2
	CONSET	*Conostylis setigera*	DS	P	B3
	CORCAL	*Corymbia calophylla*	T	P	A2
	CRAVAR	*Craspedia variabilis*	GP	P	B3
	CYAAVE	*Cyathochaeta avenacea*	Z	P	B3
	CYAGEM	*Cyanicula gemmata*	GP	P	B3
	CYASER	*Cyanicula sericea*	GP	P	B3

Weed	Species code	Species name	Life form[1]	Life style[2]	Fire response[3]
	CYRHUE	*Cyrtostylis huegelii*	GP	P	B3
	DAMLIN	*Dampiera linearis*	DS	P	A1
	DAUGLO	*Daucus glochidiatus*	H	A	A1
	DAVPRE	*Daviesia preissii*	S	P	A1
	DESFAS	*Desmocladus fasciculatus*	Z	P	B3
	DESFLE	*Desmocladus flexuosus*	Z	P	B3
	DIAREV	*Dianella revoluta*	DS	P	B3
	DROBUL	*Drosera bulbosa*	GP	P	B3
	DROERY	*Drosera erythrorhiza*	GP	P	B3
	DROMEN	*Drosera menziesii*	GP	P	B3
	DROPAL	*Drosera pallida*	GP	P	B3
	DROSTO	*Drosera stolonifera*	GP	P	B3
	ELYBRU	*Elythranthera brunonis*	GP	P	B3
	EUCMAR	*Eucalyptus marginata*	T	P	A2
	GENSP.	*Genus* sp. (orchid)	GP	P	B3
	GENSP.	*Genus* sp.(poa)	GR	A	A1
	GERSOL	*Geranium solanderi*	DS	A	A1
	GLIAUR	*Glischrocaryon aureum*	S	P	B2
	GOMCON	*Gompholobium confertum*	S	P	A1
	GOMOVA	*Gompholobium ovatum*	DS	P	A1
	GOMPRE	*Gompholobium preissii*	DS	P	A1
	GOMTOM	*Gompholobium tomentosum*	DS	P	A1
	HAEPAN	*Haemodorum paniculatum*	H	P	B3
	HAESIM	*Haemodorum simplex*	GP	P	B3
	HAKLIS	*Hakea lissocarpha*	S	P	B2
	HEMRIG	*Hemigenia rigida*	DS	P	A1
	HIBAMP	*Hibbertia amplexicaulis*	S	P	B2
	HIBCOM	*Hibbertia commutata*	S	P	B2
	HIBHYP	*Hibbertia hypericoides*	S	P	B2
	HIBRAC	*Hibbertia racemosa*	S	P	B2
	HIBSP.	*Hibbertia* sp.	S	P	B2
	HIBSPI	*Hibbertia spicata*	S	P	B2
	HOMHOM	*Homalosciadium homalocarpum*	H	A	A1
	HOVCHO	*Hovea chorizemifolia*	DS	P	B2
	HOVTRI	*Hovea trisperma*	S	P	A1
	HYDCAL	*Hydrocotyle callicarpa*	H	A	A1
	HYDDIA	*Hydrocotyle diantha*	H	A	A1
	HYPANG	*Hypocalymma angustifolia*	S	P	B2
*	HYPGLA	*Hypochaeris glabra*	H	A	A1
	ISOHYP	*Isotoma hypocrateriformis*	H	A	A1
	KENCOC	*Kennedia coccinea*	V	P	A1
	KENPRO	*Kennedia prostrata*	V	P	A1
	LABPUN	*Labichea punctata*	DS	P	B2
	LAGHUE	*Lagenophora huegelii*	GP	P	B3
	LASFLO	*Lasiopetalum floribundum*	S	P	A1
	LECBIL	*Lechenaultia biloba*	S	P	A1
	LEPCUN	*Leptomeria cunninghamii*	S	P	A1
	LEPLEP	*Lepidosperma leptostachyum*	Z	P	B3
	LEUCAP	*Leucopogon capitellatus*	S	P	A1

Weed	Species code	Species name	Life form[1]	Life style[2]	Fire response[3]
	LEUCAP	*Leucopogon capitellatus*	S	P	B2
	LEUPRO	*Leucopogon propinquus*	S	P	B2
	LEUVER	*Leucopogon verticillatus*	S	P	B2
	LEVPUS	*Levenhookia pusilla*	H	A	A1
	LOMCAE	*Lomandra caespitosa*	DS	P	B3
	LOMDRU	*Lomandra drummondii*	DS	P	B3
	LOMHER	*Lomandra hermaphrodita*	DS	P	B2
	LOMINT	*Lomandra integra*	DS	P	B3
	LOMNIG	*Lomandra nigricans*	DS	P	B3
	LOMPAU	*Lomandra pauciflora*	DS	P	B2
	LOMSER	*Lomandra sericea*	DS	P	B3
	LOMSON	*Lomandra sonderi*	DS	P	B3
	LUZMER	*Luzula meridionalis*	R	P	B2
	MACRIE	*Macrozamia riedlei*	CY	P	B3
	MICSTI	*Micrantha stipoides*	GR	P	B3
	MILTEN	*Millotia tenuifolia*	H	A	A1
	OLABEN	*Olax benthamiana*	DS	P	A1
	OPEHIS	*Opercularia hispidula*	S	P	B2
*	OXACOR	*Oxalis corniculata*	GP	P	B3
	PATBAB	*Patersonia babianoides*	GP	P	B3
	PATOCC	*Patersonia occidentalis*	DS	P	B3
	PATPYG	*Patersonia pygmaea*	GP	P	B3
	PATUMB	*Patersonia umbrosa*	DS	P	B3
	PATUMBXAN	*Patersonia umbrosa var. xanthina*	DS	P	B3
	PELLIT	*Pelargonium littorale*	DS	P	A1
	PENPEL	*Pentapeltis peltigera*	DS	P	B2
	PENSIL	*Pentapeltis silvatica*	DS	P	B2
	PERELLELL	*Pericalymma ellipticum var. ellipticum*	S	P	A1
	PERLON	*Persoonia longifolia*	S	P	B2
	PHYCAL	*Phyllanthus calycinus*	DS	P	B2
	PHYPAR	*Phyllangium paradoxum*	H	A	A1
	PIMROS	*Pimelea rosea*	S	P	A1
	PIMSP.	*Pimelea* sp.	S	P	A1
	PODANG	*Podotheca angustifolia*	H	A	A1
	PODGNA	*Podotheca gnaphalioides*	H	A	A1
	PRASP.	*Prasophyllum* sp.	GP	P	B3
	PTEESC	*Pteridium esculentum*	F	P	B2
	PTEPYR	*Pterostylis pyramidalis*	GP	P	B3
	PTEREC	*Pterostylis recurva*	GP	P	B3
	PTEVIT	*Pterostylis vittatus*	GP	P	B3
	PTIMAN	*Ptilotus manglesii*	DS	P	B3
	PTISTI	*Ptilotus stipitatus*	GP	P	B3
	PYRNIG	*Pyrorchis nigricans*	GP	P	B3
	RANCOL	*Ranunculus colonorum*	GP	P	B3
	RHOCIT	*Rhodanthe citrina*	H	A	A1
	SCALAN	*Scaevola lanceolata*	S	P	A1
	SCASTR	*Scaevola striata*	DS	A	A1
	SCHSUB	*Schoenus subflavus*	Z	P	B3
	SENHIS	*Senecio hispidulus*	DS	P	A1

Weed	Species code	Species name	Life form[1]	Life style[2]	Fire response[3]
	SENLEU	*Senecio leucoglossus*	S	A	A1
	SENPIN	*Senecio pinnatifolius*	S	A	A1
	SOWLAX	*Sowerbaea laxiflora*	GP	P	B3
	SPHMED	*Sphaerolobium medium*	S	P	B2
	SPHSP.	*Sphaerolobium* sp.	S	P	B2
	STAMON	*Stackhousia monogyna*	S	P	B2
	STYAMO	*Stylidium amoenum*	DS	P	A1
	STYBUL	*Stylidium bulbiferum*	GP	P	B3
	STYCAL	*Stylidium calcaratum*	DS	P	A1
	STYCAL	*Stylidium calcaratum*	H	A	A1
	STYCIL	*Stylidium cilatum*	DS	P	A1
	STYLUT	*Stylidium luteum*	DS	P	A1
	STYPIL	*Stylidium piliferum*	DS	P	A1
	STYSP.	*Stylidium* sp.	DS	P	A1
	STYTEN	*Styphelia tenuiflora*	S	P	A1
	SYNPET	*Synaphea petiolaris*	S	P	B3
	TETCAP	*Tetraria capillaris*	Z	P	B3
	TETHIR	*Tetratheca hirsuta*	S	P	A1
	TETHIS	*Tetratheca hispidissima*	S	P	A1
	TETLAE	*Tetrarrhena laevis*	GR	P	B3
	TETOCT	*Tetraria octandra*	Z	P	A1
	THECRI	*Thelymitra crinita*	GP	P	B3
	THESP.	*Thelymitra* sp.	GP	P	B3
	THOFOL	*Thomasia foliosa*	S	P	A1
	THYMAN	*Thysanotus manglesianus*	GP	P	B3
	THYMUL	*Thysanotus multiflorus*	GP	P	B3
	TRAPIL	*Trachymene pilosa*	H	A	A1
	TRIELA	*Tricoryne elatior*	H	P	B3
	TRIHUM	*Tricoryne humilis*	DS	P	A1
	TRISPA	*Trichocline spathulata*	GP	P	B3
	TRYFLO	*Trymalium floribundum*	S	P	A1
	TRYLED	*Trymalium ledifolium*	S	P	A1
	TRYLED	*Trymalium ledifolium*	T	P	A1
	WURSP.	*Wurmbea* sp.	GP	P	B3
	XANATK	*Xanthosia atkinsoniana*	DS	P	B2
	XANCAN	*Xanthosia candida*	DS	P	B2
	XANGRA	*Xanthorrhoea gracilis*	X	P	B2
	XANHUE	*Xanthosia huegelii*	DS	P	A1
	XANPRE	*Xanthorrhoea preissii*	X	P	B2

[1] Cy = cycad, DS = dwarf shrub (1-30 cm), F = Fern, GP = geophyte, GR = grass, H = herb, P = parasite, R = rush, S = shrub (> 31 cm), T = tree, V = vine, X = Xanthorrhoea/Kingia, Z = sedge, U = unknown.
[2] A = annual, P = perennial.
[3] A1 = seed stored in soil, A2 = seed stored on plant (serotinous), A3 = no seed on site, B1 = regeneration from epicormics, B2 = regeneration from woody rootstock or lignotuber, B3 = Regeneration from fleshy underground organ (corm, bulb, tuber, rhizome), U = unknown.

INVERTEBRATES

Janet Farr, Allan Wills, and Paul Van Heurck

Introduction

Invertebrates, including class Insecta, comprise over 95% of the planet's biodiversity and therefore represent a crucial component in any ecosystem. Invertebrates play a major role in decomposition, nutrient recycling, plant pollination 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 relics. 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 and uncut forest.
- Analyse trends in species composition, richness and abundance
- To monitor the presence of Gondwanan relic and affinity invertebrate species with respect to the above treatments
- To monitor the presence of known insect pest species.

Field survey and laboratory procedure

Sampling at Wellington was carried out in November (spring) 2008 and April (autumn) 2009 using protocols outlined in the FORESTCHECK Operations Plan. To briefly summarise: 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 one person hour per capture/habitat method. Light traps were run for three nights simultaneously at each site achieving one trap night per week for three weeks (there were light trap failures on 25/11/08 at grids FC15 and FC16 and a repeat trapping for those locations and date was not achieved); 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 compared to the extensive collection of voucher specimens held there. Morphospecies were assigned and vouchers for each morphospecies were erected as necessary and labelled according to site, date of capture and capture method and preserved as either pinned or alcohol specimens as a reference collection. To constrain sample processing times only macro-invertebrates were recorded, that is, invertebrates with a body length 10 mm or greater and Lepidoptera with a wing length of 12 mm or greater. Highly distinctive or relictual morphospecies, smaller than these sizes, were also recorded. Samples waiting to be processed were stored either frozen or in 70% ethanol.

Sampling was conducted at all nine Wellington sample grids. Sorting, specimen identification and cataloguing have been completed. This report details sampling results for 2008-09 and also includes a brief comparison with the initial Wellington results for 2002-03. Note however, this is a preliminary report and results are from data as it exists for August 2009. Morphospecies assignment may have changed

following data refinement from progressive taxonomic evaluation and will continue to be influenced by minor adjustments in the future as morphospecies assignment is further refined.

Preliminary results

Following the 2008-09 monitoring, the number of morphospecies recorded for FORESTCHECK increased to 1,953 (a total of 70,359 individual specimens). The list of all FORESTCHECK morphospecies is not included in this report but is available on request. The total number of individual specimens captured from Wellington in 2008-09 was 5,590, comprising 592 morphospecies, this compares with 374 morphospecies (adjusted from original data for synonymy) captured in 2002 and an abundance level (number of specimens) of 3,080. The species list for Wellington1 2008-09 is shown in Appendix 1. There were 177 new morphospecies from Wellington that were not previously captured on any of the FORESTCHECK sites (although this figure will reduce following our annual morphospecies revision where synonomy is examined). This is the same species increase for Donnelly and Wellington in 2002-03 but falls short of the predicted 245 new species and 2021 total species, from last year's results. Figure 1 shows the cumulative captures for the successive sampling locations. The slope of the graph is consistent between successive sampling periods and shows no current trend of reduction indicating that, at this point, there is neither a sampling plateau nor an approach to one although there is a slight drop in species acquisition from the previous sample round.

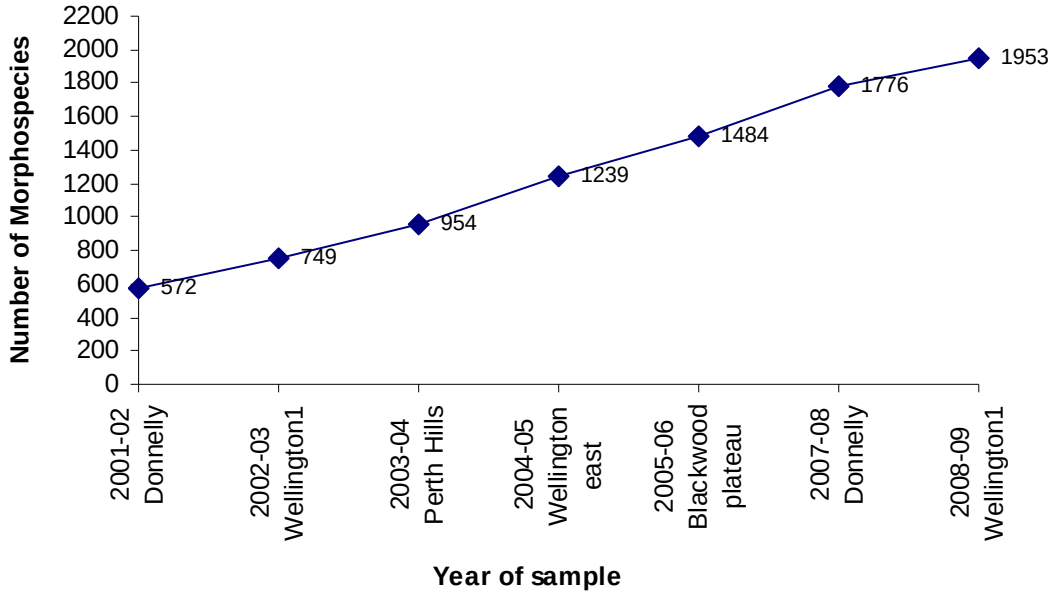


Figure 1. Cumulative morphospecies for 2001 (Donnelly) to 2008 (Wellington)

Total morphospecies capture for past sampling districts and periods are shown in Table 1. Donnelly appears the most diverse site followed by Blackwood and Wellington east. The greatest abundance of invertebrates was sampled from Wellington east, followed by the Donnelly 2007-08 sample (Table 1).

Table 1. Morphospecies comparisons between sample regions.

District	Sample period	Number of Morphospecies	Number of individuals
Donnelly	2001 – 02	572	
Wellington	2002 – 03	373	3080
Perth Hills	2003 – 04	428	4883
Wellington east	2004 – 05	624	28265
Blackwood	2005 – 06	728	6959
Donnelly	2007 – 08	787	13581
Wellington1	2008 – 09	592	5590

The numbers of morphospecies for orders where 10 or more morphospecies have been assigned are compared for Wellington1 2008-09 and 2002-03 in Figure 2. The increase capture rates in Wellington1 2002-03 are mostly within the Lepidoptera (moths) where species capture nearly doubled from 145 in 2001-02 to 282 in 2008-09. Examples of strong increases include, Coleoptera (beetles), and Orthoptera (grasshoppers and crickets), with little change in species numbers for the other orders. It might be argued that differences may be due to operator effort/skill since 33% of the team has changed since the initial Wellington sample. In addition operator skill may also have increased with successive sampling years. However, most moths are caught through trapping, indicating an environmental influence in species differences. In addition no apparent differences in operator effort were observed for the preceding Donnelly comparisons (see FORESTCHECK report 2007-08).

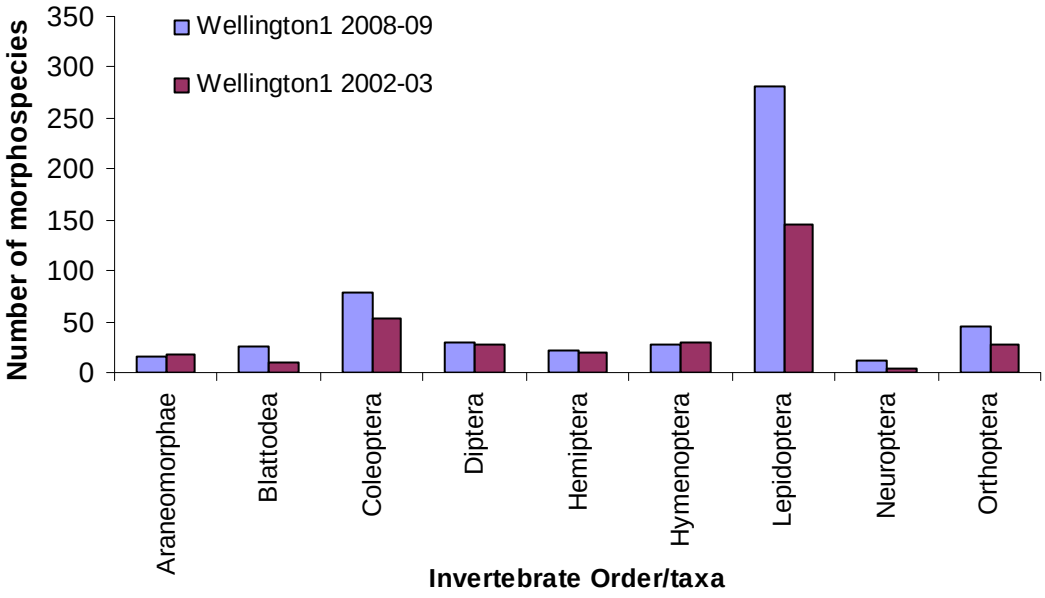


Figure 2.. Comparison of Wellington for 2008-09 and 2002-03 morphospecies numbers of invertebrate orders where ten or greater morphospecies have been assigned.

Comparing capture methods

Light trapping resulted in the most abundant and diverse captures (Table 2) with an autumn capture of 194 morphospecies comprising 1493 individuals; and a spring capture of 235 morphospecies comprising 3168 individuals. In general, species richness and abundance is highest in spring with the exception of the hand sampling techniques of beating and sweeping where species richness was greater in autumn for beating and similar for both seasons for sweeping. Litter searches result in low species richness and abundances; however this is still a valid search technique as it can capture species not otherwise encountered with other methods. Targeted pursuit is used as an additional capture technique to catch species which are distinctive and not necessarily part of a particular operator's method or within their specified search protocol; in addition this technique is employed when habitat for a specific hand sampling method (e.g. litter or coarse woody debris) is scarce and thus maintains consistent operator sampling effort within each sample grid. Although this method can inform on important taxa it is not useful in a general concept of seasonal differences but has been included in Table 2 to explain total abundance for spring and autumn.

Table 2. Number of morphospecies and specimen abundance for Wellington in 2008-09 for each capture method (CWD = coarse woody debris, TP = Targeted pursuit).

Capture Method	No. of Morphospecies		Abundance	
	Spring	Autumn	Spring	Autumn
Light	235	194	3168	1493
Pitfall	61	35	242	114
Sweep	41	42	121	87
Beat	22	37	69	98
CWD	36	24	87	46
Litter	23	19	32	26
TP	6		7	
Total			3726	1864

Comparisons of capture technique for the two Wellington samples, expressed as number of morphospecies combined for both seasons (abundance data show similar results), showed that most of the increase in species richness between the two sample periods is from light trap captures (Fig. 3). The additional species are mainly mobile Lepidopterans, (refer to Fig. 2). For pit fall trapping and litter searches (mainly ground dwelling insects) the two sample periods are similar in species richness (Wellington 2002-03 is slightly higher but this difference is unlikely to be significant). The hand capture methods of sweeping, beating and coarse woody debris searches also show a similar trend to light trapping; species richness is similar, if not slightly higher for Wellington1 2008-09. Therefore it appears that there was an increase in

species richness for canopy dwelling invertebrates for 2008-09 whereas the species richness of ground dwellers remained relatively constant.

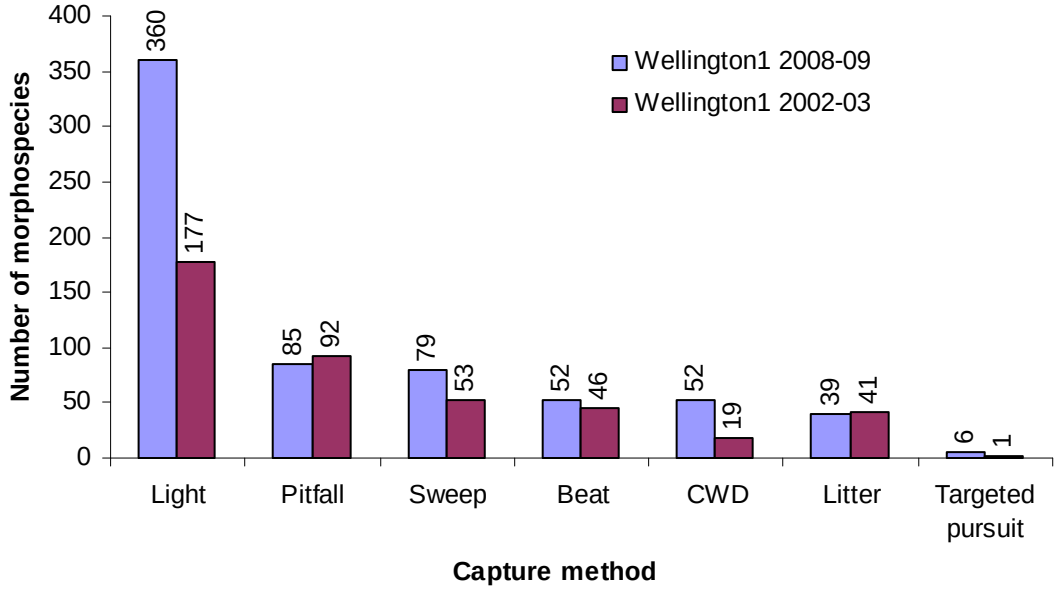


Figure 3. Comparison of the number of morphospecies (total over both seasons) for Wellington in 2008-09 and 2002-03 in respect to capture method.

Comparing sample grids and silvicultural treatments

Wellington grid comparisons for silvicultural treatments expressed as the total morphospecies and abundance for all capture methods and summed for spring and autumn seasons is shown in Figure 4. The Surface external reference grid (FC17) and the Ross shelterwood grid (FC13) had the greatest number of species (175 and 176 respectively) followed closely by the Ross gap release grid (FC12 - with a species count of 171). Abundance was highest at the Tumlo external reference grid (FC19) (count of 889) followed by the Chalk Shelterwood grid (FC18). The lowest species richness was at the Edward gap release grid (FC11) with abundance lowest at the Shelterwood Surface grid (FC15).

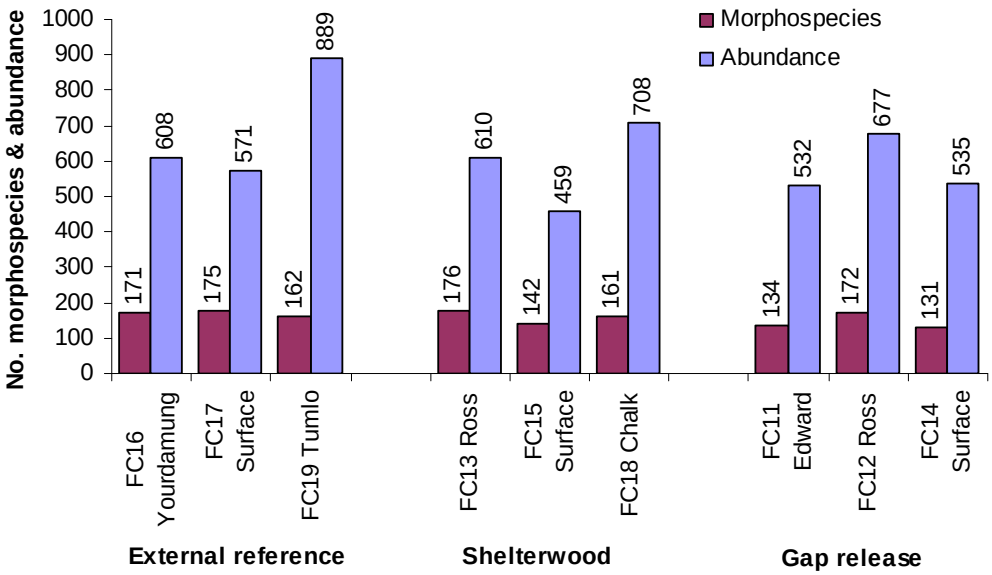


Figure 4. 2008-09 comparison of individual Wellington treatment grids for total morphospecies and number of individuals (abundance), for all capture methods, combining both seasons.

Comparison of means between treatments for 2008-09 (Fig. 5) indicates a trend of greater species richness in the external reference. Although the standard errors are small the difference in species numbers is also small and may not be significant since the previous sample period (2002-03) showed no trend between treatments. For comparison, the Donnelly sampling results have been included. For this region, with the inclusion of the Coupe buffer grids as controls, there is slightly higher species richness for the control, compared with treatment grids (otherwise there is no difference between treatments).

For the purpose of consistency and reference with past reports a summary of species richness and abundance (number of individuals captured at each grid) for capture methods, season and site are shown in Appendix 2.

Species richness and abundance for the different capture methods and treatment grids are shown in Figure 6. Both light trap captures and active captures indicate higher species diversity for the external reference, active captures having the most marked response. However, even for the active capture the significance is marginal and is unlikely to stand up to statistical scrutiny. For abundance, pitfall captures are high in the gap release sites. The standard error values indicate that this is potentially different from the external reference, perhaps indicating more mobility of invertebrates in these sites.

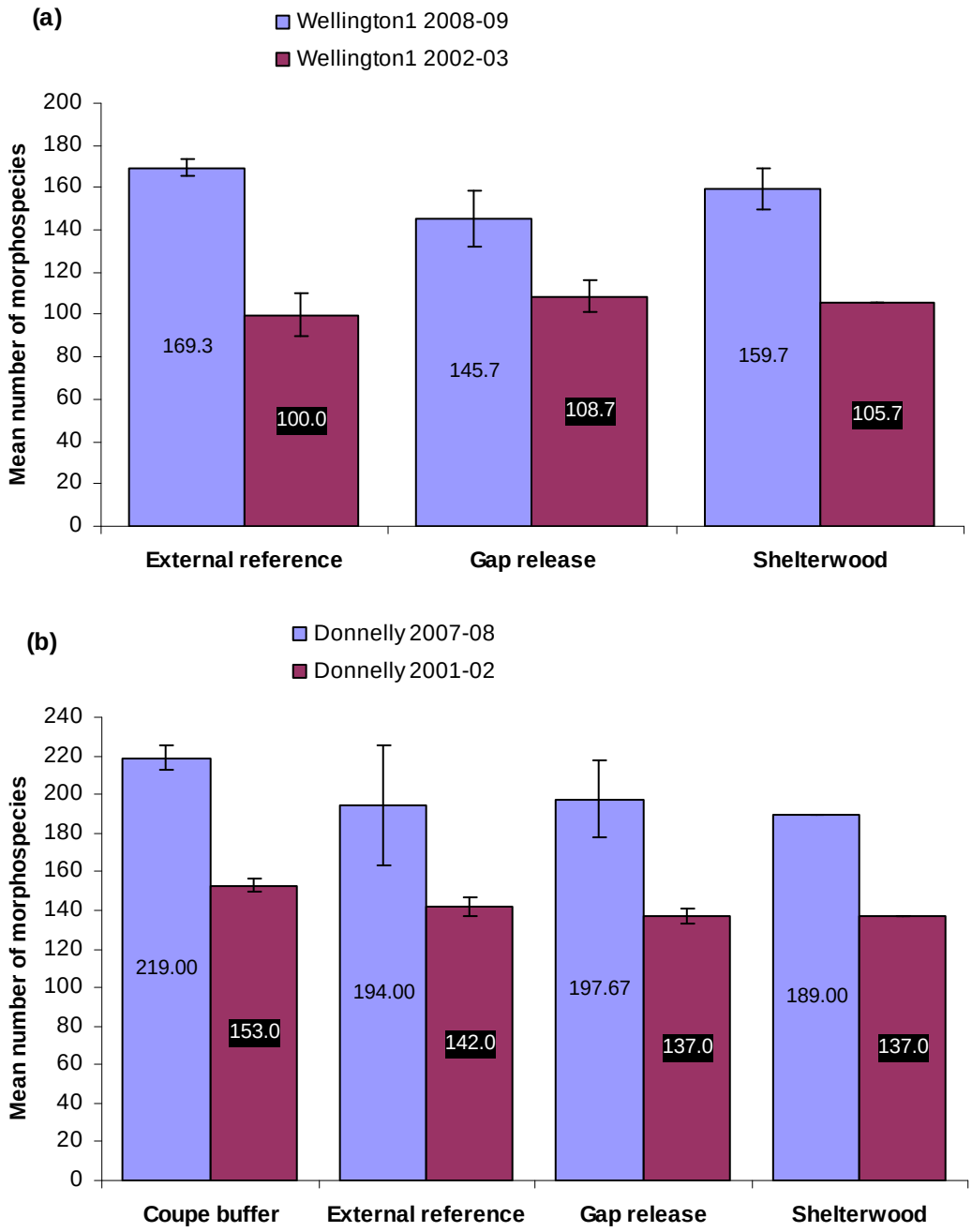


Figure 5 (a) Comparison of means (n=3, ± SE) for number of morphospecies for each treatment recorded atWellington in 2008-09 and 2002-03 in respect to silvicultural treatment. (b) Comparison of means (n=3, for each treatment except shelterwood where n=1, ± SE) for number of morphospecies recorded at Donnelly 2007-08 and 2001-02 in respect to silvicultural treatment.

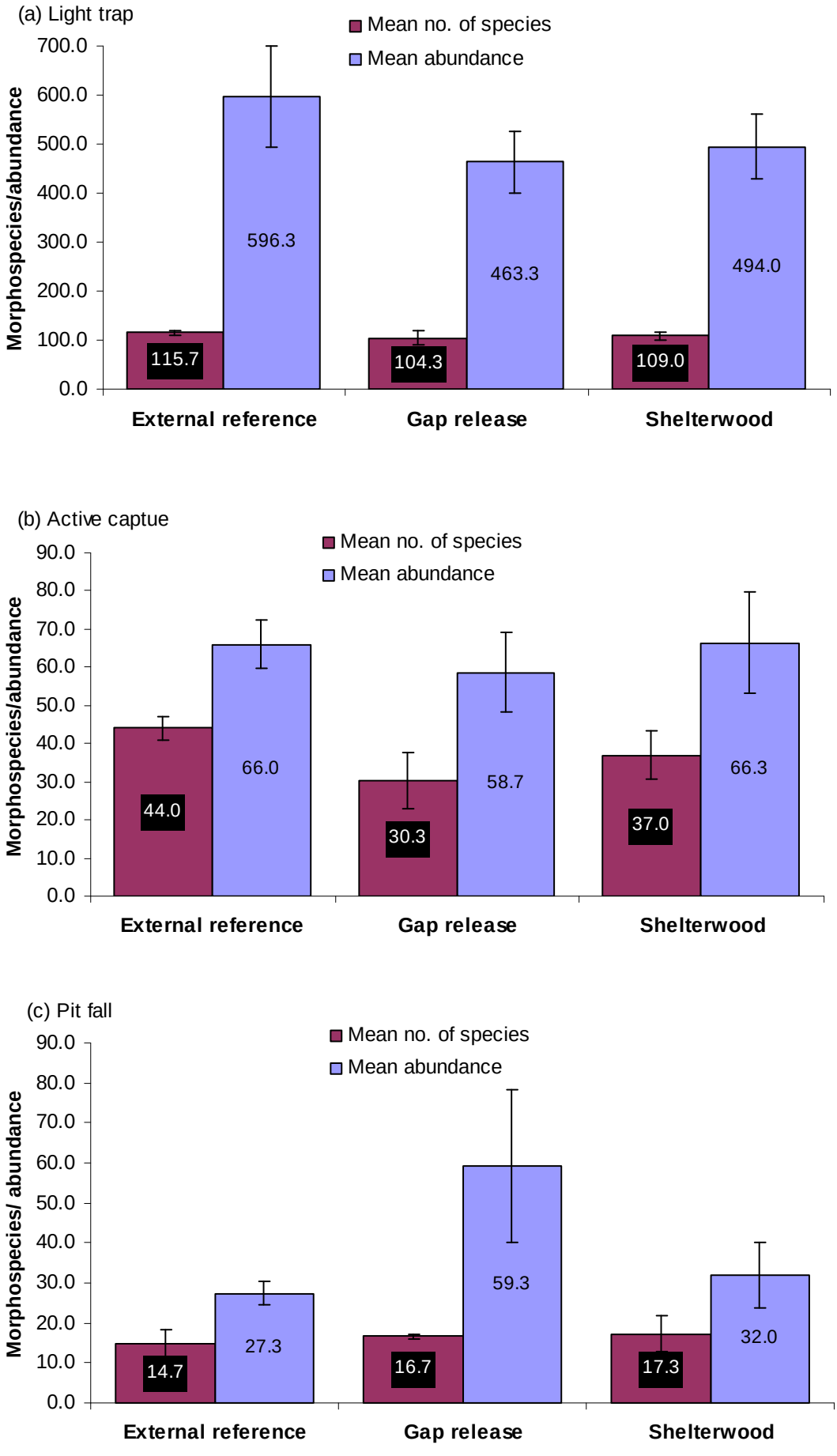


Figure 6. Mean species richness (number of morphospecies, ± SE, n = 3) and abundance for Wellington in 2008-09 against treatment grids for (a) Light traps, (b) active capture, and (c) Pitfall capture.

A fire occurred on the Surface external reference grid (FC17) during the spring sample session. Consequently, there was little understorey and foliage beating was replaced by targeted pursuit to maintain sampling effort for spring at this site. Direct comparisons between individual grid captures show there was little difference in abundance and species richness for spring in FC17 compared with other sites (Appendix 2). In fact, comparing FC17 with the other reference grids (FC16 & FC19), species richness and abundance was comparable for the combined capture methods; but active capture and pitfalls abundances were slightly higher. Examination of the active captures in more detail using external reference site FC16 for comparison, shows that during the fire both species richness and abundance were higher in CWD compared to other sample habitats indicating CWD was used as refuges from the fire.

Table 3. Comparison of each Active capture technique from Sites FC16 and FC17 for spring and autumn from Wellington in 2008-09

		FC17		FC16	
Season	Habitat	Spec no	Abun	Spec no	Abun
AU	Beat	8	15	4	5
AU	CWD	9	11	4	4
AU	Litter	3	3	4	5
AU	Sweep	6	6	8	8
SP	Beat	0	0	7	8
SP	CWD	16	30	6	8
SP	Litter	2	2	5	5
SP	Sweep	5	7	12	13
SP	TP	4	4	0	0

Species differences between localities

Table 4 shows the most frequent species captured for Wellington in 2008-09 and 2002-03 and Donnelly in 2001-02. The ant *Camponotus* (species 423) was the most frequently captured species in Wellington in 2008-09 and also featured in the top 10 most frequently sampled species for Wellington in 2002-03 and Donnelly in 2001-02. Only 40% of the top 10 Wellington 2002-03 species sample featured in the current most frequently caught species and three of the most frequent species captured in 2002-03 (species 235, 258 and 163) were not captured in the most recent Wellington sample. For Donnelly 2001-02, only 18% of the most frequent species featured in the most frequent Wellington 2008-09 sample, with three of its top 10 species (species 235, 373 and 18) not captured in the Wellington 2008-09 sample. However it needs to be pointed out at this stage that the morphospecies consolidation, where new species are examined and incorporated into the voucher collection, has as yet not been done for this sample and thus species such as 2963 and others may be synonymous with previous voucher identifications.

Table 4. Ten most frequent species captured for Wellington in 2008-09, Wellington in 2002-3, and Donnelly in 2001-02 Capture frequency is the number of times a specimen is collected over all 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 Wellington 2008-09 samples, eg. a rank of 14 for a Donnelly 2001-02 specimen means this species was the 14th most frequent species at Wellington 2008-09, rank 27 indicates 1 incidence only from Wellington 2008-09 Donnelly 2007-08; a rank = 0 indicates no specimen captured in Wellington 2008-09.

Location	Species ID number	Capture frequency	Wellington1 2008-09 capture frequency rank	Order	Family	Genus
Wellington 2008-09	423	35	1	Hymenoptera	Formicidae	Camponotus
	316	26	2	Lepidoptera		
	14	25	3	Coleoptera	Hydrophilidae	
	436	25	3	Lepidoptera	Geometridae	
	2963	23	4	Lepidoptera		
	5	23	4	Lepidoptera	Noctuidae	Pantydia
	544	23	4	Isopoda		
	23	22	5	Lepidoptera	Geometridae	Ectropis
	16	22	6	Diptera	Tipulidae	
	322	21	7	Lepidoptera		(the dart)
	221	21	7	Hemiptera	Pentatomidae	
	48	20	8	Lepidoptera		
	78	20	8	Lepidoptera	Zygaenidae	Pollanisus
	374	20	8	Lepidoptera	Notodontidae	
	223	20	8	Chilopoda	Scolopendridae	Ethmostigmus
	43	19	9	Lepidoptera	Noctuidae	Sandava
	63	19	9	Lepidoptera		
	73	19	9	Lepidoptera	Pyralidae	
	4	19	9	Lepidoptera	Notodontidae	Destolmia
	10	19	9	Lepidoptera	Thaumetopoeidae	Ochrogaster
	1051	18	10	Lepidoptera	Pyralidae	
	62	18	10	Lepidoptera	Oecophoridae?	
	436	84	3	Lepidoptera	Geometridae	
Wellington 2002-03	52	72	21	Hymenoptera	Apidae	Apis
	145	52	19	Trichoptera		
	4	27	9	Lepidoptera	Notodontidae	Destolmia
	235	25	0	Orthoptera	Acrididae	
	258	22	0	Dermaptera		
	163	22	0	Hemiptera	Reduviidae	
	10	20	9	Lepidoptera	Thaumetopoeidae	Ochrogaster
	423	19	1	Hymenoptera	Formicidae	Campanotus
	1	19	13	Lepidoptera	Carthaeidae	Carthaea
Donnelly 2001-02	52	64	21	Hymenoptera	Apidae	Apis
	6	54	27	Lepidoptera	Arctiidae	
	235	45	0	Orthoptera	Acrididae	
	373	28	0	Lepidoptera	Hepialidae	Abantiades
	39	27	14	Lepidoptera	Noctuidae	Proteuxoa
	145	26	19	Trichoptera		
	18	26	0	Lepidoptera	Noctuidae	Agrotis
	45	26	26	Lepidoptera	Zygaenidae	Pollanisus
	376	26	26	Lepidoptera		
	423	24	1	Hymenoptera	Formicidae	Campanotus
	16	23	6	Diptera	Tipulidae	

Of the 592 morphospecies found at Wellington in 2008-09, 400 had not been captured during the earlier sample period. In other words 68% of the current Wellington sample consisted of species not previously sampled in the Wellington grids. Conversely 182 species from the initial Wellington sample were not present in the current sample.

Pest presence

Jarrah leaf miner (JLM) was present on all grids (Table 5). Gumleaf skeletonizer (GLS) was apparently absent from all sites although skeletonized leaves were observed in five grids (two external reference, two gap release and one shelterwood). Leaf skeletonising alone is not usually recorded as a positive sighting for GLS, however such a high incidence indicates some form of leave feeder is at least moderate population levels at these sites. Bullseye borer (BEB) was present at all grids. Comparing the previous assessment in 2002-3, JLM was high in all grids, BEB was not observed in grids FC11, FC15, FC18 and questionable in FC19. Thus incidence of BEB and potentially GLS has increased, whereas JLM has slightly decreased. This trend is comparable to the trend seen in Donnelly in 2001 and 2007.

Table 5: Pest presence and abundance assessment at each grid for Wellington in 2008 (JLM = jarrah leaf miner; GLSab = gumleaf skeletonizer; BEB = bullseye borer; Skel = skeletonized leaves0 = absent, 1 = present, 2 = abundant).

Silvicultural Treatment	*Site No*	*Location*	*JLM*	*GLS ab*	*Skel*	*BEB ab*
External reference	FC16	Yourdamung	2	0	1	1
External reference	FC17	Surface	1	0	0	1
External reference	FC19	Tumlo	1	0	1	1
Gap release	FC11	Edward	2	0	1	1
Gap release	FC12	Ross	2	0	1	1
Gap release	FC14	Surface	2	0	0	1
Shelterwood	FC13	Ross	2	0	1	1
Shelterwood	FC15	Surface	2	0	0	1
Shelterwood	FC18	Chalk	2	0	0	1

Helena gum moth

One immediately apparent feature of the Donnelly sample from 2007-08 was the abundance of *Opodiphthera helena* (Helena gum moth, Table 6 & Fig. 8). Although this is a large distinctive species (Fig. 9), prior to 2007-08 few adults were collected in or around light traps, but in 2007-08 this species was the 3rd most abundant species captured in the Donnelly grids in 2007-08. In the current sample for Wellington abundance is still high (Table 6) compared with the previous Wellington sample from 2002-03, although not as high as for the 2007-08 sample.

Table 6. Helena gum-moth abundance (numbers summed over sites for each respective sample year) from FORESTCHECK locations using light traps from 2001-2009.

Year	*Sampling District*	*Abundance*
2001-02	Donnelly	4
2002-03	Wellington1	1
2003-04	Dwellingup	0
2004-05	Wellington east	6
2005-06	Blackwood plateau	0
2007-08	Donnelly	633
2008-09	Wellington1	24

Figure 9. Adult *Opodiphthera helena*

Figure 10. Late instar larvae of *Opodiphthera helena*. White spots show parasite eggs.

Student Project (Edith Cowan University)

In 2008 Stephen Danti completed a student project for a Graduate Diploma of Biological Sciences at Edith Cowan University. The study, entitled "The long term influence of different silvicultural treatments on coarse woody debris and saproxylic invertebrate assemblages in southern forests of Western Australia",examined CWD aspects of the invertebrate FORESCHECK study located in the Donnelly Kingston plots, FC1 9external reference), FC2 gap release) and FC3 (shelterwood). This study found no differences in silvicultural treatments, CWD dynamics and invertebrate assemblages. A copy of the study is lodged with the DEC Library.

Conclusions

In 2008-09 the wellington 1 FORESTCHECK grids were re-sampled using the same sampling methods as for 2002-03.

- The total number of invertebrate morphospecies recorded for FORESTCHECK is now 1953.

- In 2008-09, 68% of invertebrate species recorded were not captured in the previous 2002-03 sample. The higher diversity in 2008-09 was mainly attributed to light trap captures although sweeping and CWD captures did show some increase.
- A low intensity burn in grid FC17 resulted in increased CWD captures as invertebrates sought refuge in this habitat.
- In 2008-09, a significant increase in, Isopods and Helena gum moth abundance was recorded. There was also evidence of increased GLS presence in respect to skeletonized leaf damage.
- The ant *Camponotus* sp. 423 is consistently a frequent capture.

Appendix 1. Current species list including capture frequency (Cap Freq) and abundances (Abun) for invertebrates at Wellington FORESTCHECK grids in 2008-09.

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Araneomorphae					3030	1	1
Araneomorphae					3127	1	1
Araneomorphae					3142	1	1
Araneomorphae	Araneidae		*Gasteracantha*	*minax ?*	1213	3	3
Araneomorphae	Araneidae		*Nephila*	*edulis*	1551	1	1
Araneomorphae	Lycosidae				554	2	2
Araneomorphae	Lycosidae				743	1	1
Araneomorphae	Miturgidae				1574	1	1
Araneomorphae	Miturgidae				1580	1	1
Araneomorphae	Miturgidae				3158	1	1
Araneomorphae	Miturgidae				597	1	1
Araneomorphae	Sparassidae				3140	1	1
Araneomorphae	Sparassidae				3141	1	1
Araneomorphae	Sparassidae		*Olios*		939	2	2
Araneomorphae	Sparassidae		*Olios*	*diana ?*	1250	2	2
Araneomorphae	Zodariidae		*Storena*		1691	1	1
Blattodea					3013	1	1
Blattodea					3016	2	2
Blattodea					3026	1	1
Blattodea					3128	3	3
Blattodea					3146	1	1
Blattodea					3151	3	4
Blattodea					3152	1	1
Blattodea					3166	1	1
Blattodea					3169	1	1
Blattodea					3170	1	1
Blattodea	Blaberidae				410	2	3
Blattodea	Blaberidae	Diplopterinae	*Calolampra*		147	4	8
Blattodea	Blaberidae	Epilamprinae	*Laxta*		27	8	21
Blattodea	Blaberidae	Epilamprinae	*Laxta*		119	2	2
Blattodea	Blattelidae				1118	1	2
Blattodea	Blattellidae	Parcoblattini	*Neotemnopteryx*		120	2	3
Blattodea	Blattidae				878	1	1
Blattodea	Blattidae				1933	2	2
Blattodea	Blattidae				2037	1	1
Blattodea	Blattidae	Polyzosteriinae	*Platyzosteria*		899	3	5
Blattodea	Blattidae	Polyzosteriinae	*Platyzosteria*		968	1	1
Blattodea	Blattidae	Polyzosteriinae	*Platyzosteria*		971	1	1
Blattodea	Blattidae	Polyzosteriinae	*Platyzosteria*		2015	2	2
Blattodea	Blattidae	Polyzosteriinae	*Platyzosteria*		547	1	1
Blattodea	Blattidae	Polyzosteriinae	*Platyzosteria*		507	3	3
Blattodea	Blattidae	Polyzosteriinae	*Polyzosteria*	*mitchelli*	777	1	1
Chilopoda					3009	1	2
Chilopoda	Lithobiidae				228	4	4
Chilopoda	Scolopendridae				1882	4	4
Chilopoda	Scolopendridae				2050	1	1
Chilopoda	Scolopendridae				225	3	4
Chilopoda	Scolopendridae				267	1	1
Chilopoda	Scolopendridae	Otostigminae	*Ethmostigmus ?*		223	20	35
Coleoptera	Buprestidae	Agrilinae	*Cisseis*		3024	1	1
Coleoptera	Buprestidae?				3131	1	1
Coleoptera	Cantharidae				3132	1	1
Coleoptera	Carabidae				3029	1	1
Coleoptera	Carabidae				566	1	2
Coleoptera	Carabidae				1979	1	1
Coleoptera	Carabidae				529	1	1
Coleoptera	Carabidae	Pterostichinae	*Notonomus ?*		746	7	9
Coleoptera	Carabidae	Pterostichinae	*Pseudoceneus*		528	1	1
Coleoptera	Cerambycidae				3109	1	1
Coleoptera	Cerambycidae	Cerambycinae	*Stenoderus*	*suturalis*	673	2	9
Coleoptera	Cerambycidae	Cerambycinae	*Uracanthus*	*triangularis*	351	1	1
Coleoptera	Cerambycidae	Prioninae	*Sceleocantha*		1082	5	5
Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsis*		2034	1	1
Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsis*		667	6	7
Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsisterna*		786	2	2
Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsisterna*		3150	1	1

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Coleoptera	Chrysomelidae	Chrysomelinae	*Paropsisterna*		463	1	1
Coleoptera	Curculionidae				852	2	3
Coleoptera	Curculionidae				911	1	1
Coleoptera	Curculionidae				3161	2	2
Coleoptera	Curculionidae				156	1	1
Coleoptera	Curculionidae				514	3	3
Coleoptera	Curculionidae	Amycterinae			3011	1	1
Coleoptera	Curculionidae	Amycterinae			3168	1	1
Coleoptera	Curculionidae	Amycterinae	*Acantholophus*		3165	1	1
Coleoptera	Curculionidae	Amycterinae	*Acantholophus*		869	2	2
Coleoptera	Curculionidae	Amycterinae	*Acantholophus*		970	2	2
Coleoptera	Curculionidae	Amycterinae	*Acantholophus*		1523	1	1
Coleoptera	Curculionidae	Amycterinae	*Cucullothorax*	*horridus*	1571	1	1
Coleoptera	Curculionidae	Amycterinae	*Neohyborrhynchus*		814	1	1
Coleoptera	Curculionidae	Amycterinae	*Talaurinus*		817	2	3
Coleoptera	Curculionidae	Amycterinae	*Talaurinus*	*roei ?*	906	1	1
Coleoptera	Curculionidae	Aterpinae	*Rhinaria ?*		209	3	5
Coleoptera	Curculionidae	Entiminae	*Leptopius*	*maleficus?*	1225	1	1
Coleoptera	Curculionidae	Entiminae	*Mandalotus ?*		2088	1	1
Coleoptera	Curculionidae	Entiminae	*Mandalotus?*		3149	1	1
Coleoptera	Curculionidae	Entiminae	*Polyphrades*	*aesalon ?*	113	3	5
Coleoptera	Curculionidae	Gonipterinae	*Oxyops*		1278	1	1
Coleoptera	Curculionidae	Gonipterinae	*Oxyops*	*fasciata*	161	12	48
Coleoptera	Curculionidae	Gonipterinae	*Oxyops*	*pictipennis*	98	1	1
Coleoptera	Curculionidae	Molytinae	*Tranes*	*vigorsii*	291	1	1
Coleoptera	Curculionidae	Rhadinosominae	*Rhadinosomus*	*lacordaire*	157	3	6
Coleoptera	Dytiscidae	Colymbetinae	*Rhantus*	*suturalis?*	13	2	2
Coleoptera	Dytiscidae	Cybistrini?	*Onychohydrus*	*scutellaris*	2900	2	2
Coleoptera	Dytiscidae	Lancetinae	*Lancetes*	*lanceolatus*	651	15	100
Coleoptera	Elateridae				173	1	3
Coleoptera	Elateridae				636	1	7
Coleoptera	Elateridae	Agrypninae	*Conoderus*		909	5	9
Coleoptera	Elateridae	Agrypninae	*Conoderus*		1109	6	8
Coleoptera	Elateridae	Agrypninae	*Conoderus*		1816	2	2
Coleoptera	Elateridae	Agrypninae	*Conoderus*		1818	1	1
Coleoptera	Elateridae	Agrypninae	*Conoderus*		135	4	4
Coleoptera	Elateridae	Agrypninae	*Conoderus*		444	1	3
Coleoptera	Hydrophilidae				14	25	887
Coleoptera	Lycidae				1994	2	2
Coleoptera	Lycidae				3006	1	1
Coleoptera	Lycidae				3008	1	1
Coleoptera	Lycidae	Metriorrhynchinae	*Metriorrhynchus*		2000	2	2
Coleoptera	Lycidae	Metriorrhynchinae	*Metriorrhynchus*		99	4	5
Coleoptera	Scarabaeidae				3031	1	1
Coleoptera	Scarabaeidae	Dynastinae	*Cryptodus*		189	1	1
Coleoptera	Scarabaeidae	Dynastinae	*Semanopterus*		1021	1	1
Coleoptera	Scarabaeidae	Melolonthinae			1847	1	1
Coleoptera	Scarabaeidae	Melolonthinae	*Colpochila*		1866	1	1
Coleoptera	Scarabaeidae	Melolonthinae	*Colpochila*	*antennalis*	846	1	1
Coleoptera	Scarabaeidae	Melolonthinae	*Harpechys?*	*chilo?*	212	1	1
Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*		94	3	3
Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*		363	10	19
Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*		1904	1	1
Coleoptera	Scarabaeidae	Melolonthinae	*Heteronyx*		347	4	6
Coleoptera	Scarabaeidae	Melolonthinae	*Maechidus ?*		1388	1	1
Coleoptera	Silphidae	Silphinae	*Ptomaphila*	*lacrymosa*	924	2	2
Coleoptera	Staphylinidae				2094	2	2
Coleoptera	Staphylinidae				628	5	6
Coleoptera	Tenebrionidae	Alleculinae	*Metistete*		340	1	1
Coleoptera	Tenebrionidae	Stenochiinae	*Oectosis*		711	9	17
Coleoptera	Trogidae		*Omorgus*		35	1	1
Dermaptera					1538	1	2
Dermaptera					734	1	1
Dermaptera					491	5	5
Dermaptera	Anisolabididae	Anisolabidinae			257	5	5
Dermaptera	Labiduridae ?				2991	1	1
Diplopoda					3010	2	2
Diplopoda					3015	13	81
Diplopoda					3018	3	3
Diplopoda					3019	1	1
Diplopoda					3020	1	1

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Diplopoda					3147	1	1
Diplopoda	Julida				259	8	10
Diptera	Asilidae				3129	1	1
Diptera	Asilidae				3138	2	2
Diptera	Asilidae				3139	1	1
Diptera	Asilidae				3145	1	1
Diptera	Asilidae				1529	1	1
Diptera	Asilidae				1811	1	2
Diptera	Asilidae				312	3	4
Diptera	Asilidae				313	2	4
Diptera	Bombyliidae				3143	1	1
Diptera	Calliphoridae	Calliphorinae	*Calliphora*		53	1	1
Diptera	Pyrgotidae				3103	2	2
Diptera	Sarcophagidae				579	1	1
Diptera	Syrphidae				54	3	4
Diptera	Syrphidae				130	1	1
Diptera	Syrphidae				569	1	1
Diptera	Syrphidae				1421	2	22
Diptera	Syrphidae				1422	2	3
Diptera	Syrphidae				2220	2	2
Diptera	Syrphidae				129	2	2
Diptera	Syrphidae				206	4	6
Diptera	Tabanidae				3144	2	2
Diptera	Tabanidae				473	5	6
Diptera	Tabanidae				126	7	17
Diptera	Tabanidae				178	6	9
Diptera	Tabanidae				466	1	1
Diptera	Tachinidae				2911	1	1
Diptera	Therevidae				532	5	6
Diptera	Tipulidae				16	22	37
Diptera	Tipulidae				792	3	4
Hemiptera	Alydidae				1683	1	1
Hemiptera	Alydidae				1751	1	1
Hemiptera	Cicadidae				916	1	1
Hemiptera	Cicadidae				3023	1	1
Hemiptera	Cicadidae	Tibicininae	*Cicadetta*	*quadricinta?*	207	1	1
Hemiptera	Coreidae	Coreinae	*Amorbus*	*bispinus*	700	2	2
Hemiptera	Fulgoridae				3126	2	2
Hemiptera	Gelastocoridae	Nerthrinae	*Nerthra*		2694	2	2
Hemiptera	Gelastocoridae	Nerthrinae	*Nerthra*		3133	1	1
Hemiptera	Gelastocoridae	Nerthrinae	*Nerthra*		1611	1	1
Hemiptera	Hyocephalidae		*Hyocephalus*	*auprugnus*	482	5	5
Hemiptera	Membracidae				108	1	1
Hemiptera	Pentatomidae				221	21	35
Hemiptera	Pentatomidae				599	1	1
Hemiptera	Pentatomidae				1993	1	1
Hemiptera	Pentatomidae				3154	4	5
Hemiptera	Pentatomidae				153	6	19
Hemiptera	Pentatomidae				176	1	1
Hemiptera	Pentatomidae				251	9	22
Hemiptera	Reduviidae				2049	2	2
Hemiptera	Reduviidae				311	1	1
Hemiptera	Reduviidae	Emesinae			489	3	3
Hymenoptera	Anthophoridae				203	4	9
Hymenoptera	Apidae		*Apis*	*melifera*	52	7	7
Hymenoptera	Braconidae				1258	1	1
Hymenoptera	Braconidae				2908	1	1
Hymenoptera	Braconidae				3121	1	1
Hymenoptera	Braconidae				3148	1	1
Hymenoptera	Colletidae	Colletinae			3157	1	1
Hymenoptera	Formicidae				1497	7	15
Hymenoptera	Formicidae	Formicinae	*Camponotus*		423	35	55
Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*		279	1	1
Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*		712	1	1
Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*		1473	2	2
Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*		2046	1	1
Hymenoptera	Formicidae	Myrmeciinae	*Myrmecia*		2223	1	1
Hymenoptera	Ichneumonidae				2885	6	8
Hymenoptera	Ichneumonidae				2910	1	1
Hymenoptera	Ichneumonidae				3025	1	1
Hymenoptera	Ichneumonidae				3135	1	1

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Hymenoptera	Ichneumonidae				1055	5	8
Hymenoptera	Ichneumonidae				1105	1	1
Hymenoptera	Ichneumonidae				1720	2	2
Hymenoptera	Pompilidae				3167	1	1
Hymenoptera	Pompilidae ?				3153	1	1
Hymenoptera	Tiphiidae				2059	1	1
Hymenoptera	Tiphiidae				3130	1	1
Hymenoptera	Tiphiidae				3137	1	1
Hymenoptera	Tiphiidae	Thynninae			494	1	1
Hymenoptera	Tiphiidae	Thynninae			801	4	4
Isopoda					544	23	32
Isopoda					671	1	1
Lepidoptera					63	19	38
Lepidoptera					316	26	110
Lepidoptera					829	1	2
Lepidoptera					840	1	1
Lepidoptera					849	1	1
Lepidoptera					900	1	5
Lepidoptera					921	3	3
Lepidoptera					950	1	1
Lepidoptera					1031	6	8
Lepidoptera					1169	3	4
Lepidoptera					1490	2	2
Lepidoptera					1628	2	3
Lepidoptera					1631	1	3
Lepidoptera					1910	1	1
Lepidoptera					1913	1	1
Lepidoptera					1966	1	1
Lepidoptera					2125	1	1
Lepidoptera					2185	1	1
Lepidoptera					2446	1	1
Lepidoptera					2628	1	1
Lepidoptera					2657	1	1
Lepidoptera					2720	2	2
Lepidoptera					2886	2	2
Lepidoptera					2888	4	5
Lepidoptera					2890	7	33
Lepidoptera					2892	1	1
Lepidoptera					2894	1	1
Lepidoptera					2896	1	1
Lepidoptera					2897	1	1
Lepidoptera					2906	1	1
Lepidoptera					2907	1	1
Lepidoptera					2909	1	1
Lepidoptera					2913	1	1
Lepidoptera					2914	3	3
Lepidoptera					2915	6	6
Lepidoptera					2917	1	1
Lepidoptera					2924	2	13
Lepidoptera					2929	1	1
Lepidoptera					2948	3	4
Lepidoptera					2949	1	1
Lepidoptera					2950	2	2
Lepidoptera					2963	23	217
Lepidoptera					3108	1	1
Lepidoptera					3111	1	5
Lepidoptera					3115	2	2
Lepidoptera					3116	1	1
Lepidoptera					3117	1	1
Lepidoptera					3119	1	1
Lepidoptera			*the dart*		322	21	48
Lepidoptera					48	20	224
Lepidoptera					367	1	2
Lepidoptera					376	2	2
Lepidoptera					411	9	24
Lepidoptera					420	1	3
Lepidoptera					430	4	11
Lepidoptera					459	1	1
Lepidoptera					760	1	2
Lepidoptera					657	8	41
Lepidoptera		humbug 3			2158	1	1

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Lepidoptera	Anthelidae				1627	3	3
Lepidoptera	Anthelidae	Anthelinae	*Anthela*	*canescens*	352	1	1
Lepidoptera	Anthelidae	Anthelinae	*Anthela*	*ferruginosa?*	457	5	13
Lepidoptera	Arctiidae				6	1	11
Lepidoptera	Arctiidae	Arctiinae	*Spilosoma*		445	4	7
Lepidoptera	Carthaeidae		*Carthaea*	*saturnioides*	1	15	72
Lepidoptera	Depressariidae				324	9	31
Lepidoptera	Depressariidae		*Thalamarchella*	*alveola*	141	5	6
Lepidoptera	Gelechioidea	Gelechiidae ?			658	5	6
Lepidoptera	Geometridae				77	3	4
Lepidoptera	Geometridae				323	1	1
Lepidoptera	Geometridae				855	1	1
Lepidoptera	Geometridae				861	4	22
Lepidoptera	Geometridae				923	1	2
Lepidoptera	Geometridae				942	2	2
Lepidoptera	Geometridae				986	1	1
Lepidoptera	Geometridae				1030	1	1
Lepidoptera	Geometridae				1098	1	1
Lepidoptera	Geometridae				1128	1	1
Lepidoptera	Geometridae				1831	6	24
Lepidoptera	Geometridae				1857	1	1
Lepidoptera	Geometridae				1876	1	1
Lepidoptera	Geometridae				1908	1	2
Lepidoptera	Geometridae				1964	2	3
Lepidoptera	Geometridae				2639	2	5
Lepidoptera	Geometridae				2653	2	2
Lepidoptera	Geometridae				2891	1	1
Lepidoptera	Geometridae				2898	1	1
Lepidoptera	Geometridae				2899	1	1
Lepidoptera	Geometridae				2905	3	7
Lepidoptera	Geometridae				2912	1	1
Lepidoptera	Geometridae				2919	1	1
Lepidoptera	Geometridae				2926	1	1
Lepidoptera	Geometridae				3113	1	1
Lepidoptera	Geometridae				3114	1	1
Lepidoptera	Geometridae				821	1	1
Lepidoptera	Geometridae				1036	2	2
Lepidoptera	Geometridae		*Poecilasthena*		2630	4	8
Lepidoptera	Geometridae				417	1	5
Lepidoptera	Geometridae				47	2	3
Lepidoptera	Geometridae				61	3	4
Lepidoptera	Geometridae				66	9	23
Lepidoptera	Geometridae				67	8	25
Lepidoptera	Geometridae				82	1	1
Lepidoptera	Geometridae				85	1	5
Lepidoptera	Geometridae				95	14	29
Lepidoptera	Geometridae				96	1	1
Lepidoptera	Geometridae				317	3	3
Lepidoptera	Geometridae				318	1	1
Lepidoptera	Geometridae				326	16	33
Lepidoptera	Geometridae				362	2	2
Lepidoptera	Geometridae				369	1	1
Lepidoptera	Geometridae				382	2	13
Lepidoptera	Geometridae				407	3	3
Lepidoptera	Geometridae				422	9	12
Lepidoptera	Geometridae				635	1	1
Lepidoptera	Geometridae				637	1	1
Lepidoptera	Geometridae				638	5	10
Lepidoptera	Geometridae				646	7	10
Lepidoptera	Geometridae				655	3	4
Lepidoptera	Geometridae				665	1	1
Lepidoptera	Geometridae				667	1	1
Lepidoptera	Geometridae				691	7	13
Lepidoptera	Geometridae				694	3	6
Lepidoptera	Geometridae				754	5	12
Lepidoptera	Geometridae				757	2	2
Lepidoptera	Geometridae				758	10	39
Lepidoptera	Geometridae				776	10	22
Lepidoptera	Geometridae				24	6	9
Lepidoptera	Geometridae				41	1	1
Lepidoptera	Geometridae				375	3	4

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Lepidoptera	Geometridae				392	3	4
Lepidoptera	Geometridae				403	2	2
Lepidoptera	Geometridae				424	17	43
Lepidoptera	Geometridae				425	3	5
Lepidoptera	Geometridae				436	25	88
Lepidoptera	Geometridae	Ennominae			83	1	1
Lepidoptera	Geometridae	Ennominae	*Ectropis ?*		23	22	96
Lepidoptera	Geometridae	Ennominae	*Pholodes*		384	4	7
Lepidoptera	Geometridae	Ennominae	*Pholodes*		385	1	1
Lepidoptera	Geometridae	Ennominae	*Thalaina*	*clara*	450	2	3
Lepidoptera	Geometridae	Geometrinae	*Chlorocoma*		22	17	34
Lepidoptera	Geometridae	Geometrinae	*Chlorocoma*	*dicloraria*	19	11	23
Lepidoptera	Geometridae	Geometrinae	*Crypsiphona*	*ocultaria*	330	11	13
Lepidoptera	Geometridae	Geometrinae	*Eucyclodes*	*buprestaria*	357	1	1
Lepidoptera	Geometridae	Geometrinae	*Heliomystis*		663	7	10
Lepidoptera	Geometridae	Geometrinae	*Hypobapta*	*barnardi*	835	1	1
Lepidoptera	Geometridae	Geometrinae	*Prasinocyma ?*		393	1	1
Lepidoptera	Geometridae	Larentiina	*Xanthorhoe*		455	2	2
Lepidoptera	Geometridae	Larentiinae			1029	2	2
Lepidoptera	Geometridae	Larentiinae	*Xanthorhoe*		42	3	4
Lepidoptera	Geometridae	Oenochrominae			72	11	25
Lepidoptera	Geometridae	Oenochrominae	*Arhodia*		2	10	17
Lepidoptera	Geometridae	Oenochrominae	*Arhodia*		320	11	31
Lepidoptera	Geometridae	Oenochrominae	*Arhodia*		820	1	1
Lepidoptera	Geometridae	Oenochrominae	*Dichromodes*	*personalis*	321	1	1
Lepidoptera	Geometridae	Oenochrominae	*Hypographa*	*aristarcha*	1171	1	1
Lepidoptera	Geometridae	Oenochrominae	*Lissomma*	*serpentaria*	832	2	2
Lepidoptera	Geometridae	Oenochrominae	*Oenochroma*		31	9	15
Lepidoptera	Geometridae	Oenochrominae	*Oenochroma*	*cerasiplaga*	59	3	3
Lepidoptera	Geometridae	Oenochrominae	*Phallaria*	*ophiusaria*	377	8	22
Lepidoptera	Geometridae ?				862	1	1
Lepidoptera	Geometridae ?				1022	1	1
Lepidoptera	Geometridae ?				2703	1	2
Lepidoptera	Geometridae ?				3125	1	1
Lepidoptera	Geometridae ?				441	2	4
Lepidoptera	Geometridae ?				641	2	2
Lepidoptera	Geometridae ?				652	3	8
Lepidoptera	Geometridae ?				753	1	1
Lepidoptera	Hepialidae		*Abantiades*	*hydrographis*	372	5	8
Lepidoptera	Hepialidae		*Abantiades*	*ocellatus*	373	1	1
Lepidoptera	Lasiocampidae				1832	4	6
Lepidoptera	Lasiocampidae				90	6	11
Lepidoptera	Lasiocampidae				380	1	1
Lepidoptera	Lasiocampidae				755	10	22
Lepidoptera	Lasiocampidae	Lasiocampinae	*Entometa*		426	4	5
Lepidoptera	Lasiocampidae	Lasiocampinae	*Entometa*	*fervens*	91	2	2
Lepidoptera	Lasiocampidae	Lasiocampinae	*Porela?*		749	3	3
Lepidoptera	Lasiocampidae	Lasiocampinae?			693	1	1
Lepidoptera	Limacodidae		*Doratifera*		1625	1	1
Lepidoptera	Limacodidae		*Doratifera*		81	1	1
Lepidoptera	Limacodidae		*Doratifera*		332	4	6
Lepidoptera	Lymantriidae		*Teia*	*athlophora*	34	3	5
Lepidoptera	Noctuidae				413	1	1
Lepidoptera	Noctuidae				656	7	25
Lepidoptera	Noctuidae				859	1	1
Lepidoptera	Noctuidae				1046	1	1
Lepidoptera	Noctuidae				1511	1	1
Lepidoptera	Noctuidae				1858	1	1
Lepidoptera	Noctuidae				1899	7	10
Lepidoptera	Noctuidae				2627	3	3
Lepidoptera	Noctuidae				2704	2	2
Lepidoptera	Noctuidae				2887	1	1
Lepidoptera	Noctuidae				2889	3	5
Lepidoptera	Noctuidae				2895	1	1
Lepidoptera	Noctuidae				3112	3	3
Lepidoptera	Noctuidae				3118	1	1
Lepidoptera	Noctuidae				345	1	1
Lepidoptera	Noctuidae				25	16	31
Lepidoptera	Noctuidae				33	1	2
Lepidoptera	Noctuidae				38	1	2
Lepidoptera	Noctuidae				75	1	1

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Lepidoptera	Noctuidae				140	5	5
Lepidoptera	Noctuidae				383	6	8
Lepidoptera	Noctuidae				386	4	8
Lepidoptera	Noctuidae				391	3	27
Lepidoptera	Noctuidae				394	1	1
Lepidoptera	Noctuidae				419	1	1
Lepidoptera	Noctuidae				454	1	1
Lepidoptera	Noctuidae				765	1	1
Lepidoptera	Noctuidae				770	1	2
Lepidoptera	Noctuidae				446	1	1
Lepidoptera	Noctuidae	Acronictinae	*Peripyra*	*sanguinipucta*	379	2	3
Lepidoptera	Noctuidae	Amphipyrinae			523	2	4
Lepidoptera	Noctuidae	Amphipyrinae			1150	1	1
Lepidoptera	Noctuidae	Amphipyrinae			1898	1	2
Lepidoptera	Noctuidae	Amphipyrinae			414	1	1
Lepidoptera	Noctuidae	Amphipyrinae	*Proteuxoa*	*pissonephra*	39	14	28
Lepidoptera	Noctuidae	Amphipyrinae	*Proteuxoa?*		2752	1	1
Lepidoptera	Noctuidae	Catocalinae	*Dasypodia*	*selenophora*	30	1	1
Lepidoptera	Noctuidae	Catocalinae	*Lyncestis*	*melanoschista*	415	1	1
Lepidoptera	Noctuidae	Catocalinae	*Pantydia*		2	1	1
Lepidoptera	Noctuidae	Catocalinae	*Pantydia*		5	23	82
Lepidoptera	Noctuidae	Catocalinae	*Pantydia*		388	13	20
Lepidoptera	Noctuidae	Catocalinae	*Pantydia*		329	5	8
Lepidoptera	Noctuidae	Hadeninae	*Persectania*	*ewingii*	40	14	22
Lepidoptera	Noctuidae	Hypeninae	*Sandava*	*scitisigna*	43	19	22
Lepidoptera	Noctuidae ?				766	6	6
Lepidoptera	Notodontidae				2893	1	2
Lepidoptera	Notodontidae		*Destolmia*		4	19	29
Lepidoptera	Notodontidae				76	17	28
Lepidoptera	Notodontidae				80	4	5
Lepidoptera	Notodontidae				374	20	253
Lepidoptera	Notodontidae		*Danima*	*banksiae*	57	2	2
Lepidoptera	Notodontidae		*Hylaeora*	*dilucida*	370	3	3
Lepidoptera	Oecophoridae				1833	3	4
Lepidoptera	Oecophoridae				1840	6	7
Lepidoptera	Oecophoridae				1895	1	4
Lepidoptera	Oecophoridae				2719	2	3
Lepidoptera	Oecophoridae				2940	1	1
Lepidoptera	Oecophoridae				104	1	1
Lepidoptera	Oecophoridae				396	5	7
Lepidoptera	Oecophoridae ?				1626	1	1
Lepidoptera	Oecophoridae?				62	18	46
Lepidoptera	Oenosandridae		*Discophlebia*	*lucasii*	518	3	3
Lepidoptera	Pyralidae				333	14	38
Lepidoptera	Pyralidae				1051	18	58
Lepidoptera	Pyralidae				1134	1	1
Lepidoptera	Pyralidae				1491	1	2
Lepidoptera	Pyralidae				1834	1	1
Lepidoptera	Pyralidae				2115	1	1
Lepidoptera	Pyralidae				2721	1	1
Lepidoptera	Pyralidae				2901	2	2
Lepidoptera	Pyralidae				342	7	12
Lepidoptera	Pyralidae				397	4	5
Lepidoptera	Pyralidae				401	1	1
Lepidoptera	Pyralidae	Epipaschiinae			460	4	4
Lepidoptera	Pyralidae	Epipaschiinae			1126	1	1
Lepidoptera	Pyralidae	Epipaschiinae ?			73	19	45
Lepidoptera	Pyralidae	Epipaschiinae ?			1025	2	2
Lepidoptera	Pyralidae	Pyraustinae	*Uresiphita*	*ornithopteralis*	84	7	7
Lepidoptera	Pyralidae ?				837	8	16
Lepidoptera	Pyralidae ?				928	1	1
Lepidoptera	Pyralidae ?				947	2	3
Lepidoptera	Pyralidae ?				957	4	8
Lepidoptera	Pyralidae ?				1166	1	1
Lepidoptera	Pyralidae ?				661	11	19
Lepidoptera	Pyralidae ?				12	2	2
Lepidoptera	Saturniidae		*Opodiphthera*	*helena*	328	10	24
Lepidoptera	Thaumetopoeidae				1068	1	1
Lepidoptera	Thaumetopoeidae				3110	1	1
Lepidoptera	Thaumetopoeidae		*Ochrogaster*		2655	8	27
Lepidoptera	Thaumetopoeidae		*Ochrogaster*		10	19	51

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Lepidoptera	Thaumetopoeidae		*Ochrogaster*		11	1	1
Lepidoptera	Thaumetopoeidae				60	4	7
Lepidoptera	Thaumetopoeidae		*Epicoma*	*melanostica*	3	12	14
Lepidoptera	Thaumetopoeidae		*Ochrogaster*		7	10	22
Lepidoptera	Thaumetopoeidae		*Oenosandra*	*boisduvalii*	404	6	9
Lepidoptera	Thaumetopoeidae				864	8	8
Lepidoptera	Tineidae		*Moerarchis*	*clathrella*	319	8	8
Lepidoptera	UNIDENTIFIABLE		*unidentifiable*	*unidentifiable*	1172	17	42
Lepidoptera	Zygaenidae		*Pollanisus*		78	20	168
Lepidoptera	Zygaenidae		*Pollanisus*	*cupreus*	45	2	2
Mantodea	Amorphoscelidae				2722	1	1
Mantodea	Amorphoscelidae	Paraoxypilinae			132	12	34
Mantodea	Amorphoscelidae	Paraoxypilinae	*Paraoxypilus*	*tasmaniensis ?*	739	1	1
Mantodea	Mantidae		*Hierodula*		767	4	5
Mecoptera	Bittacidae				1453	5	7
Mecoptera	Bittacidae				1456	1	1
Mecoptera	Bittacidae		*Harpobittacus*		908	1	1
Mygalomorphae					3027	1	1
Mygalomorphae					3156	1	1
Mygalomorphae	Nemesiidae				3162	4	5
Mygalomorphae	Nemesiidae				1401	5	6
Mygalomorphae	Nemesiidae		*Chenistonia*		567	3	3
Mygalomorphae	Nemesiidae		*Chenistonia*		581	3	5
Mygalomorphae	Nemesiidae				590	1	1
Mygalomorphae	Nemesiidae				502	1	1
Mygalomorphae	Nemesiidae		*Chenistonia*		721	8	17
Neuroptera	Chrysopidae				2710	1	1
Neuroptera	Chrysopidae				2715	2	2
Neuroptera	Chrysopidae				2054	2	2
Neuroptera	Chrysopidae		*Chrysopa*		822	1	1
Neuroptera	Hemerobiidae				360	4	6
Neuroptera	Mantispidae				2935	1	1
Neuroptera	Myrmeleontidae				2734	1	1
Neuroptera	Myrmeleontidae				3122	2	2
Neuroptera	Myrmeleontidae				3124	1	1
Neuroptera	Myrmeleontidae				1906	1	1
Neuroptera	Myrmeleontidae				400	3	5
Neuroptera	Osmylidae				1938	4	9
Odonata					3012	2	2
Odonata	Lestdae		*Austrolestes*		3021	1	2
Oligochaeta					3159	1	1
Oligochaeta					3160	1	1
Oligochaeta				*sp. nova*	3163	1	1
Onychophora					2999	4	4
Orthoptera	Acrididae				2921	1	1
Orthoptera	Acrididae				3028	2	2
Orthoptera	Acrididae				3136	1	1
Orthoptera	Acrididae		*Goniaea*	*vocans?*	3134	1	1
Orthoptera	Acrididae				782	7	11
Orthoptera	Acrididae				174	3	3
Orthoptera	Acrididae	Catantopinae			3155	1	1
Orthoptera	Acrididae	Catantopinae	*Adreppus*		868	2	2
Orthoptera	Acrididae	Catantopinae	*Adreppus*		1323	1	1
Orthoptera	Acrididae	Catantopinae	*Cedarinia*		1453	1	1
Orthoptera	Acrididae	Catantopinae	*Cedarinia*		2916	1	1
Orthoptera	Acrididae	Catantopinae	*Cedarinia*		3014	2	5
Orthoptera	Acrididae	Catantopinae	*Cedarinia*		690	2	2
Orthoptera	Acrididae	Catantopinae	*Coryphistes*		231	6	6
Orthoptera	Acrididae	Catantopinae	*Ecphantus*	*quadrilobus?*	713	7	16
Orthoptera	Acrididae	Catantopinae	*Goniaea*		1470	2	2
Orthoptera	Acrididae	Catantopinae	*Goniaea*		1547	1	1
Orthoptera	Acrididae	Catantopinae	*Goniaea*		1984	1	1
Orthoptera	Acrididae	Catantopinae	*Goniaea*		3017	1	1
Orthoptera	Acrididae	Catantopinae	*Goniaea*		3022	1	1
Orthoptera	Acrididae	Catantopinae	*Goniaea*		233	1	1
Orthoptera	Acrididae	Catantopinae	*Goniaea*		255	2	2
Orthoptera	Acrididae	Catantopinae	*Goniaea*		871	3	4
Orthoptera	Acrididae	Catantopinae	*Goniaea*		872	9	11
Orthoptera	Acrididae	Catantopinae	*Goniaea*		256	1	1
Orthoptera	Acrididae	Catantopinae	*Goniaea*		272	1	1
Orthoptera	Acrididae	Catantopinae	*Goniaea*		274	1	9

Order	Family	Tax 3	Genus	Species	Spec ID	Cap Freq	Abun
Orthoptera	Acrididae	Catantopinae	*Goniaea*		304	3	5
Orthoptera	Acrididae	Catantopinae	*Goniaea*	*vocans?*	232	2	2
Orthoptera	Acrididae	Catantopinae	*Goniaoidea*		2061	1	1
Orthoptera	Acrididae	Catantopinae	*Phaulacridium*		293	2	5
Orthoptera	Gryllidae				857	1	1
Orthoptera	Gryllidae				2918	1	1
Orthoptera	Gryllidae				3120	1	1
Orthoptera	Gryllidae				608	1	1
Orthoptera	Gryllidae				609	1	1
Orthoptera	Gryllidae				618	1	1
Orthoptera	Gryllidae				180	1	1
Orthoptera	Gryllidae	Brachytrupinae	*Apterogryllus*		811	3	3
Orthoptera	Stenopelmatidae				1557	2	2
Orthoptera	Stenopelmatidae	Henicinae	*Onosandrus*		526	5	5
Orthoptera	Tettigoniidae				873	2	4
Orthoptera	Tettigoniidae				2041	1	1
Orthoptera	Tettigoniidae				3007	1	1
Orthoptera	Tettigoniidae				106	1	1
Orthoptera	Tettigoniidae	Phaneropterinae	*Caedicia*		485	1	1
Phasmatodea					2196	1	1
Platyhelminthes					2423	1	1
Platyhelminthes					3164	2	3
Platyhelminthes	Tricladida				521	1	1
Scorpionida					2693	1	1
Scorpionida					469	6	10
Scorpionida					568	1	1
Trichoptera					2903	5	8
Trichoptera					2904	2	7
Trichoptera					1852	2	2
Trichoptera					144	13	29
Trichoptera					145	9	20
Trichoptera					151	1	1

Appendix 2. Species richness (number of morphospecies) and abundance for active (beat, sweep, coarse woody debris, litter), light, pitfall trap and all capture techniques in spring (SP) and autumn (AU) for grids at Wellington 1 in 2008-09.

Silvicultural Treatment	Site No	Location	Season	Active		Light		Pitfall		All	
				Abun	No Spec	Abun	No Spec	Abun	No Spec	Abun	No Spec
External reference	FC16	Yourdamung	AU	22	20	214	59	13	6	249	82
External reference	FC17	Surface	AU	35	26	122	49	9	3	166	79
External reference	FC19	Tumlo	AU	31	20	297	57	9	8	337	83
Gap release	FC11	Edward	AU	36	23	67	21	6	6	109	48
Gap release	FC12	Ross	AU	35	19	130	59	7	6	172	82
Gap release	FC14	Surface	AU	12	11	183	55	25	6	220	72
Shelterwood	FC13	Ross	AU	32	25	127	49	11	6	170	78
Shelterwood	FC15	Surface	AU	23	15	160	44	23	13	206	72
Shelterwood	FC18	Chalk	AU	31	23	193	45	11	7	235	74
External reference	FC16	Yourdamung	SP	34	30	317	73	9	5	360	105
External reference	FC17	Surface	SP	43	27	339	79	23	10	405	111
External reference	FC19	Tumlo	SP	33	24	500	69	19	16	552	106
Gap release	FC11	Edward	SP	36	26	300	62	87	10	423	91
Gap release	FC12	Ross	SP	31	18	454	89	20	13	505	116
Gap release	FC14	Surface	SP	26	11	256	61	33	12	315	79
Shelterwood	FC13	Ross	SP	33	24	397	88	10	10	440	118
Shelterwood	FC15	Surface	SP	21	12	207	61	25	16	253	87
Shelterwood	FC18	Chalk	SP	59	28	398	77	16	7	473	109

DIURNAL BIRDS

G.L.Liddelow and Verna Tunsell

Introduction

Wellington FORESTCHECK grids were monitored for diurnal birds in the spring of 2008. 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 achieved by:

- Recording species richness and abundance within each treatment (external reference,
  shelterwood and gap release)
- Comparing species richness and abundance between each treatment
- Analyzing trends within species between treatments

Monitoring

Science Division was able to undertake all the diurnal bird census work in 2008 and the period was also used to train a staff member from the Wellington District. Both sight and sound are used to identify the birds and the census technique (area search) is outlined in the FORESTCHECK Operating Plan 2004.

There are nine FORESTCHECK grids in the Wellington District which include three external reference grids, three shelterwood and three gap release grids.

Preliminary Results and Discussion

A total of 36 species of birds, comprising of 581 individuals, were recorded across all nine grids. (Table 1 & Fig. 1). There were 26 species and 204 individuals in the external reference treatment, 28 species and 233 individuals in the shelterwood, and 26 species and only 144 individuals in the gap release treatment grids.

Eighteen of the 36 species recorded during this survey had 10 or more individuals. The most common bird recorded was the broad-tailed thornbill (*Acanthiza apicalis)* with 86 records, this was followed by the western gerygone (*Gerygone fusca*) with 57, striated pardalote (*Pardalotus striatus*) 52, grey fantail (*Rhipidura fuliginosa*) 38, tree martin (*Hirundo nigricans*) 31 and the golden whistler (*Pachycephala pectoralis*) with 29. Others with more than ten individuals included the twenty-eight parrot (*Barnardius zonarius semitorquatus*) 20, white-breasted robin (*Eopsaltria georgiana*) 21, grey shrike-thrush (*Colluricincla harmonica*) 11, western thornbill (*Acanthiza inornata*) 20, white-browed scrubwren (*Sericornis frontalis*) 18, red-winged fairy-wren (*Malurus elegans*) 16, spotted pardalote (*Pardalotus puntatus*) 10, silvereye (*Zosterops lateralis*) 23, western white-naped honeyeater (*Melithreptus chloropsis*) 21, western spinebill (*Acanthorhynchus superciliosus*) 17, brown honeyeater (*Lichmera indistincta*) 14, yellow-winged (New Holland) honeyeater (*Phylidonyris novaehollandiae*) 19 and the western little wattle bird (*Anthochaera lunulata*) 13.

Table 1. Bird species and number of individuals recorded in each treatment in the Wellington FORESTCHECK grids in 2008 (RAOU = Royal Australian Ornithology Union number).

RAOU	Species Name	Common Name	TOTAL	External Reference	Shelterwood	Gap Release
221	*Accipiter fasciatus*	Brown goshawk	2			2
259	*Glossopsitta porphyrocephala*	Purple-crowned lorikeet	6		6	
264	*Calyptorhynchus banksii naso*	Forest red-tailed black cockatoo	5		5	
266	*Calyptorhynchus baudinii*	Baudins cockatoo	9	9		
289	*Platycercus icterotis*	Western rosella	3	1	1	1
290	*Platycercus spurius*	Red-capped parrot	4	4		
294	*Barnardius zonarius semitorquatus*	Twenty-eight parrot	20	10	10	
337	*Cuculus pallidus*	Pallid cuckoo	1			1
338	*Cacomantis flabelliformis*	Fan-tailed cuckoo	3		3	
342	*Chrysococcyx basalis*	Horsefield's bronze-cuckoo	2		1	1
344	*Chrysococcyx lucidus*	Shining bronze-cuckoo	1			1
359	*Hirundo nigricans*	Tree martin	31	18	10	3
361	*Rhipidura fuliginosa*	Grey fantail	38	13	15	10
380	*Petroica multicolor*	Scarlet robin	8	7	1	
387	*Eopsaltria georgiana*	White-breasted robin	21	4	12	5
394	*Eopsaltria australis griseogularis*	Western yellow robin	6	5	1	
398	*Pachycephala pectoralis*	Golden whistler	29	13	9	7
408	*Colluricincla harmonica*	Grey shrike-thrush	11	6	4	1
424	*Coracina novaehollandiae*	Black-faced cuckoo shrike	6		4	2
463	*Gerygone fusca*	Western gerygone	57	16	21	20
472	*Acanthiza inornata*	Western thornbill	20	7	7	6
476	*Acanthiza apicalis*	Broad-tailed (inland) thornbill	86	24	31	31
488	*Sericornis frontalis*	White-browed scrubwren	18	4	9	5
532	*Malurus splendens*	Splendid fairy-wren	1			1
538	*Malurus elegans*	Red-winged fairy-wren	16	7	7	2
565	*Pardalotus punctatus*	Spotted pardalote	10	2	2	6
574	*Zosterops lateralis*	Silvereye	23	2	14	7
578	*Melithreptus chloropsis*	Western white-naped honeyeater	21	11	4	6
592	*Acanthorhynchus superciliosus*	Western spinebill	17	3	9	5
597	*Lichmera indistincta*	Brown honeyeater	14		3	11
631	*Phylidonyris novaehollandiae*	Yellow-winged (New Holland) honeyeater	19	5	12	2
638	*Anthochaera carunculata*	Red wattlebird	5	2	2	1
651	*Stagonopleura oculata*	Red-eared firetail	2	2		
697	*Sterpera versicolor*	Grey currawong	1	1		
710	*Anthochaera lunulata*	Western little wattlebird	13	4	8	1
976	*Pardalotus striatus*	Striated pardalote	52	24	22	6
		Total species	**36**	**26**	**28**	**26**
		Total individuals	**581**	**204**	**233**	**144**

The density of birds varied between treatments in 2008 (Fig. 2) with the external reference having 13.6 birds ha^{-1}, the shelterwood had 15.5 ha^{-1} and the gap release had 9.6 ha^{-1}. Over all the treatments the density of birds was 12.9 birds ha^{-1}. The Kingston Bird Study which has been following the effects of logging in the southern forest since 1996 has bird densities in all treatments varying from 10.4 to 13.4 ha^{-1}.

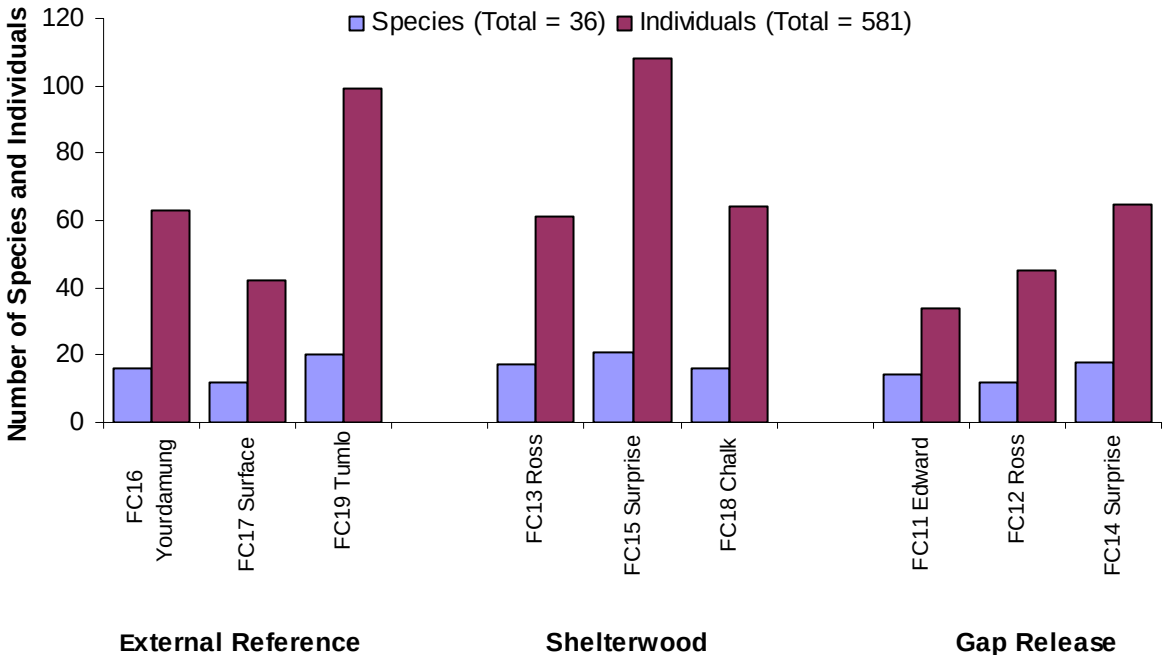


Figure 1. The number of bird species and individuals recorded in each Wellington FORESTCHECK grid.

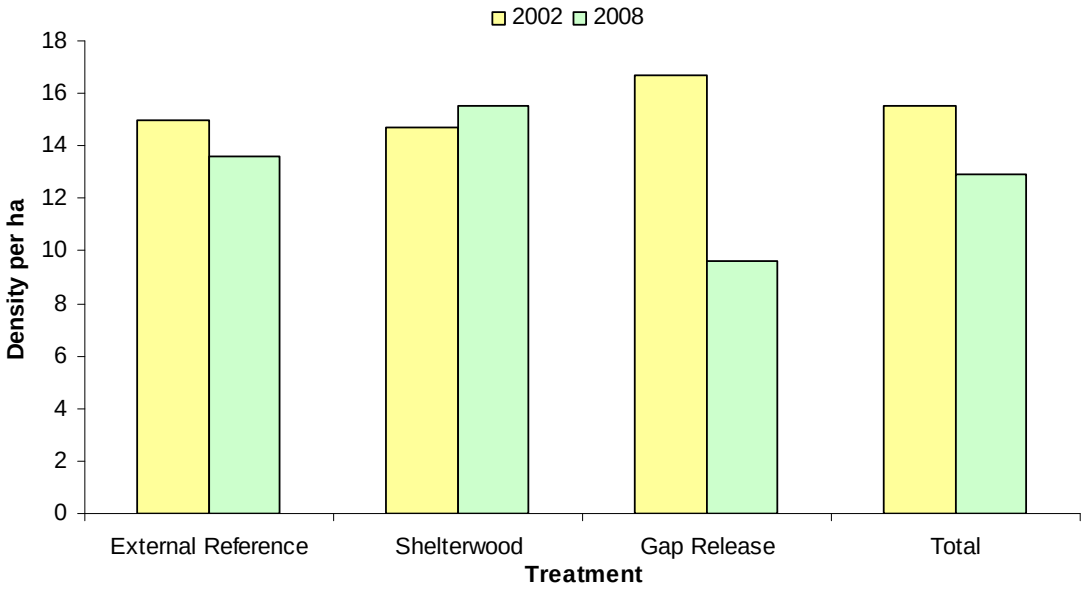


Figure 2. Bird density comparison between sample years and treatments at Wellington

Previous counts on these sites in 2002 had an overall density of 15.4 birds ha^{-1}. The treatments in 2002 had 15.0 birds ha^{-1} in the external reference treatment, 14.7 birds ha^{-1} in the shelterwood and 16.7 birds ha^{-1} in the gap release (Fig. 2).

Bird densities have not changed dramatically between 2002 and 2008 in the external reference or the shelterwood, however there was a change from 16.7 ha^{-1} in 2002 to 9.6 ha^{-1} in 2008 in the gap release treatment. On the gap release grids there were 10 species recorded in 2002 that were not recorded in 2008, these 10 species only accounted for 35 individuals and there were 6 species accounting for 18 individuals that were recorded in 2008 and not in 2002.

By far the largest change in the gap release occurred with four species recorded in both 2002 and 2008 but had large number changes. These species were the tree martin which dropped in numbers from 27 in 2002 to three in 2008, the western thornbill from 27 (2002) to six (2008), the silvereye 24 (2002) to seven (2008) and the striated pardalote from 20 (2002) to six (2008). The changes in numbers for these four species would account for a difference of 5.1 birds ha^{-1}.

The tree martin is an above canopy flyer and opportunistic feeder and whilst its numbers declined in the gap release they rose in the external reference (five to 18) and were static in the shelterwood (12 and 10).Western thornbills are an open forest bird and its numbers decreased in all treatments. Silvereyes occur in most forest types and there appears to be no reason for there numbers to decline as they are almost static in the other treatments and this also applies to the striated pardalote which only declined in the gap release.

In 2001 the Donnelly FORESTCHECK grids had 10.7 birds ha^{-1}; in 2002 the Wellington grids had 15.4 birds ha^{-1}, in 2003 the Perth Hills grids had 9.7 birds ha^{-1}, in 2004 the Wellington east grids had 9.7 birds ha^{-1} and in 2005 Blackwood Plateau grids had 8.9 birds ha^{-1}.

Ten species of birds were recorded as occurring in only one treatment (either external reference, shelterwood or gap release) (Table 1). None of these would be expected to be restricted to that treatment. Of these 10 species, five had 1-2 individuals, three had 3-5 individuals, one had six and one had nine individuals.

Even though the most commonly recorded bird was the broad-tailed (inland) thornbill with 86 records, this was down from 103 individuals recorded in 2002 (Table 2). This species enjoys the re-growth following regeneration and it was observed in all treatments being most common in the shelterwood and gap release (31 records in each). This was followed by the western gerygone with 57 records (58 in 2002) and then the upper canopy, insectivorous striated pardalote with 52 records (69 in 2002), of which 24 came from the external reference grids, 22 from shelterwood grids and as mentioned before only six from the gap release grids.

There were 36 species in 2008 and 35 in 2002 and there were 116 fewer individuals recorded in 2008 than 2002. There were six species in 2002 that were not recorded in 2008 and 7 species in 2008 not recorded in 2002 (Table 2).

Table 2. Comparison between the 2002 and 2008 surveys for birds at Wellington FORESTCHECK grids

RAOU	Common Name	Total	External Reference	Shelter-wood	Gap Release	Total	External Reference	Shelter-wood	Gap Release
221	Brown goshawk	**4**	1	2	1	**2**			2
242	Southern boobook	**1**		1					
259	Purple-crowned lorikeet					**6**		6	
264	Forest red-tailed black cockatoo	**6**		3	3	**5**		5	
266	Baudins cockatoo					**9**	9		
289	Western rosella	**2**	1	1		**3**	1	1	1
290	Red-capped parrot	**12**	4	5	3	**4**	4		
294	Twenty-eightpParrot	**19**	7	9	3	**20**	10	10	
322	Laughing kookaburra	**2**		1	1				
337	Pallid cuckoo					**1**			1
338	Fan-tailed cuckoo	**2**			2	**3**		3	
342	Horsefield's bronze-cuckoo	**1**	1			**2**		1	1
344	Shining bronze-cuckoo	**9**	5	2	2	**1**			1
357	Welcome swallow	**5**			5				
359	Tree martin	**44**	5	12	27	**31**	18	10	3
361	Grey fantail	**35**	9	15	11	**38**	13	15	10
380	Scarlet robin	**15**	5	6	4	**8**	7	1	
387	White-breasted robin	**3**		2	1	**21**	4	12	5
394	Western yellow robin	**3**	1		2	**6**	5	1	
398	Golden whistler	**32**	10	12	10	**29**	13	9	7
408	Grey shrike-thrush	**7**	2	4	1	**11**	6	4	1
424	Black-faced cuckoo shrike	**8**	4	3	1	**6**		4	2
463	Western gerygone	**63**	25	24	14	**57**	16	21	20
472	Western thornbill	**58**	21	10	27	**20**	7	7	6
476	Broad-tailed (inland) thornbill	**103**	30	35	38	**86**	24	31	31
488	White-browed scrubwren	**12**	2	4	6	**18**	4	9	5
532	Splendid fairy-wren	**31**	16	6	9	**1**			1
538	Red-winged fairy-wren					**16**	7	7	2
547	Dusky woodswallow	**6**		6					
549	Varied sitella	**19**	10		9				
556	Rufous treecreeper	**10**	2	5	3				
565	Spotted pardalote	**3**		2	1	**10**	2	2	6
574	Silvereye	**37**	4	9	24	**23**	2	14	7
578	Western white-naped honeyeater	**23**	9	8	6	**21**	11	4	6
592	Western spinebill	**28**	16	5	7	**17**	3	9	5
597	Brown honeyeater	**2**	2			**14**		3	11
631	Yellow-winged honeyeater					**19**	5	12	2
638	Red wattlebird	**12**	8	1	3	**5**	2	2	1
651	Red-eared firetail					**2**	2		
697	Grey currawong					**1**	1		
710	Western little wattlebird	**11**	4		7	**13**	4	8	1
976	Striated pardalote	**69**	22	27	20	**52**	24	22	6
	Total individuals	**697**	226	220	251	**581**	204	233	144
	Total species	**35**	27	28	30	**36**	26	28	26
	Density	**15.5**	**15**	**14.7**	**16.7**	**12.9**	**13.6**	**15.5**	**9.6**

Of the species recorded in one sample year and not the other, over 5 different days separated by a minimum of 7 days, you would expect to see one individual. Red-winged fairy-wrens were recorded in all treatments in 2008, but were not seen or heard in 2002. This bird likes thicker understory and would have been expected to be recorded in 2002 in the external reference grid at Tumlo block as well as the shelterwood and gap release grids in Surface block that same year. Splendid Fairy-wrens numbers changed dramatically from 2002 when 31 individuals were recorded to 2008 when only 1 was recorded. Both the Red-winged and Splendid Fairy-wrens usually present themselves to be seen during census and it is unlikely that there was miss identification in 2002 and 2008 as the same observers undertook both census.

Yellow-winged honeyeaters were not recorded in 2002 and there were 19 individuals either seen or heard in 2008.This species is usually relatively common in forest areas and feeds on nectar and insects associated with flowering plants. It's likely that there was little or no flowering occurring in the grids in 2002.

Conclusions

Bird species composition and abundances change continuously as the understory density and fuel ages vary. These changes occur in harvested areas as the vegetation structure changes over time through crown separation in regrowth trees and understory shrubs, and in uncut forest as structural and successional changes occur in the understory with time since fire. Changes in population also occur with variation in flowering cycles in plant species. Observations in 2008 related to these changes are:

- Red-winged fairy-wren recorded in 2008– likely related to increased density of the understory with time since regeneration and fire
- Splendid fairy-wren numbers decreased in 2008 – increased density of understory
- White-breasted robin numbers increased in 2008 – increased density of understory
- Western thornbill numbers decreased in 2008 – increased density of understory
- Yellow–winged honeyeater – flowering cycle in plant species

Mammals and Herpetofauna

G.L.Liddelow and Verna Tunsell

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 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 grids and treatments at each location and between FORESTCHECK locations
- Recording the presence of the larger mammals along set transects that cover all treatments of the FORESTCHECK location on a landscape basis
- Recording the presence of nocturnal mammals by spotlighting along set transects that cover all the treatments of the FORESTCHECK location
- Recording feral animal species and abundance using sand pads placed at regular intervals along pre-determined tracks and roads within each FORESTCHECK location.

Monitoring

Trapping was carried out on all nine grids for two weeks in spring 2008 and autumn 2009 and the program went according to plan with no interruption to any activities due to inclement weather.

In the 2008-09 monitoring period, due to constraints on personnel surveys along road transects for large mammals and spotlighting for nocturnal mammals was only carried out in autumn and sand pad monitoring to record feral animals was not undertaken.

Voucher Specimens

No specimens were lodged with the Western Australian Museum from this trapping session.

Preliminary Results

Trapping

A total of 248 individuals were trapped (Table 1, Fig. 1) with 188 individuals trapped in spring and only 60 captures in autumn.

Thirty six mammals, 33 reptiles, 116 amphibians and three birds were trapped in spring and 23 mammals, 33 reptiles and four amphibians in autumn. The most common mammal captured was the introduced rat (*Rattus rattus*) with 33 captures over the two seasons and 32 of the 33 were trapped in treatment areas. Eighteen came from the shelterwood grids and 14 came from gap release grids. Eleven pygmy possums were captured during this session of FORESTCHECK and all but one were trapped in spring. They were captured in all treatment types with the majority in the

shelterwood treatment. Amphibian captures were high in the spring (Fig. 1), with116 of the 120 captures occurring in this season. Normally the reverse would be expected, with most amphibians being caught in autumn after the breaking rains. However, there had been no rain prior to or during trapping in April.

Table l: The number of animals captured in spring 2008 and autumn 2009 on the Wellington FORESTCHECK grids.

Species	Spring 2008	Autumn 2009	Total
MAMMALS			
Antichinus flavipes	1	2	3
Cercartetus concinnus	10	1	11
Dasyurus geoffroii		1	1
Mus musculus	7		7
Rattus fuscipes		1	1
Rattus rattus	18	15	33
Sminthopsis sp.		2	2
Tachyglossus aculeatus		1	1
Total	**36**	**23**	**59**
REPTILES			
Acritoscincus trilineatum	1		1
Aprasia pulchella	1		1
Ctenotus labillardieri		1	1
Diplodactylus polyophthalmus	1		1
Egernia napoleonis	3	12	15
Hemiergis peroni	8		8
Lerista distinguenda	1	8	9
Menetia greyii	6	4	10
Morethia obscura	9	3	12
Pogona minor		2	2
Tiliqua rugosa	1		1
Ramphotyphlops australis	2		2
Acanthophis antarticus		1	1
Parasuta gouldi		1	1
Parasuta nigriceps		1	1
Total	**33**	**33**	**66**
AMPHIBIANS			
Crinia georgiana	21	3	24
Crinia glauerti	4		4
Geocrinia leai	6		6
Heleioporus eyrei	74	1	75
Limnodynastes dorsalis	11		11
Total	**116**	**4**	**120**
BIRDS			
Eopsaltria georgiana	1		1
Corvus coronoides	2		2
Total	**3**		3
All Species Total	**188**	**60**	**248**

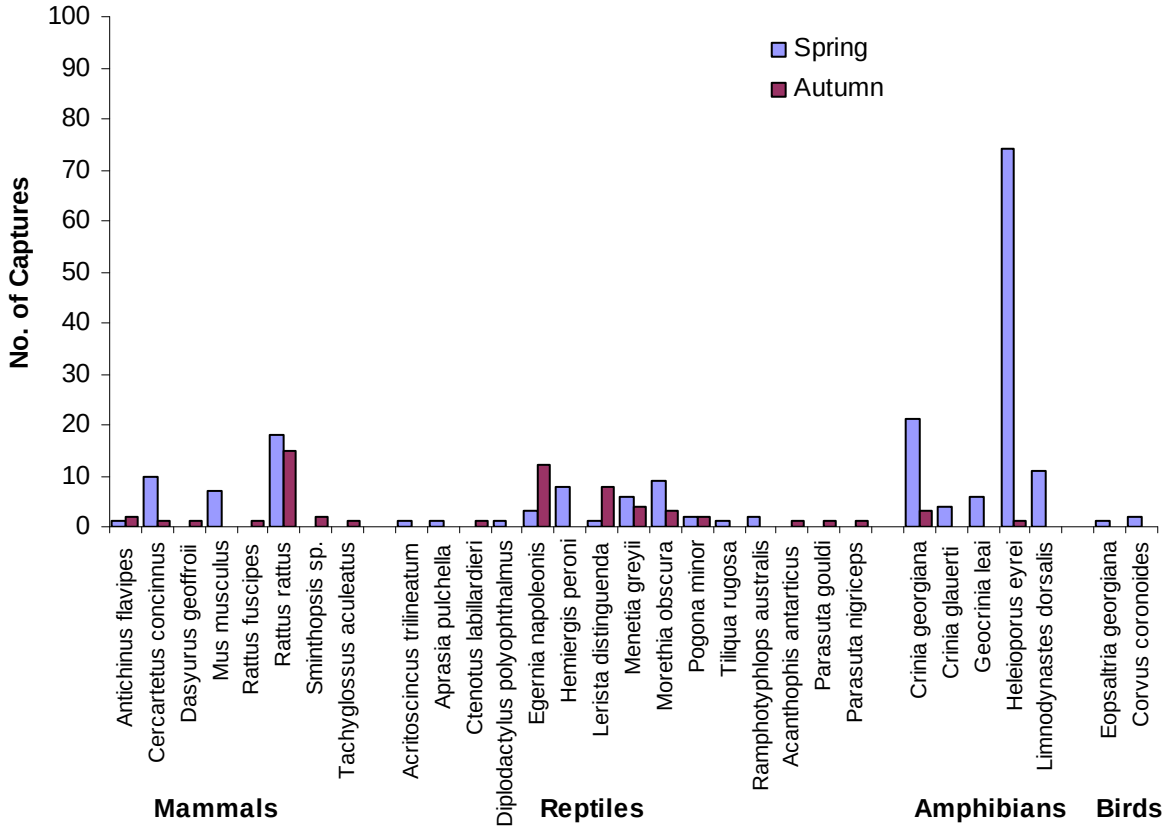


Figure 1. The number of animals captured in spring and autumn on the Wellington FORESTCHECK grids in 2008-09.

Wire cage traps

Wire cage traps were not as successful as pit traps with only 48 of the 248 captures being in this trap type (Table 2, Fig. 2). Introduced rats (*Rattus rattus*) were the most commonly caught mammal with 33 captures, next was the introduced mouse (*Mus musculus*) with 6 captures.

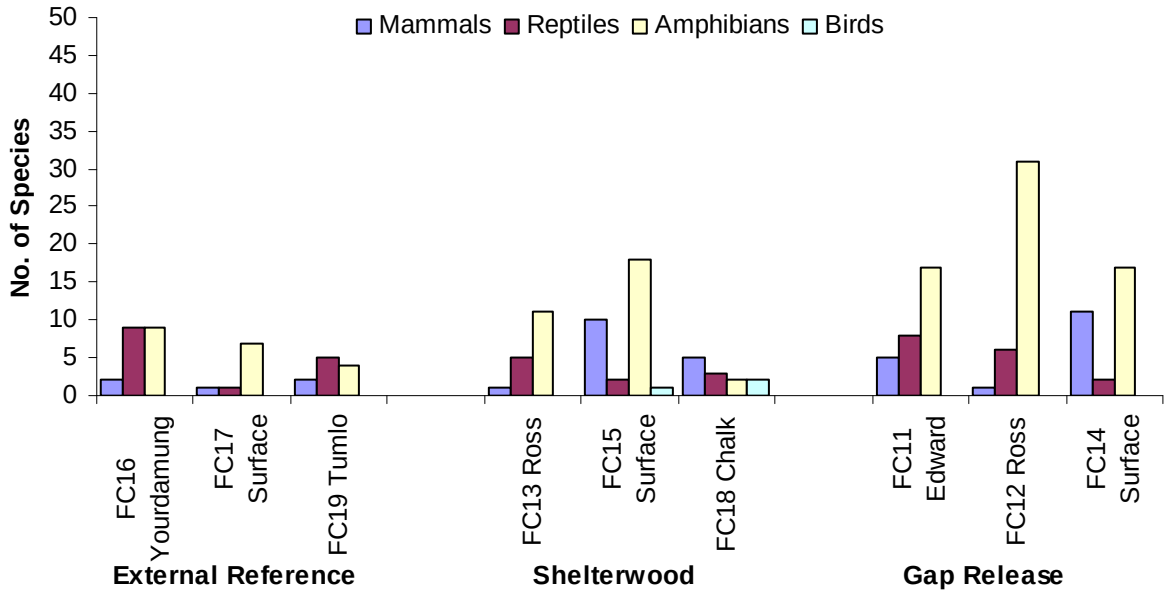
Of native mammal species there was a total of 6 captures comprising of 3 mardo (*Antechinus flavipes*), 1 chuditch (*Dasyurus geoffroii*), 1 echidna (*Tachyglossus aculeatus*) and 1 bush rat (*Rattus fuscipes*). There was also 1 reptile, 1 amphibian and 3 birds trapped in wire cages over both spring and autumn sessions.

As was the case in 2002-03 no brushtail possums were trapped in 2008-09. One possum was sighted during the spotlight survey near the Surface reference grid (FC17) on Asquith Rd. (Fig. 3) and possum scats were recorded in five of the grids (FC12,13,14,16 and 18). Only one chuditch was trapped in 2008-09 and staff from the DEC Wellington District have been trapping substantial numbers of chuditch further east at Batalling forest block and south-east of the Muja Powerhouse in Centaur forest block

Table 2. Comparison of trapping results by trap type and treatment at Wellington in 2008-09

Species	External Reference		Shelterwood		Gap Release	
	Wire	**Pit**	**Wire**	**Pit**	**Wire**	**Pit**
MAMMALS						
Antichinus flavipes					3	
Cercartetus concinnus		2		6		3
Dasyurus geoffroii					1	
Mus musculus		1	3		3	
Rattus fuscipes	1					
Rattus rattus	1		16	2	14	
Sminthopsis sp.				2		
Tachyglossus aculeatus			1			
REPTILES						
Acritoscincus trilineatum						1
Aprasia pulchella						1
Ctenotus labillardieri						1
Diplodactylus polyophthalmus						1
Egernia napoleonis		6		2		7
Hemiergis peroni		2				6
Lerista distinguenda		3		6		
Menetia greyii				2		8
Morethia obscura		3		2		7
Pogona minor				1		1
Tiliqua rugosa					1	
Ramphotyphlops australis		1		1		
Acanthophis antarticus						1
Parasuta gouldi				1		
Parasuta nigriceps						1
AMPHIBIANS						
Crinia georgiana		1	1	9		13
Crinia glauerti				2		2
Geocrinia leai				1		5
Heleioporus eyrei		9		21		45
Limnodynastes dorsalis		11				
BIRDS						
Eopsaltria georgiana			1			
Corvus coronoides			2			
Total	**2**	**39**	**24**	**58**	**22**	**103**

(a) Spring – all traps



(b) Autumn – all traps

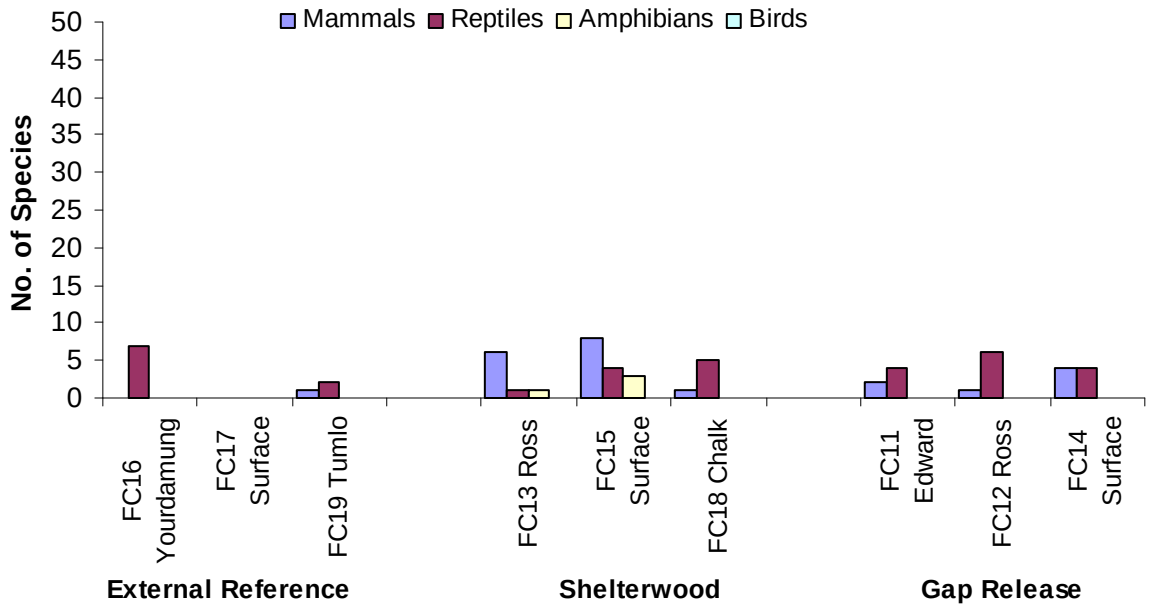
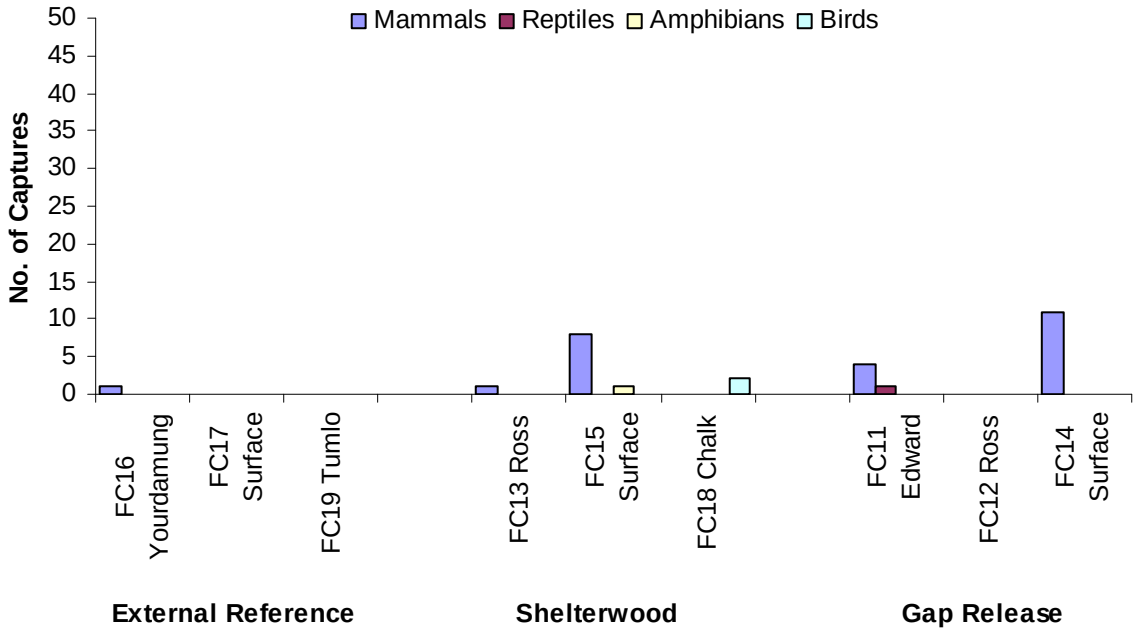


Figure 2. The number of mammals, reptiles and amphibians recorded in all traps in spring (a) and autumn (b) on the Wellington FORESTCHECK grids in 2008-09.

(a) Spring – wire traps



(b) Autumn – wire traps

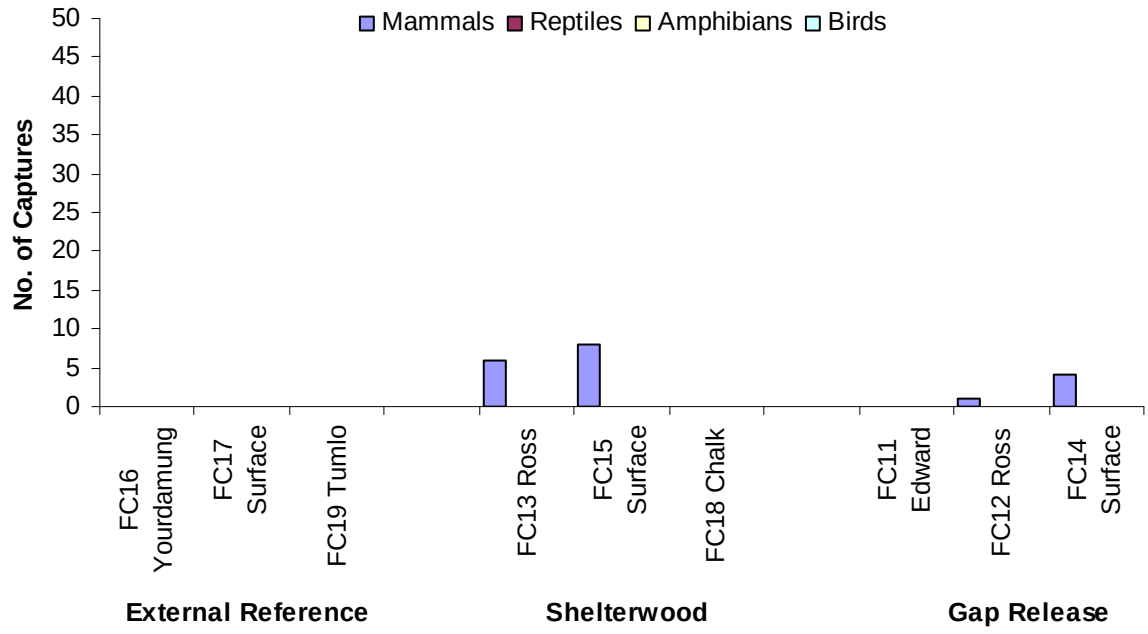


Figure 3. The number of individual mammals, reptiles and amphibians recorded in wire traps in the spring (a) and autumn (b) on the Wellington FORESTCHECK grids in 2008-09.

Pit fall traps

Pit fall trapping was relatively successful with 200 of the 248 total captures occurring in pit falls. Only 16 mammals were trapped in pits and 11 of these were pygmy possum (*Cercartetus concinnus*), the other five were two dunnarts (*Sminthopsis* sp.), two introduced rats and one introduced mouse. All but one pygmy possum was caught in spring and both of the dunnarts were caught in autumn. Sixty-five of the 66 reptiles and 119 of the 120 amphibians were trapped in pits. Reptiles were trapped in equal numbers in spring and autumn but of the 119 amphibians trapped in pits, 115 were caught in spring and only 4 in autumn (Fig. 4).

2008-09 was the first time that a southern death adder (*Acanthophis antarticus*) was caught in our traps. It appears to be a southerly extension in range along the Darling scarp, and as identification is straight forward for this species it was considered that there was no need for a voucher specimen to be made for the Museum.

As mentioned earlier, the dry conditions experienced in autumn were not ideal for this type of trapping. We would normally expect to have large numbers of amphibians at this time of year but we only had a total of four. Unfortunately the Surface external reference grid (FC17) was burnt in a wildfire in early summer and there were no captures recorded there in autumn. The gap release grids had the highest number of captures especially in spring, followed by the shelterwood and then the external reference grids (Fig. 4).

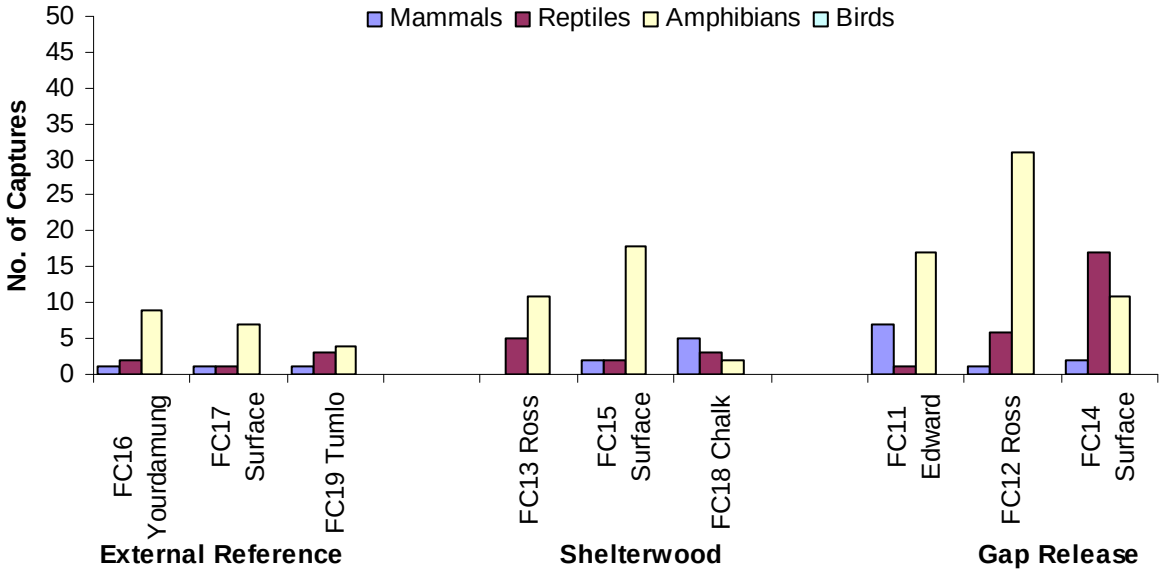
The results of trapping at the Wellington grids in both 2002-03 and 2008-09 are shown in Table 3. In 2002-03, trapping was conducted over one week. Since 2007 trapping has been extended to two weeks in order to increase the number of captures.

Apart from capturing 11 pygmy possums and some introduced mice in 2008-09 there were no obvious or notable changes in the mammals for the Wellington location.

Reptiles, however, were a different story. Even though there was only one week of trapping in 2002-03 the difference in reptile numbers was dramatic with 145 captures in spring of 2002 whilst in 2008 with two weeks trapping there were only 33 captures. When trapping was carried out in Spring 20002 there had been little or no rain for the two weeks prior and during the week of trapping, so temperatures were rising and the reptiles were very active. In spring of 2008, 47 mm of rain was recorded prior to and during trapping along with cool temperatures, which explains why the reptiles were not as active and also why there so many amphibians were trapped. Reptile captures for autumn in both years were 27 in 2003 and 33 in 2009.

Low numbers of amphibians were recorded in autumn in both 2003 and 2009, likely because the season breaking rains did not occur until well after the trapping session was completed.

(a) Spring – pit fall traps



(b) Autumn – pit fall traps

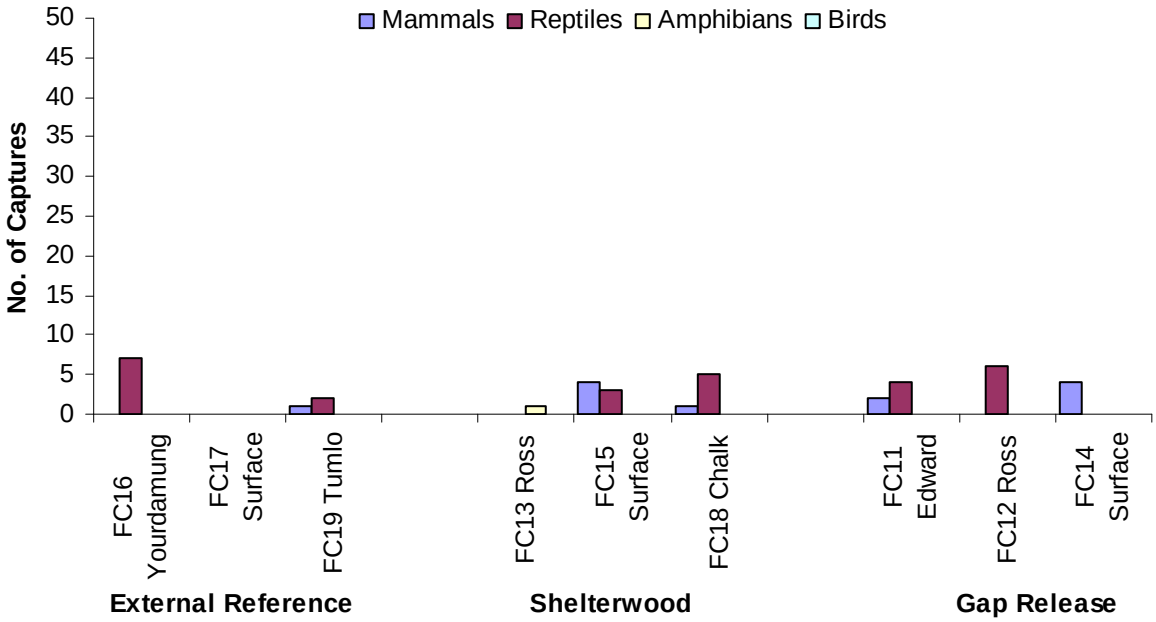


Figure 4. The number of individual mammals, reptiles and amphibians recorded in pit fall traps in the spring (a) and autumn (b) on the Wellington FORESTCHECK grids in 2008-09.

Table 3. Comparison between 2002-03and 2008-09 trapping results at the Wellington grids.

	2002-2003			2008-2009		
Species	**Spring**	**Autumn**	**Total**	**Spring**	**Autumn**	**Total**
MAMMALS						
Antichinus flavipes	1		**1**	1	2	**3**
Cercartetus concinnus			**0**	10	1	**11**
Dasyurus geoffroii			**0**		1	**1**
Mus musculus			**0**	7		**7**
Rattus fuscipes			**0**		1	**1**
Rattus rattus		19	**19**	18	15	**33**
Sminthopsis sp.	2	2	**4**		2	**2**
Tachyglossus aculeatus	1		**1**		1	**1**
REPTILES						
Acritoscincus trilineatum	3		**3**	1		**1**
Aprasia pulchella	13		**13**	1		**1**
Christinus marmoratus	3		**3**			**0**
Ctenotus labillardieri	19		**19**		1	**1**
Diplodactylus polyophthalmus	2		**2**	1		**1**
Egernia napoleonis	9		**9**	3	12	**15**
Hemiergis initialis	3	1	**4**			**0**
Hemiergis peroni	3		**3**	8		**8**
Lerista distinguenda	29	5	**34**	1	8	**9**
Menetia greyii	22	16	**38**	6	4	**10**
Morethia obscura	35	4	**39**	9	3	**12**
Pogona minor	1		**1**		2	**2**
Tiliqua rugosa	1		**1**	1		**1**
Ramphotyphlops australis	2		**2**	2		**2**
Acanthophis antarticus			**0**		1	**1**
Notechis scutatus		1	**1**			**0**
Parasuta gouldi			**0**		1	**1**
Parasuta nigriceps			**0**		1	**1**
AMPHIBIANS						
Crinia georgiana	2	1	**3**	21	3	**24**
Crinia glauerti			**0**	4		**4**
Geocrinia leai			**0**	6		**6**
Heleioporus eyrei		2	**2**	74	1	**75**
Limnodynastes dorsalis			**0**	11		**11**
BIRDS						
Eopsaltria georgiana				1		**1**
Corvus coronoides				2		**2**
Total	151	51	**202**	188	60	**248**

Spotlighting

Due to cool misty weather in spring spotlight surveys were only undertaken in autumn.

Four species were recorded; kangaroo, brushtail possum, tawny frogmouth and owlet nightjar (Fig. 5). Although brushtail possums were not trapped on any grids, one was recorded during the spotlight survey and, as mentioned previously, evidence of possums in both treatment and reference grids was noted during trapping. The possum observed was along Asquith Road and was inside a controlled burn carried out by the district in spring. Diurnal bird surveys do not usually produce records of either the tawny frogmouth or owlet nightjar but they are generally recorded during spotlight surveys.

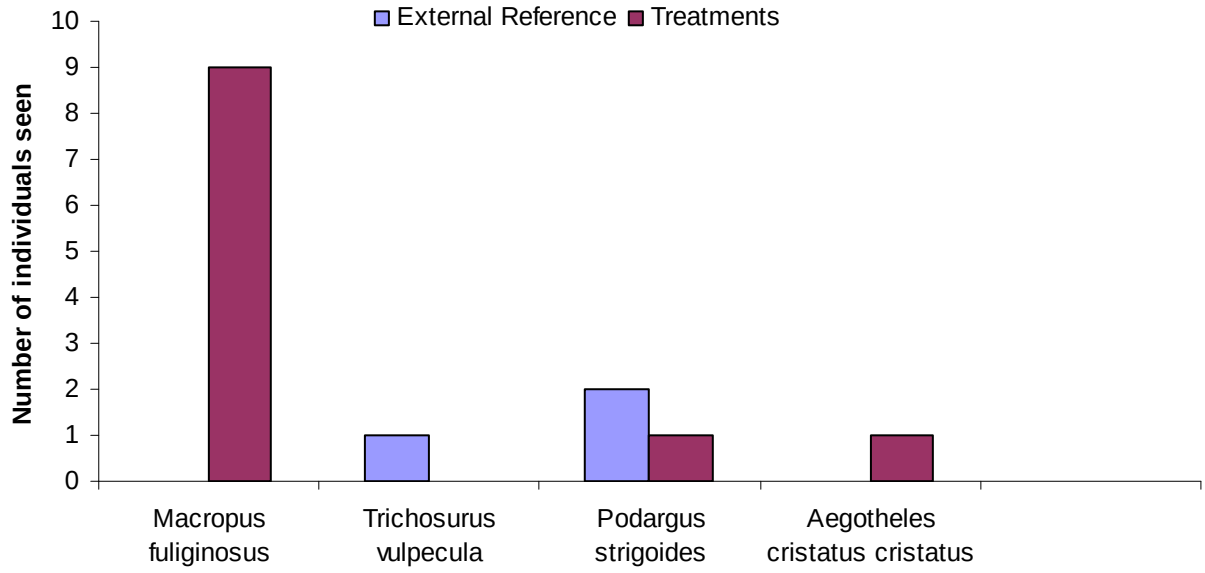


Figure 5. Species recorded along spotlight transects in Wellington district in 2009.

Road Transects

The weather did not allow road transects surveys to be carried out in spring but two were undertaken in autumn. Transects are used to record macro fauna and two 25 km routes extend to roads including forest with grids in all treatments. A southern transect included Caversham, Chalk and Trees Roads and a northern transect included Asquith, Possum Creek and Dooganally Roads. In total, 58 kangaroos and 19 brush wallabys were seen along the two transects. In autumn 2003, 25 kangaroos and 3 brush wallabys were recorded along the same transects.

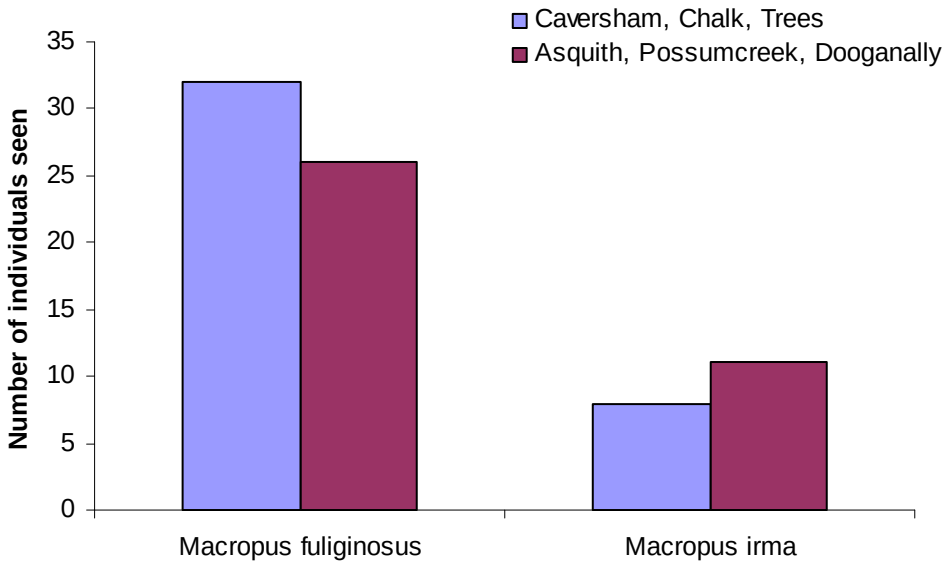


Figure 6. Macro fauna recorded during autumn road transects in Wellington district in 2009.

Conclusions

There appears to be no reason why medium sized mammals were low in numbers in the Wellington grids in 2008-09. The area is baited under the Western Shield program, there is more than adequate vegetation cover over all treatments whether they have been logged or not and there is a variety of burn ages throughout the grids that provide fire successional stages that would cater for all medium sized mammals that would be expected to be trapped in the area.

Acknowledgements

We would like to thank Christine Gilbert, Kelly Bennett and George Bradshaw from the DEC Wellington District Nature Conservation program and Laura Henningson and Paul Blei from the University of Applied Science, Eberswalde in Germany for their assistance.

DATA MANAGEMENT AND STORAGE

Verna Tunsell

Introduction

The group is responsible for entering and storing the collected data for dirurnal and nocturnal birds, mammals and herpetofauna, vascular plants, macrofungi and cryptogams into electronic format, databasing collected voucher specimens (Flora, Cryptogams and Fungi) and storing the electronic data for invertebrates.

Data entry

A Microsoft 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 for Donnelly have been completed. A Metadata form, as shown in Appendix A, is also completed.

Data validation

Entered data for all the groups is validated. The validation date is 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 is 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 when the DEC network drive is backed up

daily. The final version of the validated data is printed and kept in a filing cabinet and will be archived in the Forest Science library at the completion of the project.

Voucher specimens

The 13 vascular plant, 44 fungi and 6 cryptogam specimens collected during the period, have been identified (as far as possible), prepared, and the vascular plants and cryptogams lodged at the WA Herbarium. The fungi collection is housed at the Tony Annels Herbarium in Manjimup to enable work on descriptions and identification to be completed. The low number of vouchers collected for the vascular flora is the result of only collecting species not yet vouchered on the Donnelly FORESTCHECK grids. The cryptogam collections are for photographic material and redetermination of unknown species. The fungi collections are new species and some for redetermination of previously collected species.

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

Vascular plant specimens are pressed and dried, then mounted, with specialised 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, then wrapped in greaseproof paper inside zip-lock bags and put into boxes to prevent damage. Very large specimens remain unboxed.

Each voucher specimen is data based on the Max system and submitted electronically to the WA Herbarium for incorporation into the herbarium database. Max was developed by Simon Woodman and Paul Gioia (DEC) and is used as the primary means of submitting specimen information to the WA Herbarium. While there are many facets to Max, the sections used for FORESTCHECK are the collecting book and reporting facilities.

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 Specimen labels generated in Max-V3

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Cassytha racemosa forma ***pilosa*** (Benth.) J.Z.Weber

Lauraceae

Identified by:

Parastitic perennial climber frequent. Hill to plain; gravelly brown sandy clay. Forest with associated vegetation of Corymbia calophylla and Eucalyptus marginata.

Loc.: Forestcheck monitoring site 5, N side of Wagelup Road 1.4 km W of railway line, Yornup Forest block

Lat.: 34°6'24.0" S **Long.:** 116°8'33.0" E (WGS84)

Coll.: R.J. Cranfield 23238 **Date:** /09/2008

Voucher: Forestcheck Monitoring Program

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Lomandra nigricans T.Macfarlane

Dasypogonaceae

Identified by:

Height to 20 cm, width to 15 cm; flowers white. frequent. Hill to plain; gravelly brown sandy clay. Forest with associated vegetation of Corymbia calophylla and Eucalyptus marginata. Percentage of population flowering: 10

Loc.: Forestcheck monitoring site 5, N side of Wagelup Road 1.4 km W of railway line, Yornup Forest block

Lat.: 34°6'24.0" S **Long.:** 116°8'33.0" E (WGS84)

Coll.: R.J. Cranfield 23239 **Date:** /09/2008

Voucher: Forestcheck Monitoring Program

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Leucopogon capitellatus DC.

Epacridaceae

Identified by:

Shrub, height to 30 cm, width to 40 cm; growth phase is active with flower buds, vegetative buds and flowers, white frequent. Hill to plain; gravelly brown sandy clay. Forest with associated vegetation of Corymbia calophylla and Eucalyptus marginata. Percentage of population flowering: 30

Loc.: Forestcheck monitoring site 5, N side of Wagelup Road 1.4 km W of railway line, Yornup Forest block

Lat.: 34°6'24.0" S **Long.:** 116°8'33.0" E (WGS84)

Coll.: R.J. Cranfield 23240 **Date:** /09/2008

Voucher: Forestcheck Monitoring Program

WESTERN AUSTRALIAN HERBARIUM, PERTH
Flora of Western Australia

Leucopogon pulchellus Sond.

Epacridaceae

Identified by:

Erect compact perennial shrub, height to 40 cm, width to 40 cm; flower buds white and pink frequent. Hill to plain; gravelly brown sandy clay. Forest with associated vegetation of Corymbia calophylla and Eucalyptus marginata. Percentage of population flowering: 30

Loc.: Forestcheck monitoring site 5, N side of Wagelup Road 1.4 km W of railway line, Yornup Forest block

Lat.: 34°6'24.0" S **Long.:** 116°8'33.0" E (WGS84)

Coll.: R.J. Cranfield 23241 **Date:** /09/2008

Voucher: Forestcheck Monitoring Program

Appendix C: Example of report generated in Max V3.

27/02/2009 Forestcheck Donnelly 2007-2008 1

COLLECTOR_NO	SHEET_NO	GENUS	SPECIES	INFRA_RANK	INFRA_NAME
23250	6666795	Caladenia	arrecta		
23240	6666728	Leucopogon	capitellatus		
23243	6666752	Senecio	hispidulus		
23244	6666760	Senecio	hispidulus		
23249	6666787	Luzula	meridionalis		
23239	6666701	Lomandra	nigricans		
23241	6666736	Leucopogon	pulchellus		
23245	6666779	Senecio	quadridentatus		
23238	6666698	Cassytha	racemosa	forma	pilosa
23133	6667031	Cassytha	racemosa		
23251	6666809	Caladenia	reptans		
23242	6666744	Brachythecium	sp. FC5 (R.J. Cranfield 2324		
23133	6667023	Billardiera	variifolia		