Chapter 4: RESEARCH FINDINGS

4.1 What are the Forests like?

4.1.1 Density of Trees:

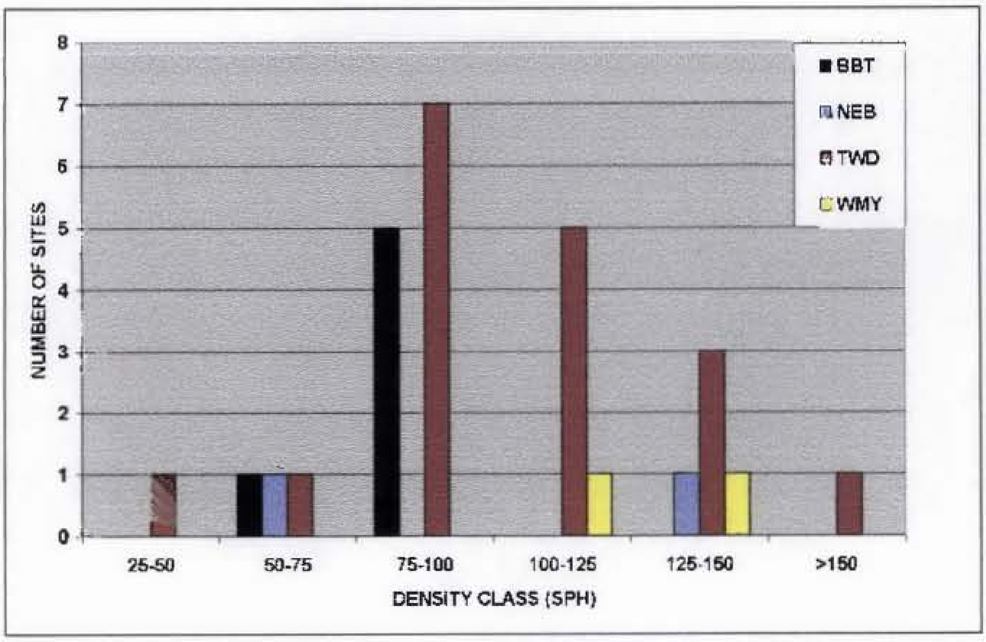
The density of trees across the 28 study sites ranged from 38 to 151 stems >30cm DBHOB per hectare (sph), with an average of 100 stems per hectare.

The forest types of Dry Blackbutt (Forest Type 37=85sph, n=6) and Tallowwood/Sydney Blue Gum (Forest Type 47=103sph, n=18) did not significantly differ in mean tree density ($F_{1,22}$=1.25, P=0.27). The forest types of White Mahogany (Forest Type 60=121sph, n=2) and New England Blackbutt (Forest Type 163=102sph, n=2) were not analysed because of small sample sizes. However, Forest Type 47 (Tallowwood-Sydney Blue Gum) extends over a wide range of tree densities (Figure 8).

The association between the number of trees of particular species and tree density classes was significant (χ^2_{64}=1222.43, P<0.01). There were more Blackbutt, Brush Box, Tallowwood and Red Mahogany trees than expected on open sites (<100sph), and more White Mahogany, Forest Oak, New England Blackbutt and rainforest trees than expected on dense sites (>100sph).

A significant association between tree density and the number of trees in different size classes (χ^2_{12}=65.30, P<0.01) shows that, as is to be expected, tree density is inversely proportional to size.

Figure 8: The forest type[1] and tree density of sample sites at Dorrigo.



[1]'BBT' = Blackbutt, 'NEB' = New England Blackbutt, 'TWD' = Tallowwood-Sydney Blue Gum, and 'WMY' = White Mahogany.

Tree density also forms a number of significant linear associations with several forest floristic, structural and management characteristics (Table 4).

4.1.2 Size of Trees:

Tree sizes sampled ranged from 30cm to 230cm DBHOB (Appendix 6), with an average tree size of 54cm DBHOB. Proportions of small (30-60cm DBHOB), medium (60-90cm DBHOB) and large (>90cm DBHOB) trees

>30cm DBHOB on sites ranged from 35 to 98%, 2 to 33% and 0 to 35%, respectively. The density of large trees (>90cm DBHOB) per site ranged from 0 up to 32 large trees per hectare.

Table 4: Significant correlations and linear associations between tree density and various forest structural, floristic and management characteristics at Dorrigo.

Associated Variable	Correlation (r^1)	P^2
30-60cm DBHOB	0.88	<0.0001
Food Trees	0.69	<0.0001
Forest Oak	0.59	0.0008
Rainforest trees	0.47	0.011
Wattles	0.46	0.014
Number of Loggings	0.38	0.044

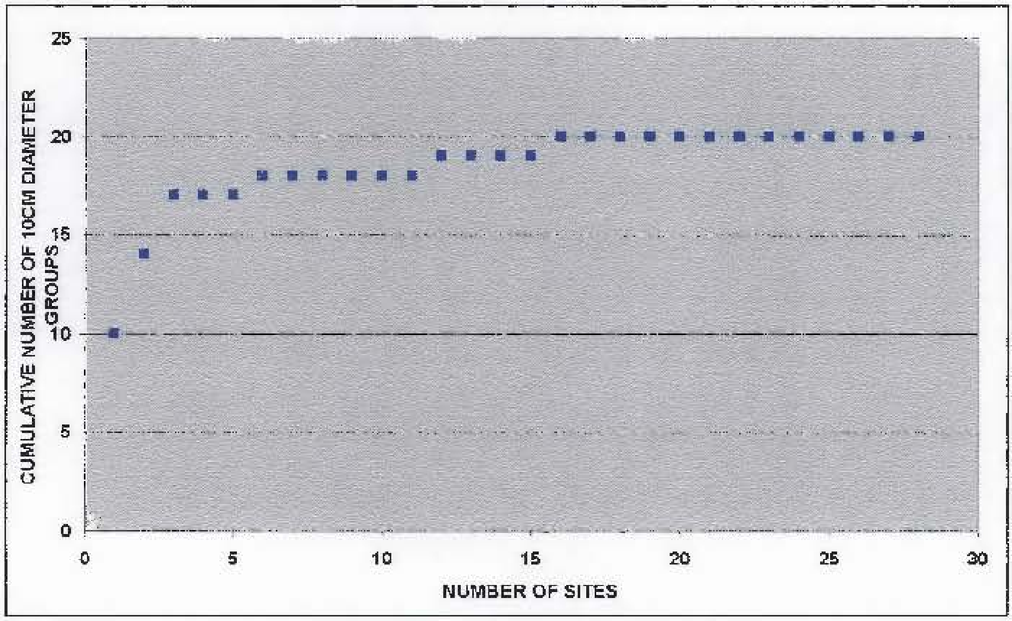
[1]Correlation co-efficient.
[2]Linear regression probability level.

An assessment was made of whether the 28 sites adequately sampled the range of tree sizes (Figure 9). Beyond about 16 sites, no new tree species were encountered, and so this study more than adequately sampled the variation in tree sizes at Dorrigo.

Tree size is significantly associated with several forest characteristics (Table 5). Several size classes are strongly associated with various tree species, koala food trees and the number of logging events. Wattles are disturbance dependent but are not very long-lived species compared with eucalypts. Therefore, they are most likely to be found in association with relatively younger forest stands. Many of the large 90-120cm DBHOB retained trees are Tallowwood because this species was often left behind operations as a favoured seed tree on moist forest sites or because it was too defective.

Repeated logging operations quite often select 30-60cm DBHOB trees for poles and small/quota sawlogs because these sized trees are often reasonably sound and are readily marketable. Blackbutt stands are highly productive and most stands have been intensively logged, leaving fewer large-sized trees.

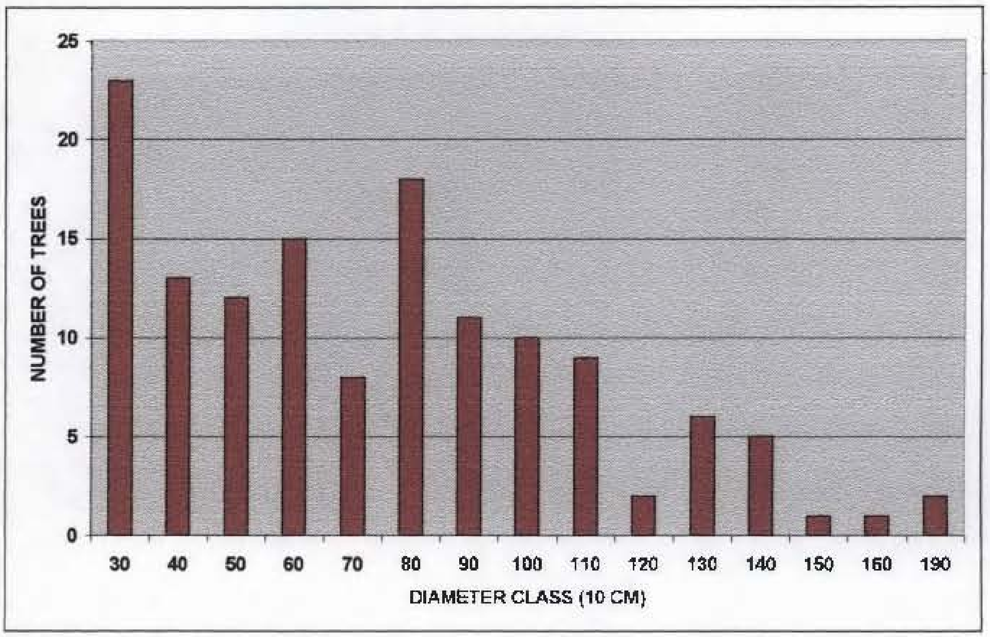
Figure 9: Relationship between the cumulative diversity of tree sizes (10cm DBHOB groups) and sampling effort at Dorrigo.



Variation between sites in the proportions of smaller to larger stems may be a reflection of the degree and length of time between (logging) disturbance events (Figure 10).

Figure 10: Contrast in tree size distributions for two study sites at Dorrigo.

a) Compartment 579 (Site E8), Wild Cattle Creek State Forest:



b) Compartment 514 (Site E13), Wild Cattle Creek State Forest:

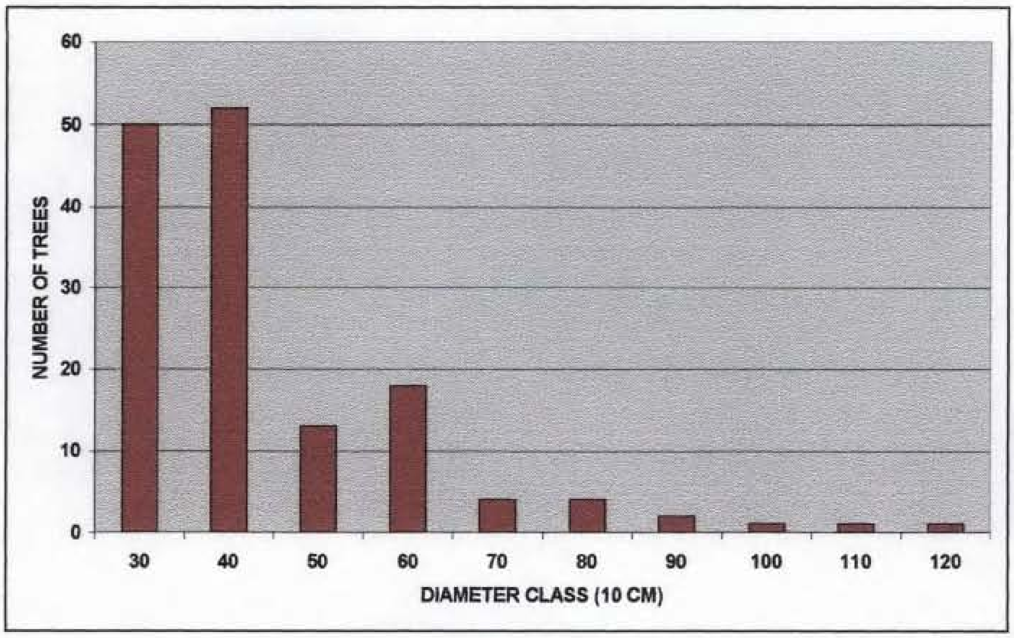


Figure 10 shows the difference in forest structure at two sites which have had a high number of logging events, but differ in the length of time since the last logging event. Site E8 (Figure 10a), with 29% of trees >30cm DBHOB used by koalas, has had 11 logging events with the last logging event 58 years ago. In comparison, Site E13 (Figure 10b), with 8% of trees >30cm DBHOB used by koalas, has had 8 logging events with the last logging event only 14 years ago. The more recent interval between logging events at Site E13 in comparison with Site E8 may account for the apparent discrepancy in the number of larger and smaller stems.

Table 5: Highly significant correlations and linear associations between tree size classes and forest structural, floristic and management characteristics at Dorrigo.

Associated Variables	**Correlation (r[1])**	**P[2]**
30-60cm & Wattles	0.62	0.0004
90-120cm & Tallowwood	0.61	0.0006
30-60cm & Number of Loggings	-0.60	0.0007
90-120cm & Blackbutt	-0.56	0.002

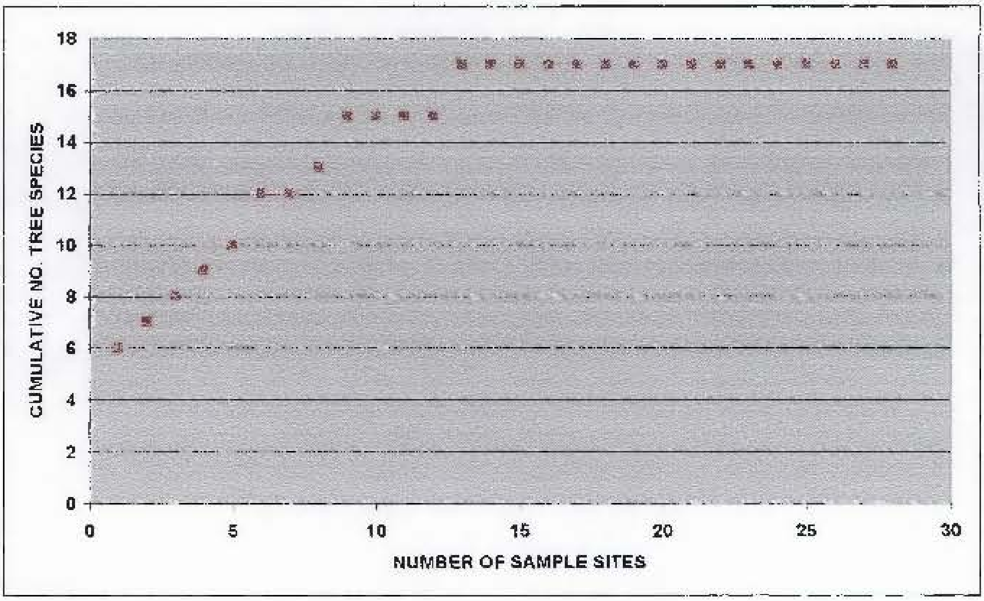
[1]Correlation co-efficient.
[2]Linear regression probability level.

4.1.3 Tree Species:

The study sampled fifteen tree species across all sites, excluding a number of rainforest trees and wattles that were pooled into these two additional groups. The number of tree species (ie species richness) on any site ranged from four to thirteen species, with an average per site of about 7 tree species.

Because of the diversity of tree species over the four forest types, an assessment was made of whether the 28 sites adequately sampled the range of species (Figure 11). Beyond thirteen sites no new tree species were encountered, and so this study more than adequately sampled the variation in tree species (excluding rainforest trees) at Dorrigo.

Figure 11: Relationship between species richness and sampling effort within the Dorrigo study area.



With the two rainforest and wattle groups included, 59% of tree species were classed as koala food tree species. However, 88% of all the trees sampled were koala food trees, with this proportion varying from 24% to 100% across all sites. Forest Oak was the most frequently occurring tree species, with over 800 trees (21% of total trees) >30cm DBHOB recorded on the 28 sites (Appendix 6). Sydney Blue Gum (13%), Blackbutt (12%), Turpentine

(11.5%) and Tallowwood (11%) also had high proportions of trees. The proportion that any one tree species made of total trees on a site ranged up to 75% of trees (for New England Blackbutt), but the average number of trees for each species on sites ranged from 11 to 40 trees.

The association between the number of trees of particular species and tree size classes was significant (χ^2_{48}=607.334, P<0.01). In the 30-60cm DBHOB size class, Forest Oak and rainforest trees were significantly more frequent than expected, while Tallowwood, Brush Box and White Mahogany were less frequent than expected (Table 6).

Table 6: Observed and expected numbers of different tree species in particular tree sizes (cm DBHOB) at Dorrigo.

Species	**30-60cm Obs[1] (Exp[2])**	**60-90cm Obs (Exp)**	**>90cm Obs (Exp)**
Forest Oak	738 (587)	84 (157)	4 (82)
Sydney Blue Gum	328 (374)	87 (100)	111 (52)
Tallowwood	222 (313)	101 (84)	117 (44)
White Mahogany	211 (254)	104 (68)	42 (35)
Turpentine	304 (331)	128 (88)	33 (46)
Brush Box	179 (226)	97 (60)	42 (31)
Blackbutt	366 (351)	99 (94)	29 (49)
Rainforest species	173 (132)	8 (35)	4 (18)
New England Blackbutt	149 (128)	21 (34)	10 (18)
Brush Cypress Pine	56 (43)	5 (12)	0 (6)
Red Mahogany	48 (38)	5 (10)	0 (5)
Diehard Stringybark	39 (30)	3 (8)	0 (4)
Silvertop Stringybark	8 (11)	6 (3)	2 (2)
Grey Gum	18 (28)	18 (5)	4 (4)
Flooded Gum	23 (20)	3 (5)	2 (3)
Other species	14 (10)	0 (3)	0 (1)
Total	2876	769	400

[1]Observed frequencies, [2]Expected frequencies.

In the 60-90cm DBHOB size class, White Mahogany, Turpentine, Brush Box and Grey Gum trees were significantly more frequent than expected, while Forest Oak and rainforest trees were less frequent than expected. In the 90+cm DBHOB size class, Tallowwood and Sydney Blue Gum trees were significantly more frequent than expected, while Forest Oak, Blackbutt, Brush Cypress Pine and rainforest trees were less frequent than expected.

Tallowwood, Sydney Blue Gum and Brush Box make up large proportions of the larger-sized trees (76% of trees >120cm DBHOB). However, only Tallowwood steadily increases the proportion of large trees to total trees as tree size increases.

Highly significant linear associations occurred between tree species and other site characteristics (Table 7).

Table 7: Highly significant correlations and linear associations between tree species and other variables at Dorrigo.

Associated Variables	**Correlation (r^1)**	**P^2**
Tallowwood & Sydney Blue Gum	0.66	0.0001
Turpentine & Altitude	-0.64	0.0002
Brush Cypress Pine & Sydney Blue Gum	0.62	0.0004
Grey Gum & Altitude	-0.55	0.003
White Mahogany & Turpentine	0.51	0.006
White Mahogany & Food Trees	0.50	0.007
Tallowwood & Turpentine	-0.50	0.007
Forest Oak & Rainforest trees	0.49	0.008

[1]Correlation co-efficient.
[2]Linear regression probability level.

Tallowwood and Sydney Blue Gum often occur together in forests at Dorrigo, as indicated by their identification as a separate forest type (Forest Type 47). Turpentine generally tends not to occur in forest types at higher elevations, although a similar relationship with Grey Gum may be due to little or no sampling done in Marengo and northern Chaelundi State Forests.

4.1.4 Effects of Logging:

Most survey sites within the study area at Dorrigo have had more than one logging operation, with the average number of loggings equal to 5 ± 2.8.

A comparison of tree species before and after routine logging is shown in Table 8. A third of the trees (32%) over 30cm DBHOB were harvested from the site. No Forest Oak, Brush Cypress Pine or wattles were harvested. However, half of Brush Box trees (49%), 27% of Sydney Blue Gum and 18% of Tallowwood trees were harvested. Of the trees removed, over 68% were Brush Box. A small percentage of rainforest trees were also removed (14%), but this is likely to be through damage rather than for a marketable product. The association between the number of trees of different species harvested and retained was significant (χ^2_2=16.06, $P<0.01$). Significantly more Brush Box trees were harvested than expected and fewer trees of other species were retained than expected (Table 8).

Table 8: The numbers of different tree species harvested and retained on Control Site 2, Wild Cattle Creek State Forest, Dorrigo.

Species	Retained Obs[1] (Exp[2])	Harvested Obs (Exp)	Total
Brush Box	29 (39)	28 (18)	57
Brush Cypress Pine	1	0	1
Forest Oak	11	0	11
Rainforest species	12	2	14
Sydney Blue Gum	24 (22)	9 (11)	33
Tallowwood	9	2	11
Wattles	1	0	1
Other[3]	34 (26)	4 (12)	
Total	87	41	128

[1]Observed frequencies

[2]Expected frequencies, where contingency table cells were not amalgamated because of cell frequencies below a value of '5'.

[3]All other tree species grouped together, except Brush Box and Sydney Blue Gum, to enable analysis of the contingency table data.

About 64% of trees on the site over 30cm DBHOB were in the small size class (ie 30-60cm), with 26% and 10% of trees in the 60-90cm and 90+cm size classes, respectively (Table 9). Over 90% of the large trees over 90cm DBHOB were retained. Of the trees remaining, 70% were small (30-60cm) and 16% were medium (60-90cm). Of the trees harvested, roughly equal proportions were small (51%) and medium (46%) size trees.

There was a significant association between the number of trees of particular sizes harvested and retained (χ^2_2=14.97, P<0.01). Significantly more medium-sized trees (60-90cm DBHOB) than expected were harvested, and fewer medium-sized trees than expected were retained (Table 9).

Table 9: The numbers of trees in 30cm DBHOB size classes harvested and retained on Control Site 2, Wild Cattle Creek State Forest, Dorrigo.

Size Class (cm)	Retained Obs[1] (Exp[2])	Harvested Obs (Exp)	Total
30-60	61 (56)	21 (26)	82
60-90	14 (22)	19 (11)	33
90-120	5	1	6
120-150	4	0	4
150-180	2	0	2
210+	1	0	1
Total	87	41	128

[1]Observed frequencies
[2]Expected frequencies, where contingency table cells were not amalgamated because of cell frequencies below a value of '5'.

The interaction between species logged or retained in the different size classes reveals that most large trees (69%) were Tallowwood (ie many large Tallowwood trees were retained). Ninety one percent of medium sized trees (60-90cm) were Brush Box, but over 50% of medium sized trees were harvested. It appears that, immediately after logging, all tree species increased in proportional abundance in the stand compared to Brush Box that has declined from 44% to 33% of the stand. Similarly, all size classes increased in proportion compared to the 60-90cm DBHOB class that decreased in abundance from 26% to 16%.

4.1.5 Summary:

The forests of the study area at Dorrigo are quite variable in their floristic and structural composition. The forests:

- Have tree densities that vary from 38 to 151 sph, with an average of 100sph per site,
- Show an association between tree density and tree species,
- Have trees that range in size over 30cm DBHOB to 230cm DBHOB, with an average of 54cm DBHOB per site,
- Have large trees (>90cm DBHOB) that range in density from 0 to 32 trees per hectare per site,
- Have 15 tree species (excluding rainforest trees and wattles), and sites range from 4 to 13 species with an average of 7 species per site,
- Have a high proportion of trees that are classed as koala food trees (ie 88% of all trees sampled),
- Show an association between tree species and tree size,
- Have mostly been logged in some fashion more than once,
- May only slightly change in floristic and structural composition with a selective (thinning) harvesting operation.

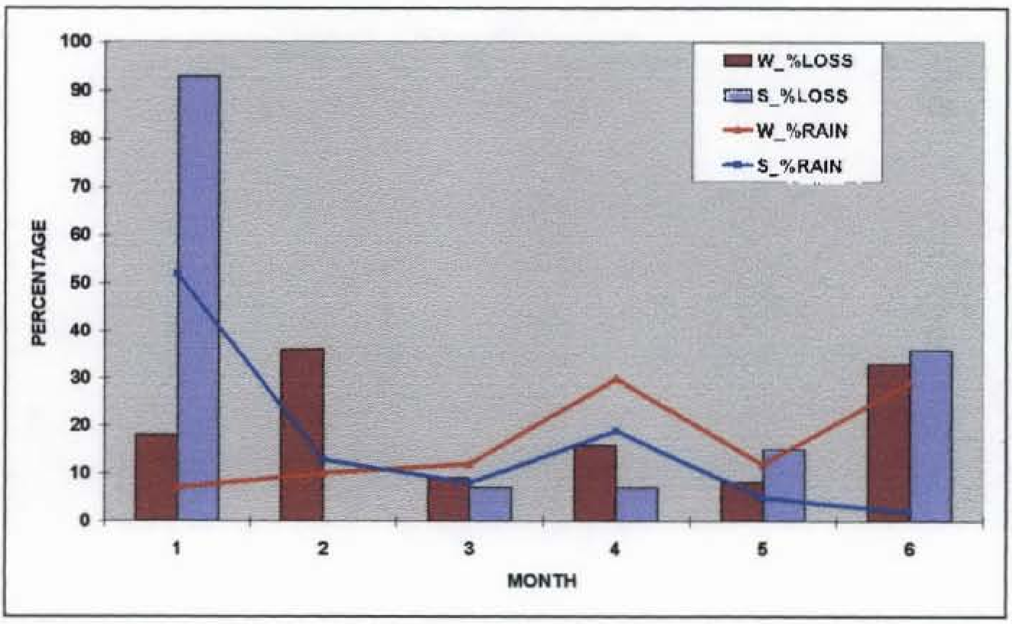
4.2 The Detection of Koala Faecal Pellets in the Forest:

The decomposition of pellets and the search effort may affect the detection of koala faecal pellets in the field. It is relevant to examine how these factors affect detection, because the validity of inferences about preferences of trees discussed later may also be affected.

4.2.1 Rainfall:

To see if rainfall contributed to the decomposition or loss of scats, the rate of loss of scats over winter and summer six monthly periods was compared with rainfall between measurements (Figure 12). During the winter period (red bars), 54% of scats were lost within the first two months. However, during the summer period (blue bars), 93% of scats were lost within the first two months. Only 17% of the 6-monthly rainfall (red line) was received in the first two months of winter compared to 65% of the 6-monthly rainfall (blue line) over this period in summer. Hence, an early and dramatically high rainfall appeared to result in a drastic loss of scats.

Figure 12: The progressive percentage loss from 19 groups of koala faecal pellets at three sites compared with percentage of total rainfall over six successive months in each of summer (S) and winter (W) seasons at Dorrigo.



4.2.2 Invertebrate Activity:

Many pellets found during surveys were substantially disfigured and partially decayed (Plate 12). Many pellets contained one or more larvae that had made caverns within the koala scats and exit holes were seen on several pellets. Even the fresh pellets used for the deterioration trial developed exit holes and caverns within scats and also contained larvae.

Moths pupated from the larvae at State Forests of NSW Research Division in Pennant Hills, Sydney in the third week of April 1998. The moths have been sent to Marianne Horak (CSIRO, Canberra) for identification but, as yet, remain unidentified. The moths are likely to be a species of *Telanepsia*, a koala scat moth within the Oecophorid group of Lepidoptera moths, which was first identified from similar studies of koalas in southeastern NSW (Common and Horak, 1994). Hence, this larval activity is likely to play some role in the breakdown and decay of koala scats.

Plate 12: Koala faecal pellets in various states of decay (bottom) collected at Dorrigo. Note the larvae tunnels in scat numbers 4 and 5 from the bottom left.

4.2.3 Vertebrate Activity:

In many instances, sites were identified as having scratchings on the ground with significant surface disturbance. Of the total number of scat groups inspected (19 groups x 13 visits), 8% showed signs of physical ground disturbance (Table 10).

Table 10: Numbers of koala faecal pellet groups surveyed and disturbed at Dorrigo.

Visit Number	Number of Scat Groups	Number Of Sites Disturbed	Disturbances Resulting in No Scats	Sum of 1+ Disturb. Events[1]	Sum of 2+ Disturb. Events[2]
1	19	0	0	0	0
2	19	1	0	1	0
3	19	2	0	3	0
4	19	0	0	3	0
5	19	0	0	3	0
6	19	3	2	4	2
7	19	3	3	5	3
8	19	1	0	5	4
9	19	0	0	5	4
10	19	2	1	7	4
11	19	1	1	7	5
12	19	1	1	8	5
13	19	5	4	10	7
Total	247	19[3]	12[4]	10[5]	7[6]

[1]Cumulative number of pellet groups disturbed at least once out of thirteen visits.
[2]Cumulative number of pellet groups disturbed at least twice out of thirteen visits.
[3]Represents 8% of all 247 pellet group samples.
[4]Represents 63% of all 19 pellet groups disturbed.
[5]Represents 53% of all 19 pellet groups disturbed.
[6]Represents 37% of all 19 pellet groups disturbed.

Of these disturbance occurrences, 53% of pellet groups were disturbed at least once out of the thirteen visits, 37% were disturbed two or three times, and 63% resulted in no further scats being recorded from these sites (Table 10). Hence, physical ground disturbance was not an uncommon occurrence on the forest floor, but where it occurred further detection of koala faecal pellets was significantly affected.

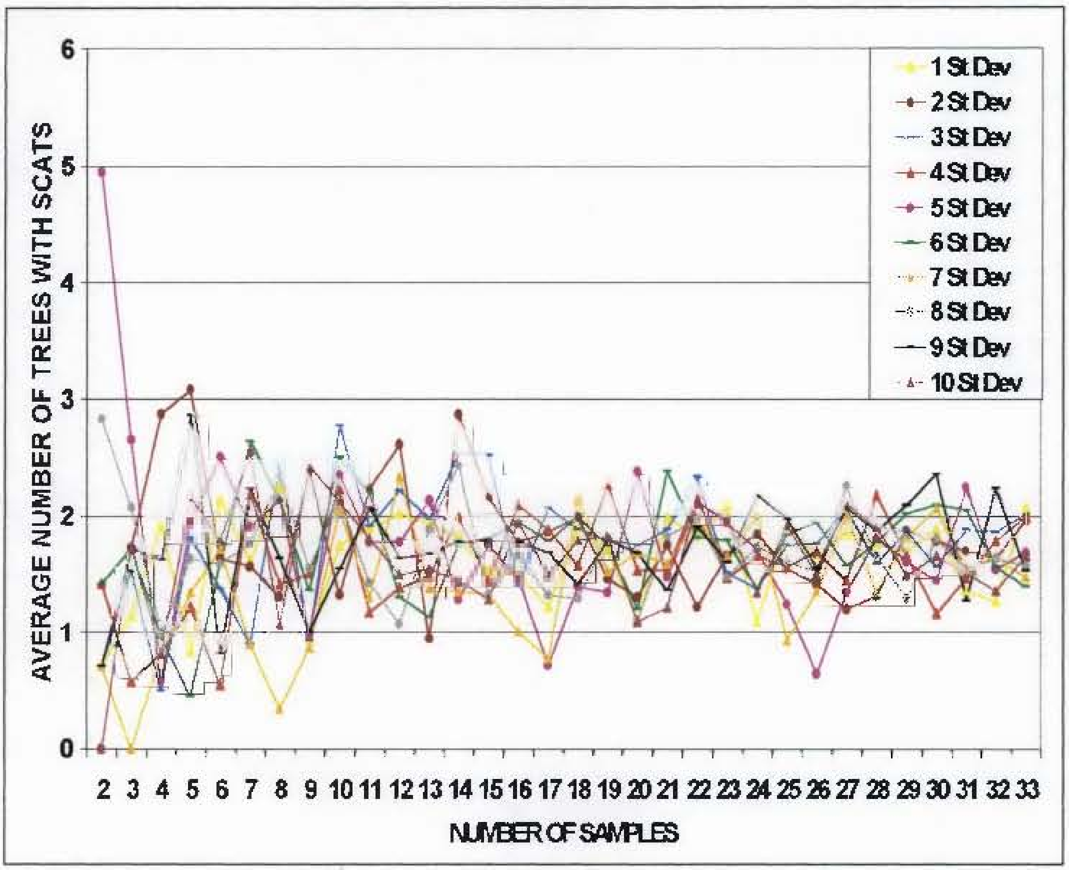
A Superb Lyrebird was observed foraging on the ground close to one of the sites during one inspection. This animal and several others, such as the echidna (*Tachyglossus aculeatus*) and the Brush Turkey (*Alectura lathami*), may significantly affect the detection of koala faecal pellets at sites where they forage.

4.2.4 The Number of Transects:

The average number of trees with koala faecal pellets on any 100 metre (40m wide) length of transect is variable, and may vary from 0 to 4 trees with scats. An increase in the minimum number of 100 metre transects searched may reduce the variability in finding trees with scats to within 20% of the average.

The running mean number of trees with scats from an increasing number of randomly selected 100 metre transects (up to 33 transects) was calculated on ten independent occasions (Figure 13). A comparison of the standard deviations for the ten events shows that seven 100 metre transects are required to adequately detect a number of trees with scats that does not vary by more than about 20% from the average.

Figure 13: Running standard deviation of the mean number of scats from an increasing number of randomly selected 100 metre transects for all study sites at Dorrigo.



Seven 100m transects equates to an area search of about 2.8 hectares for each site (ie 700m x 40m). This equates to a search that is double the area of plots surveyed in this study.

4.2.5 Summary:

The decomposition of pellets does affect the detection of koala faecal pellets in the field. However, the significance of these effects is not completely known, but is probably not overwhelming. Early and high rainfall may result in a drastic loss of scats, and invertebrate and vertebrate activity has some effect on koala faecal pellets.

The search effort does affect the detection of koala faecal pellets in the field, where seven 100m x 40m transects will reduce the variability in finding trees with scats to within 20% of the average.

4.3 What are the Forests used by Koalas like?

4.3.1 Detection of Koalas within Forests:

Koalas had previously been recorded over 128 times from State forests in the Dorrigo District (Figure 14) and it was evident that koala occurrence was relatively widespread across the district. Fifty percent of koala sightings were recorded from forest types sampled in this study.

A visual comparison between Figures 14 and 5 suggests that there is some association between koala sightings and the distribution of Forest Type 47 (Tallowwood/Sydney Blue Gum). This is supported by comparisons of locations of koala sightings with mapped forest types (Figure 15, Appendix 7). About 29% of koala sightings were recorded from Forest Type 47 (Tallowwood/Sydney Blue Gum), even though this type only comprised about 10% of the total area of all forest types on State Forest at Dorrigo. Proportional sightings of koalas within a forest type were also greater than the corresponding proportional area of the forest type for plantations and Forest Type 37 (Dry Blackbutt).

Figure 14

Distribution of Koala Sightings in Dorrigo District.

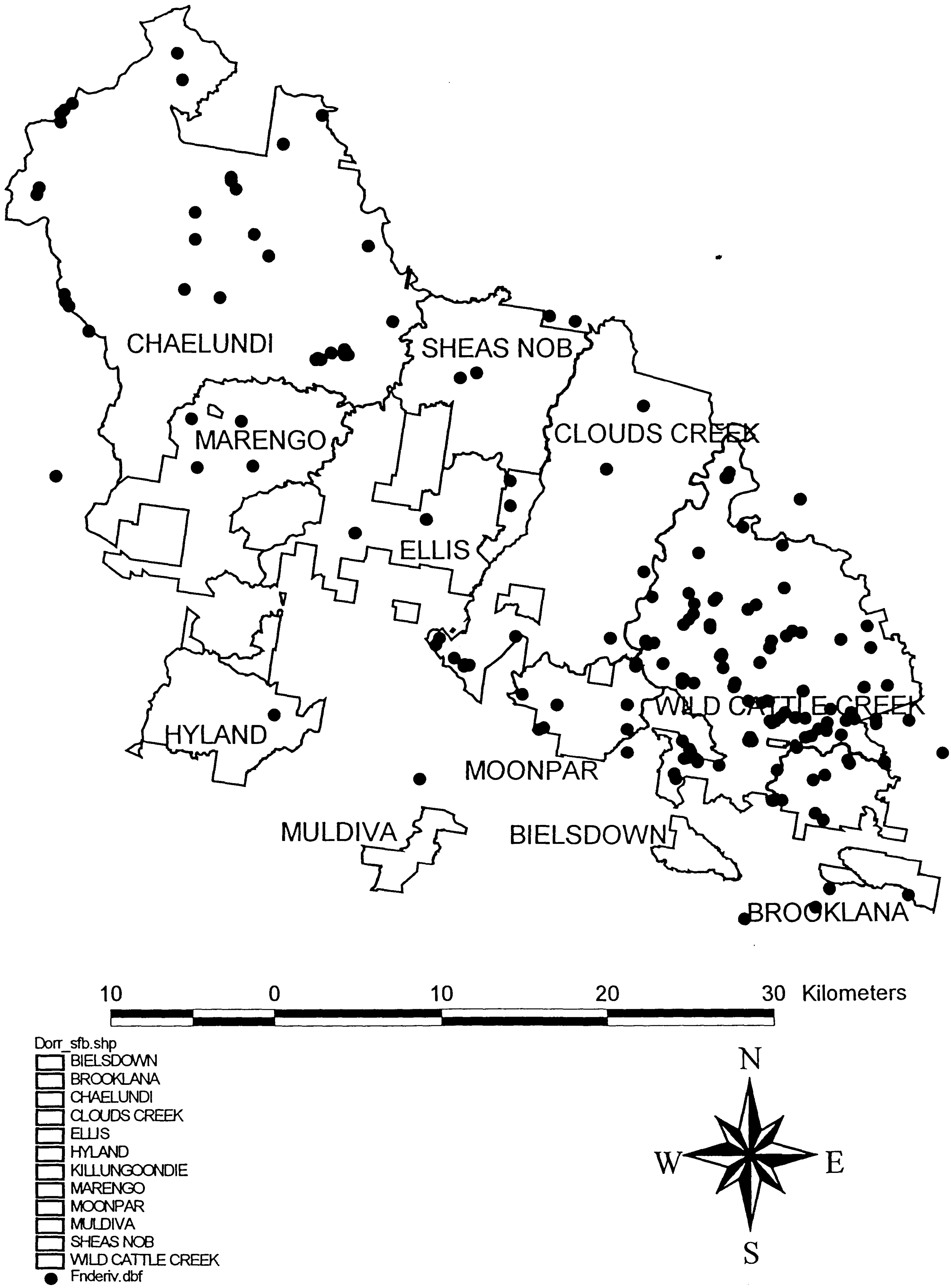
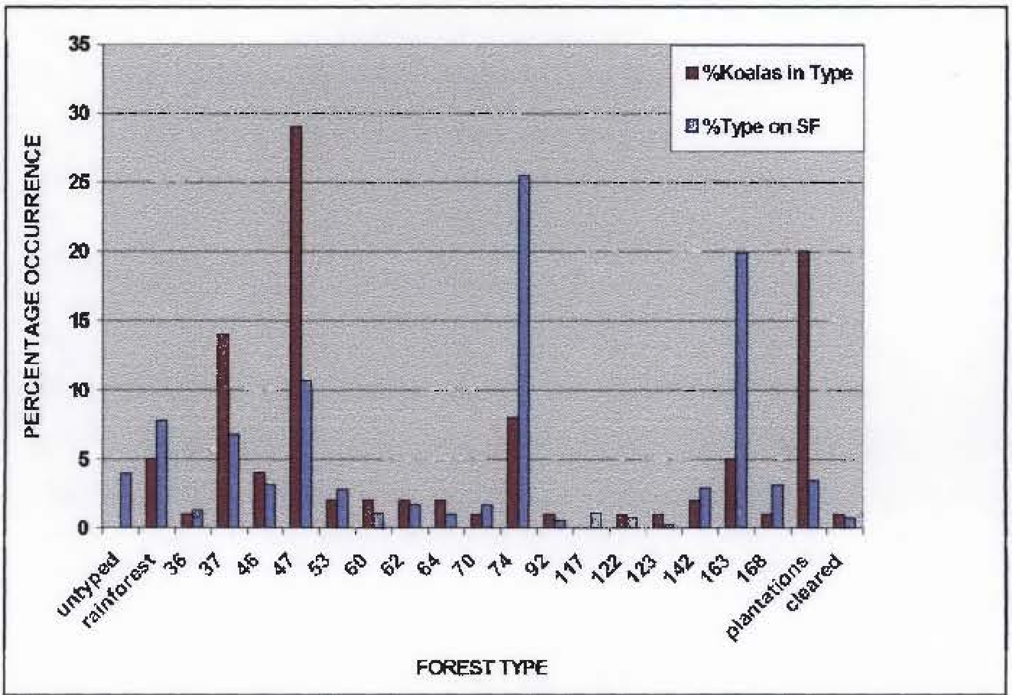


Figure 15: Percentage occurrence[1] of koala sightings within forest types[2] compared with percentage occurrence[1] of forest types[3] in Dorrigo District (data courtesy of State Forests of NSW).



[1]Percentage occurrences have been rounded to the nearest whole number.
[2]'36'=Moist Blackbutt, '37'=Dry Blackbutt, '46'=Sydney Blue Gum, '47'=Tallowwood-Sydney Blue Gum, '53'=Brush Box, '60'=Narrowleaved White Mahogany-Red Mahogany-Grey Ironbark-Grey Gum, '62'=Grey Gum-Grey Ironbark-White Mahogany, '64'=Grey Gum-Stringybark, '70'=Spotted Gum, '74'=Spotted Gum-Ironbark/Grey Gum, '92'=Forest Red Gum, '117'=Scribbly Gum, '122'=New England Stringybark, '123'=Coastal Stringybark, '142'=New England Peppermint, '163'=New England Blackbutt, '168'=Silvertop Stringybark-Gum.
[3]Forest types with percentage occurrences (of koalas and of the total area of types) of '0' were omitted from the figure.

Supplemental spotlighting data during spring 1997 (Appendix 8) show that koalas (n = 5) were found predominantly in Tallowwood trees within Forest

Types 47 (Tallowwood/Sydney Blue Gum) and 60 (Narrowleaved White Mahogany-Red Mahogany-Grey Ironbark-Grey Gum).

Most study sites (64%) were located in Forest Type 47, having been selected on the basis of substantial use by koalas. The average percentage tree use by koalas in Forest Type 47 across all sites was higher (8.1 %, n=18) than for other forest types (FT37=5.4%, n=6; FT60=6%, n=2; FT163=1%, n=2).

These results suggest that koalas are associated with Forest Type 47, more so than other forest types. However, study sites were also located within other forest types (Forest Types 37, 163 and 60), and Tallowwood, Sydney Blue Gum, White Mahogany and Blackbutt all occur as associate species in all of these forest types. Perhaps one or more of these or other tree species are favoured in some manner by koalas. Therefore, forest types and species will be examined further in the following sections.

4.3.2 Detection of Koala Pellets within Forests:

Koala pellets were found on about 89% of all study sites. Because half of the sites were chosen on the basis of finding evidence of koalas, this figure may be misleading. However, koala pellets were also found on 79% of randomly chosen study sites, which indicates that koalas are common in this study area.

The average number of trees with scats was about 5.6% of the total number of trees on all sites, and ranged between 0 and 20% of trees >30cm DBHOB (Appendix 5). As half of the sites were randomly chosen and half were chosen on the basis of substantial koala use, these two types of sites were compared to see if more usage is detected on sites where koalas are known to be present. There were more trees >30cm DBHOB with scats than expected on koala sites and fewer trees >30cm DBHOB with scats than expected on randomly chosen sites (χ^2_1=40.73, P<0.01).

Similarly, more scats than expected were found on koala sites and fewer scats than expected were found on randomly chosen sites (χ^2_1=1267.89, P<0.01). These results suggest that forest managers can be reasonably confident that field observers are adequately sampling forest where there is a higher likelihood of finding evidence of koalas.

4.3.3 Koala Associations with Topography:

4.3.3.1 Altitude:

There were no significant linear or other associations (Table 11) between the number of trees with scats and altitude ($F_{1,26}$=2.47, P=0.128; χ^2_1=0.47, P>0.05).

Table 11: Observed and expected number of trees with and without scats in two elevation classes at Dorrigo.

Number of Trees	440-649 metres asl[1] Obs[2] (Exp[3])	650-860 metres asl[1] Obs (Exp)	Total
With Scats	113 (107)	114 (120)	227
With No Scats	1802 (1808)	2016 (2010)	3818
Total	1915	2130	4045

[1]Above Sea Level.
[2]Observed frequencies.
[3]Expected frequencies.

4.3.3.2 Slope:

There is a significant association (χ^2_2=38.36, P<0.01) between the number of trees with scats and slope class (Table 12). There were more trees with scats than expected on sites with a slope of 10 degrees or higher, and fewer trees with scats than expected on sites with a slope of less than 10 degrees.

Table 12: Observed and expected number of trees with and without scats in three slope (degrees) classes at Dorrigo.

Number of Trees	5-9° slope Obs[1] (Exp[2])	10-14° slope Obs (Exp)	15-20° slope Obs (Exp)	Total
With Scats	66 (111)	94 (69)	67 (47)	227
With No Scats	1917 (1872)	1128 (1153)	773 (793)	3818
Total	1983	1222	840	4045

[1]Observed frequencies.
[2]Expected frequencies.

This result should be treated with caution, as 'slope' was assessed as being the maximum slope over the whole of each 1.44ha site determined from topographic maps. It is feasible that some areas within sites could have a lower average slope which may correspond with the occurrence or otherwise of trees with scats.

4.3.3.3 Aspect:

No significant linear associations were found in comparisons between the number of trees with scats and (i) the aspect of each transect (north, south, east and west), and (ii) the number of main aspects on each site.

4.3.4 Koala Associations with Forest Use:

4.3.4.1 Last Logging Event:

The time (years) since the last logging event for each site was grouped into one of four logging history classes (Table 13). There was a significant association between the number of trees with scats and the four classes (χ^2_3=39.50, P<0.01), with more trees with scats than expected occurring on sites where the last logging event was greater than 30 years ago. This suggests that disturbance frequency may have an effect upon koalas, and that a longer period between logging events may be beneficial to koalas.

Table 13: Observed and expected number of trees with and without scats in four logging interval classes at Dorrigo.

Number of Trees	Last Log[1] <10yrs Obs[2] (Exp[3])	Last Log 11-20yrs Obs (Exp)	Last Log 21-30yrs Obs (Exp)	Last Log 31+yrs Obs (Exp)
With Scats	28 (40)	68 (81)	74 (79)	57 (27)
With No Scats	678 (666)	1377 (1364)	1329 (1324)	434 (463)
Total	706	1445	1403	491

[1]Last Log is the number of years since the last logging event.
[2]Observed frequencies.
[3]Expected frequencies.

This result should be interpreted with some caution because the classification of 'last logging event' applied to any class of logging, from low intensity pole harvesting to high intensity sawlog harvesting. With sites that fit into the '<11 years' class for example, the most significant disturbance event may have been older, and it is likely that this comparison was an under-estimate of the time since last logging event.

4.3.4.2 Number of Logging Events:

There is a significant association between the number of trees with scats and the number of logging events (χ^2_2=63.49, P<0.01). Sites with 3 or more logging events have significantly more trees with scats than expected, and sites with less than 3 logging events have significantly fewer trees with scats than expected (Table 14). This suggests that there may be some characteristic/s of sites with many logging events that koalas are interested in.

Table 14: Observed and expected number of trees with and without scats in three logging frequency classes at Dorrigo.

Number of Trees	**1-2 Loggings Obs[1] (Exp[2])**	**3-6 Loggings Obs (Exp)**	**>6 Loggings Obs (Exp)**
With Scats	9 (59)	136 (113)	82 (55)
With No Scats	1036 (986)	1887 (1909)	895 (922)
Total	1045	2023	977

[1]Observed frequencies.
[2]Expected frequencies.

4.3.5 Koala Associations with Forest Type:

Survey sites were classified into four floristically distinct groups (Tallowwood/Sydney Blue Gum forest, moist White Mahogany/Blackbutt forest, moist forest, and drier Blackbutt/mixed hardwood forest) by hand ranking in decreasing order of the relative abundance of Tallowwood trees >30cm DBHOB (Table 15).

Table 15: Classification of sites into four floristic groups[1] according to the mean number of stems (>30cm DBHOB) of each species on sites at Dorrigo.

Species	TWD-SBG	WMY-BBT	Moist Forest	BBT-Mixed Hwd
Tallowwood	34.6	16	8.7	4.2
Forest Oak	23.6	31.6	33.7	29.8
Sydney Blue Gum	41.4	12	17.7	5.8
Blackbutt	21.7	19.3	5.5	21.8
White Mahogany	0.4	21.9	7.7	19.4
Turpentine	3.0	15.3	21.5	26.0
Brush Box	12.0	9.4	15.2	9.6
Rainforest trees	4.1	11.1	11.3	1.2
Brush Cypress Pine	6.9	0	0.5	1.2
Grey Gum	0	0	0.8	4.4
Red Mahogany	2.0	0.1	0.5	4.4
Red Bloodwood	0	0	0	0.4
Flooded Gum	0	0	4.5	0.1
No. Sites in Group	7	7	6	8
Mean No. Trees with Scats	12.7	2.7	9.8	7.5

[1]'TWD-SBG'=Tallowwood-Sydney Blue Gum forest, 'WMY-BBT'=moist White Mahogany and Blackbutt forest, 'Moist Forest'=moist forest dominated by Sydney Blue Gum, Brush Box, Turpentine and rainforest trees, 'BBT-Mixed Hwd'=drier forest with Blackbutt, White Mahogany and lower proportions of a wide range of species.

Tallowwood was the only discriminating factor used because of the perceived importance of this species to koalas compared with other species in the local area, and the relative abundance and distribution across forest types. The forest type with the second highest density of Tallowwood (ie moist White Mahogany/Blackbutt forest) had the lowest mean number of trees with scats (ie was the least preferred) (Table 15). The site with the second highest mean number of trees with scats (ie moist forest) had a lower density of Tallowwood. Densities of Forest Oak were similarly high across all floristic groups.

The mean abundance of trees with scats differed significantly across floristic groups (Table 16), decreasing correspondingly from Tallowwood/Sydney Blue Gum forest type, moist forest, BBT-mixed hardwood to moist White Mahogany/Blackbutt forest type with the lowest mean number of trees with scats.

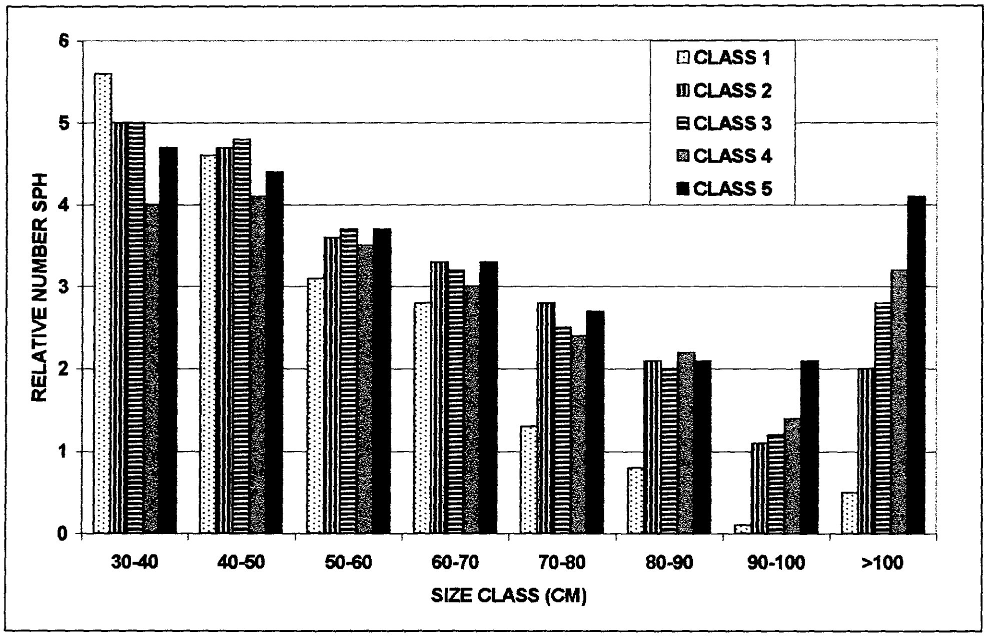
Table 16: One-way ANOVA for the significant association of (log transformed) trees with scats and floristic groups at Dorrigo.

Source of Variation	SS	df	MS	F	P-value
Between Floristic Groups	1.133353	3	0.377784	3.30	0.038
Within Floristic Groups	2.747825	24	0.114493		
Total	3.881178	27			

4.3.6 Koala Associations with Forest Structure:

Survey sites were classified into five structurally distinct groups, similarly to the method of Smith and Andrews (unpublished). This was done by transforming (log2) the number of stems per hectare in eight diameter classes and then hand ranking in increasing order of the predominance of stems in larger size classes (>80cm DBHOB). This reflects a gradient from younger forests with some older elements to older forests with a relative abundance of old trees (Figure 16).

Figure 16: Forest structure of survey sites at Dorrigo, showing the relative number of stems per hectare[1] (SPH) in increasing size classes in each of 5 structural groups.



[1] after log2 transformation of data to prevent over-weighting of the number of stems in smaller diameter classes.

There was no significant difference between the groups in the mean number of trees with scats ($F_{4,23}$=1.44, P=0.254). All groups had some trees in every size class. Because the grouping was done manually, this exercise was repeated splitting up sites into 2, 3, 6 and 7 groups, but no significant result was obtained.

4.3.7 Summary:

Koalas are reasonably common in the forests of the study area, and the following characteristics outline what the forests used by koalas in this study are like.

- Trees with koala faecal pellets are associated with slope (ie slopes of 10 degrees or more), but not altitude or aspect,
- Trees with scats are associated with logging history (ie sites with three or more logging events, but sites that have not been logged for more than 30 years),
- Trees with scats are associated with forest type (ie forests in which Tallowwood, Sydney Blue Gum and Forest Oak are dominant), and
- Trees with scats are not associated with forest structure.

4.4 What are the Trees used by Koalas like?

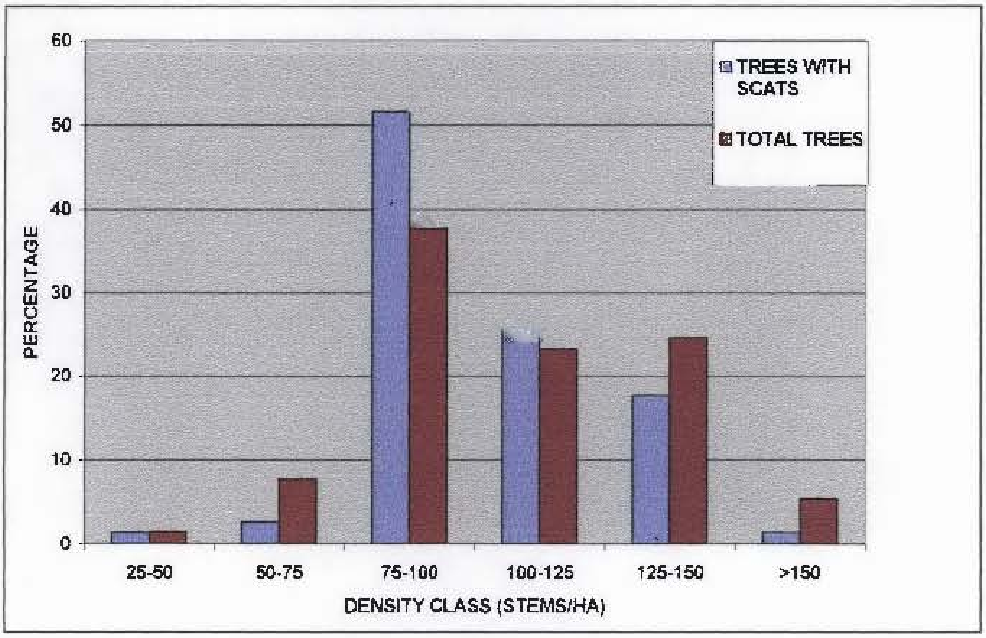
4.4.1 Density of Trees:

4.4.1.1 The Number of Trees with Scats:

Koala faecal pellets occurred under about 6% (ie 227 trees) of the 4045 trees 30cm DBHOB and over that were sampled. The number of trees with scats beneath them ranged from 0 to 27 trees per site, with an average of about 8 trees with scats on a site.

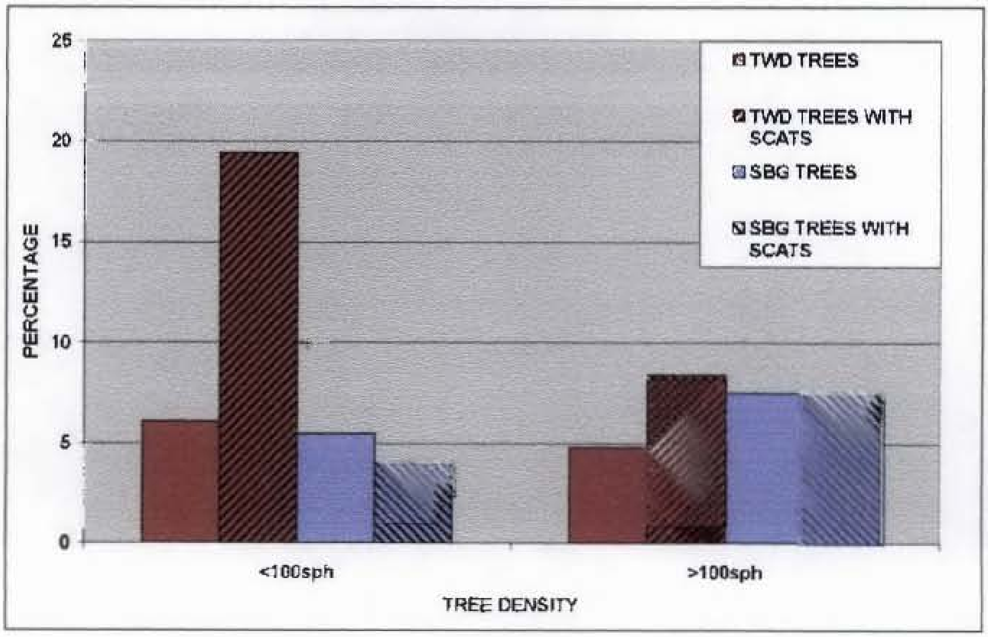
There was a significant association between the number of trees with scats and tree density classes (χ^2_5=32.888, P<0.01). More trees with scats than expected occurred on sites with 75-100sph and fewer trees with scats than expected occurred on sites with 50-75, 125-150 and >150sph (Figure 17).

Figure 17: Percentage of trees with scats compared with percentage of total numbers of trees in each of six tree density classes at Dorrigo.



An association between density and tree size might be expected, as dense sites would have many more smaller trees and fewer large trees that koalas could select from. However, there was a significant association between the number of trees with scats of particular tree species and tree density (χ^2_5=14.00, P<0.05). Significantly more Tallowwood trees with scats than expected occurred on open sites and significantly fewer Tallowwood trees with scats than expected occurred on dense sites (Figure 18).

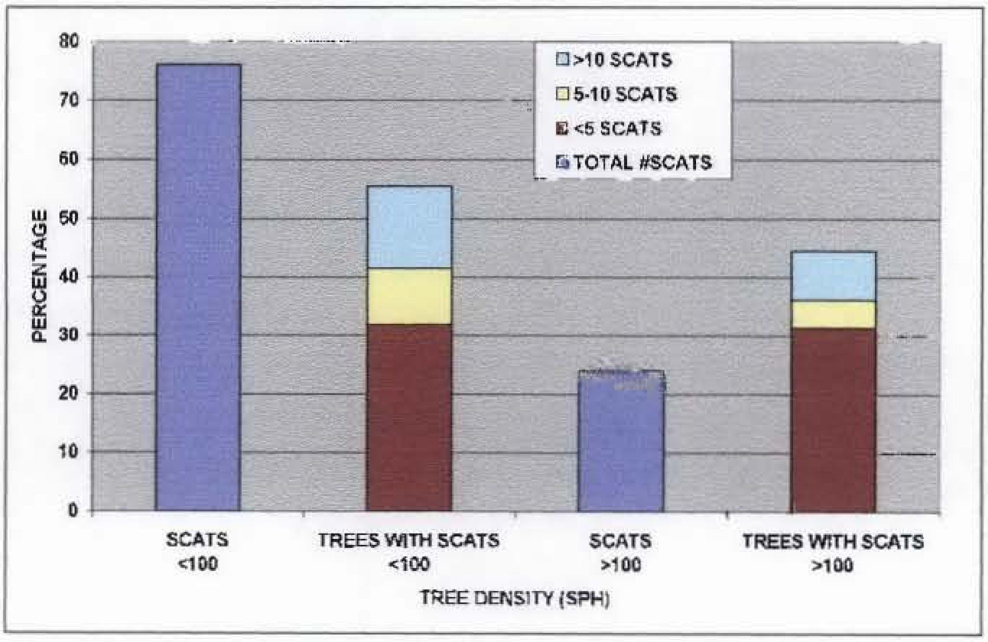
Figure 18: Tallowwood (TWD) and Sydney Blue Gum (SBG) trees with scats as percentages of total trees with scats, compared with numbers of Tallowwood and Sydney Blue Gum trees as percentages of the total number of trees, on open (<100sph) and dense (>100sph) sites at Dorrigo.



4.4.1.2 The Number of Scats:

Significantly more scats were found on open sites (ie <100sph) than dense sites (χ^2_1=596.74, P<0.01) (Figure 19). However, there was no association between tree density and trees with different numbers of scats (χ^2_8=13.95, P>0.05). It appears from these results that more trees on open sites had high numbers of scats.

Figure 19: Percentages of total scats and trees with particular numbers of scats on open (<100sph) and dense (>100sph) sites at Dorrigo.

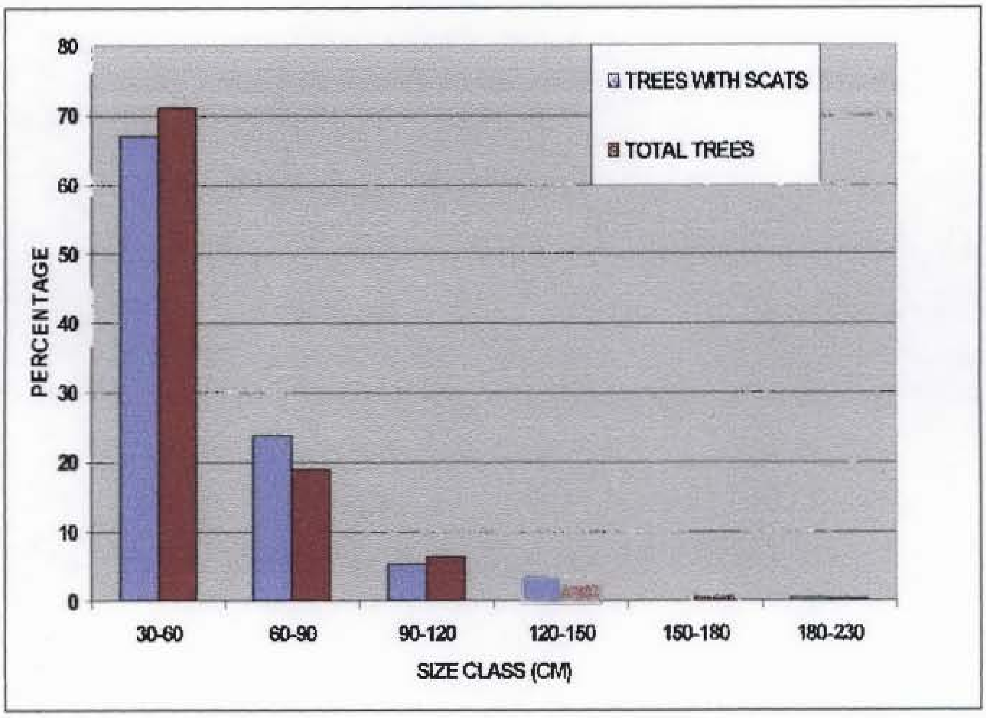


4.4.2 Tree Size:

4.4.2.1 The Number of Trees with Scats:

In this study, trees with scats ranged in size from 30cm DBHOB to 1.92m DBHOB (Figure 20). The numbers of trees with and without scats were compared between 30cm size classes >30cm DBHOB for all sites. There were no significant differences between observed and expected numbers of trees with scats (χ^2_3=4.13, P>0.05) (Figure 20). Furthermore, no significant associations were found between trees with scats and other size classes such as 10cm (χ^2_{10}=4.94, P>0.05), 20cm (χ^2_6=5.99, P>0.05) and 40cm (χ^2_2=0.55, P>0.05) tree size classes.

Figure 20: Percentage of total numbers of trees compared with percentage of trees with scats within size groups >30cm DBHOB for all study sites at Dorrigo.

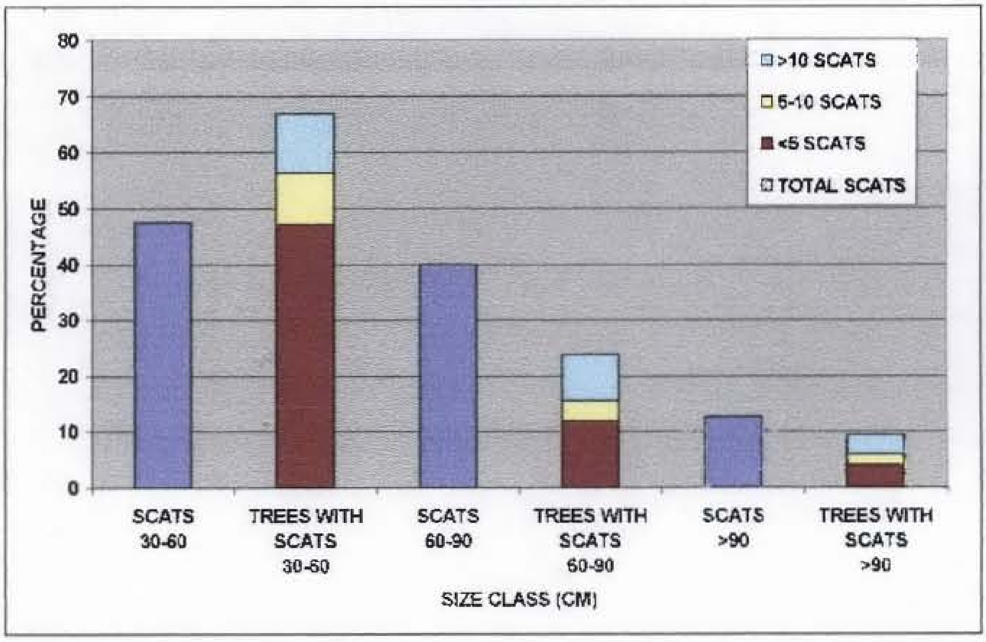


4.4.2.2 The Number of Scats:

It is apparent from Figure 21 that most trees >30cm DBHOB with scats (63%) have fewer than 5 scats beneath them. Also, there is a significant association between the number of trees with various numbers of scats and tree size (χ^2_6=13.78, P<0.05). Significantly more medium (60-90cm) to large

(>90cm) trees than expected have 10 or more scats beneath them, but fewer small (30-60cm) trees than expected have 10 or more scats beneath (Figure 21).

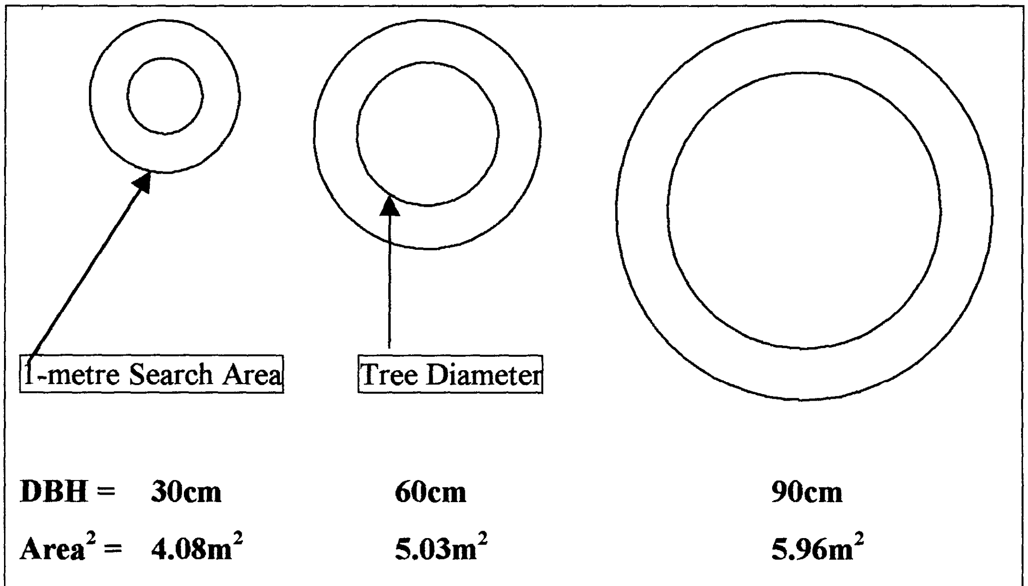
Figure 21: Percentages of scats and trees with scats within size groups for all study sites in Dorrigo District.



One would expect that there would be more larger trees with more scats because of the increase in search area for bigger trees (Figure 22). If an increase in search area is affecting the likelihood of finding trees with 10 or more scats, then the proportional increase in trees with 10 or more scats should match or be greater than the proportional increase in search area. However in this case, proportional increases in occurrence of trees with 10 or more scats (19.4% and 2.9%) are less than the proportional increases (23.3% and 18.5%) in search area between 30 to 60cm DBHOB and 60 to 90cm

DBHOB sized trees. Therefore, koalas may be located in larger trees more frequently or for longer periods than smaller trees, thereby contributing to larger numbers of scats found beneath these trees.

Figure 22: Increase in the 1-metre radius search area around trees with increasing tree size (diameter) at Dorrigo[1].



[1]Diagram not to scale.
[2]Search area in square metres.

Five koalas were found during spotlighting in trees that ranged in size between 27.8cm and 79.7cm DBHOB (Appendix 8). However, the limited data collected may also be misleading in that (i) more smaller trees increases the chance of finding koalas in these tree sizes, and (ii) logging may have an impact on the range of tree sizes close to roads where most spotlighting is confined to.

4.4.3 Tree Species:

4.4.3.1 Trees with Scats:

About 87% of the tree species sampled in this study had scats recorded beneath them, excluding the pooled "unidentifiable" rainforest and wattle groups. The number of tree species with scats on each site ranged from 0 to 7 species, with an average of 3 tree species with scats per site.

There was a significant association between the number of trees with scats and koala food trees (χ^2_1=12.92, P<0.01). Fewer trees with scats than expected were found under non-food tree species. This suggests that the assumed range of koala food tree species describes the actual range of food trees well (assuming scats beneath a tree are indicative of that tree being used for food).

Forest Oak and Tallowwood trees had the highest proportions of all trees that had scats beneath them, as well as high proportions of total numbers of trees with scats of each species (Figure 23, Table 17).

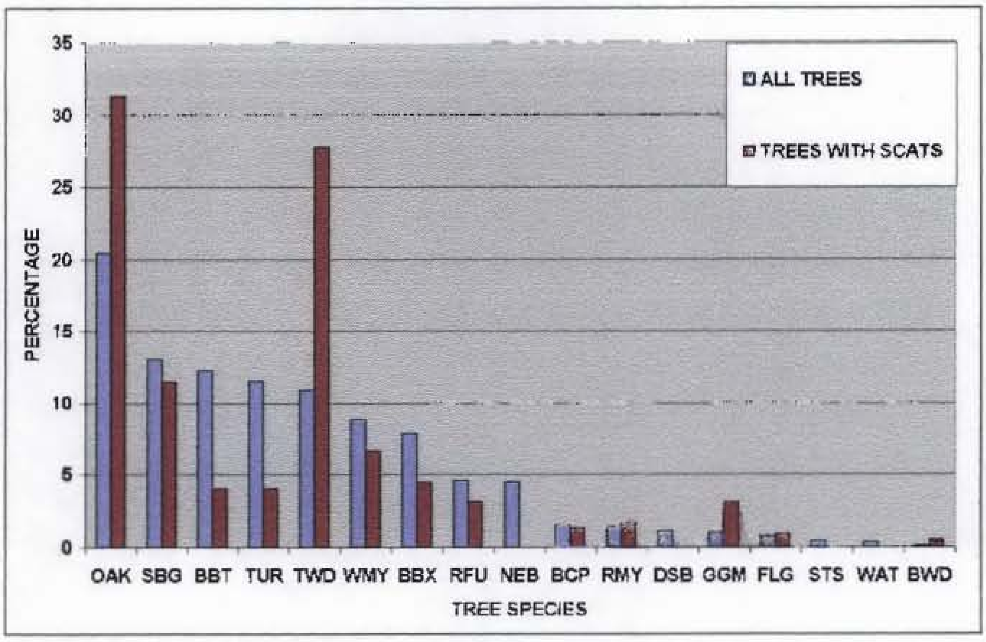
The remaining tree species had quite low proportions of trees with scats; with four species (New England Blackbutt, Diehard Stringybark, Silvertop Stringybark and wattles) having no evidence of scats. These figures indicate utilisation of tree species, rather than a preference or choice.

Table 17: Trees with scats as a percentage of the total number of trees in each species[1]/size class (cm DBHOB) at Dorrigo.

Species	30 - 60	60 - 90	90 - 120	120 - 150	150 - 180	180 - 230	Total[2]	Total[3]
OAK	7.6	17.8	0	0	0	0	8.6	31
TWD	12.6	19.8	12.3	17.6	0	16.7	14.3	28
SBG	5.5	4.6	3.8	4.2	0	0	4.9	11
WMY	6.2	1.9	0	0	0	0	4.2	7
BBX	3.4	2.1	5.3	5.9	0	0	3.1	4
BBT	2.2	1.0	0	0	0	0	1.8	4
TUR	2.3	1.6	0	0	0	0	1.9	4
RFU	4.0	0	0	0	0	0	3.8	3
GGM	5.6	33.3	0	0	0	0	17.5	3
RMY	6.2	20.0	0	0	0	0	7.5	2
BCP	5.4	0	0	0	0	0	4.9	1
FLG	4.3	33.3	0	0	0	0	7.1	1
BWD	33.3	0	0	0	0	0	33.3	1
NEB	0	0	0	0	0	0	0	0
DSB	0	0	0	0	0	0	0	0
STS	0	0	0	0	0	0	0	0
WAT	0	0	0	0	0	0	0	0
Total	5.3	7.0	4.6	7.8	0	7.7	5.6	100

[1] 'OAK'=Forest Oak, 'TWD'=Tallowwood, 'SBG'=Sydney Blue Gum, 'WMY'=White Mahogany, 'BBX'=Brush Box, 'BBT'=Blackbutt, 'TUR'=Turpentine, 'RFU'=rainforest species (unidentified), 'GGM'=Grey Gum, 'RMY'=Red Mahogany, 'BCP'=Brush Cypress Pine, 'FLG'=Flooded Gum, 'BWD'=Bloodwood, 'NEB'=New England Blackbutt, 'DSB'=Diehard Stringybark, 'STS'=Silvertop Stringybark, 'WAT'=wattle species.
[2]Indicates trees with scats as a % of total number of trees in the species.
[3]Indicates trees with scats as a % of total number of trees.

Figure 23: Percentage of trees with scats compared with percentage of total numbers of trees for all tree species[1] at Dorrigo.



[1]Refer to species abbreviations in Table 17.

There was a significant association between the number of trees with scats and tree species (χ^2_{13}=135.22, P<0.01). Red Bloodwood, Grey Gum, Tallowwood, Forest Oak, Red Mahogany and Flooded Gum trees with scats occurred more frequently than expected, while Blackbutt and Turpentine trees with scats occurred less frequently than expected.

There was a significant association between the number of trees with scats of particular species and tree size (χ^2_6=34.469, P<0.01). Significantly fewer Forest Oak trees with scats than expected occurred in the >90cm size class, significantly more large (>90cm DBHOB) Tallowwood trees with scats occurred than expected, and significantly fewer small (30-60cm DBHOB) Tallowwood trees with scats occurred than expected (Table 18).

Table 18: Observed and expected numbers of trees of particular species with scats in particular tree sizes at Dorrigo.

Species	30-60cm Obs[1] (Exp[2])	60-90cm Obs (Exp)	>90cm Obs (Exp)
Forest Oak	56 (48)	15 (17)	0 (7)
Tallowwood	28 (42)	20 (15)	15 (6)
Sydney Blue Gum	18 (17)	4 (6)	4 (2)
Other Tree Species	50 (45)	15 (16)	2 (6)

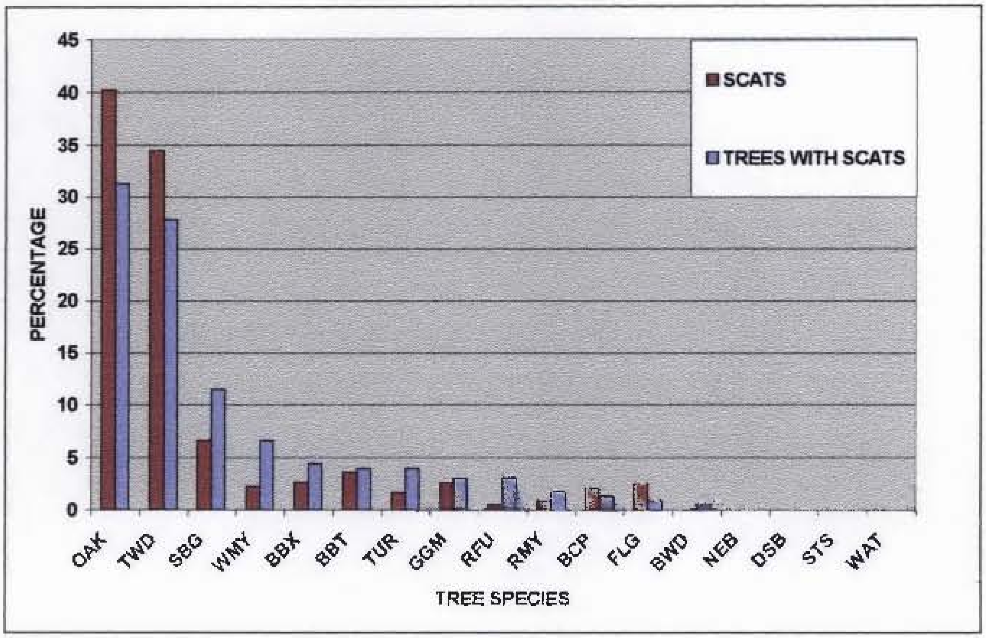
[1] Observed frequencies,
[2] Expected frequencies.

4.4.3.2 Number of Scats:

Forest Oak (40%) and Tallowwood (34%) trees had the highest proportions of all scats, in comparison to other tree species (Figure 24, Appendix 9). Again, these figures indicate utilisation of tree species, rather than a preference or choice.

Although two Tallowwood and Forest Oak trees had over 200 scats each, there was no significant association between the number of trees with various numbers of scats and tree species (χ^2_8=8.56, P>0.05) (Table 19).

Figure 24: Percentage of total numbers of scats compared with percentage of total numbers of trees with scats of each tree species[1] at Dorrigo.



[1]Refer to species abbreviations in Table 17.

There were also significant linear associations between the number of koala food trees and the number of trees with less than 5 scats ($F_{1, 26} = 15.62$, $P = 0.0005$, $r = 0.613$), and the total quantities of scats with the density of Tallowwood trees ($F_{1, 26} = 5.48$, $P = 0.027$, $r = 0.417$).

Table 19: Observed and expected numbers of trees of particular species with various numbers of scats at Dorrigo.

Species[1]	<5 Scats Obs[2] (Exp[3])	5-9 Scats Obs (Exp)	>9 Scats Obs (Exp)	Total
OAK	39 (44)	12 (10)	20 (16)	71
TWD	39 (39)	9 (9)	15 (14)	63
SBG	15 (16)	6 (4)	5 (6)	26
WMY	13 (9)	0 (2)	2 (3)	15
Others[4]	36 (32)	6 (8)	10 (12)	52
Total	142	33	52	227

[1]Refer to species abbreviations in Table 17.
[2]Observed frequencies.
[3]Expected frequencies.
[4]'Others'=summed results for Brush Box, Turpentine, Blackbutt, Brush Cypress Pine, rainforest species, Red Mahogany, Bloodwood, Grey Gum and Flooded Gum.

There was a significant association between the number of scats under particular tree species and tree size (χ^2_{30}=902.138, P<0.01). Tallowwood and Sydney Blue Gum trees had significantly fewer scats than expected under medium-sized trees, and more scats than expected under large trees (Table 20). Forest Oak, Grey Gum and Flooded Gum trees had more scats than expected under medium-sized trees, and only Forest Oak had fewer scats than expected under large trees. Blackbutt and Brush Cypress Pine also had more scats than expected under small trees, but Blackbutt had fewer scats than expected under medium-sized trees.

The spotlighting results, although limited (n = 5), indicate that Tallowwood and Sydney Blue Gum are tree species utilised by koalas (Appendix 8). Furthermore, three samples of koala pellet material, sent for content analysis at the University of New England showed that:

- Sample A (small Tallowwood) had no Forest Oak present.
- Sample B (large Forest Oak) had some Forest Oak present, but not in large amounts and with no obvious oak-leaf tips.
- Sample C (small Forest Oak) had Forest Oak present in larger amounts than Sample B, much of which was leaf tips.

All samples contained epidermis from Tallowwood foliage, as well as from other species. These results indicate that at least Tallowwood and Forest Oak are used for food by koalas at Dorrigo.

Table 20: Observed and expected numbers of scats found beneath particular tree species of particular tree sizes (cm DBHOB) at Dorrigo.

Species[1]	**30-60cm Obs**[2] **(Exp**[3]**)**	**60-90cm Obs (Exp)**	**90-120cm Obs (Exp)**	**Total**
TWD	374 (359)	171 (302)	212 (95)	757
OAK	328 (419)	554 (352)	0 (111)	882
SBG	80 (69)	9 (58)	56 (18)	145
WMY	44 (23)	5 (20)	0 (6)	49
BBT	78 (38)	1 (32)	0 (10)	79
BBX	18 (28)	33 (24)	8 (7)	59
BCP	46 (22)	0 (18)	0 (6)	46
GGM	10 (28)	48 (23)	0 (7)	58
FLG	5 (27)	51 (22)	0 (7)	56
Others[4]	60 (31)	6 (26)	0 (8)	66
Total	1043	878	276	2197

[1]Refer to species abbreviations in Table 17.
[2]Observed frequencies.
[3]Expected frequencies.
[4]'Others'=summed results for Turpentine, rainforest species, Red Mahogany, Bloodwood.

4.4.4 Summary:

Trees with koala faecal pellets beneath them are reasonably scarce in the study area. The following characteristics outline what the trees used by koalas in this study are like.

- Trees with scats are associated with tree densities of 75-100sph,
- There is an association between tree density and tree species (ie more Tallowwood on open sites),
- Trees with scats range in size from 30cm DBHOB up to 192cm DBHOB,
- The presence of scats beneath trees is not associated with tree size,
- The abundance of scats beneath trees is associated with tree size (ie larger trees have more scats),
- The number of tree species with scats ranges from 0 to 7 species per site, with an average of 3 species per site,
- Trees with scats are associated with koala food tree species (ie fewer non-food trees with scats),
- Trees with scats are associated with tree species (ie more Red Bloodwood, Grey Gum, Tallowwood, Forest Oak, Red Mahogany and Flooded Gum trees with scats than expected),
- Tree species with scats are associated with tree size (ie more large Tallowwood trees with scats),
- The number of scats beneath species is associated with tree size (ie more scats beneath large Tallowwood and Sydney Blue Gum trees), and
- Forest Oak and Tallowwood trees form part of the diet of koalas at Dorrigo.

4.5 Preference and Importance of Trees to Koalas:

4.5.1 Tree Size:

4.5.1.1 Comparisons using Trees with Scats:

There is some disproportionate use of trees in particular size classes >30cm DBHOB, although relative exploitation indices tend to approximate '1' (Table 21). Large trees in the 120-150cm DBHOB size class were ranked as the most preferred tree size by koalas at Dorrigo (Table 21). The >180cm DBHOB size class was not sufficiently sampled in this study.

Table 21: The relative exploitation, ranked preference and importance indices for tree size classes >30cm DBHOB at Dorrigo, with relative utilisation based on the number of trees with scats.

Tree Size (cm DBHOB)	No. Trees	No. Trees with Scats	RE[1]	Preference Index (rank[2])	Importance Index (rank[2])
30-60	2876	152	0.94	0.163 **(4)**	0.614 **(1)**
60-90	769	54	1.25	0.216 **(3)**	0.290 **(2)**
90-120	260	12	0.83	0.142 **(5)**	0.042 **(4)**
120-150	102	8	1.40	0.242 **(1)**	0.048 **(3)**
150-180	25	0	0	0	0
>180	13	1	1.25	0.237 **(2)**	0.006 **(5)**

[1]Relative exploitation is the ratio of the proportional use of a factor to its availability. '>1' represents over-exploitation and '<1' represents under-exploitation.
[2]Rank is the order of preference or importance of a factor to the koala ('1' is the most preferred or important).

Once the abundance of trees in each size class was taken into account, small (30-60cm DBHOB) and medium (60-90cm DBHOB) sized trees became the more important tree sizes to koalas (Table 21), because of the much greater availability of these relatively smaller trees.

4.5.1.2 Comparisons using Trees with 10 or more Scats:

Medium-sized (60-90cm DBHOB) trees with 10 or more scats were the most preferred and the most important tree sizes to koalas (Table 22).

Table 22: The relative exploitation, ranked preference and importance indices for tree size classes >30cm DBHOB at Dorrigo, with relative utilisation based on the number of trees with 10 or more scats.

Tree Size (cm DBHOB)	No. Trees	No. Trees with Scats	RE[1]	Preference Index (rank[2])	Importance Index (rank[2])
30-60	2876	24	0.66	0.056 **(5)**	0.227 **(2)**
60-90	769	19	1.96	0.166 **(2)**	0.532 **(1)**
90-120	260	5	1.53	0.129 **(4)**	0.109 **(3)**
120-150	102	2	1.56	0.132 **(3)**	0.044 **(5)**
150-180	25	0	0	0	0
180-230	13	1	6.12	0.517 **(1)**	0.087 **(4)**

[1]Relative exploitation is the ratio of the proportional use of a factor to its availability. '>1' represents over-exploitation and '<1' represents under-exploitation.
[2]Rank is the order of preference or importance of a factor to the koala ('1' is the most preferred or important).

Comparing preference and importance indices between trees with 10 or more scats (Table 22) and trees with any number of scats (Table 21) shows that the preferred and important size classes change in favour of medium-sized trees in both cases. This may be due to the occurrence of more medium and large sized trees with more scats than expected (see Section 4.4.2).

4.5.2 Tree Species:

4.5.2.1 Comparisons using Trees with Scats:

Red Bloodwood, although being used five times more than expected, was not well sampled and had a low expected frequency. Grey Gum and Tallowwood were the most exploited and preferred tree species (Table 23).

Table 23: The relative exploitation, ranked preference and importance indices for tree species at Dorrigo, with relative utilisation based on the number of trees with scats.

Tree Species	No. Trees	No. Trees with Scats	RE[1]	Preference Index (rank[2])	Importance Index (rank[2])
Forest Oak	826	71	1.53	0.076 **(4)**	0.304 **(2)**
Tallowwood	440	63	2.55	0.126 **(3)**	0.449 **(1)**
Sydney Blue Gum	526	26	0.88	0.044 **(7)**	0.064 **(3)**
White Mahogany	357	15	0.75	0.037 **(9)**	0.031 **(5)**
Brush Box	318	10	0.56	0.028 **(11)**	0.016 **(7)**
Blackbutt	494	9	0.32	0.016 **(13)**	0.008 **(11)**
Turpentine	465	9	0.34	0.017 **(12)**	0.009 **(10)**
Grey Gum	40	7	3.12	0.155 **(2)**	0.061 **(4)**
Rainforest species	185	7	0.67	0.033 **(10)**	0.013 **(9)**
Red Mahogany	53	4	1.34	0.067 **(5)**	0.015 **(8)**
Brush Cypress Pine	61	3	0.88	0.043 **(8)**	0.007 **(12)**
Flooded Gum	28	2	1.27	0.063 **(6)**	0.007 **(12)**
Red Bloodwood	3	1	5.94	0.294 **(1)**	0.017 **(6)**

[1]Relative exploitation is the ratio of the proportional use of a factor to its availability. '>1' represents over-exploitation and '<1' represents under-exploitation.
[2]Rank is the order of preference or importance of a factor to the koala ('1' is the most preferred or important).

The most significant "under exploited" species were Blackbutt and Turpentine. However, Grey Gum and Red Bloodwood have low relative abundances, which is why they do not rank as high in importance. Tallowwood and then Forest Oak rank as the most important tree species to koalas at Dorrigo because they were both preferred and were relatively abundant (Table 23).

4.5.2.2 Comparisons using Trees with 10 or more Scats:

Grey Gum, Flooded Gum, Tallowwood and Brush Cypress Pine were all 'over-exploited' tree species (Table 24). Turpentine and Blackbutt were again the most 'under-exploited' tree species. Grey Gum was the most preferred tree species (Table 24). However, because Grey Gum has a low relative abundance, the most important species becomes Tallowwood because of its preference and relative abundance.

Comparing preference and importance indices between trees with 10 or more scats and trees with any number of scats shows that the preferred and important species did not seem to change with a focus on fewer trees with more scats.

Table 24: The relative exploitation, ranked preference and importance indices for tree species at Dorrigo, with relative utilisation based on the number of trees with 10 or more scats.

Tree Species	No. Trees	No. Trees with Scats	RE[1]	Preference Index (rank[2])	Importance Index (rank[2])
Forest Oak	826	20	1.89	0.111 **(5)**	0.378 **(2)**
Tallowwood	440	15	2.64	0.156 **(3)**	0.399 **(1)**
Sydney Blue Gum	526	5	0.74	0.044 **(7)**	0.037 **(5)**
White Mahogany	357	2	0.43	0.026 **(8)**	0.009 **(8)**
Brush Box	318	1	0.24	0.014 **(9)**	0.003 **(9)**
Blackbutt	494	1	0.16	0.009 **(11)**	0.002 **(10)**
Turpentine	465	1	0.16	0.010 **(10)**	0.002 **(10)**
Grey Gum	40	2	3.84	0.229 **(1)**	0.078 **(3)**
Rainforest species	185	0	0	0	0
Red Mahogany	53	1	1.46	0.086 **(6)**	0.015 **(7)**
Brush Cypress Pine	61	2	2.53	0.150 **(4)**	0.051 **(4)**
Flooded Gum	28	1	2.75	0.164 **(2)**	0.028 **(6)**
Red Bloodwood	3	0	0	0	0

[1]Relative exploitation is the ratio of the proportional use of a factor to its availability. '>1' represents over-exploitation and '<1' represents under-exploitation.
[2]Rank is the order of preference or importance of a factor to the koala ('1' is the most preferred or important).

4.5.3 Summary:

Koalas at Dorrigo, through the presence and abundance of faecal pellets beneath trees, display distinct preferences towards particular tree sizes and species. However, certain tree sizes and species become more important to koalas once the abundance of trees is taken into account.

- The presence of scats indicate that large trees (120-150cm DBHOB) are the most preferred tree size, but small trees (30-60cm DBHOB) are the most important tree size to koalas,
- The abundance of scats indicate that medium-sized trees (60-90cm DBHOB) are the most preferred and the most important tree size to koalas,
- The presence and abundance of scats both indicate that Grey Gum trees are the most preferred species, but Tallowwood is the most important species to koalas.