# Chapter 5: DISCUSSION AND CONCLUSION

## 5.1 Rationale for the Study – A Review:

Legislation requires managers to survey and manage habitat for koalas in their local area. However, forest managers often require more information about the koala in their local area to make more informed decisions. The outcome from current field surveys depends heavily on observer selection of the most appropriate tree species and size during the survey.

At Dorrigo, trees with scats are generally sparsely distributed (ie one tree in eighteen on average). Therefore, the selection of individual trees for sampling becomes critical to the outcome. Some local understanding of the koala's use of trees is important to be able to effectively implement surveys and manage trees and koalas in native forests. The following discussion contributes to the level of local understanding about the features of trees and forests that are important to utilisation by koalas.

## 5.2 Research Questions:

5.2.1 Is koala tree use associated with types of forests?

*5.2.1.1 The Structural and Floristic Composition of Forests:*

There is wide variation in the density, size and species of trees on sites within the study area at Dorrigo. Despite a sampling effort of only 0.08%, the range of tree densities, sizes and species appears to be more than adequately sampled. The associations between tree density and species, and size and species explain much of the variation in the structural and floristic composition of forests.

In terms of the association between tree density and tree species, dense sites may be expected to have more Forest Oak and rainforest trees than open sites, because these species are relatively shade tolerant and able to persist beneath and among canopies. They also do not generally grow into 'large' (ie >90cm DBHOB) trees. Forest Oak grows quickly and on a range of soils (Nicholls, 1991), but may be limited in stands tending towards rainforest species (Boland et al., 1984). More Tallowwood, Blackbutt, Brush Box and Red Mahogany trees on open sites may occur because these species have a capacity to grow into very large trees (ie large Tallowwood, Blackbutt and Brush Box trees make up 76% of trees >150cm DBHOB), dominating stands in terms of structure and providing seed sources for regeneration of these species. On dense sites there may be fewer of these species because they may have been selectively logged in past operations with few left in regrowth stands, or a wide range of other shade tolerant species, such as rainforest may competitively exclude them.

In terms of the association between tree species and tree size, there may be more large Tallowwood, Brush Box, Sydney Blue Gum and White Mahogany trees because many large trees have been left as seed/habitat trees in recent logging operations, or because of defect or fluctuating markets. Fewer small

trees of these species may occur because of regeneration difficulties within moist forests. Rapid development of a dense mesophytic understorey often hinders the survival and development of eucalypt regrowth. Successful regeneration in moist forest often relies on canopy gap creation and disturbance of undergrowth during logging, a post-log burn of logging slash and/or supplementary planting (Forestry Commission of NSW, 1985).

*5.2.1.2 Impacts of Logging on Structure and Floristic Composition:*

Logging activity has the potential to substantially influence the forest structural and floristic composition, as most sample sites have had at least one treatment.

The experimental harvesting operation in this study is more of a thinning operation because only one third of the trees were logged. The general effect of the particular type of thinning harvesting operation in this study has been no change to the proportional abundance of trees of different species and size classes, except 10% reductions in numbers of Brush Box and of trees in the 60-90cm DBHOB size class.

Mostly Brush Box trees were removed as (i) these trees are generally sound, making high quality sawlogs, and (ii) the previous logging operation may have left more Brush Box because of peculiarities of demand in wood product markets at that time. Forest Oak, wattles and Brush Cypress Pine are sometimes removed for timber, but only for high-grade products and only if the particular tree is of exceptional quality. Logging in rainforest forest types ceased in 1979, but many hardwood forest types contain rainforest species in

the understorey which are often damaged during the removal of large hardwood sawlogs, as has been the case in this instance.

The harvesting of many 60-90cm DBHOB trees may be because this is the size of tree that is most commonly within quota sawlog size, ie >40cm centre diameter under bark (CDUB) but has minimal internal defect compared to that often found in larger tree sizes.

Most of the large trees over 90cm DBHOB were retained because (i) these trees are more likely to have internal defect which would minimise recovery, and (ii) State Forests of NSW prescriptions for logging specify certain numbers of mature trees to be retained as habitat trees. It is not known whether the required number of habitat trees has been reached or exceeded in this instance. A high number of retained large old hardwood trees and rainforest understorey may compromise regeneration within the forest. However, a high number of trees retained in the small to medium size classes indicates that the forest manager is not solely relying on regeneration, but has left the site to grow on to one or more thinnings or "end-point".

The structural and floristic composition of forests after any harvesting operation may differ appreciably between stands depending on the tree size distribution, species composition and markets. However, harvesting operations in general may affect forests in the following way:

- Many large mature trees will be retained to act as habitat trees,

- Some rainforest and other understorey tree species within moist eucalypt forest types will often be damaged through the tree-felling and extraction process,

- Less than 50% of the basal area or numbers of trees >30cm DBHOB will usually be removed in any thinning operation, unless the stand is due for silvicultural "restart".

In terms of the implications for koalas, low intensity 'thinning' operations may be favourable to koalas, because the structural and floristic composition does not dramatically change, and most recognised food trees (ie Tallowwood, Forest Oak and Sydney Blue Gum) are retained.

*5.2.1.3 Koala Association with Topography:*

Koalas may be associated with topographic features of forests. Kavanagh et al. (1995) found that koalas were associated with lower elevation forests in northeastern NSW. While no association was found in this study with altitude, trees with koala scats were positively associated with steeper slopes over 10 degrees.

The disturbance factor may be affecting the apparent response of koalas to slope, where koalas may be favouring the steeper sites that have not been disturbed for a long time compared to more accessible flatter sites.

*5.2.1.4 Koala Association with Land Use:*

State Forests of NSW (1997) found that while more trees with scats occurred in forests with a long or frequent logging history, they were only abundant in parts of forests that had not been recently logged (within the last 10 years). This study found similar results, except that the abundance of trees with scats was associated with a considerably longer time since the last logging event (30 years). This may be expected since the coastal forests near Coffs Harbour have been logged for longer and, in many cases, more intensively than at Dorrigo, leaving the forests in varying stages of regrowth (State Forests of NSW, 1997). At Pine Creek State Forest, there has not been the opportunity to detect trees with koala scats from older forests and forests with a wider logging history, as has been the case in this study at Dorrigo. This finding again suggests that koalas may be affected by recent disturbance, as seen in the association with topography above, and that it takes long periods of time for koala populations to recover after displacement.

There is no explanation offered by State Forests of NSW (1997) for the apparent positive association with logging frequency or number of logging events. As seen earlier, logging has the potential to significantly alter the structural and floristic composition of forests. Koalas may benefit from the structural diversity and/or stimulation of new leaf growth created by a diverse, long and frequent logging history. Landsberg (1990) found that young foliage and epicormic foliage produced after defoliation has enhanced nutritional status for insects compared to mature foliage.

However, in recent years logging has generally become more of an intensive disturbance activity, because of the ability to sell a range of products from the stand and a management objective to maximise the efficient utilisation of

timber resources and the growth potential of the site. Sites with few logging events may have been logged more intensively than sites with many logging events that may have fewer disturbances, such as pole or sleeper cutting.

Examining where many koala records have been located may further support the food hypothesis of koala preference based on the stimulation of new leaf growth. At Dorrigo, it has been seen that one fifth of sightings were in eucalypt plantations. At Pine Creek, State Forests of NSW (1997) found that koala scats in plantations were most abundant near the edge. Since the sightings at Dorrigo were along roads, it may be that koalas utilise plantations because of the abundance of relatively young plantation trees with new leaf growth, in comparison to adjacent forests of mixed-age.

*5.2.1.5: Koala association with Forest Type:*

Koala use of forests is associated with forest type. In this study, trees with koala scats were most abundant in forests dominated by Tallowwood and Sydney Blue Gum species, and least abundant in forests dominated by Blackbutt and White Mahogany species.

One forest type with higher levels of Tallowwood was used less by koalas, while another forest type with lower levels of Tallowwood was used more by koalas. This suggests that the forest type in which certain tree species are dominant is most favourable to koalas and provides a better indication of habitat quality than perhaps individual tree species occurrence, as suggested by Jurskis (unpublished).

*5.2.1.6: Koala association with Forest Structure:*

A lack of association between trees with scats and forest structure at Dorrigo is contrary to what was found by State Forests of NSW (1997) and what was suggested by Jurskis and Potter (1997) and Jurskis (unpublished). The forest groups had similar numbers, or at least some proportion, of trees in all tree size classes.

State Forests of NSW (1997) found that in native forest at Pine Creek State Forest, scats were most abundant in structurally complex, uneven-aged forests with some mature and old growth elements and mixed species associations dominated by Tallowwood and Forest Oak. There is more variability within Pine Creek forests because of the cumulative effects of a longer logging history and, although these forests may be relatively younger and even-aged in comparison to Dorrigo forests, there are still limited large, mature and old-growth trees (60-100cm DBHOB) present (State Forests of NSW, 1997). In contrast, Dorrigo forests have considerably more large trees and are mostly structurally complex and uneven-aged compared to Pine Creek, meaning that koala preference for this type of habitat at Dorrigo becomes less distinguishable. As we have seen above, there was sufficient variability in various tree species at Dorrigo to differentiate between forest types in their use by koalas, but tree level preferences by koalas may be less important except perhaps in marginal habitats.

5.2.2 Is koala tree use associated with tree density?

*5.2.2.1 Detection of Koala Faecal Pellets:*

Although koala sightings were numerous and widespread and koala faecal pellets were also widespread, only about 6% of trees sampled had evidence of koalas. This indicates that koalas may exist in relatively sparse populations throughout the forests of Dorrigo. This study measured a considerable number of trees, but evidence of koalas is quite low in comparison to other studies (Table 25).

**Table 25**: Tree utilisation data from various studies indicating usage as a percentage of total trees measured.

| Study | Total Trees Measured | Trees Used by Koalas | % Tree use |
|---|---|---|---|
| Robbins & Russell (1978) | 1316 | 106 | 8 |
| Hindell & Lee (1987) | 6652 | 743 | 11.2 |
| Moon (1990) | 145 | 32 | 22.1 |
| This study | 4045 | 227 | 5.6 |

Sampling of only four transects (2 x 100m and 2 x 80m) per survey site in this study, incurs too much variability in the detection of trees with scats. This study indicates that perhaps seven 100m transects would provide a less variable estimate of the number of trees with scats. Putman (1984) pointed out that the use of certain size and shape sample quadrats depends considerably on faecal density. With the low density of faecal pellets in this study, extra transects may not be worthwhile and observers may have to accept some variability in the levels of detection. Although adjustment of the length of transects may further increase variability because of the extension into other habitat types, adjustment of the width of transects could reduce variability because of the concentration within home ranges.

*5.2.2.2 Tree Density:*

At Dorrigo, koala use is associated with relatively open stands with a tree density of 75-100 sph. This finding is consistent with that of Hindell and Lee (1987), Cork et al. (1990), Melzer and Lamb (1994) and State Forests of NSW (1997) who indicate that koalas are associated with open forests and woodlands. A tree density of 75-100sph may not be as open as habitats described elsewhere, but it is comparatively less than other habitats in this study. The tree density of 75-100sph may be optimal for koalas at Dorrigo, being sufficiently open to permit ease of travel between trees, yet with enough trees for food and shelter requirements.

On open sites (<100sph), the use of Tallowwood trees was disproportionately more than its availability (ie there was a preference by koalas for Tallowwood).

Koalas may be utilising some trees on open sites considerably more often or for longer than the rest, because of the proportionately higher numbers of scats under similar numbers of trees with scats between the two tree density classes.

5.2.3 Is koala tree use associated with tree size >30cm DBHOB?

*5.2.3.1 The Number of Trees with Scats:*

Koalas used a wide range of tree sizes in this study in comparison to other studies (Table 26). However, trees with scats were not associated with tree size in this study.

Although no trees of a particular size with scats occur more or less frequently than expected, the proportional use of trees by koalas compared to their availability (ie preference) is highest for large trees (ie 120-150cm DBHOB). Whilst this is not statistically significant for all tree species, particular tree species with scats do have a statistically significant association with larger trees (Table 18).

**Table 26**: The range of tree sizes used by koalas from various studies.

| Study | Size Range of Trees Used (m DBHOB) |
|---|---|
| Faulks (1990)[1] | 0.12-1.97 |
| Jurskis et al. (1994) | 0.12-1.10 |
| Lunney et al. (1996)[1, 2] | 0.31-0.70 |
| State Forests of NSW (1997) | 0.10-1.20 |
| This study[2] | 0.30-1.92 |

[1]Cited in State Forests of NSW (1997).
[2]Sample does not include trees <30cm DBHOB.

Hindell and Lee (1987) also found preferences for large trees by koalas in the Brisbane Ranges west of Melbourne. In considering the differences in nutritional properties of leaves between small and large trees, they suggested that preferences for large trees could be for some other purpose, such as shelter from weather and predators, or because large trees have more foliage thereby reducing the requirement to move to other trees. Melzer and Lamb (1994) commented that koalas have a very low metabolic rate and undertake activity patterns that minimise this metabolic rate. Although environmental conditions are not as harsh at Dorrigo compared with Springsure in central Queensland, koalas may prefer large trees for energy efficiency reasons and/or for shelter.

Small trees were more important to koalas, because small trees are much more readily available. Although the 'mechanics' of climbing may be related to this importance (Jurskis and Potter, 1997), it is more probable that this is simply a case of "lots of trees – lots of use".

*5.2.3.2 The Number of Scats:*

Koala faecal pellet abundance is associated with tree size. Although most small trees had few scats under each tree, there were more medium and large sized trees (ie >60cm DBHOB) with many scats and fewer small trees (30-60cm DBHOB) with many scats. Similarly, Hasegawa (1995) found that koala pellets occurred under most of the large trees, and most of the occurrences of pellets were of five pellets or more.

This finding suggests that koalas may be defecating more often or over a longer period in larger trees. The implication therefore is that koalas may be spending more time in larger trees. Time spent in trees may reflect relative tree size. Koalas may be spending more time in larger trees because large trees have more food, or because large trees provide more security and shelter (Hindell and Lee, 1987; Melzer and Lamb, 1994).

This association between tree size and trees with many scats also means that, to some extent, a simple measure of occurrence of scats beneath trees may not fully reflect the amount of use of trees, and that scat abundance should be measured.

This study found that medium-sized trees (60-90cm DBHOB) with 10 or more scats were preferred by koalas, as opposed to large trees >90cm DBHOB. Trees of 60-90cm DBHOB may be preferred because:

1. they offer koalas a mechanical advantage in climbing,
2. they are still quite large trees (60cm DBHOB is just beyond the reach of the average person around the circumference of the tree) providing feeding efficiency and shelter, and
3. they are (older) regrowth to early mature trees with sufficient quantities of suitably nutritious foliage.

Medium-sized trees were also the most important tree size to koalas. This is because they were not only highly preferred, but also relatively abundant. These results agree with findings from Jurskis and Potter (1997) and State Forests of NSW (1997) who indicate that koalas prefer tree sizes in the ranges of 30-90cm DBHOB and 50-80cm DBHOB, respectively.

5.2.4 Is koala tree use associated with tree species?

*5.2.4.1 The Numbers of Trees with Scats:*

There is considerable diversity in tree species with scats in this study and this is equivalent to findings by other studies (Table 27). The increasingly common view that many local tree species are used in some fashion by koalas is supported in this study.

**Table 27**: Number of tree species used by koalas from a range of other studies.

| Study | Number of Tree Species Used by Koalas |
|---|---|
| White & Kunst (1990) | 7 |
| Reed et al. (1990) | 5 (at Dorrigo) |
| | 8 (at Coffs Harbour) |
| Jurskis et al. (1994) | 8 |
| Melzer & Lamb (1994) | 17 |
| State Forests of NSW (1997) | 10 |
| This study | 7 |

State Forests of NSW (1997) identified many tree species in scats from Pine Creek State Forest (Table 3, Section 3.4.1) and this indicates that many tree species used are being used for food. Assuming that a tree with scats indicates use of that tree for food, the actual range of food tree species in this study corresponds well with the assumed range of koala food tree species taken from State Forests of NSW (1997). In this study, trees with scats occurred only where there was at least 3 koala food tree species per site, which equates with a similar finding of 4 food trees per site at Pine Creek.

Koala use of trees is associated with tree species at Dorrigo. Tallowwood, Forest Oak and Grey Gum trees with scats occurred more frequently than expected. This was found at Pine Creek State Forest 40km away from Dorrigo (State Forests of NSW, 1997). These species, along with Red Bloodwood and Red Mahogany, were 'over-exploited', comparing favourably with findings (Table 28) from White and Kunst (1990) at Sheldon in southeastern Queensland.

Observations from the study at Pine Creek State Forest (State Forests of NSW, 1997) indicate disproportionate use of Tallowwood by koalas. The few observations from this study, although too few to generalise, tend to support the Pine Creek study. Also, Standing (1990) noted that Tallowwood was the most favoured tree species from koala sightings in the Macleay Valley in northern NSW.

**Table 28**: Selected relative exploitation (RE) indices of tree species by koalas, modified from White and Kunst (1990).

| **Over Exploited RE>1** | | **Under Exploited RE<1** | | **Negligible RE=0** |
|---|---|---|---|---|
| Forest Red Gum | 5.63 | Brush Box | 0.68 | Forest Oak |
| Tallowwood | 4.45 | Red Bloodwood | 0.61 | |
| Grey Gum | 2.26 | | | |
| Red Mahogany | 1.13 | | | |

The inter-relationship between tree species and size was also associated with koalas use of trees, where large (>90cm DBHOB) Tallowwood trees appear to be preferred by koalas.

Red Bloodwood, Grey Gum and Tallowwood were the most preferred tree species, although the significance of Red Bloodwood is dubious because of the low numbers of trees of this species sampled. Grey Gum and Tallowwood are cited elsewhere as preferred food of the koala (Osawa, 1993; State Forests of NSW, 1997), and so the preference for these species is probably mainly on nutritional grounds.

Once the abundance of tree species is taken into account however, Tallowwood appears as the most important tree species to koalas, followed by Forest Oak and Sydney Blue Gum. Faecal pellet content analysis in this study confirms that Tallowwood and Forest Oak are used for food by koalas, and State Forests of NSW (1997) confirms that Sydney Blue Gum is also an important food species to koalas. The lower importance of Red Mahogany, Red Bloodwood and Grey Gum would be due to the very low abundance of these species.

*5.2.4.2 The Numbers of Scats:*

Although most Tallowwood, Forest Oak, Sydney Blue Gum and White Mahogany trees had low numbers of scats, some trees of these species had considerable numbers of scats. This suggests that koalas do not spend much time in most trees of any species, but that some individual trees of preferred species may be utilised considerably more than others, similar to that found by Hindell et al. (1985) and Hindell and Lee (1987).

Grey Gum, Flooded Gum and Tallowwood trees with 10 or more scats were the most preferred species. However, the most important species of trees with 10 or more scats were again Tallowwood, Forest Oak and Grey Gum due to their relative abundance.

Tree species of highest preference and importance to koalas did not change considerably using a dependent variable of presence of scats to a dependent variable of numbers of scats, indicating that there is no advantage in either method of assessing the dependent variable. Therefore, it is clear that

Tallowwood is both a highly preferred and highly important tree species to koalas at Dorrigo.

### 5.3 Conclusions:

This study demonstrates that the distribution and abundance of koala faecal pellets are associated with particular forests and trees at Dorrigo.

At the forest level, trees with koala pellets are associated with the Tallowwood/Sydney Blue Gum floristic forest type because of the particular occurrence of preferred tree species, but not structural composition because of the inability to distinguish between the structurally complex, uneven-aged forests with many older trees. Because the environmental coverage of a forest type is narrower than that of a species, forest type may be a better indicator of habitat quality than individual species occurrence. Therefore, at Dorrigo koalas may prefer habitat where Tallowwood, Forest Oak and Sydney Blue Gum (and perhaps levels of other tree species) predominate.

Trees with koala pellets are associated with steeper slopes, but this may be because of less disturbance in these areas. Trees with koala pellets are also associated with a long history of logging, but are also associated with forest that has not been disturbed by logging for more than 30 years.

Trees with koala pellets are associated with less dense forests of 75-100 stems per hectare. On open sites, koalas prefer Tallowwood trees.

At the tree level, although there was no association between koala pellets and tree size, trees within the 60-90cm DBHOB size class are the most preferred and important size to koalas. The abundance of koala pellets is associated with larger trees. Also, it may be more appropriate that faecal pellet surveys measure the abundance of pellets, rather than presence, to assess the use of tree sizes by koalas.

Tree use by koalas, indicated by faecal pellets, is associated with tree species. Tallowwood (particularly large Tallowwood >90cm DBHOB) was found to be highly preferred and the most important tree species to koalas. Forest Oak, Grey Gum and Sydney Blue Gum are also preferred and important tree species. Forest Oak and Tallowwood both constitute part of the diet of koalas at Dorrigo.

## 5.4 Implications of Findings:

### 5.4.1 Implications for Koala Survey:

This study has shown that rainfall within the first two months has a substantial effect on the persistence of koala faecal pellets after deposition. Scats are much less likely to persist during this period in the summer months at Dorrigo where rainfall is generally higher than in winter. This agrees with findings of Taylor and Williams (1956), Wallmo et al. (1962) and Johnson and Jarman (1987) that rainfall affects the persistence of faecal pellets of animals. Although Wallmo et al. (1962) found that only 38% of pellet 'groups' were removed by rains in less than 2 months, the annual precipitation (up to

533mm) in the western Texas region of their study is about a half to three-quarters of that experienced at Dorrigo.

However, this study also shows that a proportion of faecal pellets can remain intact and identifiable for at least six months under varying extremes in environmental conditions. This is comparable with the finding by Jurskis and Potter (1997) that pellets can last up to 12 months on wetter sites, considering the higher rainfall experienced at Dorrigo. It is unlikely that rainfall significantly affected the search effectiveness in this study because of this persistence, the experience of observers and the search effort. However, rainfall and the major causes of pellet deterioration and loss from coprophagous invertebrate activity and vertebrate disturbance activity, must all be taken into account during surveys.

Little is known about the *Telanepsia* genus of Oecophorid invertebrates, including the relationship between this genus and Australian marsupial faecal pellets, including those of the koala. It is possible that the moth specimen is a new species or, at least, is likely to substantially contribute to existing knowledge. However, the results that have been found in this study raise more questions on the role that invertebrate larvae play in the decomposition of koala scats. Points worthy of further investigation include larval life cycle and activity periods, decomposition rate, selectivity in decomposition, point at which pellets become unrecognisable, and whether other factors, such as rain, are associated with larva decomposition?

Based on results of this study, the following guidelines should be considered for koala faecal pellet surveys.

- Moth larvae and ground-foraging vertebrates are intimately involved in the breakdown of koala faecal pellets. It appears that these are most active around spring when temperatures are warmer. Therefore, in order to maximise the capacity to observe faecal pellets, surveys may be better conducted in autumn and winter.

- Because rain is likely to dramatically increase the deterioration of scats within two months of deposition, surveys for koala faecal pellets are probably best done during drier periods in autumn, winter and spring.

- The variability in finding trees with scats at Dorrigo will be reduced to within 20% of the average number of trees with scats if the area searched is twice the size of plots within this study (ie increased from 1.44ha to 2.8ha).

- Forests in which Tallowwood, Sydney Blue Gum and Forest Oak are predominant should be targeted for koala pellet surveys. Other factors that may be important to where koala pellets can be found include steeper slopes, forests with a long history of logging, and forests that have not recently been disturbed (ie preferably as long as 30 years).

- Forest Oak, which has been found in this study and by State Forests of NSW (1997) to constitute part of the diet of the koala, should be a tree species that is included in surveys, particularly for faecal pellets. Forest Oak has also been shown to be a considerably important tree species to koalas at Dorrigo.

- Tallowwood, which is the most preferred and important tree species to koalas at Dorrigo, should receive more focus and preference in tree selection during surveys than other species.

- Although large trees >90cm DBHOB may be preferred by koalas, 60-90cm DBHOB trees may be more important as a size class to koalas and should be considered during the selection of trees for survey. Large Tallowwood trees with scats however, may be encountered more than expected.

- Trees with 10 or more scats beneath them may be a better indicator of tree use by koalas than just the presence of pellets. More scats beneath individual trees may indicate more time that koalas spend in those trees, thereby expressing the importance of those trees to koalas.

5.4.2 Implications for Timber Harvesting and Forest Management:

The association of koalas with logging is an important, but complex one involving various positive and negative impacts, the effects of which depend on the intensity, frequency and selectivity of logging (State Forests NSW, 1997). Less intense thinning operations like that demonstrated in this study, are likely to be more typical of future selection timber harvesting which koalas may be able to tolerate. However, logging may impinge on some aspects of koala habitat that may temporarily or permanently reduce the value of habitat. The impacts of logging and forest management practices upon

koalas and their habitat should be managed in such a way as to benefit the long-term survival of populations in the forests of Dorrigo.

Based on results of this study, the following guidelines for koala and habitat protection and/or management should be considered.

- Increasing the interval between timber harvesting operations in known sensitive areas to at least 10 years, and preferably up to 30 years, from the date of the last logging operation.

- Scheduling harvesting to increase the number of areas logged more than twice.

- Retaining or maintaining around 75-100 stems >30cm DBHOB per hectare in areas where koalas are known to occur.

- Retaining trees with many scats (ie around 10 or more), particularly trees >60cm DBHOB and Tallowwood trees >90cm DBHOB.

- Retaining or maintaining at least three recognised koala food tree species per site in areas where koalas are known to occur.

- Damage to preferred tree species should be avoided if practicable.

- Encouraging regeneration of preferred tree species, including Tallowwood, Forest Oak, Sydney Blue Gum and Grey Gum, through the use of cultural operations such as logging, post-log burning and

planting/seeding and in ways that do not significantly compromise koalas where they are known to occur.

- Logging variables in this study ('Last Logging Event' and 'Number of Loggings') may have some association, and may be complicated by differences in the intensity of logging events. Therefore, some caution should be given to recommendations and further detailed research should be undertaken to specifically address the types of logging.

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## APPENDIX 1: GENERAL LICENCE (TS0067) PRESCRIPTION.

The following is an excerpt from prescriptions for logging under General Licence TS0067 issued to State Forests of New South Wales by the NSW National Parks and Wildlife Service.

*7.4 Koala*

A. *If a past record of a Koala is accurately known or if evidence of regular Koala activity is detected prior to or during forestry operations, operations will be excluded from within 100 metres of the location of the record or the location of the evidence of activity until the assessment in paragraph B below has been undertaken.*

B. *The extent of habitat use and preferred food trees within the 100 metre radius area referred to in A above shall be assessed using a method approved by the Director-General. Paragraph C, D or E below will then apply as appropriate to the outcome of that assessment.*

C. *If no further evidence of regular Koala activity is found, forestry operations may resume but a minimum of 5 Koala food trees must be retained within the 100 metre radius area referred to in A above. If a Koala was recorded in a preferred food tree, that tree must be included among the retained trees.*

D. *If regular Koala activity is detected but less than 20% of trees examined have Koala faecal pellets underneath and no further Koalas are observed, limited forestry operations may resume under the following conditions:*

   *(i) trees with evidence of regular Koala activity shall be retained;*

   *(ii) a minimum of 15 Koala food trees per hectare shall be retained within the 100 metre radius area referred to in A above;*

*(iii)* *if the density of Koala food trees per hectare does not permit the above specified number of trees to be retained, all existing Koala food trees shall be retained.*

*E.* *If regular Koala activity is detected and more than one Koala is observed or more than 20% of trees examined have Koala faecal pellets underneath, forestry operations, including post-harvest and hazard reduction burning, shall be excluded from the 100 metre radius area referred to in A above and the Director-General notified.*
*For the purposes of A to E above, Koala food trees shall be leafy with broad crowns and represent the range of sizes greater than 40cm dbh present and be selected with preference to Tallowwood (Eucalyptus microcorys), Small-fruited Grey Gum (E. propinqua), Grey Gum (E. punctata), Forest Red Gum (E. tereticornis), and Sydney Blue Gum (E. saligna). If these species are not present in adequate numbers, food trees should be selected from the following species:- Blackbutt (E. pilularis), Flooded Gum (E. grandis) and Red Mahogany (E. resinifera). Koala food trees retained pursuant to this condition may be counted as habitat trees or habitat recruitment trees for the purposes of other conditions.*

*For the purposes of A to E above, regular Koala activity is indicated by the presence of Koala faecal pellets beneath trees or by characteristic claw scratch marks on the trunks of trees.*

## APPENDIX 2: KOALA PRESCRIPTIONS – LOGGING IN NORTH COAST FOREST TYPES.

Objectives:

- To complement the koala habitat value of reserve land tenures by maintaining important elements of koala habitat on State forest.
- To plan harvesting operations with a knowledge of koala requirements for successful breeding and dispersal.
- To effect operations in a manner that ensures continued occupation by koala across the forested landscape.
- To minimise deleterious impacts in an efficient, well planned and auditable manner.
- To find koalas where they occur and determine the significance of occurrence.
- To identify and protect breeding aggregations of koalas.
- To plan and carry out timber harvest in an efficient manner with due regard to economic and silvicultural principles.

Review Clause:

The Coastal Prescriptions will be reviewed starting at 1 May 1996.
This prescription is endorsed by State Forests of NSW and the NSW National Parks and Wildlife Service. It will be implemented for a period of three months starting from the 22nd of February 1996.

State Zones:

The Koala prescriptions are based on four zones: Western, Coastal, Tablelands and Southern Forests. The demarcation between the Western zone and the three eastern zones is based on reasonably apparent differences in forest types and provides little problem on State Forest tenure lands. The boundary between Coastal, Southern and Tablelands is based on differences in forest types that have also been partially reflected by past management practice. The Coastal Prescription will apply north of Sydney only.

Reconnaissance, training and background information required:

Field staff will be trained in the identification of koala tracks and traces, calls and primary and secondary feed tree preferences.

General knowledge of the distribution of koalas in the District will be compiled and maintained at District offices. This will consist of local knowledge, formal and informal survey results, SFNSW database records and NPWS Wildlife Atlas records.

Data forms for surveys will need to be on hand. These should be of the standard format (attached as Appendix 1), clearly documenting all information recorded. Hardware and software compatible with the SFNSW database will be required to link survey results to the appropriate agencies, for data storage and for facilitation of future planning.

## COASTAL PRESCRIPTIONS

This prescription applies north of Sydney to the following forest types listed in Research Note 17:

- Rainforest Group
- Maritime, Blackbutt, Sydney Blue Gum and Spotted Gum Leagues
- Grey Gum-Grey Ironbark, Grey Box-Ironbark and Red Gum Leagues
- Eucalypt Plantations

### Planning

At the beginning of the harvest planning process, locally compiled records will be consulted to determine if there is a reliable record of a Koala within 2 km of the boundary of the logging compartment boundary. Due recognition will be taken of local and historical knowledge with regard to koala distribution. If a record exists as described, or consideration of historical and local knowledge (including suitability of habitat) indicates that koalas are likely to occur, a methodical survey for koala or signs of koala presence will be undertaken during inspections of the proposed logging area prior to compiling the harvesting plan.

Community dialogue about Koalas should be initiated and maintained at an early stage. This need not be high profile and time consuming, but as a minimum should include contact and exchange of information with

neighbours and local animal welfare and conservation groups. Many interest groups, and the general public, have knowledge of Koala populations in their area. In some situations, animal care groups may be notified in case of accidental injury to koala.

The following procedures will be applied to EUCALYPT PLANTATIONS on State Forest lands ONLY where there are more than twenty stems per hectare of primary browse species (greater than fifteen centimetres dbhob).

The first step in planning the Koala survey will be to review a forest type map (where available) and other habitat assessments of the logging area to: i) to determine and document which forest types to select as priorities for sampling, and ii) to decide which forest types may carry these species, or are used locally by Koalas. The planning documents will be available on request.

Survey Method

The survey will proceed according to the following guidelines:

- A walk transect of the logging area will be done to sample a representative and well distributed cross section of the area at a minimum rate of one kilometre for each 100 ha of the logging area. The transect may contain infrequent bends and may be broken into segments. The transect may cross small patches or narrow linear strips of non-logging area or unlikely habitat but larger area blocks (>10 ha) that will not be logged will be excluded from sampling.

- During the walk transect, the area FIVE trees (if available) on each FIFTY metre segment of the transect.

- Primary browse species, preferably larger than 15 cm dbhob with an average of more than 50 cm DBHOB, will be targeted for dung searches. Secondary and then other species will be used in that priority to make up the numbers per FIFTY metres of transect. (When choosing trees to be sampled, those with interlocking crowns should be avoided wherever possible).

- If trees as defined above are not available, those tree species and size classes which are present will be sampled.

- Indicative primary browse species for the Coastal zone are: tallowwood, grey gum, and forest red gum and swamp mahogany. Most other eucalypts, plus larger Casuarinacea and broadleaf paperbark are commonly considered secondary browse species. Brush Box, turpentine, apple and bloodwood can be considered incidental browse.

- A search of ONE minute per tree, within two metres concentrated around the base of the tree, will comprise the basic search unit. A scan of the area below the crown of the tree should also be done on the way to the tree.

- Scats will be left *in situ*, other than small samples taken for identification or other analyses.

- Fire events on the compartment within the past year will be recorded.

- Sampling should not be undertaken within one month following fire events.

Recording Results

- The results of this survey will be recorded on standard format data forms (attached as Appendix 1). (See "Reporting" section for further requirements).

- The actual transect route taken will be accurately recorded on a map and justification given for the route taken.

- The locality of apparent runway trees found, and any Koala found (with special annotation for mother Koala with young), shall be accurately recorded on the same map.

- The number of scats beneath each tree does not need to be counted or recorded except where there is a very high number (ie close to 20) or they are of distinctly different sizes.

- The approximate locality of any transect section having THREE trees with Koala dung pellets out of any ten consecutive trees searched will be shown on this map as a transect section showing high use of Koala.

- "High use areas" in subsequent intensive walk surveys will be identified by this same criterion –ie. Areas with Koala dung pellets under THREE out of any ten consecutive trees searched.

- Subsequent intensive surveys by walk transect will be done to (i) map the extent of high use areas indicated by high use sections of transect and (ii) to determine the importance of areas adjacent to reported runaway trees or mother Koalas (where these areas are not associated with high dung pellet counts).

STAR Methodology

- Walk transects will consist of six additional radiating transects to determine the high use area, sampled at the same rate as above, with primary and then secondary browse species as targets for tree searches. These will start in the centre of the high use area on the original transect. Two of these will be established perpendicular to the original. The remaining four additional transects will be done on the diagonal between the perpendicular and the original transects. These transects will thus form a STAR pattern. These transects shall be carried out for at least 100 metres beyond any delineation of the high use area. Where the person undertaking the transects is satisfied that koala habitat is present they may choose to forego the interior parts of the additional transects and commence survey near what they consider to be the edge of the high use area.

- Intermediate use compartments will be defined as compartments in the dot point following and compartments which have Koala dung under two out of ten trees in any one 100 m segment.

- Where high use by Koalas is identified on a transect by only 3 to 4 trees with dung and where subsequent radiating six transects fail to show high use, this area will not be mapped to the Harvesting Plan as a high use Koala area, but defined as an intermediate use area.

- The high use area boundary will be checked by inspection around the perimeter defined by the points above. The results of this inspection will be recorded as a concise narrative on the data sheet and mapped to the Harvesting Plan. Any data collected will be clearly reported on the data

sheets.

- Where high usage is detected near the boundary (within 50 m) of the proposed logging area, minor but appropriate and indicative sampling of relevant adjacent habitat – up to 100 m into adjacent State Forest or National Park – will supplement the walk transect. This sampling will consist of inspection for Koalas, Koala dung and Koala habitat.

- Where this situation occurs adjacent to private lands a comment is required on the survey record and any associated report as to whether suitable Koala habitat, and possible Koala populations, extends into that land.

- Concise notes about adjacent habitat will be made on the data form, where relevant.

- Areas identified on forest type maps larger than about 10 hectares of forest types that carry primary browse species that were not sampled by transect shall be inspected for Koala evidence and results recorded as concise narrative on the data sheet. Information which should be used to identify these areas include Research Note 17 and local knowledge.

At the harvest planning stage, reserves, exclusions, and retention rates for high use and intermediate use areas will be planned and designed according to the following section.

Reserves and Exclusions

*Special conditions for this species:*
Individual Koalas will be protected from tree felling operations wherever detected. A tree containing a Koala will not be felled or damaged while the Koala is known to be in the tree.

Detection of a Koala will trigger actions listed below (see Operations).

Logging will be excluded from within fifty metres of high use areas. This will be documented and mapped in the Harvesting Plan.

In intermediate use areas, the following prescriptions apply:

1. Ten primary browse trees (or secondary browse species if primary are unavailable) will be retained per hectare in the compartment. These may include habitat trees if they meet the browse requirements.

2. Gap creation for silvicultural purposes will not take place in preferred forest types.

Where a high use area is identified in a eucalypt plantation, specific management of the area will be negotiated with NPWS.

Other reserves and exclusions will be planned by the District at this harvest planning stage. See box concerning plantations.

*Extra measures required:*
Proactive dialogue with contractors will be essential to ensure knowledge and attitude is compatible with compliance with this prescription. This should be initiated during this pre-logging joint inspection stage when going into known Koala areas.

## Operations

Compartment Marking:

Exclusion zones will be marked to clearly exclude logging from those areas of compartments with positive koala records and where survey results show high use. If koalas are encountered during this phase of operations the prescriptions set in harvesting (below) will be followed.

Trees to be retained in intermediate use areas will be clearly marked for retention.

During tree marking, primary browse trees should be briefly scanned for koalas and koala pellets (see section for description of required action if a koala is detected).

Harvesting:

Continued dialogue with contractors is needed to ensure knowledge and attitude is compatible with compliance with this prescription on all compartments. A planned and documented process for inspection of operations will be required in those compartments with exclusion zones for the protection of koala habitat.

If a koala is observed during marking or logging (in an area that has not previously been found to be a high use area), numerous dung pellets (more than twenty below a tree) are found, or where less than twenty pellets of two markedly disparate sizes (medium plus about half sized) are found, the following procedure will be followed:

- Walk transects will be initiated consisting of eight transects in the cardinal and sub-cardinal directions, and centred on the observation, to determine the extent of any high use area that may occur. The sampling will be at the same rate as the transect method described previously, with primary and then secondary browse species as targets for dung searches. These transects shall be carried out for at least 100 metres beyond any delineation of a high use area. Where the person undertaking the transects is satisfied that koala habitat is present they may choose to forego the interior parts of the transects and commence survey near what they consider to be the edge of the high use area.

- Any high use area boundary found will be checked by inspection around the perimeter defined by the transects. The results of this inspection will be recorded as a concise narrative on the data sheet and mapped to an Amendment to the Harvesting Plan.

- The results and maps will be promptly forwarded to NPWS (see Reporting Section).

**All tree felling will immediately and subsequently be excluded from within fifty metres of a high use area, or modified within intermediate use areas.**

Post-log Burning (associated with this operation):

As far as practicable post logging fire is to be kept out of the area reserved from logging for the protection of koala habitat.

Monitoring:

Koala monitoring will be conducted as part of the general monitoring procedures planned by State Forests. Compartment monitoring may be advantageous to Districts for future planning in areas that have positive koala records and prior management.

At the initial stage the state wide monitoring of koala populations will require a comprehensive compilation of the location and extent of high use areas. The monitoring program will be designed to give information on the effectiveness of these prescriptions in meeting their objectives.

The survey methodology for detecting koalas and determining high use areas (contained in these prescriptions) may be reviewed in the light of findings from the monitoring program.

Reporting:

"Hard copy" of all survey results (including Amendments to Harvesting Plans) will be archived by the District on the compartment history. All koala sightings will be incorporated into SFNSW database with subsequent prompt transfer to NPWS. Survey records (including Amendments to Harvesting Plans) will be reported in the same manner.

Maps will accompany survey results in relevant communications in either digital format (GIS) or as a clear paper copy. This will include the actual transect route taken, accurately recorded on a map. The locality of relevant koala or koala (including that of relevant adjacent areas) sign will be recorded on the same map. (Positive and negative results are both important.)

## APPENDIX 3: AREA OF FOREST TYPES WITHIN DORRIGO DISTRICT.

| Forest Type No. | Gross Area (ha) | Forest Type No. | Gross Area (ha) |
|---|---|---|---|
| Untyped | 5,329 | 93 | 247 |
| Rainforest | 10,521 | 98 | 173 |
| 31 | 3 | 111 | 35 |
| 36 | 1,796 | 117 | 1,480 |
| 37 | 9,227 | 122 | 1,025 |
| 39 | 38 | 123 | 373 |
| 45 | 75 | 128 | 103 |
| 46 | 4,226 | 136 | 10 |
| 47 | 14,490 | 142 | 3,902 |
| 48 | 65 | 151 | 3 |
| 51 | 32 | 152 | 42 |
| 52 | 25 | 153 | 297 |
| 53 | 3,798 | 154 | 14 |
| 54 | 4 | 159 | 113 |
| 60 | 1,444 | 161 | 110 |
| 62 | 2,258 | 163 | 26,908 |
| 64 | 1,328 | 167 | 8 |
| 65 | 574 | 168 | 4,219 |
| 70 | 2,270 | 214 | 3 |
| 74 | 34,545 | Plantations | 4683 |
| 80 | 5 | Cleared | 1,034 |
| 82 | 2 | Shrub & Herb | 41 |
| 92 | 780 | Rock & Water | 653 |

Source: Forestry Commission of NSW (1989).

## APPENDIX 4: COMPARISON OF KOALA SURVEY METHODS:

The aim of surveys can be to directly observe animals or indirectly observe signs of their presence. Tree searches, radio tracking and spotlighting are common methods of direct observation, and confident conclusions can usually be drawn about an animal's occurrence because an actual animal is observed. However, usually considerable effort is required to obtain meaningful statistically analysable data because of the low rates of visual detection.

### Daytime Tree Searches:

Daytime tree searches for koalas depend significantly on prior knowledge of koala presence, the openness of overstorey vegetation, koala density and home-range size (Jurskis et al., 1994). Detection is often hindered because during the day koalas usually rest against the tree in the canopy reducing visibility against a contrasting sky (personal observation).

### Radio Tracking:

Tagged animals are relatively easy to locate by radio tracking, which allows observers to study koalas in a free-ranging situation and increases probabilities of repeated detection. Radio tracking can more precisely determine tree species utilisation by koalas than faecal pellet detection, and is particularly useful for detecting individual and seasonal variations in utilisation (Hasegawa, 1995). However, the findings of radio tracking studies need to be interpreted correctly. Although Hasegawa (1995) found seasonal

changes in utilisation of tree species by koalas from radio tracking, these changes were not reflected in faecal pellet dietary analysis. Radio tracking also uses costly specialist equipment and has animal welfare implications in the capture and handling of animals. It also takes time to set up and is not a feasible technique for quick or broadscale survey. In terms of this study though, probably the most important disadvantage of radio tracking is that it is not a good technique for finding out about population preferences, since it is so influenced by individual koala habits.

**Spotlighting:**

Spotlighting depends greatly on the density of koalas, season, weather (Davey, 1990) and skill of observers, and the ease of detection varies considerably between species which may influence estimated relative abundances of species (Bennett et al., 1991).

**Indirect Surveys:**

Call playback, predator faecal pellet hair analysis, scratch marks upon trees and faecal pellets on the ground are methods of observing signs of an animal's presence. The benefit of observations of these types is that evidence is relatively fixed in space and time which involves less time and cost in obtaining meaningful data.

**Call playback:**

Koala vocalisations can be readily evoked in response to taped call playback. However weather, season and equipment operation can affect response rates. For example, koalas are socially more active in the breeding season and male koalas may respond more readily than females to the playing of a male koala's call (Mitchell, 1990; Jurskis et al., 1994).

**Predator scat hair analysis:**

Predator scat hair analysis is seldom used for detecting koalas because the koala makes up a relatively low proportion of the diet of most predators. In a recent batch of predator scats analysed from Port Stephens in central New South Wales, one in 70 predator scats had evidence of koala (Triggs, personal communication). Also, only general localities and not specific locations of koalas can be derived (Jurskis et al., 1994).

**Scratch Marks:**

Koalas often leave scratch marks on trees. However, a number of factors influence the detectability and identification of scratch marks, such as:

- The type of surface bark of a tree. Smooth-barked trees readily show evidence compared with rough or stringy-barked trees (Jurskis et al., 1994). However, some Tallowwood (*Eucalyptus microcorys*) trees are known to have obvious double-tracked pathways extending up the length of trees (personal observation).

- Scratches may only show part of the gait of an animal.

- The tree has been well used and identification of an individual koala's marks may be difficult.

- Another scansorial animal has left marks that are indistinguishable from the koala. Gliders, possums and goannas often make larger, more numerous and visible marks on trees than koalas (Jurskis et al., 1994).

## APPENDIX 5: CHARACTERISTICS OF MAIN SURVEY SITES WITHIN DORRIGO DISTRICT STUDY AREA.

| Site No. | Measure Date | AMG Coordinates | SF No. | Cpt | F/T | No. Trees >30cm | No. Scat Trees |
|---|---|---|---|---|---|---|---|
| E1 | 25/7/94 | 440125, 6675680 | 996 | 135 | 163a | 102 | 1 |
| E2 | 27/7/94 | 476760, 6662225 | 488 | 530 | 47 | 55 | 3 |
| E3 | 2/8/94 | 477075, 6661860 | 488 | 530 | 47 | 117 | 12 |
| E4 | 28/6/94 | 472350, 6653900 | 488 | 562 | 47 | 161 | 13 |
| E5 | 4/8/94 | 477175, 6661650 | 488 | 530 | 47 | 137 | 9 |
| E6 | 23/8/94 | 476100, 6662000 | 488 | 530 | 37a | 132 | 4 |
| E7 | 21/10/94 | 481400, 6616000 | 488 | 579 | 47 | 138 | 27 |
| E8 | 25/11/94 | 481000, 6651500 | 488 | 579 | 47 | 136 | 27 |
| E9 | 11/1/95 | 476100, 6663900 | 488 | 530 | 37a | 141 | 18 |
| E10 | 17/1/95 | 476100, 6663400 | 488 | 530 | 47 | 161 | 11 |
| E11 | 31/1/95 | 475750, 6663500 | 488 | 530 | 37a | 106 | 5 |
| E12 | 29/6/95 | 479450, 6666825 | 488 | 512 | 47 | 123 | 5 |
| E13 | 12/7/95 | 480800, 6665200 | 488 | 514 | 60 | 146 | 8 |
| E14 | 24/8/95 | 479525, 6666650 | 488 | 512 | 47 | 146 | 5 |
| | | | | | | **1801** | **148** |
| C1 | 4/3/96 | 473250, 6660350 | 488 | 540 | 47 | 117 | 3 |
| C2 | 17/3/96 | 474350, 6660025 | 488 | 539 | 47 | 128 | 3 |
| C3 | 25/5/96 | 482525, 6656150 | 488 | 571 | 47 | 165 | 14 |
| C4 | 25/8/96 | 453375, 6670875 | 831 | 206 | 37a | 117 | 0 |
| C5 | 7/9/96 | 462500, 6673250 | 803 | 221 | 37a | 118 | 0 |
| C6 | 27/10/96 | 462700, 6665225 | 111 | 122 | 47 | 200 | 25 |
| C7 | 19/10/96 | 481700, 6662575 | 488 | 326 | 37a | 122 | 9 |
| C8 | 3/11/96 | 464200, 6655975 | 489 | 81 | 163a | 193 | 2 |
| C9 | 10/11/96 | 472400, 6660100 | 488 | 545 | 60 | 202 | 9 |
| C10 | 16/11/96 | 470625, 6670450 | 111 | 149 | 47 | 204 | 3 |
| C11 | 29/11/96 | 465650, 6671725 | 111 | 141 | 47 | 196 | 1 |
| C12 | 30/11/96 | 470250, 6669100 | 111 | 146 | 47 | 160 | 7 |
| C13 | 15/12/96 | 461525, 6665800 | 111 | 120 | 47 | 217 | 3 |
| C14 | 9/2/97 | 464150, 6665675 | 111 | 124 | 47 | 105 | 0 |
| | | | | | | **2244** | **79** |

Note: 'AMG' is the Australian Map Grid co-ordinates, 'SF No.' is the State Forest number, 'Cpt' is the Compartment number, and 'F/T' is the Forest Type number.

## APPENDIX 6: FREQUENCY OF SPECIES WITHIN SIZE CLASSES (FOR TREES >30CM DBHOB ONLY) FOR ALL STUDY SITES AT DORRIGO.

| | 30-60 | 60-90 | 90-120 | 120-150 | 150-180 | 180-230 | Total |
|---|---|---|---|---|---|---|---|
| **TWD** | 222 | 101 | 65 | 34 | 12 | 6 | 440 |
| **OAK** | 738 | 84 | 4 | 0 | 0 | 0 | 826 |
| **SBG** | 328 | 87 | 80 | 24 | 5 | 2 | 526 |
| **WMY** | 211 | 104 | 32 | 9 | 1 | 0 | 357 |
| **BBT** | 366 | 99 | 17 | 7 | 4 | 1 | 494 |
| **TUR** | 304 | 128 | 29 | 4 | 0 | 0 | 465 |
| **BBX** | 179 | 97 | 19 | 17 | 3 | 3 | 318 |
| **RFU** | 173 | 8 | 4 | 0 | 0 | 0 | 185 |
| **NEB** | 149 | 21 | 7 | 3 | 0 | 0 | 180 |
| **BCP** | 56 | 5 | 0 | 0 | 0 | 0 | 61 |
| **WAT** | 11 | 0 | 0 | 0 | 0 | 0 | 11 |
| **RMY** | 48 | 5 | 0 | 0 | 0 | 0 | 53 |
| **DSB** | 39 | 3 | 0 | 0 | 0 | 0 | 42 |
| **STS** | 8 | 6 | 0 | 2 | 0 | 0 | 16 |
| **BWD** | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| **GGM** | 18 | 18 | 3 | 1 | 0 | 0 | 40 |
| **FLG** | 23 | 3 | 0 | 1 | 0 | 1 | 28 |
| **Total** | 2876 | 769 | 260 | 102 | 25 | 13 | 4045 |

## APPENDIX 7: KOALA SIGHTINGS WITHIN FOREST TYPES ON STATE FOREST IN DORRIGO DISTRICT.

| Forest Type Number | Forest Type Description | Tally |
|---|---|---|
| 5/11 | Booyong/Coachwood-Crabapple | 4 |
| 6/23 | Fig-Giant Stinger/Myrtle | 1 |
| 21 | Hoop Pine | 1 |
| 26 | Viney Scrub | 1 |
| 36 | Moist Blackbutt | 1 |
| 37 | Dry Blackbutt | 18 |
| 46 | Sydney Blue Gum | 5 |
| 47 | Tallowwood-Sydney Blue Gum | 37 |
| 53 | Brush Box | 2 |
| 60 | White Mahogany-Red Mahogany-Grey Gum-Grey Ironbark | 3 |
| 62 | Grey Gum-Grey Ironbark-White Mahogany | 2 |
| 64 | Grey Gum-Stringybark | 2 |
| 70 | Spotted Gum | 1 |
| 74 | Spotted Gum-Ironbark/Grey Gum | 10 |
| 92 | Forest Red Gum | 1 |
| 122/163 | New England Stringybark/New England Blackbutt | 1 |
| 123 | Coastal Stringybark | 1 |
| 142/163c | New England Peppermint/New England Blackbutt | 2 |
| 163 | New England Blackbutt | 7 |
| 168 | Silvertop Stringybark-Gum | 1 |
| 216 | Improved Pasture and Cropland | 1 |
| 218h(BBT) | Hardwood Plantations (Blackbutt) | 4 |
| 218h(FLG) | Hardwood Plantations (Flooded Gum) | 14 |
| 218h(BBT+FLG) | Hardwood Plantations (mixed Blackbutt and Flooded Gum) | 7 |
| 218s | Softwood Plantation | 1 |
| TOTAL | | 128 |

## APPENDIX 8: SPOTLIGHTING RESULTS AT DORRIGO - OCTOBER 1997.

| Date | Road No. | SF | Road | Length (km) | Animal | Tree Sp | Tree Size (cm DBH) | Dist. from Road (m) | AMG | Map F/T | Observer |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4/10/97 | 1 | 489 | Rigby's | 0.6 | 0 | | | | | | |
| | 2 | 488 | Cedar | 2.3 | 0 | | | | | | |
| | 3 | 488 | Retrievers | 1.6 | Greater Glider | SBG | 45 | 30 | 473625, 6660450 | 47 | Roberts |
| | 3 | 488 | Retrievers | 2.1 | Koala | SBG | 61.3 | 60 | 473900, 6660725 | 47 | Roberts |
| | 3 | 488 | end (on MRR) | 4.6 | | | | | | | |
| 9/10/97 | 1 | 488 | Morora | 4.2 | Koala | TWD | 27.8 | 3 | 482725, 6656400 | 47 | Roberts |
| | 1 | 488 | end Morora | 4.8 | | | | | | | |
| | 2 | 488 | FH, Timmsvale | 6.5 | Greater Glider | BBT | 28.3 | 25 | 482000, 6661775 | 37 | Griffin |
| | 2 | 488 | FH, Timmsvale | 6.75 | Greater Glider | BBT | 64.4 | 5 | 481875, 6662000 | 37 | Griffin |
| | 2 | 488 | FH, Timmsvale | 7 | Greater Glider | BBT | 69.5 | 5 | 481825, 6662300 | 37 | Griffin |
| | 2 | 488 | FH, Timmsvale | 8.4 | Boobook Owl | on | road | 0 | 481650, 6663550 | 37 | Roberts |
| | 2 | 488 | FH, Timmsvale | 9.25 | Greater Glider | WMY | 59.5 | 5 | 481900, 6664350 | 60 | Roberts |
| | 2 | 488 | FH, Timmsvale | 9.4 | Greater Glider | TUR | 90 | 50 | 481900, 6664475 | 60 | Roberts |
| | 2 | 488 | FH, Timmsvale | 9.5 | Koala | TWD | 31.8 | 2 | 481875, 6664575 | 60 | Griffin |
| | 2 | 488 | end | 10.7 | | | | | | | |
| 11/10/97 | 1 | 111 | Deadmans Range | 0.6 | Greater Glider | TUR | 50.2 | 32 | 465450, 6671700 | 47 | Roberts |
| | 1 | 111 | Deadmans Range | 0.6 | Greater Glider | WMY | 124.9 | 11 | 465450, 6671700 | 47 | Griffin |
| | 1 | 111 | Deadmans Range | 2.6 | Sooty Owl | | heard | | 466475, 6670350 | 47 | Roberts |
| | 1 | 111 | Deadmans Range | 2.7 | Greater Glider | SBG | 100 | 50 | 466550, 6670300 | 47 | Wilson |
| | 1 | 111 | Deadmans Range | 2.7 | Greater Glider | WMY | 64.3 | 5 | 466550, 6670350 | 47 | Wilson |
| | 1 | 111 | Deadmans Range | 2.9 | Greater Glider | SBG | 101.7 | 11 | 466775, 6670350 | 46 | Wilson |
| | 1 | 111 | Deadmans Range | 2.9 | Sugar Glider | | heard | | 466775, 6670350 | 46 | Roberts |
| | 1 | 111 | Deadmans Range | 3 | Greater Glider | SBG | 60.4 | 3 | 466850, 6670350 | 46 | Roberts |
| | 1 | 111 | end | 3.6 | | | | | | | |
| 18/10/97 | 1 | 111 | Charlies Camp | 0.7 | Greater Glider | NEB | 60 | 50 | 467450, 6670325 | 46 | Roberts |
| | 1 | 111 | Charlies Camp | 0.95 | Greater Glider | Stag | 110 | 5 | 467550, 6670450 | 46 | Roberts |
| | 1 | 111 | Charlies Camp | 0.95 | Greater Glider | SBG | 50 | 40 | 467550, 6670450 | 46 | Griffin |
| | 1 | 111 | Charlies Camp | 2.35 | Yellow Bellied Glider | TWD | 90 | 7 | 468150, 6671525 | 46 | Griffin |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 111 | Charlies Camp | 2.65 | Yellow Bellied Glider | TWD | 50 | 10 | 468375, 6671725 | 46 | Griffin |
| | 1 | 111 | end | 3.7 | | | | | | | |
| 30/10/97 | 1 | 111 | Kelly's Creek | 0.5 | Boobook Owl | | heard | | 467825, 6670050 | 47 | Roberts |
| | 1 | 111 | Kelly's Creek | 1.5 | Yellow Bellied Glider | | heard | | 468600, 6669400 | 47 | Roberts |
| | 1 | 111 | Kelly's Creek | 3.1 | Ringtail Possum | Euc | 2 | 1 | 469925, 6669000 | 47 | Roberts |
| | 1 | 111 | end | 4.2 | | | | | | | |
| | 2 | 488 | Lower Bielsdown | 2 | Koala | TWD | 79.70 | 8 | 473300, 6653150 | 47 | Griffin |
| | 2 | 488 | Lower Bielsdown | 2.3 | Ringtail Possum | US | 3 | 2 | 473550, 6653225 | 47 | Roberts |
| | 2 | 488 | end | 2.8 | | | | | | | |
| | 3 | 488 | Karore | 0.5 | Koala | TWD | 28.8 | 10 | 474100, 6653400 | 60 | Roberts |
| | 3 | 488 | end | 0.9 | | | | | | | |

## APPENDIX 9: NUMBERS OF SCATS WITHIN SPECIES AND SIZE CLASSES >30CM DBHOB AT DORRIGO.

| | **30-60** | **60-90** | **90-120** | **120-150** | **150-180** | **180-230** | **Total** |
|---|---|---|---|---|---|---|---|
| TWD | 374 | 171 | 144 | 32 | 0 | 36 | 757 |
| OAK | 328 | 554 | 0 | 0 | 0 | 0 | 882 |
| SBG | 80 | 9 | 26 | 30 | 0 | 0 | 145 |
| WMY | 44 | 5 | 0 | 0 | 0 | 0 | 49 |
| BBT | 78 | 1 | 0 | 0 | 0 | 0 | 79 |
| TUR | 34 | 3 | 0 | 0 | 0 | 0 | 37 |
| BBX | 18 | 33 | 1 | 7 | 0 | 0 | 59 |
| RFU | 9 | 0 | 0 | 0 | 0 | 0 | 9 |
| NEB | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BCP | 46 | 0 | 0 | 0 | 0 | 0 | 46 |
| WAT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RMY | 16 | 3 | 0 | 0 | 0 | 0 | 19 |
| DSB | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| STS | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BWD | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| GGM | 10 | 48 | 0 | 0 | 0 | 0 | 58 |
| FLG | 5 | 51 | 0 | 0 | 0 | 0 | 56 |
| Total | 1043 | 878 | 171 | 69 | 0 | 36 | 2197 |