DISTRIBUTION SURVEYS, HABITAT ASSESSMENT and MANAGEMENT RECOMMENDATIONS for the KOALA (*Phascolarctos cinereus*) in the SHOALHAVEN GORGE REGION of NSW

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Chris Allen
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Photo on front cover: Measuring tree diameters at an active site

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Executive Summary

During the Hylands Fire of 24 December, 2001 to 29 January 2002, several calls (source unknown) were received at the NPWS South Coast Region concerning the welfare of the 'koala colony' at Nerriga. At the time NPWS considered that the fire was not a threat to koalas as the western extremity of the fire front was east of Ettrema Gorge and in the Sassafras area.

Following the fire a koala habitat survey was commissioned by the NPWS South Coast Regional office at Nowra to investigate the habitat potential for koala in the Nerriga area near Bees Nest Nature Reserve, and Morton National Park, the Tolwong Plateau, Morton National Park and Bungonia State Recreation Area.

Objectives
Specific objectives of the survey were to:

- To assess sites within NPWS estate and other tenures for koala presence and potential habitat;
- To implement investigations consistent with the draft NSW Koala Recovery Plan;
- To provide NPWS with information regarding the status of known koala populations in the Shoalhaven Gorge region;
- To identify interested people as local contacts for koala population monitoring;
- To report on findings of the assessment & survey with recommendations for on-going management of koala populations.

Methods
In order to gather anecdotal information about koalas in the study area a verbal questionnaire survey was conducted. The people interviewed included residents, non-resident landowners, individuals with an interest in the study area (mainly bushwalkers) and local NPWS staff.

Search areas were chosen in localities where there were clusters of koala records, including and particularly those collected as part of this project and, where possible following a preliminary site visit to enable a range of habitat types to be sampled. The search methods used involved targeted sweep searches in the areas by teams of between six and twelve people looking for evidence of koalas. One objective of the survey was to locate suitable active sites that could be revisited at least annually as part of a monitoring program for koalas in the study area.

Results
In addition to NPWS staff, 29 people with knowledge of the area to the east and south of the Shoalhaven Gorge were interviewed. The information they provided confirmed the persistence of koalas in areas to the north east of Nerriga and to the north and east of the Endrick River Bridge on the Braidwood/Nowra Road. The information also suggested that the area to the west of Tulleyangela Clearing is a core koala area.

13 NPWS staff and 13 volunteers participated in the surveys. These were conducted in 16 areas in 7 localities in the study area. Data on koala tree species preferences were collected at 14 active sites. Koala evidence was recorded at 22 other locations. Evidence warranting their selection as potential permanent study plots was located at 9 sites. 20 eucalypt species and one hybrid were identified at the assessed active sites. Of these, 16 species had pellets under one or more trees in one or more of the assessed active sites.

The assistance by members of the local community and the bushwalking fraternity given to this koala survey resulted in a significant increase in the number of koala records and greatly enhanced the quality and extent of information gathered during the project.

Recommendations
Eleven recommendations have been made to further investigate the ecology and help conserve the habitat of koalas in the Shoalhaven Gorge region with a view to sustainably managing a viable population within the gorge and plateau landscape.

Summary of Recommendations

Recommendation 1:
Undertake taped call and sweep search surveys between September and November 2002 at locations and in areas listed in Table 7 and assess whether koalas have used the potential permanent study plots and surrounding areas listed in the same table. Collect data at appropriate active sites using the methods described in this report.

Continue field surveys using the methods described in this report and if possible, integrate these with a targeted survey during the koalas' breeding season, using the taped calls of a male koala.

Recommendation 2:
Approach appropriate tertiary educational institutions and encourage their participation in a post-graduate study of koalas in the study area.

Recommendation 3:
Ensure that the process for selecting the floristic ecosystem map to be used as a primary layer in a koala habitat model for the study area is consistent with modeling undertaken as part of the NSW koala recovery process. If the forest ecosystem mapping for the Southern CRA is to be used as the basis of the koala habitat model it should be refined so that more accurately reflects existing vegetation in the study area.

Recommendation 4:
Maximise the research, koala habitat conservation/restoration and public education opportunities offered by the Bungonia SRA.

Recommendation 5:
Develop an integrated research plan and program that involves the local community, members of the bushwalking fraternity, local Aboriginal communities, appropriate NPWS staff from the zone and districts, NPWS TSU staff involved in the NSW Koala Recovery Program, tertiary education institutions and the Australian Koala Foundation.

Recommendation 6:
Undertake a mail-out to local landholders, preferably with the support and involvement of the landcare movement. This should discuss the importance of conserving and restoring koala habitat on private land, ways in which restoration works can be integrated into normal farming practices and options for reaching conservation agreements with the National Parks and Wildlife Service or the Department of Land and Water Conservation.

Recommendation 7:
Explore options to assist koala habitat conservation at Tolwong Station. This could include purchase, property management or voluntary conservation agreement on some parts of the property, support for habitat restoration works and informing owners of koala conservation efforts in the Shoalhaven Gorge region.

Recommendation 8:
Develop strategies to minimise the severity and frequency of fire regimes, particularly in core koala areas. This could include the strategic support for landholders on the edge of koala areas to maintain low fuel loads. Maintaining low fuel loads in patches of non-koala habitat along the road to the Tolwong Station should also be considered. The Regional Fire Service should be informed of the likely distribution and importance of the koala population. Koala surveys should be undertaken in koala habitat before fuel reduction burns are undertaken.

Recommendation 9:
Advise those planning the upgrade of Main Rd 92 that minimal works on the existing section of Main Rd 98 in the Endrick River Bridge/Bulee Gap area would be the best option to reduce impacts on koalas. The moneys thus saved could be allocated to good signage and further koala research. The erection of koala-proof fencing and construction animal tunnels under the road could also be considered.

Recommendation 10:
Encourage those developing and implementing the NSW Koala Recovery Program to regard the management of koalas in the study area as a case study and to disseminate information about this amongst relevant NPWS staff and other interested parties.

Recommendation 11:
Encourage the NSW Koala Recovery Program to seek funding to enable the appointment of a coordinator to manage the implementation of recovery actions in the Shoalhaven Gorge region.

Briefing members of the survey team

1. BACKGROUND

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The dominant and central geographical feature of the study area is a plateau dissected by steeply-sloped gorges and gullies that are part of the Shoalhaven River and associated drainage systems. The river is one of the largest eastward-flowing drainage systems of South East NSW, rising near Snowball south of Braidwood and entering the Tasman Sea near Nowra. The Shoalhaven Gorge, extending from near Nerriga to Tallowa Dam, is a major landform through which the river flows (Figure 1a). The Gorge is relatively remote from major population centres, with Goulburn being the nearest main town to the north west, Nowra to the east, Braidwood to the south west and Bowral to the north, and is within the National Parks and Wildlife Service (NPWS) South Coast Region.

The study area is bounded by the Ettrema Gorge to the north west, the Shoalhaven Gorge to the north and south west, the boundary of the Bungonia SRA to the east, and the Nowra Braidwood Rd (Main rd 92) to the south. Anecdotal information was also provided to the study from the south west of this area.

Most of the study area is protected in reserves, these being primarily the Morton National Park (NP) and Bungonia State Recreation Area (SRA). Within Morton NP there are some small (40 - 100 ha) leasehold portions that form part of Tolwong Station. The main part of Tolwong Station is in the northern part of the plateau where approximately 200 ha has been cleared for grazing.

Private landholdings predominate in the southern portion of the study area. The more fertile areas (mainly near the township of Nerriga) have been cleared for agriculture, whilst in the south east and south west parts of the area forest cover remains on most private land. This is either relatively undisturbed or regeneration from earlier clearing for agriculture.

The geology varies in the study area. Sandstones predominate, with occasional basalt outcrops. Ordivician metasediments occur in the south-west whilst to the north-west the sandstones are interspersed with patches of shale, ironstone and limestone. There is also a high diversity of coastal and tableland floristic ecosystems in the study area (NPWS 2000).

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Recent sightings of the Koala (*Phascolarctos cinereus*) by National Parks and Wildlife Service (NPWS) staff in the Morton NP and Bungonia SRA, together with anecdotal reports to the NPWS of koala sightings in these reserves and nearby areas indicated that koalas persist there. Additional evidence from the results of a taped koala calls survey that was undertaken in 1999 as part of the Comprehensive Regional Assessment (CRA) that recorded five responses from male koalas in areas to the north east and north west of Nerriga (Mike Crowley, SFNSW, pers. comm). This was the largest cluster of responses obtained in the whole of the Southern CRA region. However, little was known about the broader distribution, habitat requirements and status of the species.

During the December 2001/January 2002 wildfire in Morton NP and nearby areas the NPWS received calls from people concerned about the fate of koalas in the reserve and adjoining areas. This encouraged the NPWS to initiate a koala survey program to improve understanding of this koala population and clarify management approaches that could assist its conservation.

This report provides information about koala habitat and recommendations for the sustainable management of this population. The project was initiated to assist factual reporting on indicators of ecologically sustainable forest management (ESFM). Reporting on biodiversity indicators is a requirement of NPWS as part of the Southern Regional Forest Agreement (RFA) outcomes. The Southern RFA has a twenty-year timeframe. Viable koala populations in the region are desirable in NPWS' view and the population is considered to be a good candidate to develop understanding and conservation management. Although the population probably represents the greatest density of koalas in the NPWS South Coast Region, the animals appear to be thinly distributed in the area.

The context and framework for this study are the methods for measuring and defining browse species and habitat categories and accompanying concepts that are discussed in Phillips (2000). This includes such concepts as *strike rates*, *activity levels*, *primary and secondary and/or supplementary browse species* and *primary and secondary habitat (Classes 1 & 2)*. Explanations for these are summarised in Appendix 1 and are essential to understanding the methods used in this study, the results thus derived and some of the recommendations that are in this report

2. Scope and Objectives of the Study

The scope of the project was to gain a greater understanding of the current distribution, habitat requirements and population status of koalas in the Shoalhaven Gorge landform to assist the conservation management of the species in the study area and adjoining districts. Specific objectives were to:

- To assess sites within NPWS estate and other tenures for koala presence and potential habitat;
- To implement investigations consistent with the draft NSW Koala Recovery Plan;
- To provide NPWS with information regarding the status of known koala populations in the Shoalhaven Gorge region;
- To identify interested people as local contacts for koala population monitoring;
- To report on findings of the assessment & survey with recommendations for on-going management of koala populations.

3. Methods

The study commenced with a verbal questionnaire survey to compile existing information about koalas in the study area. The people interviewed included residents, non-resident landowners, individuals with an interest in the study area (mainly bushwalkers) and local NPWS staff.
Specifically each person was asked the following questions:

1. Have you ever seen koalas in the region and if so can you remember the date when and the location where this occurred?
2. Do you know of any other person who has seen koalas in the region?
3. In what sort of habitat do you feel are local koalas likely to be found?
4. Do you feel that koala numbers have declined or increased in recent years?

Each person was informed that the NPWS was particularly interested in koalas in the region and wanted to encourage ongoing cooperation between the local community and the NPWS to improve knowledge about koalas and their habitat. They were also informed about the koala survey program and those who expressed keen interest were invited to participate in the field survey component.

Almost all of those contacted lived, or had knowledge of the country to the east and south of the Shoalhaven Gorge. Time did not permit an extensive survey of residents in the Bungonia and Windellama districts. However, anecdotal koala records from the latter district and surrounding areas that have been compiled by a local resident were provided to the study (Table 8, Appendix 2).

Several NPWS personnel, including the manager of the Bungonia SRA and rangers from nearby districts also provided information. In addition, a NPWS field officer with a keen interest in and knowledge of the Bungonia SRA provided information to and participated in the survey.

3.2.1 Selecting search areas

Because of the difficulty of locating koala evidence in forests that are potentially used by low-density koala populations, areas that appeared most likely to yield evidence of koala use were selected for survey.

These were chosen on the basis of the following information:

- Koala records, including and particularly those collected as part of this project
- Where possible following a preliminary site visit to enable a range of habitat types to be sampled.

Figures 1a & b shows the location of the survey areas. More detailed maps of the areas selected for survey are shown Appendix 3.

3.2.2 Search methods

The search methods employed in this survey were those developed for surveys of low-density populations in forests in the Far South Coast of NSW and described in Allen (1999a & b). Sweep searches were undertaken in the designated survey areas by teams of between six and twelve people. Where possible the team formed a line with one member being close to a clear landmark such as a track, ridge-line or gully. The line then worked through the forest and woodland areas searching for evidence of koalas, particularly for koala fecal pellets.

3.2.3 Assessment of active sites

Sites where koala fecal pellets were located were designated as active sites. Some of these were assessed using the methods described in Allen (1999a & b) and Phillips and Callaghan (2000), although a larger number of trees (a minimum of 30) in each plot were sampled than was the case in the surveys described by the former author. Sites selected for assessment were a minimum of 100 meters apart.

In this assessment the tree under which the pellets were first found, or in which a koala was sighted, was recorded as the centre tree of the plot. The plot size had a minimum radius of 10m, but was extended further if necessary to include the nearest 30 trees (a tree being defined as a live woody stem of any plant species, excepting palms, cycads, tree-ferns and grass-trees) with a DBH of 100mm or greater. These trees were marked with flagging tape.

The survey team then undertook a thorough search for koala fecal pellets, extending for one meter around the base of each taped tree. The base of each tree was searched for at least two person minutes, unless a pellet was found within that period. This firstly involved scanning the area to be searched and then carefully raking away ground litter, looking for pellets.

Where a single koala fecal pellet was found it was scored against the tree under which it was located. If a pellet was found within the search areas of one or more trees, it was scored against each tree respectively. The DBH and species of each tree in the plot was measured and recorded, along with the presence or absence of pellets. The flagging tape was then removed except for that which was around the centre tree. Other physical characteristics of the site, the plot radius and botanical data (both floristic/structural and an assessment of apparent tree health) and evidence of disturbance history were also recorded.

3.2.4 Potential permanent study plots

One objective of the survey was to locate suitable active sites that could be revisited at least annually as part of a monitoring program for koalas in the study area. Sites were considered to be potential permanent study plots (PSP's) if they met any of the following criteria:

- Koala fecal pellets of different ages were present indicating that the site was being revisited by koalas;
- Large and small fecal pellets of consistently different sizes were present indicating that the site was being used by mother and young;
- There was an activity level (Phillips and Callaghan 1995; Phillips and Callaghan in prep.) of more than 20%: ie where there were fecal pellets under more than 20% of trees in the plot, not include those sites where the pellets had probably come from a koala in a larger tree over-shadowing a number of smaller trees;
- The site was in primary habitat.

4. Results

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Twenty five residents and owners of land who were non-residents were contacted. Four other individuals with a good knowledge of the area were also contacted. Table 1 summarises their responses to the survey questions. A more detailed summary the locations of koala sightings and of other information collected in the verbal questionnaire survey is provided in Appendix 2.

Table 1: Summary of responses people contacted

	Residents	**Non-resident owners**	**Bushwalkers /visitors**
Never seen koalas	6	4	
Seen one koala in the past decade	5	1	1 & 1*
Seen more than one koala in past decade	4	1	3
Seen one or more koalas more than ten years ago	3 & 2**	1	

* A friend reported seeing one to a non-resident owner
** Two people have seen several koalas both in the past decade and more than 10 years ago

The anecdotal reports predominantly came from three areas:

1. North east of Nerriga: 5 sightings in and near Portions 133 and 134, Jerralong Parish. One resident reported sighting a koala on two different occasions in the past five years, one of which was a mother with one back-young.
2. North and east of the Endrick River Bridge on the Braidwood/Nowra Road. Nine koala sightings in the past fifteen years were reported, including five along the road itself. A landholder living approximately 4 kilometers north of the Endrick River Bridge stated that he had seen and heard koalas regularly during the 25 years he had lived there.
3. The Tolwong Plateau. Two long-term residents and two bushwalkers reported they had repeatedly seen and heard koalas in this area. The information they provided suggested that the area to the west of Tulleyangela Clearing through to the Shoalhaven Gorge including Deep Oaky Creek, Little Oaky Creek, the unnamed creek between these and Tims Gully appeared to be a core koala area (Figure 1b).

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4.2.1 Search Areas

Figures 1a and 1b shows a map of the study area, the locations of areas where sweep searches for evidence of koalas were undertaken.

Figures 2, 3, 4, 5 & 6 (Appendix 3) show the search areas in more detail, the locations the active sites where data were collected and other active sites where there was evidence of koala use.

4.2.2 Overview of field survey results

Surveys were undertaken in 16 areas in 7 localities in the study area. Data on koala tree species preferences were collected at 14 active sites (Table 1). Koala evidence was recorded at 22 other locations (Table 2). Evidence warranting their selection as potential permanent study plots was located at 9 sites (Table 3).

Figure 1a: Areas searched in the study area

Figure 1b: Probable Core Koala Area

4.2.3 Active Sites

Table 1 lists the site numbers, locality and co-ordinates of 14 active sites where data were collected. The Table includes summaries of koala evidence observed and the search areas in which they were located.

Table 1: Site numbers, locality and co-ordinates of the assessed active sites, summaries of koala evidence observed at these sites and the search areas in which they were located.

Site No	Survey area	Site Locality	UTM Zone	AGD Eastings	AGD Northings	Type of evidence
Sh/001	1a	"Phoenix" Portion 133	56	229641	6115214	Koala fecal pellets
Sh/002	1a	"Phoenix" Portion 133	56	230036	6115502	Koala fecal pellets
Sh/003	2a	Rolfes Gap, Portion 22	56	236741	6116012	Koala fecal pellets
Sh/004	2b	Rolfes Gap, Morton NP	56	237774	6115214	Koala observed. No pellets located
Sh/005	2b	Rolfes Gap, Morton NP	56	238088	6114954	Koala fecal pellets
Sh/006	3a	North of Tims Gully, Morton NP	56	236494	6137609	Koala fecal pellets
Sh/007	3b	North of Tims Gully, Morton NP	56	236173	6138504	Koala fecal pellets
Sh/008	3b	North of Tims Gully, Morton NP	56	236122	6138706	Koala fecal pellets
Sh/009	4a	Ironpot Clearing, Portion 15	56	234948	6143680	Koala fecal pellets. Koala observed nearby
Sh/010	4b	North of Fryingpan Creek, Portion 9	56	236195	6141518	Koala fecal pellets
Sh/011	5b	West of Tullyangela Clearing, Portion 61	56	239376	6131270	Koala fecal pellets
Sh/012	1a	"Phoenix" Portion 133	56	229892	6115297	Koala fecal pellets
Sh/013	6a	Bungonia SRA, "Blue" Track	56	226772	6143905	Koala fecal pellets. Koala observed (probably a young female) nearby
Sh/014	6b	Bungonia SRA, South east of Ranger Station	56	226191	6143268	Koala fecal pellets

Koala fecal pellets located at active site SH013

Table 2 lists the survey areas, locality and co-ordinates of each of the 22 active sites where no assessment was undertaken. The Table also provides summaries of koala evidence observed at these sites and the search areas in which they were located.

Table 2: Locality, survey areas and co-ordinates of active sites where no assessment was undertaken, summaries of koala evidence observed at these sites and the search areas in which they were located.

Survey area	Site Locality	UTM Zone	AGD Eastings	AGD Northings	Type of evidence
1a	"Phoenix" Portion 133	56	229972	6115397	Koala fecal pellets
1a	"Phoenix" Portion 133	56	229874	6115206	Koala fecal pellets
1a	"Phoenix" Portion 133	56	229894	6115303	Koala fecal pellets
1a	"Phoenix" Portion 133	56	230036	6115522	Koala fecal pellets
1a	"Phoenix" Portion 133	56	229600	6115522	Koala fecal pellets
1a	"Phoenix" Portion 133	56	229594	6115546	Koala fecal pellets
1a	"Phoenix" Portion 133	56	229136	6114307	Breeding female sighted in *E. melliodora* in 1999. Pellets found under same tree on 29/4/02.
1a	"Phoenix" Portion 133	56	229864	6115283	Koala fecal pellets
Near 1a	"Phoenix" Portion 133	56	229889	6115709	Fresh pellets located by G. Taylor 9/6/02
3b	North of Tims Gully, Morton NP	56	236100*	6138600*	Koala fecal pellets
4a	Ironpot Clearing, Portion 15	56	234842	6143691	Koala fecal pellets
4a	Ironpot Clearing, Portion 15	56	234869	6143642	Koala observed 2/5/02. Fresh pellets collected and sent for DNA analysis (Sample Sh1)
4a	Ironpot Clearing, Portion 15	56	234669	6143820	Koala fecal pellets
4a	Ironpot Clearing, Portion 15	56	234726	6143841	Koala fecal pellets
4a	Ironpot Clearing, Portion 15	56	234725	6143815	Koala fecal pellets
4b	North of Fryingpan Creek, Portion 9	56	236028	6141484	Koala fecal pellets
4b	North of Fryingpan Creek, Portion 9	56	236061	6141526	Koala fecal pellets
4b	North of Fryingpan Creek, Portion 9	56	239430	6131209	Koala fecal pellets
5b	West of Tullyangela Clearing, Portion 61	56	239448	6131065	Koala fecal pellets
5b	West of Tullyangela Clearing, Portion 61	56	239449	6131064	Koala fecal pellets
6c	Trestle Track	56	226562	6141054	Koala fecal pellets

6a	Bungonia SRA, “Blue” Track	56	226770	6143857	Koala observed 16/5/02. Fresh pellets collected and sent for DNA analysis (Sample Sh2)

4.2.4 Potential Permanent Study Plots

Nine active sites were selected as potential permanent study plots (PSP's). Of these five had evidence of repeated use, either because fecal pellets of different ages were present or because a koala had previously been observed in a tree where pellets were located during the survey. Two sites were selected because, in each case, evidence of koala use was located at a primary browse species growing in primary habitat. Another two sites were selected because, in each case, evidence of koala use was located at an *E. tereticornis* in an area where this species was well represented in the wider area.

Table 3 provides the co-ordinates and summary information about potential permanent study plots and the survey areas where they were located.

Table 3: Co-ordinates and summary information about potential permanent study plots

Site No	Survey area	UTM Zone	AGD Eastings	AGD Northings	Reason for selection	Details
No site number	1c	56	229136	6114307	Evidence of repeated use	Breeding female sighted in *E. melliodora* in 1999. Pellets found under same tree on 29/4/02.
Sh/007	3b	56	236173	6138504	Evidence of repeated use	Center Tree (E. punctata) has many scratchmarks of different ages; possibly a home range tree
Sh/008	3b	56	236122	6138706	Evidence of repeated use	Site with highest activity level (29%). Koalas observed and male koalas heard bellowing in the vicinity during the breeding season in 1998
Sh/009	4a	56	234948	6143680	Primary habitat	*E viminalis*
		56	234869	6143642	Primary habitat	*E viminalis*
Sh/011	5b	56	239376	6131270	E. tereticornis habitat.	Centre tree (*E. tereticornis*) has the largest DBH and is probably the oldest tree in plot. It is three forked and the only one on the plot where evidence of koala use was located
No site number	5b	56	239448	6131065	E. tereticornis habitat.	E. tereticornis (DBH 1003) with koala fecal pellets
Sh/013	6a	56	226772	6143905	Evidence of repeated use	Site appears to be used by a young female; may be on edge of maternal home range
Sh/014	6b	56	226191	6143268	Evidence of repeated use	Koala observed feeding in center tree (E. bridgesiana) on several occasions since 1997. Many pellets found under leaning branch on 16/5/02

4.2.5 Eucalypt species, Forest/woodland complexes and activity levels

Table 4 lists the eucalypt species and the modeled forest/woodland complexes (CRAFTI 1999) present at the assessed active sites. In the case of the Dry Tableland & Escarpment Box Complex (E21) there were sometimes species also present that are normally associated with the Coastal Dry Box Complex (E8) such as Coastal Greybox (*E. bosistoana*). In each case the Tableland complex is given in this table.

Table 4: Eucalypt species, modeled Forest/Woodland Complexes (CRAFTI) and activity levels at active sites where data were collected

Site No	Eucalypt species at active site (in order of abundance)	CRAFTI code	Modeled Forest/Woodland Complex
Sh/001	E. mannifera, E. macrorrhyncha, E. melliodora, E. rossi	E21/E26	Dry Tableland & Escarpment Box/Dry Tableland & Escarpment Gum/Stringybark Complex
Sh/002	E.globoidea, , E. macrorrhyncha, E. melliodora, E. dives	E21	Dry Tableland & Escarpment Box Complex
Sh/003	E. melliodora, E bosistoana, E. muelleriana	E26	Dry Tableland & Escarpment Gum/Stringybark Complex
Sh/004	E. smithii	E16	Peppermint Complex
Sh/005	E. muelleriana , E.globoidea, E. sieberi, E.smithii	E12	Dry Coastal Stringybark Complex
Sh/006	E. viminalis, E. viminalis/radiata, E. radiata, E.globoidea, E. smithi	E16	Peppermint Complex
Sh/007	E. punctata, E. radiata, E.globoidea, E. rossi, E. muelleriana	E12	Dry Coastal Stringybark Complex
Sh/008	E. rossi, E. mannifera, E. amplifolia, E. melliodora	E26	Dry Tableland & Escarpment Box Complex
Sh/009	E. viminalis, E.globoidea	E16	Peppermint Complex
Sh/010	E. punctata, E.globoidea, E agglomerata	E12	Dry Coastal Stringybark Complex
Sh/011	E. tereticornis, E bosistoana, E. melliodora,	E11	Forest Red Gum Complex
Sh/012	E. macrorrhyncha, E.globoidea, E agglomerata E. mannifera, E bosistoana,	E08/E21	Dry Tableland & Escarpment Box Complex
Sh/013	E. eugenoides, E. melliodora, E. bridgesiana	E21	Dry Tableland & Escarpment Box Complex
Sh/014	E. dives, E. bridgesiana, E. macrorrhyncha, E. rossi, E. mannifera,	E21/E26	Dry Tableland & Escarpment Box/Dry Tableland & Escarpment Gum/Stringybark Complex

4.2.5 Eucalypt Species Strike Rate

A total of twenty eucalypt species and one hybrid were identified at the assessed active sites. Of these, 16 species had pellets under one or more trees in one or more of the assessed active sites.

Table 5 shows the eucalypt species that were identified at the assessed active sites, the number of trees of each species that were sampled, the number of trees where koala evidence was located and the strike rate for each species.

Table 5: Tree species data and strike rates

Eucalypt Species	Number of trees sampled	Number of trees with koala evidence	Strike Rate
E. rossi	33	9	.2727
E. amplifolia	4	1	.25
E. punctata	10	2	.2
E. macrorrhyncha	35	5	.1388
E. bosistoana	11	2	.1818
E. eugenoides	11	2	.1818
E. bridgesiana	7	1	.1428
E. radiata	9	1	.1111
E. dives	10	1	.1
E. globoidea	62	4	.0645
E. muelleriana	16	1	.0625
E. viminalis	35	2	.0571
E. melliodora	37	2	.054
E. mannifera	21	1	.0476
E. tereticornis	25	1	.04
E. smithii	34	1	.0294
E. agglomerata	5	0	0
E. cinerea	1	0	0
E. radiata/viminalis	6	0	0
E. rubida	1	0	0
E. sieberi	7	0	0

Habitat at active site SH014

4.2.7 Activity levels

Table 6 shows the activity levels (see Appendix 1) for each assessed active site. The site locality of, and eucalypt species present at each site is also included again in this table. Those sites with higher activity levels suggesting site use of a more sedentary nature (Appendix 1) are in bold.

Table 6: Site locality, eucalypt species and activity levels at each assessed active site

Site No	Site Locality	Eucalypt species at active site (in order of abundance)	No of Trees Sampled	No of Trees with Pellets	Activity Level
Sh/001	"Phoenix" Portion 133	E. mannifera, E. macrorrhyncha, E. melliodora, E. rossi	36	3	8.33%
Sh/002	"Phoenix" Portion 133	E.globoidea, , E. macrorrhyncha, E. melliodora, E. dives	30	2	6.66%
Sh/003	Rolfes Gap, Portion 22	E. melliodora, E bosistoana, E. muelleriana	33	1	3.03%
Sh/004	Rolfes Gap, Morton NP	E. smithii	32	1	3.13%
Sh/005	Rolfes Gap, Morton NP	E. muelleriana , E.globoidea, E. sieberi, E.smithii	32	3	9.38%
Sh/006	North of Tims Gully, Morton NP	E. viminalis, E. viminalis/radiata, E. radiata, E.globoidea, E. smithi	29	2	6.89%
Sh/007	North of Tims Gully, Morton NP	E. punctata, E. radiata, E.globoidea, E. rossi, E. muelleriana	31	1	3.22%
Sh/008	North of Tims Gully, Morton NP	E. rossi, E. mannifera, E. amplifolia, E. melliodora	31	9	29.00 %
Sh/009	Ironpot Clearing, Portion 15	E. viminalis, E.globoidea	33	1	3.03%
Sh/010	North of Fryingpan Creek, Portion 9	E. punctata, E.globoidea, E agglomerata	33	3	9.09%
Sh/011	West of Tullyangela Clearing, Portion 61	E. tereticornis, E bosistoana, E. melliodora,	33	1	3.03%
Sh/012	"Phoenix" Portion 133	E. macrorrhyncha, E.globoidea, E agglomerata E. mannifera, E bosistoana,	34	5	14.70 %
Sh/013	Bungonia SRA, "Blue" Track	E. eugenoides, E. melliodora, E. bridgesiana	32	2	6.25%
Sh/014	Bungonia SRA, South east of Ranger Station	E. dives, E. bridgesiana, E. macrorrhyncha, E. rossi, E. mannifera,	33	5	15.15 %

5. DISCUSSION

[redacted]

Surveys of local communities' knowledge of koalas have been undertaken in many areas (eg Lunney et al 1997, Ward and Close 1998, Lunney and Mathews 2000, Close et al 2000). In this survey local landholders were contacted by telephone and asked if they had seen koalas or if they knew of anyone who had. Their responses gave a number of leads to follow.

Only three of the people contacted were reluctant to discuss the subject of koalas, two of whom said it was because they felt that the fewer the number of people who knew about the koalas the better it would be for the animals. Two of the respondents had a keen interest in koalas and had kept records of sightings and anecdotal reports (See Appendix 3). Although this information had been given to NPWS staff most of it was not entered on the Wildlife Atlas and therefore was not readily available.

Most of the respondents did not provide an opinion as to what was the most suitable habitat, nor whether koala numbers had declined. However, of those who did, some were of the view that koala numbers were higher in the gorges or steeper gullies whilst others believed that the plateau country, particularly where there was "better quality timber like the boxes" was more suitable. Most felt that koala numbers had not declined in recent years. One long-term resident suggested that many years ago koalas had almost been eradicated by an epidemic and that there were more now than in the initial decades following this episode. This may be referring to an epidemic of *Clamydia* that swept through the populations of Eastern Australia in the early 20th Century causing the regional extinction of koalas in many areas (eg Lunney and Reed (1990).

However, the anecdotal records (Table 7, Appendix 2) collected from the Windellema district and adjoining areas to the south west of the study area show a decline in reported koala reports in this area in recent decades.

The assistance by members of the local community and the bushwalking fraternity given to this koala survey resulted in a significant increase in the number of koala records and greatly enhanced the quality and extent of information gathered during the project. Four local people and one regular visitor (a bushwalker) also participated in the surveys and provided key local knowledge about specific areas and koala sightings in two of these areas. This demonstrates the value of reaching into and working well with these groups in this kind of work and reinforces the case that an ongoing partnership between the NPWS and these groups is a key strategy in ongoing surveys, research and sustainable management of koalas in the study area.

[redacted]

5.2.1 Activity levels

The activity levels at most active sites were similar to those described for sites located in the coastal areas near Bermagui (South East Forests Conservation Council 1997), the Numerella area (Allen 1999a) and the Campbelltown area (Phillips and Callaghan 2000) and reflect a widely scattered low-density population using secondary habitat. The low-density nature of the population was also reflected in the distance that often occurred between active sites and in the difficulty in locating sites in some areas that appeared to contain suitable habitat, namely Survey Areas 1b, 2a & b, 3a and 5a.

A few low-activity active sites had other pellet sites that were relatively easily located in their vicinity. An example of this is in Survey Area 1a where two plots were initially sampled, each giving an activity level of 8.33% and 6.66% respectively. Pellets were located at 6 other nearby sites during the survey and one active site was located soon after this. A subsequent assessment of one of these plots revealed an activity level of 14.7%. Because there was a relatively high number of active sites in this survey area, and because one of these had a relatively high activity level, this area should probably be included in any ongoing monitoring program.

Site Sh/008, which is to the south-west of Tolwong station and on the northern side of Tims Gully in the Morton NP, had the highest activity level (29%) of all those where data were collected. 8 out 17 *E. rossi* having pellets beneath, giving this species a comparatively high strike rate of 47% at this plot.

Active Site SH008

5.2.2 Browse and Habitat preferences

Phillips (see South East Forests Conservation Council 1998) considers that data on koalas' use of individual tree species are most useful for statistical analyses when they have been collected from a minimum of seven independent sites and where more than five trees of the species in question have evidence of koala use. On this basis too few data have yet been collected to enable robust statistical analysis of any koalas' use of any tree species in the study area.

Nevertheless some inferences can be made from the data that has so far been collected. One of these is the diversity of eucalypt species that were sampled in the study area (20 & one hybrid) and the high number of species under which pellets were found (16). This compares with a dataset of approximately the equivalent size from the Numerella area where 7 eucalypt species were recorded with pellets found under six of these (Allen 1999a). The high number of eucalypts reflects the presence and diversity of both coastal and tableland ecosystems and some eucalypts at the western (eg *E. viminalis, E. bosistoana*), southern (eg. *E. punctata*) and southernmost (eg *E. mollucana*) limits of their range in the study area. The diversity of trees being used by koalas reflects their diversity in the landscape and may be a factor contributing to the presence of koalas in the area.

The data suggests that koalas' use of habitat types in this area appears to be broadly consistent with those predicted to be the case for a koala population using secondary habitat (see Table 2, Section 4.2.) in coastal and tableland areas in SENSW (Phillips 2000).

Only one active site would probably not be considered to be koala habitat; that was where Gully Gum (*E. smithii*) was the only overstorey species present. Interestingly, this was a site where a koala was observed but where no fecal pellets were located. This suggests that the animal had not been feeding in this tree and may have been using it as a day-time roost site.

All other active sites would probably classify either as Class A or B secondary habitat or, in one case, as primary habitat (Appendix 1).

One of these sites (Sh/008), 8 out 17 Scribbly Gums (*E. rossii*) had pellets beneath them, giving the species a comparatively high strike rate of 47% at this site. *E. rossii* is not listed as a preferred species in Phillips (2000) and the high strike rate probably reflects the presence of the primary species, Cabbage Red Gum (*E. amplifolia*), at this site. Nevertheless, data collected in the Numerella area (Allen 1999a, AKF unpublished data) suggests *E. rossii* might possibly feature as a koala browse species in that area. The data collected at this site suggests that this may be the case as well. Appropriate statistical analysis (of a larger dataset) will be needed to establish whether or not this is the case.

Most of the sites were found in eucalypt associations containing Box/Stringybark complexes (CRAFTI 2000). Active sites were also located in Ribbon Gum/Narrowleaved Peppermint, Grey Gum/ Stringybark, Red/Ribbon Gum/Box, Stringybark and Scribbly Gum/Brittle Gum/Cabbage Redgum complexes (See Table 4, Section 4.2.5).

The following secondary feed tree species, all of which had evidence of koala use at one or more of these species, were present at one or more sites: Apple Box, (*E. bridgesiana*); Grey Box (*E. mollucana*); Yellow Box (*E. melliodora*); Coastal Grey Box (*E. bosistoana*); Red Stringybark, (*E. macrorhyncha*); White Stringybark (*E. globoidea*); Blue Stringybark (*E agglomerata*) Yellow stringybark (*E. muelleriana*), Brittle Gum (*E. mannifera*), Grey Gum (*E. punctata)*.

5.2.3 Primary feed trees

Three eucalypt species listed as primary species, Forest Red Gum (*E. tereticornis*), Ribbon Gum (*E viminalis*) and Cabbage Red Gum (*E. amplifolia*), were also present at one or more of the active sites sampled. However, none of the activity levels observed in the 14 active sites, nor the strike rates for the pooled data on each of these species, suggest that koalas are using these species as primary feed tree species or primary koala habitat (see Appendix 1).

Forest Red Gum (*E. tereticornis*)

Indeed, one active site (Sh/011), where 25 *E. tereticornis* were sampled, only one had a koala fecal pellet. This tree had a DBH (1126mm) that was larger than the other trees (between 255mm and 755mm). This plot was in an area of several hectares that had probably been cleared for grazing many years ago and now consisted primarily of regenerating *E. tereticornis* growing on sandy soil. No other evidence of koalas was found in the survey of this regenerating area. However koala pellets were located under another *E. tereticornis* (DBH 1003), an *E viminalis* (DBH approx 800mm) and an *E. globoidea* (DBH 392mm) near to this regenerating area. Time did not permit the collection of data at the other sites. The information gathered at SH001 and the surrounding area supports the case put by Phillips (2000) that *E. tereticornis* is not a primary koala feed tree when growing on an infertile substrate. It also suggests that tree size may be important in koalas' use of this species.

Ribbon Gum *E viminalis*

Another active site (Sh/009) was the only one with basalt substrate that was sampled during the survey. This site could be classified as primary koala habitat as 66% (22 out of 33) of the trees sampled were *E viminalis*. However koala fecal pellets were only found under one tree, an *E viminalis* with a DBH of 862mm, giving an activity level of 3.03%. A wider survey of the area (Survey Area 4a, Appendix 3) located a koala in another *E. viminalis* (DBH 830) and koala fecal pellets under an *E. globoidea* 820mm, an *E. sieberi* (530mm) and an *E. punctata* (681). All these sites were on basalt. Although no further data from these areas were collected the activity levels around these trees did not appear to be any higher than at plot Sh/009. Again, the larger DBH sizes of the trees used suggests that the koala's selection of trees at this site might be influenced by the size of these trees. No sites were found on the eastern part of this survey area where skeletal soils on sandstone predominated.

Phillips and Callaghan (in prep.) has suggested that the low activity levels such as those observed at both Sh/009 & Sh/00911 would be evidence that the koala's use of this area may be of a transitory nature. This would explain why Sh/011 had such low activity level even though it is clearly primary koala habitat. A related factor is that the area where overstorey vegetation growing on basalt in this survey area only extends over 10/20 ha while the rest of the basalt area has been cleared for grazing. Therefore the amount of suitable habitat may be relatively small.

Evidence of koala use of primary browse species is extremely rare in SENSW. For this reason alone both these sites and the surrounding area should be monitored and further data collected. The fact that 3 active sites were located near Sh/009 and 4 active sites were located near Sh/011 suggests that both areas may be more important that the low activity levels at the active site sampled might otherwise suggest.

Cabbage Red Gum (*E. amplifolia*)
The most commonly observed primary browse species in the study area was *E. amplifolia*. This was present in Survey Areas 1b and 3a, and was the predominant species in some of the steeper gullies in the survey areas in the Bungonia SRA. No koala fecal pellets were located under *E. amplifolia* in any of the areas searched apart from Sh/008 where four *E. amplifolia* were sampled with one having pellets beneath. This information, albeit limited, suggests that *E. amplifolia* may also not be a primary feed tree species where growing on highly fertile substrates.

The generally low strike rates of the primary browse species, the low activity levels in sites where primary feed trees are present and the difficulty in locating fecal pellets in search areas where primary and secondary browse species are well represented suggest that some of the koala habitat in the study area is currently unoccupied. Some evidence to support this comes from Bungonia where anecdotal reports indicate that koalas have only reappeared in the past five years following an apparent absence of 19 years following the 1977 wildfire (B. Richardson pers. comm.). This is consistent with evidence suggesting that koalas may take up to 30 years before beginning to recover from severe impacts (Phillips 2001). Given the above information, and the fact that the level of disturbance in the study area has lessened in recent decades, it could be concluded that population is only now starting to recover.

5.2.4 The gorge and gully areas
Apart from Survey Area 7a and 7b and parts of Survey Area 6b none of the steeper areas were searched for koala evidence in the surveys and no koala evidence was located in the above areas. It is the view of some ecologists that koalas prefer the more undulating areas (see references in Cork et al 2000). However, the following information suggests that important koala habitat could also be located in steeper areas:

- A site being used by a female with young was located on an extensive slope that was more than 25 degree in steepness in the Numerella region (AKF unpublished data);
- Koalas are also using steep country in the Strezlecki Ranges (J. Callaghan pers. comm.);
- The gorge systems in the Campbelltown area are a key habitat resource of the koalas in this area and provide important fire refuges (R. Close pers. comm.);
- The lower slopes of the some of the steeper areas in the study area support a higher proportion of primary feed tree species;
- Lower fuel loads in the steeper areas may reduce the severity and frequency of fire in some of these areas.

This information supports the views of those who provided information to the community survey that at least the less precipitous parts of the gorge systems in the study area may be an important part of the habitat that is sustaining koalas in the region.

[redacted]

The following information provides particularly strong evidence that a breeding association of koalas is present in and near to Survey Area 3b which is on the northern side of Tims Gully in the Morton NP:

- The area is close to locations where koalas had been both sighted and where, in September 1999 three koalas were heard bellowing (Warick Blaydon pers. comm., Appendix 3). Bellowing of this number of koalas would suggest the presence of at least one breeding female.
- The high activity level at this site is evidence of a more sedentary ranging pattern and thus within an area of major activity.
- The centre tree of Sh/007, which is within the survey area and is approximately 250m to the south of of Sh/008, was an *E. punctata* with many scratchmarks that were consistent with those made by a koala. This suggested one or more koalas had made repeated visits to this tree, raising the possibility that this is a home range tree (Phillips and Callaghan in prep). Despite this evidence the low activity level recorded at this site could also be interpreted that the koala's use of this site might be of a transitory nature.

[redacted]

Both the anecdotal information collected (Appendix 2) and the data collected in this survey indicate the following:

- A low-density population of koalas is spread at least in patches through the study area. This population probably mainly consists of breeding associations utilising secondary habitat as described in Phillips (2000) and NPWS (in prep.) that are linked by the movements of dispersing young.
- The habitat (primarily secondary habitat, Class B), the scattered nature of the active sites and the low activity levels at most active sites all suggest that the koalas have large home range sizes.
- Anecdotal evidence suggests that parts of the Tims Gully and associated areas (eg the Oaky Creeks) may sustain higher koala densities than those found in the current survey. However, apart from the survey areas 3a & 3b these catchments were not searched in this survey.
- The western side of the Shoalhaven Gorge has suffered a higher level of human impact in the past 150 years, primarily because of mining (G Richardson pers. comm.), clearing for agriculture and subdivision (Paul Alessi pers. comm.). Koala numbers may be very low in this area. However, the reappearance of koalas in the northern section of the Bungonia SRA in 1996 after apparently being absent since the 1977 wildfire gives some hope that koalas in this area are sufficiently robust to recover from catastrophic events.

A review of the Forest Ecosystems model undertaken for the Southern CRA (CRAFTI 1999) suggests there is approximately 7,500 ha of secondary habitat in the study area. Koalas in the Campbelltown area in similar habitat are estimated to have a population density of approximately .035 koalas per ha. (S. Ward pers comm.). If the average home range size of koalas in the study area is similar then it would have a potential carrying capacity of approximately 250 koalas. However, the scattered active sites and low activity levels suggest that some of this habitat is currently unoccupied and that koala numbers in the study area are lower than this. On the other hand the apparent robustness of the population and the relatively high number and scattered nature of recent anecdotal records does suggest a population of more than 100 koalas. On the basis of this information I estimate that the population is between 80 and 150 koalas.

The population may extend beyond the study area. However some of the surrounding areas are subject to the pressures of urbanization, rural subdivision, clearing for agriculture and mining, together with the absence of suitable habitat in some areas, probably indicates that koalas in these areas are widely scattered and few in number.

Given the limited and preliminary nature of the surveys, this population estimate must be considered tentative at present. Nevertheless this low number does suggest that if this population is disjunct, it is probably not viable in the long term (eg Briggs 1999) unless long-term management strategies that conserve and restore koala habitat in the study area and adjoining areas are implemented to improve its long-term viability.

[redacted]

An assessment of the importance of the Shoalhaven Gorge koala population needs to be undertaken in the context of what is known about other populations in SENSW. Koalas are rare and have declined in numbers in recent decades in this part of the state (Reed et al 1990). The most significant populations currently known are in the following areas:

- Campbelltown. This population is also utilising secondary habitat (Phillips and Callaghan 2000) in plateau country that is deeply dissected with gorges. It has a population of approximately 300 animals (R. Close pers. comm.).
- The Nepean and Avon catchments and surrounding areas. The koala population appears to be widespread in this area (Close et al 2000) and may also be in the low hundreds. This may be linked to the Campbelltown population through the movements of dispersing young.
- Canyonlea. A small population appears to exist on private land in this area (AKF unpub. data). The population size is unknown but it is unlikely to be more than a hundred koalas given the size of the forested area and the predominant nature of the habitat (A & B secondary habitat).
- Numerella. A relatively robust population appears to exist across various land tenures in this region (Allen 1999a, AKF unpub. data). The population size is unknown but it is probably not more than a hundred koalas given the size of the forested area and the poor quality of much of the habitat.

- The NSW Far South Coast. The number of koalas in this region is a contentious issue with estimates as high as 1500 animals (Jurskis et al in prep). After reviewing the available data, which included an estimate as low as 50 surviving koalas, Briggs (1999) concluded that the number may be in the low hundreds.

Of these populations the first two are close to large urban areas. Increasing urbanisation and accompanying severe and frequent wildfires threaten both populations.

There may be other significant koala populations in SENSW but information about these is not currently available.

The koala population in the Shoalhaven Gorge study area is important for the following reasons:

- It is probably amongst the larger of the koala populations in SENSW;
- It appears robust enough for there to be a relatively high number of anecdotal sightings from a small rural community and also appears to be recovering from the 1977 wildfire, at least in the north western portion of the study area;
- There is a diversity of coastal and tableland eucalypt communities sustaining this population that could therefore be a source from which the young may disperse to both coastal and tableland areas;
- Much of the habitat sustaining the core of the population (particularly the Tolwong Plateau, Figure 1b) is protected geographically by the Shoalhaven and associated gorges. This geographical remoteness means that human impacts are likely to be less than those impacting on other populations;
- Although this koala population is functioning primarily in secondary habitat this does not lessen its significance. This is the case for almost all known koala populations in SENSW. Koalas are well adapted to living at low densities and indeed this form of habitat use may have been the norm before European settlement (Martin 1992).
- The gorge country also provides extensive fire refuges;
- Much of the habitat is also protected because it is in the Morton NP and Bungonia SRA;
- The rural communities adjacent to the reserves are relatively small and, with the exception of the subdivisions occurring to the south-west and south of the study area, recent human impacts on existing forest have been relatively low. There is a good opportunity to build a partnership with the NPWS to jointly care for the habitat sustaining this population.
- The population offers important opportunities for further koala research into low-density populations (see 5.6, below).

[redacted]

5.6.1 Research

Despite the importance of low-density koala populations in SENSW (Martin 1992) little research has been undertaken into their ecology. This is primarily because koala evidence is difficult to locate in habitat used by low-density populations. The Campbelltown koala population has been studied (eg Ward and Close 1998). Research has also been undertaken in the NSW Far South Coast region (Jurskis and Potter 1997, South East Forests Conservation Council 1998, Allen in prep.). Survey work has also been undertaken in the Numerella region (Allen 1999a, Allen and Callaghan in prep.). This is probably the extent of this work in SENSW.

Because the koala population in the Shoalhaven Gorge region appears relatively robust and koala evidence is relatively easy to obtain, there are good opportunities for koala research in the region (see Recommendations, Section 6.1 for further details).

5.6.2 Monitoring; the role of permanent study plots

In order to demonstrate that koala populations are being sustainably managed effective monitoring techniques are required. These need to be able to confirm koalas' ongoing occupation of particular areas and gauge population trends.

Developing appropriate techniques for medium or low-density koala populations is difficult and no commonly agreed approach has yet been developed. Probably a combination of techniques is necessary. These could involve the careful monitoring of anecdotal sightings, a taped calls program repeated perhaps every five years, and the establishment of permanent study plots (PSP's) at appropriate locations that are revisited on an annual basis.

Pilot projects have been initiated in the Tweed Heads area of northern NSW (Phillips pers. comm.) and the Bermagui area of SENSW (Allen 2001) where have PSP's been established at active sites. These sites have been selected because they have evidence of intensive or repeated use. Revisiting them on an annual basis may provide an efficient way of assessing whether koalas are still in specific areas.

Such sites were also located during the surveys that are the subject of this report (Table 3). Those selected as potential PSP's in the study area had a range of characteristics that suggested they might be appropriate for long-term monitoring. This included the following:

- Evidence of repeated or intensive use;
- Koalas using *E. tereticornis*. Two sites are included because in each case, pellets were located under this species, which was also the predominant eucalypt in the search area (5b). Although these eucalypts were growing in infertile soils and this area would not be considered to be primary koala habitat, revisiting this site is justified in this case because evidence of koala use of this important browse species is rare in SENSW;
- Sites in primary habitat (two sites);

It may also be appropriate to include the more intensively used sites in Search Area 1b in this survey.

If possible, these potential PSP's, and if possible the surrounding areas, should be revisited in the September/November survey (See Recommendations, Section 6.1.2).

[redacted]

The major threats to the koala population in the Shoalhaven Gorge region appear to be the following:

5.7.1 Wildfire

Wildfire is regarded as a serious threat to the survival of koalas (ANZECC 1998). For example, in the NSW Far South Coast region there is extensive anecdotal information of local extinctions of small koala populations caused by the 1952 wildfire. Koalas do not appear to have returned to many of these areas (Allen in prep.).

An example of the long-term impacts of severe wildfire can be found in the Mundoonen NR where, 1979 approximately 50% of the Reserve was severely burnt, probably killing the koalas in that area. Results of a survey in 1999 (Allen 1999c) suggested that the koalas were surviving predominantly in the areas that had not been burnt since before 1920 and koalas had not returned to much of the burnt area.

Koalas also appear to have been destroyed in the Bungonia SRA by the 1977 wildfire, with no sightings recorded in the SRA between then and 1996.

5.7.2 Fuel reduction burning

Whilst koalas probably gain some protection from wildfire on hot summer days by seeking the shelter of moist cool gullies, they may be more vulnerable to higher intensity fuel reduction burns in the cooler months. Anecdotal evidence suggests that they probably favour warmer areas as roosting locations on sunny winter days and these areas are more likely to be targeted for such burns and to burn more severely.

High frequency fires, even at low intensity can reduce the quality and availability of habitat for koalas, particularly by reducing the regeneration of preferred trees and change floristics by promoting fire-retardant species (NPWS in prep).

5.7.3 Habitat removal and degradation associated with subdivision

Extensive subdivision has occurred in koala habitat in forest and woodland areas that are to the south west of and contiguous with the study area. Clearing for house sites, fire protection and fencing, an increase in domestic and escaped domestic dogs and logging for firewood has accompanied this process. There appears to be an associated decline in koala numbers in this area (Paul Alessi pers. comm., Table 8, Appendix 2).

Although the Native Vegetation Conservation Act (1998) is supposed to prevent large scale clearing of native vegetation on private land there is little protection afforded against the incremental impacts of widespread smaller-scale clearing and logging for domestic purposes. Furthermore the current NSW

government regulations (SEPP 44) designed to conserve some "core" koala habitat does not in fact protect any secondary habitat: no secondary/supplementary browse species are listed in the Schedules (Koala Food Tree Species) that guide the implementation of these regulations (Department of Planning 1995). Discussions are currently underway so that this list can better reflect existing knowledge about koalas' tree species preferences (S. Phillips pers. comm.) However, the protection of unoccupied koala habitat is unlikely under these regulations.

Therefore, with increasing pressures of subdivision the incremental pressures of habitat clearing and degradation will probably reduce the ability of private land to sustain koalas in some areas unless this process is accompanied by koala habitat conservation and restoration initiatives that are at least commensurate with those associated impacts.

5.7.4 Main Rd 92

Because koalas are vulnerable to road traffic (ANZECC 1998) the increase in the speed and number of vehicles that would be associated with the proposed upgrading of Main Rd 92 poses a threat to the koalas in the study area. The key area of concern is the area of koala habitat between Bullee Gap and just west of the Endrick River Bridge, which is approximately three kilometers to the north-east of Nerriga. At this point the road has several corners as it traverses moderately steep country.

The relatively large number and persistence of koala records indicates that a breeding population is near to and is probably utilising the vegetation on both sides of the road in this area. This area may be sustaining the southern edge of the population, or it may form an important corridor with breeding associations (if they are persisting) to the south. Whatever the case the longer-term management of this area should be based on the assumption that this is sustaining a breeding association of koalas and is at least potentially a key north/south corridor.

A related threat to this development is the increasing human impacts that are likely to occur as a result of upgrading the road. These include an increased likelihood of wildfire and subdivision pressures with the accompanying pressures for habitat destruction and degradation discussed above.

Two options are proposed for this road (R. Pietsch pers. comm.). The first is to upgrade and straighten the existing road so that traffic can move more quickly though the area. The second is to build a new road throuh relatively undisturbed koala habitat in the Willies Creek catchment. This is discussed further in Recommendations (Section 6.4)

6. RECOMMENDATIONS

[redacted]

6.1.1 Overview of survey and research requirements

The koala survey described in this report is a first step in what needs to be an ongoing survey and research program in the study area. More information is required to gain sufficient understanding to be able to confidently monitor and sustainably manage this koala population. This includes:

- A robust database on koalas' tree species preferences in the region (See 6.1.2, below);
- A greater understanding of the relative importance of primary and secondary browse species; (Appendix 1);
- A more accurate estimate of population size and trends;
- The location and assessment of the ecological characteristics of breeding female areas;
- The role of gorge areas as fire refuges;
- Research to assess whether higher activity levels at active sites reflect the core areas of koalas' home ranges; and,
- The effectiveness of koala habitat restoration efforts in assisting the recovery of koalas.

The following sections discuss the next steps to gather this information.

6.1.2 Targeted taped calls and sweep search surveys

The NSW Koala Recovery Plan (NPWS in prep) proposes to develop regional koala habitat models for key regions that are based on identifying preferred floristic ecosystems where koala browse species are well represented. As there are insufficient data on koalas' preferred browse species in this part of NSW to enable appropriate robust statistical analysis, the modeling process is dependent on gathering further data.

Furthermore discussions are currently being undertaken with DUAP (S. Phillips pers. comm.) to redefine koala habitat on the basis of what we understand to be primary and secondary koala browse species. Again, robust data is required for this to be completed.

For these reasons, gathering further data on preferred browse species, using sweep surveys to locate active sites, should be a primary initial objective of field surveys. Data collection at these sites should follow the methods described in this report so that data can be pooled with those that already exist on browse species preferences in the region. These surveys will provide the opportunity to revisit the potential permanent study plots (Table 1) and surrounding areas to assess whether further koala activity has occurred there.

A survey using the taped calls of a male koala should be undertaken in conjunction with the sweep search survey. This will need to be undertaken during the koalas' breeding season (September/November). The methods used in the survey need to be finalised but should if possible be consistent with those used in the koala playback survey undertaken in the Southern Region for the CRA. In developing the methods the following should be considered:

- Primarily for ease and repeatability of this survey the locations where the calls are played should be accessible by vehicle;
- The locations should be a minimum of one kilometer apart to try to ensure that any responses recorded are coming from different koalas;
- There should be a minimum of three participants in each survey team that should be stationed along the road approximately 300 meters apart to maximise the chances of hearing responses;
- Sweep search surveys should be undertaken as soon as possible in areas where positive responses are recorded.

The potential permanent study plots could be revisited in this survey and assessed whether koalas have used the site in the intervening period. If possible the surrounding areas should also be briefly examined. Decisions can then be made as to whether they should be included as plots to be monitored annually.

Table 7 lists the areas and locations where, in order of priority, targeted taped calls and sweep search surveys should be undertaken between September and November 2002 and provides an estimate of the time that could be spent on these surveys. The table also provides the locations of associated potential permanent study plots that could be revisited. It is assumed that a survey team would consist of 5/6 people.

Table 7: Areas where, in order of priority, targeted taped calls and sweep search surveys should be undertaken between September and November 2002, estimated time to be spent on the surveys and the locations of associated potential permanent study plots.

Locality	Details	Approx. sweep search survey time	Suggested coordinates for associated taped call locations	Approx. survey time for taped calls (< 3 people)	Associated potential PSPs to be revisited
West of Tulleyangela Clearing	Area between Little Oakey and unnamed creek to north	2 team days	239625/6128150 239200/6129350 238950/6130550 240000/6131400	1 team evening	239376/6131270
North west of Tulleyangela Clearing	Area between unnamed creek and North Oakey Creek	2 team day	<1k intervals from above to join with Tolwong taped call stations	1 team evening	
South west of Tolwong Station	South west of survey areas 3a & 3b	2 team days.	236800/6137650 237375/6138075 237250/6139225	2 team evenings	236173/6138504 236122/6138706

			236100/6138725 Then <1k intervals along track to Tolwong mines		
Vicinity of Ironpot Clearing		1 team day	236600/6140300 235650/6142000 234850/6142900 234900/6143800 233750/6143275 234050/6144300 234050/6145675	2 team evenings	234948/6143680
Bulee Gap	Willies Creek	1 team day	238050/6113250 237375/6114200 236375/6114100 236725/6115300 Then <1k intervals on track towards Douglas Paddock	2 team evenings	
Bungonia SRA			To be finalised Include lookout locations.	2 team evenings	226772/6143905 226191/6143268
Tims Gully	Peach Tree Canal/ Windeglass spur	1 team day			
Phoenix property and north	Beesnest NR & Rolfe's Property	2 team day	228600/6115000 229750/6156550 230750/6115300 229600/6117275 229000/6117700 230000/6118300 Then <1k intervals on track north	2 team evenings	229100/6114266 & Survey Area 1a

N.B. The priority ordering in this table is based on selecting those areas that appear most likely to provide data on koalas' habitat use. If it is considered important to gather to assist assessing the impacts of Main Rd 92 then the Willies Creek survey should be given higher priority.

Other objectives of this survey program could include:

- Locating areas used by breeding females (primarily by locating sites with large and small fecal pellets of consistently different sizes);
- Locating potential permanent study plots (see Methods, Section 4.3);
- Locating active sites where primary feed tree species are well represented;

Recommendation 1:

Undertake taped call and sweep search surveys between September and November 2002 at locations and in areas listed in Table 7 and assess whether koalas have used the potential permanent study plots and surrounding areas listed in the same table. Collect data at appropriate active sites using the methods described in this report.

6.1.2 Involving a tertiary educational institution

Some of the information needed to sustainably manage the koala population in the study area (see 6.1.1) could be obtained through a research project involving a post-graduate student. Gaining the support of an educational institution able to undertake such an initiative would enable a cost-effective contribution to the survey program. Contacting potential supervisors would be a first step in this process. I suggest that discussions are initiated with Professor Rob Close (University of Western NSW, 0246203203) and Dr Steve Phillips (Griffith University 0755528498) seeking their advice about this.

Recommendation 2:

Approach appropriate tertiary education institutions and encourage their participation in a post-graduate study of koalas in the study area.

6.1.3 Vegetation modeling/mapping

One of the objectives listed in the NSW Koala Recovery Plan (NPWS in prep) is to develop regional habitat models for key regions across the geographic range of the koala in NSW. Management issues such as the maintenance of appropriate fire regimes and research issues such as the quantifying habitat and assessing population trends require an accurate model of koala habitat.

The primary layer of any koala habitat model needs to be the floristic ecosystems or eucalypt constellations in which primary and secondary koala browse species are well represented (eg Lunney and Mathews (2000), Phillips and Callaghan (2000) and Allen and Clarke (2001).

A preliminary assessment of the forest ecosystem mapping for the Southern CRA (NPWS 2000a) suggests that it is not yet sufficiently accurate on a fine scale to be useful for the purposes of koala habitat modeling in the study area. On the other hand the project that modeled the overstorey component of broad floristic groups using aerial photographic interpretation methods (CRAFTI 1999) appears to more accurately reflect existing vegetation in the study area. However, the floristic group classification used in this project may be too broad to confidently select those forest/woodland complexes that should be included as koala habitat.

There are good reasons to refine the Southern CRA forest ecosystem mapping so that it more accurately reflects existing vegetation in the study area. This would be essential for the maintenance of appropriate fire regimes generally and for the accurate identification of threatened floristic ecosystems. The refinement of similar forest mapping of the Eden region has been undertaken (Max Beukers pers. comm.) so that this can be confidently used as a management tool. If a similar refinement was undertaken for vegetation mapping within the study area then this would probably provide the most useful primary layer on which to base the koala habitat model for the study area.

However, the process for selecting appropriate regional models of floristic ecosystems should probably be developed at NSW Koala Recovery Team level so that a consistent approach to koala habitat modeling is undertaken throughout NSW. Discussions regarding this issue should include the Australian Koala Foundation as this organisation has had most experience in developing koala habitat models that are based primarily on floristic ecosystem models or maps.

Recommendation 3: Ensure that the process for selecting the floristic ecosystem map to be used as a primary layer in a koala habitat model for the study area is consistent with modeling undertaken as part of the NSW Koala Recovery process. If it is to be used as the basis of the koala habitat model, refine the forest ecosystem mapping for the Southern CRA so that more accurately reflects existing vegetation.

6.1.4 Opportunities offered by the Bungonia SRA

For the following reasons the northern part of the Bungonia SRA offers important research opportunities for monitoring and research of koalas:

- The available evidence suggests that koala numbers are beginning to recover in this area following the 1977 wildfire;
- The facilities in and easy access to this area would facilitate research efforts;
- Particularly given the presence of NPWS staff and the high number of visitors to this area, there are good opportunities to establish a koala monitoring program that assesses population trends and habitat use in the SRA;
- The presence of NPWS staff also may offer greater opportunities for effective fire management and monitoring of impacts on koalas in the event of fire;
- Much of the area is young forest recovering from past human disturbance with a relatively high proportion of primary and secondary browse species. There are also some cleared areas and some patches where only one or two overstorey species are growing. This offers an excellent opportunity to undertake to establish this as a demonstration site for best practice koala habitat conservation and restoration where the establishment of a high diversity of koala browse and appropriate understorey species in those areas where overstorey vegetation cover and diversity are currently lacking is undertaken;
- In the long term the monitoring of koalas' use of re-vegetated areas could provide valuable information as to the effectiveness of koala habitat restoration works.

Such research and restoration activities, combined with the high visitor-rate to the SRA, offers important opportunities to the NPWS to develop a public education program based in the Bungonia SRA. This could inform many people about low-density koala populations in SENSW, the work that is being undertaken to improve our understanding about them, the efforts of the Service to care for and restore koala country that it manages and the important role that adjoining landholders have in this work.

Recommendation 4:

Maximise the research, koala habitat conservation/restoration and public education opportunities offered by Bungonia SRA.

Develop an integrated survey and research plan

One of the most rewarding aspects of the koala survey that has just been undertaken was the enthusiastic involvement of NPWS staff and members of the local community and the bush-walking fraternity. Maintaining this level of involvement should be a key strategy of the survey and research program both because of the increased information that will be collected and the educational and training opportunities that will be provided. Developing an integrated survey and research plan to maximise the effectiveness of this involvement will assist this process. Any post-graduate studies that are initiated should be part of this integration.

Such an approach should also encourage the involvement of the local Aboriginal community

The Australian Koala Foundation has also undertaken field surveys in the Southern Tablelands and Highlands MA and gathered data on browse species preferences. The Foundation intends to continue this work and would be supportive of such an integrated approach.

Recommendation 5:

Develop an integrated research plan and program that involves the local community, members of the bushwalking fraternity, local Aboriginal communities, appropriate NPWS staff from the zone and districts, NPWS TSU staff involved in the NSW Koala Recovery Program, tertiary education institutions and the Australian Koala Foundation.

[redacted]

6.2.1 Habitat conservation and restoration on private land

A number of active sites were found on private land, particularly on Portion 133, near Ironpot Clearing and near Tullyangela Clearing. This highlights the importance of private property for the Shoalhaven koala population, particularly as those private property areas may in more fertile areas that are able to sustain more nutritious browse (see references in Cork et al 2000).

In addition, even though extensive forest and woodland areas in the study area may not be occupied by resident breeding associations of koalas they may be important for dispersing young and may act as a buffer between agricultural land and occupied koala habitat. In the medium to long term these areas may become important koala habitat particularly in the more fertile parts of the study area.

For this reason the conservation and restoration of koala habitat needs to be encouraged amongst local landholders and indeed, the sustainable management of koalas can be used as a good example for why the conservation and restoration of existing bushland is important.

Establishing conservation agreements on private land is an increasingly important strategy for the conservation of important ecosystems on private land. For example, in the Bega Valley area an initiative in the mid nineties by a few landholders to establish voluntary conservation agreements (VCAs) on their properties has resulted in a snowball effect with more than 50 VCAs having being signed in this area (Allen in prep).

Such a process could also occur in the study area and adjoining lands[1].

[1]

To assist community understanding about importance of the koala population and the habitat that sustains it a mail-out to local landholders should be undertaken, perhaps with the support and involvement of the local landcare movement. This can inform local landholders of the importance of conserving and restoring koala habitat on private land, options for reaching conservation agreements with the National Parks and Wildlife Service or the Department of Land and Water Conservation and ways in which restoration works can be integrated into normal farming practices.

Recommendation 6:
Undertake a mail-out to local landholders, preferably with the support and involvement of the landcare movement. This should discuss the importance of conserving and restoring koala habitat on private land, ways in which restoration works can be integrated into normal farming practices and options for reaching conservation agreements with the National Parks and Wildlife Service or the Department of Land and Water Conservation.

6.2.2 Tolwong Station

The Tolwong Station is a unique property on Tolwong Plateau. It is a series of portions scattered through the Morton NP within what is considered to probably be the core area sustaining koalas in the study area (see Discussion Section 5.3). The sizes of these portions vary between 40 and 200 ha and the total holding is approximately 1000 ha. Most of these portions (largely the most fertile areas) have been cleared for grazing in the past. Some of these portions are now regenerating, including areas where there is a high proportion of koala primary browse species (eg Ironpot Clearing, Survey Area 4a) and as such are potentially a key long-term resource for koalas in the study area. For this reason the future ownership and management of this property is important to those responsible for the sustainable management of the koala population.

Options should be therefore explored that could assist koala habitat conservation on and adjoining Tolwong Station. These could include:

- The purchase of the property by the NPWS or Bush Heritage Fund if all or any portions become available for sale;
- Discouraging the break-up of the property into smaller holdings which would inevitably result in greater human impact;
- Support any owner who wishes to reach a Conservation Agreement on appropriate portions that assists the conservation of existing koala habitat and encourages its restoration on adjoining areas.
- Maintaining a good relationship with the owners and informing them as much as possible about koala recovery efforts in Shoalhaven Gorge region. Funding options for koala habitat restoration could also be explored if the present or future owners are interested.

Recommendation 7:
Explore options to assist koala habitat conservation at Tolwong Station. This could include purchase, property management or voluntary conservation agreement on some parts of the property, support for habitat restoration works and informing owners of koala conservation efforts in the Shoalhaven Gorge region.

[redacted]

As emphasised in Section 6.1.1 more information is required to confidently enable the sustainable management of the koala population in the study area. This includes the management of fire in koala areas. The suggestions and recommendations below are given on the basis that fire management needs to be an iterative process that develops and can change as more data becomes available.

Although wildfire is a major threat to koalas in the study area it is also a natural part of its ecology. Hence, the maintenance of fire regimes within the lower and upper temporal threshold appropriate to particular ecosystems, with temporal and spatial variation in fire regimes across the landscape, is a management strategy that should be generally supported.

Within the context of that strategy management options that reduce both the severity and frequency of fire (Martin 1989) is also supported. Some of these options include:

- Undertaking koala surveys in areas where fuel reduction is proposed and planning this activity so that the burning of areas of high use is minimised with other methods of fuel reduction being considered if necessary. These surveys should be integrated into the survey and research program discussed above

and could probably best be undertaken by those engaged in the burning operations, provided there is appropriate guidance. Such an approach would reduce the chances of koalas being injured or killed in fuel reduction burns, encourage a greater awareness about koalas amongst NPWS staff, and contribute to the survey and research program.

- Supporting landholders maintain low fuel loads on edge of forest and woodland areas, particularly on the western edge of the Bungonia SRA. This can be achieved through stock grazing, encouraging native herbivors and also with limited and carefully controlled fuel reduction burns.
- Considering establishing low-fuel zones in areas along the road to Tolwong station, particularly in patches of vegetation where Scribbly Gum *E. sclerophylla* predominates. This would reduce the threat of wildfire entering what appears to be the core koala area.
- Informing the Regional Fire Service (RFS) and land managers of the likely distribution and importance of the koala population in the Shoalhaven Gorge region, the vulnerability of the species to fire and the need to minimise the frequency and severity of fire in koala areas.

In the event of fire, searches for injured koalas in the burnt areas should be undertaken if possible. Local people who have contributed to this project could be encouraged to participate in this. Appropriate veterinary services and facilities for the care of injured animals should also be available.

Recommendation 8:
Develop strategies to minimise the severity and frequency of fire regimes, particularly in core koala areas. This could include the strategic support for landholders on the edge of koala areas to maintain low fuel loads. Maintaining low fuel loads in patches of non-koala habitat along the road to the Tolwong Station should also be considered. The Regional Fire Service should be informed of the likely distribution and importance of the koala population. Koala surveys should be undertaken in koala habitat before fuel reduction burns are undertaken.

[redacted]

Because the proposed upgrading of Main Rd 92 poses a threat to koalas particularly in the Endrick River Bridge/Bulee Gap area (Section 5.7.4) the NPWS should advise relevant parties that ameliorative measures would be helpful to reduce the potential impacts on the population. There may be other important locations along this route but further research is required to establish whether this is the case.

Of the two options currently available for this area that of upgrading the existing road would be preferable to cutting through relatively undisturbed koala habitat to construct a new road in the Willies Creek area. The most beneficial outcome for koalas would be if the works undertaken retained all existing sharp bends so that reduced vehicular speeds are encouraged. Such an approach would only increase journey time by a few minutes but would both offer considerable savings, as well as assisting the conservation of koalas. Some of these could be allocated to good signage that informs drivers of the necessity of driving carefully through the area, and ongoing koala research in the area. These savings would probably also cover the costs of the erection of koala-proof fencing and construction of one or two animal tunnels under the road, which have been used to good effect in north-east NSW (S. Phillips pers. comm.).

Recommendation 9: Advise those planning the upgrade of Main Rd 92 that minimal works on the existing section of Main Rd 98 in the Endrick River Bridge/Bulee Gap area would be the best option to reduce impacts on koalas. The moneys thus saved could be allocated to good signage and further koala research. The erection of koala-proof fencing and construction animal tunnels under the road could also be considered.

[redacted]

6.4.1 An important source population for the NSW Koala Recovery Program

The information presented in Section 5.5 of this report indicates that the koala population in the study area is an important source population and has a key role to play in koala recovery efforts in SENSW. This is particularly the case as the population is spread into two koala management areas (the South Coast and Southern Tablelands and Highlands Management Areas) as defined by the NSW Koala Recovery Plan (Appendix 1) and possibly extends into a third (the Central Coast Management Area). Furthermore, unlike many koala populations in NSW (Reed et al 1990) the core koala area appears to be mainly in areas

managed by the NPWS and as such provides the Service with an important opportunity to demonstrate how to sustainably manage a low density-koala population.

On this basis the management of koalas in the study area should be considered by those developing and implementing the NSW Koala Recovery Plan as a case study for the sustainable management of low-density populations, information about which is made available to appropriate NPWS staff and other interested parties.

Recommendation 11:
Encourage those developing and implementing the NSW Koala Recovery Program to regard the management of koalas in the study area as a case study and disseminate information about this amongst relevant NPWS staff and other interested parties.

6.4.2 Seeking funding to employ a koala recovery co-ordinator

Currently the NPWSTSU employs a part-time casual employee to co-ordinate the implementation of locally agreed koala recovery actions in the South Coast Management Area. To date the primary focus of these activities has been in the southern portion of the management area.

The recommendations in this report would be most effectively implements if a similar position was established to undertake this work in the study area and surrounding areas. This is particularly because the development of a partnership with the local community will occur more effectively if there is an individual clearly identified who can be responsible for the necessary communication and compiling of information.

The NSW Koala Recovery Plan will be seeking funding to enable the implementation of actions proposed in the plan (NPWS in prep). The provision of funding to employ a coordinator to manage the implementation of recovery actions in the management areas where this population is located should be a part of the plan's funding package.

Recommendation 12:
Encourage the NSW Koala Recovery Program to seek funding to enable the appointment of a coordinator to manage the implementation of recovery actions in the Shoalhaven Gorge region.

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Appendix 1: DEFINITIONS OF TERMS AND CONCEPTS

[redacted]

The “strike rate” for a particular tree species refers to the level of use of that species by koalas as revealed by presence/absence data from a pooled dataset of tree species use by koalas (Phillips 2000 and Phillips in prep). For example, if 25 trees from a sample of 100 have koala evidence the species would have a strike rate of .25. This is used to measure the relative importance of, and to categorise browse species (see 1.2 below).

The "activity level" refers to data from individual plots that compare the number of trees with evidence of koala use with those without (Phillips 2000 and Phillips in prep). For example, if 15 trees from a particular plot have evidence of koalas out of a total sample of 30 trees then this plot would have an activity level of 50%. This measurement is used to measure relative importance of and to define habitat categories (see 1.3 below).

[redacted]

1.2.1 Primary and secondary and/or supplementary browse species

Phillips (2000) lists and categorises koala browse species present in each management area. The selection of these species is based on statistical analysis of data using the tree sampling methodology used in this survey (see Methods, Section 4.2). The approach is supported by a robust database for NSW the bulk of which is maintained by the Australian Koala Foundation (29,038 trees from 571 independent sites). Additional data is held by the South-East Forests Conservation Council (3,543 trees from 133 sites).

On the basis of the "level of use" by koalas of these eucalypt species demonstrated by these data Phillips (2000) classifies koala browse species as primary and secondary and/or supplementary species and provides the following definitions of these categories:

> *Primary food trees exhibit a level of use that is significantly higher than that of other Eucalyptus spp. while also demonstrating a mode of utilisation by koalas that is independent of density as demonstrated by the simplified logit models of Phillips et al. (2000).*
>
> *Secondary and/or Supplementary* food trees, invariably exhibit (on average) a significantly lower level of use than a primary food tree while also demonstrating evidence of more complex variables associated with their use, generally by being both density and/or size class dependent (see Phillips and Callaghan 2001).*
>
> *Supplementary food trees arguably represent a third tier in the koala food resource. In common with secondary food tree species they exhibit a level of utilisation that is also size class/density dependent. However, the levels of utilisation of supplementary food tree species are generally lower that that of a secondary food tree species, and possibly dependent upon the presence of the latter in the first instance. Interestingly, supplementary food tree species invariably tend to be Stringybarks but with significant variation in the use of some species across their range.*

1.2.2 Browse species in the South Coast and Southern Tablelands and Highlands MA

In the South Coast Management Area the browse species listed Phillips (2000) are as follows:

> Primary Food Tree Species: Cabbage Gum *E. amplifolia*, Ribbon Gum *E. viminalis*, Forest Red Gum *E. tereticornis*.
>
> Secondary Food Tree Species: Yellow Box *E. melliodora*, Brittle Gum *E. mannifera*, Yertchuk *E. consideniana*, Swamp Gum *E. ovata*; Large-fruited Red Mahogany *E. scias*, Apple-topped Box *E. bridgesiana*, Monkey Gum *E. cypellocarpa*, Woollybutt *E. longifolia*, Maiden’s Gum *E. maidenii*, Snow Gum *E. pauciflora*, Red Box *E. polyanthemos*, Coast Grey Box *E. bosistoana*, Blue Box *E. baueriana*, Bastard Eurabbie *E. pseudoglobulus*.

Stringybarks: White Stringybark *E. globoidea*, Yellow Stringybark *E. muelleriana*, Blue-leaved Stringybark *E. agglomerata*, Brown Stringybark *E. capitellata*, Southern White Stringybark *E. yangoura*, *E. baxteri*.

In the Southern Tablelands and Highlands Management Area the browse species listed in NPWS are as follows:

Primary Food Tree Species: Ribbon Gum *E. viminalis,* River Red Gum *E. camaldulensis.*

Secondary Food Tree Species: Candlebark *E. rubida*, Eurabbie *E. bicostata*, Broad-leaved Sally *E. camphora*, Argyle Apple *E. cinerea*, Maiden's Gum *E. maidenii*, Swamp Gum *E. ovata*, Bundy *E. goniocalyx,* Blakely's Red Gum *E. blakelyi*, Apple-topped Box *E. bridgesiana*, White Box *E. albens*, Yellow Box *E. melliodora,* Western Grey Box *E. microcarpa*, Red Box *E. polyanthemos*, Large-flowered Bundy *E. nortonii*, Snow Gum *E. pauciflora*, Tumbledown Gum *E. dealbata,* Brittle Gum *E. mannifera*, Mountain Gum *E. dalrympleana*.

Stringybarks: Red Stringybark *E. macrorhyncha*, Yellow Stringybark *E. muelleriana*.

Author's notes:

- Although a formidable database exists for some management areas, sufficient data to enable robust statistical analysis is yet to be gathered for the Southern Tablelands and Highlands area. Phillips (South East Forests Conservation Council 1998) considers that data relating to a given tree species is most useful when it has been collected from a minimum of seven independent sites and that *niPi* and *n(l-Pi)* are both equal to or greater than 5.
- Phillips (2000) noted that while the majority of koala food trees do not appear to exhibit any significant variation across substrates, field data suggests that *E. tereticornis* and *E. viminalis* exhibit significant substrate-based differences in their use as food trees. Both species clearly conform to the primary food tree criteria when growing on nutrient rich (eg volcanic and/or alluvial) substrates; but do not demonstrate the same patterns of use on low nutrient (eg podzolics and/or upland) substrates.
- The species list presented here is that which occurs in NPWS (draft). As a result of the surveys that are the subject of this report, additional species have been recommended for each of these lists.

[redacted]

Based on this categorisation koala habitat is then classified according to the proportion of primary food trees, secondary and/or supplementary food trees present within an active site. The NPWS (draft) provides the following definitions:

Primary Habitat: Areas of forest and/or woodland wherein primary food tree species comprise the dominant (ie > 50%) overstorey species. Capable of supporting high density (>0.75 koalas/ha) koala populations.

Secondary Habitat Class A: Primary feed tree species present (but not always) growing in association with one or more secondary species. Capable of supporting medium density (>0.10 - koalas/ha but < 0.75 koala/ha) koala populations.

Secondary Habitat Class B: Primary food trees absent, habitat comprising of secondary and supplementary food tree species only. Capable of supporting viable, low density (<0.10 koala/ha).

[redacted]

Due to the wide distribution of koalas in NSW and the variation in issues related to its ecology and conservation across the State, the NSW Koala Recovery team designated seven management areas for the purpose of recovery planning and management (Phillips 2000). These management areas are broadly based on the distribution of food tree species but have been adjusted to follow local government area boundaries.

The study area that is the subject of this report spans two such areas: the Southern Tablelands and Highlands Management Area (ST&HMA) and the South Coast Management Area (SCMA), with the boundary between the two being that of the Shoalhaven and Tallaganda Shires (Figures 1a & b). Directly to the north is a third management area, that of the Central Coast MA.

Appendix 2: SUMMARY OF SUPPLEMENTARY INFORMATION

[redacted]

Table 7 provides koala records gathered in this study in addition to those recorded in the field survey. Most of this information came from the community survey. Wildlife Atlas records and others provided by NPWS staff are also included.

Table 7: Locations of anecdotal records

Date	Who	UTM Zone	AGD Eastings	AGD Northings	Details
1930 –2000	Kevin Smith				Has regularly seen koalas to the north west of Nerriga
1930 – 2002	Mick Crisp				Has seen koalas on average 6/12 times a year on the north of the Tolwong Plateau
1975 -2002	John & Barbara Hay	56 56	237500* 237625*	6116500* 6115375*	Regularly heard koalas in forested area to the east their home and seen koalas on road north of Rolfes Gap
1980 approx	Arthur Newling	56	229700	6120000	His bother-in-law probably observed koala.
1886 approx	Kevin Buchan	56	236150*	6113600*	Observed koala running along the road just in from the junction off the Endrick River Bridge.
1990 -2001	Cliff Harris	56	238500	6113500	Regularly observed koalas on Tolwong Plateau, west of Tulleyandra Clearing
1993 (approx.)	Kevin Buchan	56	236150*	6113600*	Koala observation reported to Kevin Buchan.
?/9/1991	Warick Blaydon	56	238800	6130400	Observed koala
1995	NPWS Officers	56	240300	6125300	Observed koala
1996 (approx.)	Wayne Beckenham	56	235500	6166100	Observed two koalas
1996 (approx.)	Cliff Harris	56	238000	6133000	Observed four koalas in this creek area
1997	Anon (via NPWS Ulladulla)	56	229140	6114290	Two koalas observed on Phoenix property
19/01/97	Warick Blaydon	56	239900	6120500	Heard two koalas bellowing
?/6/97?	Peter and Anne Williams	56	237550	6113150	Saw koala crossing road at night
?/6/97?	Jodie Stirling	56	238050	6113100	Saw koala crossing road
?/6/97?	Glen Brydon	56	236900	6113080	Saw koala crossing road
29/12/97	Gary Taylor	56	227000	6143300	Atlas record. Female with young?
10/01/98	Gary Taylor	56	227150	6141200	Atlas record. Female with young?
?12/98	Warick Blaydon	56	242100	6126900	Atlas record. Encounter with a juvenile koala
1998 (approx)	Mat Jocelyn	56	229800*	6114250*	Observed koala
Nov 1998 (approx)	Gary Neilsen	56	237250	6116100	Observed koala in large tree on north eastern corner of their block
16/01/99	A.Vilder	56	236900	6134900	Atlas record
10/09/99	Warick Blaydon	56	236900	6135000	Atlas record. Observed koala

?9/99	Warick Blaydon	56	236500	6136700	3 koalas heard bellowing, observed 2 koalas
11/11/99	M. Bransky	56	238300	6113200	Atlas record
May-00	Scott Wells	56	238400	6133000	Observed koala
Jan 2001	Kevin Smith	56	228825	6197350	Observed koala crossing road
Dec 2000-March 2001	John & Barbara Hay	56	237600	6115350	Observed old koala drinking from puddle several times
25/01/00	V. Judson	56	235800	6141600	Atlas record
29/11/00	T. Fleming	56	232900	6138600	Atlas record
21/10/01	Gary Taylor	56	227970	6115208	Atlas record
?/11/01	Ricky Scraggs	56	238400	6113000	Observed old koala
2001	Cliff Harris	56	238500*	6113500*	Observed evidence of koalas in Bulee Gap area.
30/03/02	Ricky Scraggs	56	239800	6113400	Observed young koala cross road
21/03/02	Warick Blaydon	56	236100	6138600	Observed koala
4/05/02	Murray Dow	56	233000	6149000	Observed koala in tree looking over edge of gorge
19/6/02	R. Pietsch (NPWS)	56	237703	6113501	Located fresh koala pellets –probably under an *E maniffera*

Table 8 provides a summary of the information gathered in the community survey

Table 8: Summary of Anecdotal Information from Nerriga/Tolwong Plateau

Person Contacted	**Other Information**
Wayne Beckenham	Believes they are mainly in the area of Wineglass Tor, Horseshoe Bend, Peach Tree Canal. Saw two in area of 235500/6166100 about 5/6 years ago
Warick Blaydon	Keen bushwalker and has been visiting the area since 1970. Has seen and heard koalas on 5 occasions since Jan 1997. All of these sightings have been in bush off the Tolwang Road north of Quiera Clearing. Reported these sightings in detail to NPWS Ulladulla. Sent letter to Chris Allen with detailed information about these sightings on 5/4/02. Keen to participate in surveys.
Noel Bowden	Worked out at Douglas Paddock. Known the area for a long time. Unable to contact him.
Ken Browne	Owned Portion 21 for 15 years. Fire Captain for many years and feels there should be more HR. Never seen a koala anywhere on the South Coast.
Kevin Buchan	Very interested. Saw a koala about 15 years ago running along the road just in from the junction off the Endrick River Bridge. Has looked out for koalas ever since. Looked for them on his place with his children. A friend saw one in the same area about 9 years ago. Doesn't believe that they are in the "Snappy Gum" country, rather the taller timber where there is Manna Gum. Wants to be sent information and will let us know if he finds any evidence of koalas or hears about them from anyone else. His place got shot up by people a couple of years ago -"like they had a machine gum". So has kept the place locked ever since.
Les Canthill	Used to see koalas regularly when working on Tolwong Plateau. The gorge country is the most important habitat for koalas but sometimes they come up out of them to use the plateau country.
Mick Crisp (also Peter Zagorowski	Lived at Tolwang all his life (now 75 years old). Sees on average 6/12 koalas per year. Koala numbers have remained steady but he has seen more dead ones recently. Saw piebald koala last year with young on its back. Fuel loads in bush are very high. Peter Zagorowski also there. Koalas on road from Quiera Clearing north, along Frying Pan, Ironpot, and probablyTryers Creeks. Also one seen down by Tolwong mine. Also around Little and Big Oaky Creeks. They started bellowing there (they make a helluva noise when they get going) and stampeded the cattle. This was about 30 years ago. Reiterated that he sees about 6 koalas a year, though doesn’t get around so much now..

Murray Dow	Observed koala in tree looking over edge of Shoalhaven Gorge 4/5/02, Ottawa Creek catchment area.
Alan & Felicity Davey	Keen bushwalkers. Seen a koala when walking with Warick Blaydon
Paul Foulkes	Never heard of koalas here.
Gary & Maureen Hansell	Contacted Maureen. No info about koalas. Portion 22 is 1200 acres of rugged and innaccessible country backing down to the Endrick River. Had property for 10 years, but it has been in the family for longer. (Gerry's uncle owned "Wiluna" on other side of river as well. Road down to waterfall is E. rossi country leading into "better timbered" country. Gate is locked to prevent access
Mick Hansell	Deep attachment to the country. Areas that he would love to get back into that he can't because of locked gates and can't walk so far now. Never been interested in bears. Believes that they nearly all disappeared through disease and that koala numbers have picked up since then. Believes that they might be scattered through the more remotes areas of Morton NP.
Cliff Harris	Engineer for Shoalhaven City Council, working on Main Road 92. Keen bushwalker. Has seen koalas on quite a few occasions in the past decade. Most of them in the unnamed creek below North Oaky Creek. On one day saw four koalas there. Also koalas on the eastern and western side of Tims Gully, to the west of this creek. Not in the deep gorges and hasn't seen any near the Shoalhaven Gorge; poorer habitat over that way. Also undertook preliminary survey for koalas along area where work on Main Rd 92 is to be undertaken near Bulee Gap and found evidence of koalas along there.
John & Barbara Hay	Did not want to provide information about koalas initially because he was concerned that people would shoot them. Found a skull of a koala that had been shot. Lived on block for over 20 years. Regularly has seen koalas on northern side of Rolfes Gap. Approx 18 months ago saw an old male several times drinking from a puddle. Heard bellowing near his place. Thought it was pigs. Followed up the noise but never found evidence. Delighted to hear that it might be koalas.
Mat Jocelyn	Established cabins on property which abuts the Shoalhaven Gorge. Never seen koalas on his place but did see one on edge of Gary Taylor's place. Keen to plant koala sopecies. Ricky Scraggs said that he used to hangglide there 20 years ago and "the boys" regularly reported seeing koalas
Shirley Lock	NANA member. Has undertaken koala handler's course.
Niel & Robin Mcmillian	Manage the Nerriga General Store and Caravan Park. Old timers used to talk about keeping koalas for pets. Not many around now but may be in more remote country
Arthur Newling	Owns Portion 57, which is relatively remote, with the Shoalhaven to the west and north and the Endrick River to the east. Arthur only visits it occasionally. His brother-in-law, an experienced bushman, told him that there was a koala on the roof of the hut about 20 years ago. The Nerriga Fire Brigade did a burn that got away about 20 years ago and nearly burnt his hut down.
Nielson	Saw koala on property about two and a half years ago
Jill and Bob Nicholson	Heard noises at night but not sure what it was
John and Anne Rolfe	Doesn't know anything about koalas. Need to go though his property to access to Beesnest NR. Unlikely to grant access but prefers to meet with me to discuss it face to face rather than talk on the telephone.
Robert and Yvonne Rolfe	Yvonne contacted: never seen a koala. Lost 800 sheep to dingoes. NPWS not very popular with them. (However, another contact stated that Robert kept one as a pet for a few months).
Ricky Scraggs	Has seen koalas twice on Braidwood Rd east of Endrick Bridge: 1) Big old buck on road approx 6113000/238400 approx Nov 2000, covered in flies, moved off road, still had a lot of energy, took phot; 2) saw young koala cross road at 239800/6113400 approx 30/3/02. Marked tree -E.dives? Also heard koala "cry" (young koala?) on northern side of his block approx 6 months ago.
Kevin Smith	Lived in area all his life (aged 72?) and has regularly seen koalas in and near to Portion 134. Also saw koala on Braidwood/Nerriga Rd in Jan 2000 just north of the Mongarlo turnoff. Numbers don't seem to have changed. Is interested in them and keen to do what he can to help protect koalas. Believes that the few people who know about koalas the safer

	they will be. Koalas are also at Endrick Bridge (seen by a truckie about one month ago and in an area called "Tall Timber", about 5k out towards Douglas Paddock. Told story about Rolfe's keeping a koala for a few months as a pet.
Gary Taylor	Very interested in koalas and keen to support surveys. Has seen a koala on his block on two occasions. First one was a female and young near to crossroad junction where road (recently widened for access to cabins) leads to "Old Timberlight" (Check Atlas. The most recent was on 21/10/01 of young animal (record on Atlas).
Bruce and Bev. Temple	Used to see koalas regularly but doesn't go out in the bush now. Particularly along Alum FT, off Endrick River Rd in heavily timbered country. Also in Endrick river area beyond Rolfes Gap, again in heavily timbered country. There he saw a female with young. Dingoes have increased in number and might be a problem. Area to the south of Nerriga Rd hasn't been burnt for at least 30 years and fuel loads are too high.
Scott Wells	Keen bushwalker. Engineer for Shoalhaven City Council. Has seen koala once (237200/6133800 approx). In mallee type eucalypt on plateau country (Aug. 2000). Has heard of koala sightings mainly in gullies and gorges from Tulleyandra Clearing right through to the Tolwong Mine area (Wineglass Tor, Horseshoe Bend, Peach Tree Canal). Very keen to get copy of report.
Anne & Peter Williams	Members of NANA. Keen to be involved. Ran the Commercial Hotel in Nerriga until 2001. Aware of three koala sightings on road between Endrick Bridge and Bulee Gap (dates?). Also seen koala on Muffets Rd nearer to Goulbourne about 12 months ago.
Craig & Bianca (surname unknown)	Believe they have heard koalas bellowing occasionally, but another resident suggested that they were hearing Masked owls. Have undertaken some logging on their property.

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Information about koala sightings was provided by Brian Richardson (Manager at Bungonia SRA) and John Walshaw (part-time Field Officer at Bungonia SRA). Most of the koala sightings they reported have been recorded in the Wildlife Atlas. The selection of the survey areas in the Bungonia SRA was based on this information.

Information about koala sightings in the wider area was also provided by Windellema resident, Paul Alessi. This is summarised in Table 9, below.

Table 9: Summary of anecdotal information provided by Paul Alessi

Person contacted	Date Contacted	Address	Phone	Date of sighting	Details
Dawn Mc-Morrow		Portion 17		1940's & 1950's	Dawn was told of a Koala population at Rocky Creek, Windellama by an old timer who frequented those parts
Fred Hawke		Quialligo		late 1950's and early 1960's	Koalas were sighted by at his property.
Dawn Mc-Morrow (nee Williams)		Nerrimunga parish,		late 1950's	Dawn was shown an albino koala at the property *Bullamalita* during clearing operations(Gundary plains) approx 10km S/E of Goulburn township.
From Lloyd Turner	13/8/98	Roberts Rd Oallen		late 1940's to early 1950's	A friend of his named Max was working for the water board. He was doing a vegetation survey for the proposed Welcome Reef Dam and sighted Koalas in the area where the dam wall would be.

Lynton Roberts	3/8/98	Bushfire Captain Windellama		1960's ?	Bushfire Captain, Windellama .Koalas down Roberts Rd Oallen years ago about 1km south of the end of the road.
Alex Berg					There were reported sightings close by in the 1970's by friends of Alec
Uldis Neimannis				1980's	Another sighting in the Gang Gang property or the property adjoining to the south by friends of.Uldis who was the property owner at that time.
Ray Gough	31/8/98				Ray, a long time prospector who camped at Oallen Ford each winter for many years, said he had seen 3 or 4 over 15 or more years. Two were within 1 km of Welcome Reef Homestead. One was north on the other side of the River and the other south east on the Ningee Nimble Creek.
Sharon Alessi				1985	2 koalas sighted in *E. mannifera* at the entrance gate to property (Gang Gang) which adjoins Portion 10 Parish of Nerrimunga on its southern boundary
Manuela Bennett			4821 8443	20/3/ 1992	She has newspaper article about a koala found sitting at edge of road in Bungonia area
Jan Green	5/8/98	Taralga Coordinator for WIRES	4840 2218	about 1994 or 1995	Jan Rang said she would send fax of newspaper clipping re. Koala found at side of road and handed in to WIRES. She said she thought *E .agglomerata* was a food tree.
Jeff Lloyd	25/8/98	Lot 3 near Spa Rd gravel pit		1997	Theo said he saw a Koala down near his back fence….
Patricia Weigon	June 2002	4104 Oallen Ford Rd Windellama	4844 5339		Around 1998- Koala crossing road approx 300metres East of Bradley's Corner,. Quialigo , close to the recent clearing of stringybark for the turkey farm.
Ian Vardanega		Field Inspector SCA		1998	Koala sighted and photographed on Nerriga/Braidwood Rd at Nulla Nulla Hill
Theo	31/10/2000	Lot3 Spa Rd Nerrimunga Parish		Sept 2000	Second sighting of mother with young on her back close to his back (western) fence.
Patricia Weigon	June 2002	4104 Oallen Ford Rd Windellama	4844 5339	Nov. 2000. 11.20 am	Approx 900 metres East of Muffetts Lane, Quialigo, koala running along the roadside.
Patricia Weigon	June 2002	4104 Oallen Ford Rd Windellama	4844 5339		Patricia's neighbour (Northside) has often seen koalas on his property, no further details, he is a bit shy of divulging information.
					This ties in with a sighting by mailman Trevor (surname not known) who claims to have seen a Koala last year in the above vicinity on the Oallen Ford Rd, a few hundred metres south of Johnno's Shop.

Appendix 3: SURVEY AREAS

[redacted]

3.1.1 Survey Areas 1a & 1b:
These survey areas are on the property named "Phoenix" (Portion 133), currently owned by Mr Gary Taylor. He reported two koala sightings on this property (Table 7) and has located koala fecal pellets on one occasion. The survey areas can be accessed from the road leading into Mr Taylor's property.

Survey area 1a (Figure 2) was selected because koala scats were located in a preliminary survey on the 28/4/02. The area is relatively undisturbed. The predominant eucalypts in this area are Yellow Box (*E. melliodora*), Red Stringybark, (*E. macrorhyncha*), White Stringybark (*E. globiodea*), Brittle Gum (*E.* manifera) and Scribbly Gum (*E. rossi*).

Survey area 1b (Figure 2) is also Portion 133. It was selected for survey because Mr Taylor had observed a koala on the edge of the survey area (beside the Shoalhaven Gorge) on the 21/10/01 and had found koala fecal pellets in the gully area in February 2001, approximately (Appendix 1). Although the actual survey area is relatively undisturbed, it is adjacent to an area of approximately 20/25 ha which was ring-barked about 70 years ago by a previous owner (K. Smith pers. comm.) to the extent that no eucalypts were left standing. Clearing of a further 150ha was undertaken to the south of this area.

The predominant eucalypts in this survey area are Yellow Stringybark (*E. melliodora*), Red Stringybark, (*E. macrorhyncha*), White Stringybark (*E. globiodea*). Brittle Gum (*E.* manifera) and Scribbly Gum (*E. rossi*) predominate on the upper slopes.

An outlying location (1c) was also visited and surveyed briefly. This was on the edge of a cleared area where Mr Taylor had seen a female koala with joey on the10/01/98.

3.1.2 Survey Areas 2a & 2b:
These areas (Figure 2) are on either side of the bluff divided by Rolfes Gap and can be accessed from the road that leads from the Endrick River Bridge through Rolfes Gap to Douglas Paddock. They were selected for survey because there had been several anecdotal records in the general vicinity in recent years. Other locals advised that koalas were spread through this area (Tables 7&8). The selection of Survey Area 2a was influenced because it was part of the Morton National Park, with much of the rest of this area being private land.

Survey Area 2a has regenerating forest that is >50 years old in the easternmost gully, Gully Gum (*E. smithi*) predominating. This species and River peppermint (*E. elata*) are most commonly found in the gully and creek areas while Silvertop Ash (*E sieberi*),

Survey Area 2b is on private land (Portion 22) and is located on the northernmost side of the bluff that is to the west of Rolfes Gap (Figure 1a). Some selective logging has been undertaken in Gully Gum (*E. smithii*) and River Peppermint (*E. elata*) are most commonly found in the gully and creek areas while Yellow Stringybark (*E. muellerana*), Grey Box (*E. bosistoana*), Yellow Box (*E. melliodora*) are most commonly found in the mid and upper slope areas.

3.1.3 Survey Areas 3a & 3b:
These areas are to the north of Tims Gully and east and south east of the Tolwong Station (Figure 4). They were selected for survey because koalas had been heard bellowing and had been seen on several occasions by Mr Warick Blaydon (Appendix 1). These are relatively undisturbed areas.

Survey Area 3a is on undulating terrain on the north-western side of a track that leads east from the Tolwong Station Rd to Portion 50. Grey Gum (*E. punctata*) and one of the Stringybarks are predominant on the south-eastern of this area. Ribbon Gum (*E viminalis*), Narrow-leafed Peppermint (*E. radiata*), White Stringybark (*E. globiodea*) and what appears to be a cross between the first of these two species, were most commonly found in the north western portion of the area.

Survey Area 3b is to the north of Survey Area 3a and can be accessed from the road that goes from the Tolwong Station to the Tolwong Mine. The predominant eucalypts are Scribbly Gum (*E. rossi*), Cabbage Red Gum (*E. amplifolia*) and Brittle Gum (*E. manifera*) in the northern portion of the survey area and Grey Gum (*E. punctata*) and one of the Stringybarks to the south.

3.1.4 Survey Areas 4a & 4b:
These areas are to the north and south of Ironpot Creek and can be accessed from the road that leads from Tolwong Station to Ironpot Clearing (Figure 4). They were chosen for survey because a number of local people (including the owners of Tolwong Station) reported seeing koalas in this general area.

Survey Area 4a is in the western side of Ironport Clearing. The eastern edge of this area is basalt with Ribbon Gum (*E viminalis*) and White Stringybark (*E. globiodea*) predominating. Further to the west the substrate changes to sandstone. *E. globiodea* continues to be present in this area with Silvertop ash (*E sieberi*) and Grey Gum (*E. punctata*) being the most commonly encountered species. Further to the west the eucalypt species mix changes with Scribbly Gum (*E. rossi*) predominating.

Survey Area 4b is on the eastern side of the road approximately 2 kilometers south of Ironpot Clearing. Part of the survey area covers the north-western corner of Portion 9. The southern part of this survey area has been logged for fence posts. The predominant eucalypt species are Grey Gum (*E. punctata*) and White Stringybark (*E. globiodea*).

3.1.5 Survey Areas 5a & 5b:
These areas are on the eastern and south western sides of the Tulleyandra Clearing, which is on the road that leads to the Tolwong Station (Figure 5). Survey area 5a was selected because a koala sighting was reported from this area by an employee of Tolwong Station and because Ribbon Gum (*E viminalis*) was well represented in this area.

Survey Area 5a directly adjoins the eastern boundary of Tulleyandra Clearing. This area forms the lower slopes of the Tullyangela Creek as it leaves the Clearing. On the forest edge of this area there is Swamp Gum (*E. ovata*) regenerating. To the east of this regenerating the predominant eucalypts are Ribbon Gum (*E. viminalis*), Brown Barrel (*E. fastigata*), White Stringybark (*E. globiodea*) and Gully Gum (*E. smithi*).

Survey Area 5b can be accessed from a track that leads from in a westerly direction from the road to Tolwong Station on the southern edge of Portion 61, Tulleyandra Clearing. It was initially selected because a koala fecal pellet was located under an *E. viminalis* on the edge of the survey area. On the upper (south western edge of this area White Stringybark (*E. globiodea*) and Silvertop Ash (*E sieberi*) predominate. Grey Box (*E. bosistoana*) and Ribbon Gum (*E viminalis*) are also present. In most of the survey area the predominant species is Forest Redgum (*E. tereticornis*). This is mainly regeneration that is <50 years old.

[redacted]

3.2.2 Survey Areas 6a and 6b
These areas are in the main tourist area of the Bungonia SRA (Figure 6) and are accessed from the main road that leads into the Reserve. The area has a rich diversity of eucalypts with the species composition changing quickly across the landscape. On the flatter areas there are patches dominated by the stringybarks, Red Stringybark (*E. macrorhyncha*), White Stringybark (*E. globiodea*) and xxxxx (*E. eugenoides*). In other patches the box eucalypts, Grey Box (*E. bosistoana*), Yellow Box (*E. melliodora*) and Grey box (*E mollucana*) predominate. Apple Box (*E. bridgesiana*) and Silverleafed Stringybark (*E. cinerea*) are also found throughout this area while Cabbage Red Gum (*E. amplifolia*) is found more frequently in the gully areas. To the south the overstorey is dominated by Scribbly Gum (*E. rossi*) and Brittle Gum (*E. manifera*), whilst in the upper gully areas towards the gorge *E. amplifolia* and *E.bosistoana* are most frequently encountered.

These areas were selected for survey because koalas have been relatively frequently reported from all these areas during the past five years. One of the survey participants, Mr John Walshaw, has spent much time searching for and recording evidence of koalas. He knows the area extremely well; sufficient to be able to guide us to a number of trees where koalas had been sighted or where koala fecal pellets had been located.

3.2.2 Survey Areas 7a, 7b, 7c and 7d

These areas are accessed from the Trestle Track that leads to the Shoalhaven Gorge approximately 4k south of the ranger station at Bungonia SRA. They were selected for survey because of reported koala sightings and (in the case of Survey Areas 7a and 7b) to try to sample some of the lower slopes of the Shoalhaven Gorge area.

The upper slopes of this area appear to have been heavily disturbed in the past, with younger trees predominating on the upper slopes and ridges. The area is dominated by Silvertop Ash (*E sieberi*) and the Stringybarks, primarily White Stringybark (*E. globiodea*) and Blue-leaved Stringybark (*E. aglommerata*). *Cabbage* Red Gum (*E. amplifolia*) and Grey Box (*E. bosistoana*), are found more frequently in the gully areas.

Figure 2: Survey Areas and Pellet Sites at Portion 133, Nerriga

Figure 3: Survey Areas and Pellet Sites at Rolfes Gap, Nerriga

Figure 4: Survey Areas and Pellet Sites at Tulleyangela Clearing

Figure 5: Survey Areas and Pellet Sites north of Tolwong Station

Figure 6: Survey Areas and Pellet Sites at Bungonia SRA

Appendix 4: DATASHEETS FROM SURVEY