Koala surveys in the coastal forests of the Bermagui–Mumbulla area: 2007–09 – An interim report

Introduction

Since 1996, koalas have been repeatedly recorded in only two areas of the Eden Forest Management Area (Eden FMA): the coastal forests of the Bermagui–Mumbulla area and the forests to the north-east of Wyndham (Tantawangalo–Yurammie Section of the South East Forests National Park and Yurammie State Forest) (Figure 1). There are pre-1996 records scattered through much of the Eden FMA, but if they persist, the koalas in these areas appear to be at very low densities.

This document outlines the results of a survey for koalas in the Bermagui–Mumbulla area carried out between October 2007 and June 2009.

The study set out to assess the distribution and abundance of this population of koalas in order to provide information to guide its future management. Approximately 21,000 hectares was surveyed on National Park, Nature Reserve, State Forest and private land (Figure 2) from immediately north of Tanja through to Gulaga National Park north-east of Bermagui.

Similar surveys are currently under way in the Tantawangalo–Yurammie area with the results expected to be publicly available later in 2010.

Survey and analysis methods

Survey method

The survey method used is known as the *Regularised Grid-Based Spot Assessment Technique* (RGBSAT) and was developed by Dr Stephen Phillips of Biolink Pty Ltd. It has been used successfully to assess the distribution and abundance of medium-density populations in numerous studies including:

- the Coombabah Koala Habitat Area and Coomera–Pimpama Koala Habitat Area in south-east Queensland (Phillips et al. forthcoming)
- the Lake Broadwater area in south-west Queensland (Stephen Phillips, pers. comm.)
- Port Macquarie (Phillips & Horseman 2003, 2004)
- North Hawkes Nest (Phillips & Pereglou 2004)
- Raymond Island (Phillips et al. 2002).

Most recently the RGBSAT method underpinned the Comprehensive Koala Plan of Management for the Eastern Portion of the Kempsey Local Government Area (Phillips & Hopkins 2008).

Figure 1: Koala records in the Eden Management Area

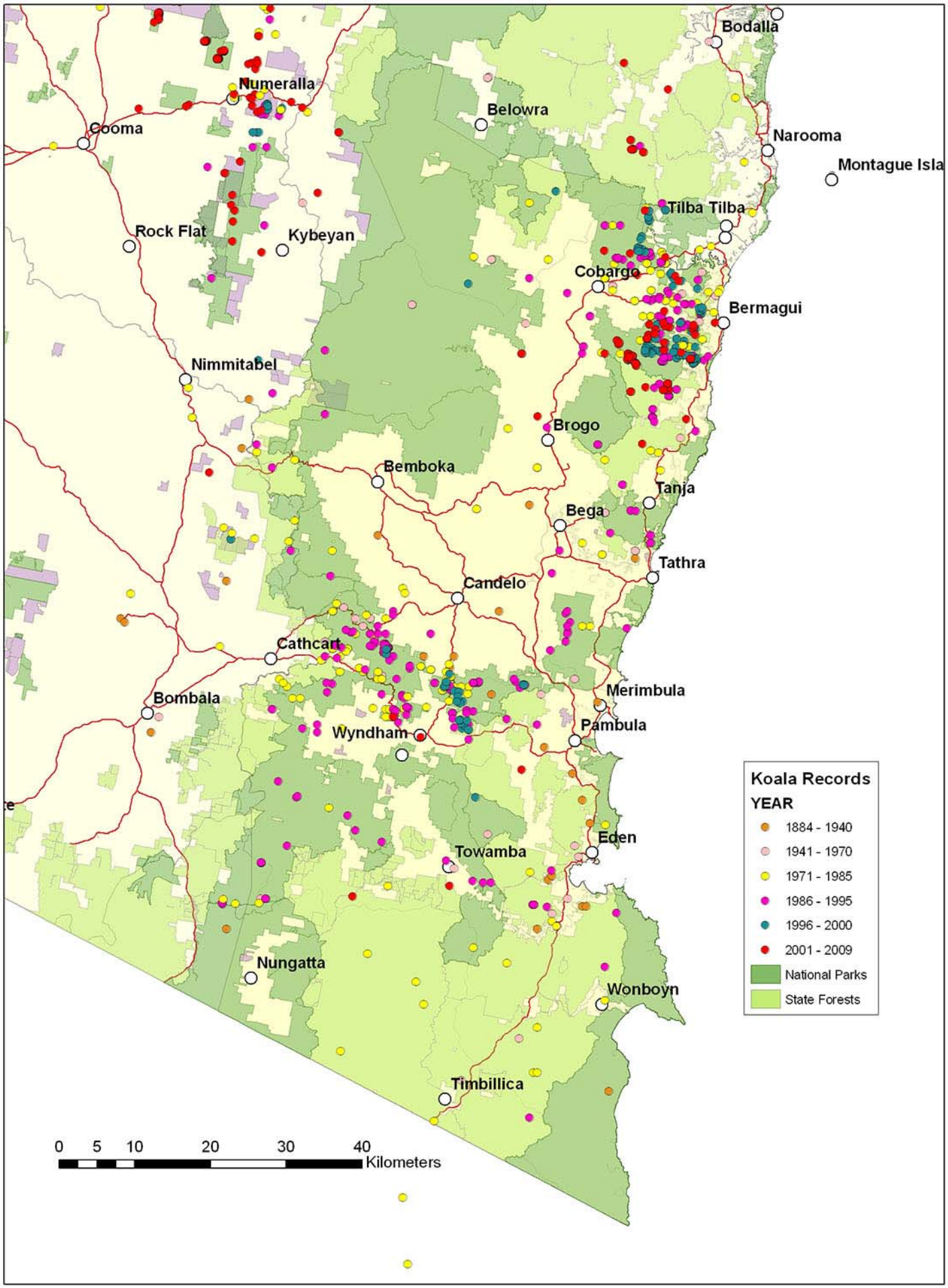
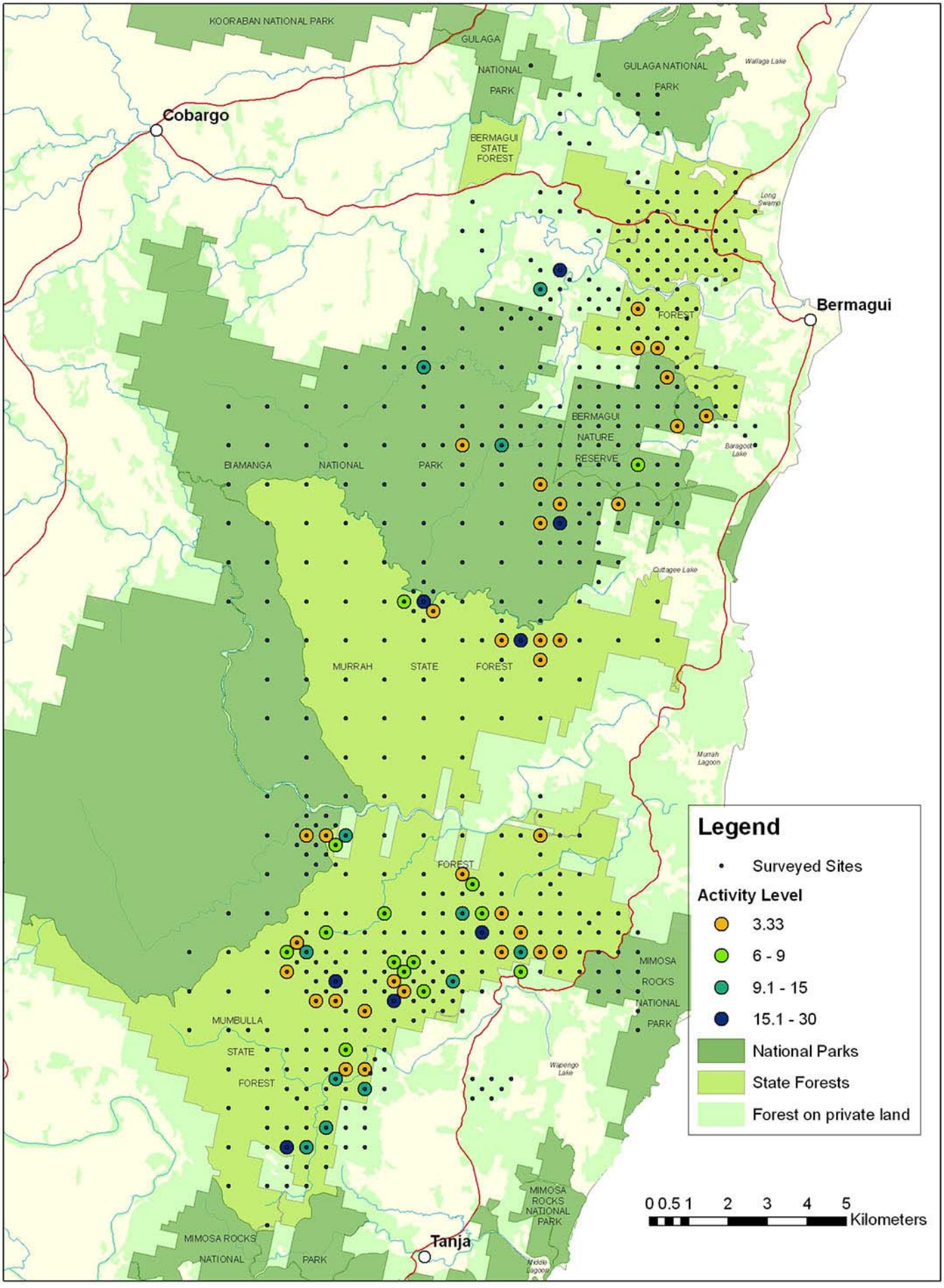


Figure 2: Distribution of the survey sites and the recorded activity levels



As the RGBSAT technique had not previously been used to survey koalas at the low population densities that occur in south-east NSW, Dr Phillips was initially engaged to trial the method in the Wapengo area of Mumbulla State Forest (Biolink Ecological Consultants 2007). The trial was successful and agreement was reached with Forests NSW that this method would be employed for surveying the remainder of the study area.

The survey teams conducted searches for evidence of koalas in a pre-determined grid pattern across the study area. Initially the searches were conducted at sites at either 350-metre or 500-m intervals.[1] After 14 months of fieldwork, the survey data was analysed. It was concluded that the larger areas of koala activity would still be detected at sites at 1000-m intervals. This coarser sampling interval was adopted for the remainder of the survey in order to increase the geographic coverage.

An adaptive sampling approach was taken (see Thompson & Seber 1996) that is where koala activity was detected, neighbouring sites within 350 m of the detection sites were also surveyed to provide finer resolution in the delineation of the boundaries of the active areas.

The location of each of the surveyed sites is shown as a black dot on Figure 2. A total of 589 was surveyed.

At each of these sites the base of the closest 30 live trees over 150 millimetres in diameter at breast height (dbh) were searched for koala faecal pellets out to a metre from the trunks. The species and dbh of each of the 30 trees were recorded. The radius of each of the sites was only recorded in the latter half of the survey. Of those sampled (n = 202), the variation was not substantial (range 8–40 m, mean = 20.1 m, standard error ± 0.4), with 70% of these sites having radii between 15 and 25 m.

Pellets were placed into two age classes on the basis of their general appearance. Those which were dry and faded in colour were considered ‘old’, those with patina (a shiny film of mucus) remaining were classed as ‘fresh’. Old and fresh pellets occurring together were classified as ‘mixed’. Pellet longevity is generally considered to be in the order of several months on average (McAlpine et. al 2007). Worth (2001) reported that in general pellets remain recognisable for between 6 and 18 months, with drier conditions more conducive to pellet longevity.

The proportion of trees with koala pellets compared with the total number of trees assessed at each site (30 per site) is termed the site’s *activity level* (Phillips 2000; Phillips & Callaghan 2000; Phillips et al. 2000). The activity level at each of the 589 sites was calculated.

Identification of activity cells

A Geographic Information System mapping tool described as *regularised splining* (Biolink Ecological Consultants 2007) was used to analyse the activity level at each of the survey sites in relation to the activity level recorded at neighbouring site and delineate *activity cells* (Figure 3). Activity cells may encapsulate only one survey site but are generally clusters of sites where koala evidence was found. Activity cells are approximately analogous to home ranges. However, more than one animal may be using the area within an activity cell.

The technique does not distinguish between resident animals and those that might be dispersing, through clusters of active sites, particularly those with relatively higher activity levels that are more likely to be occupied by resident koalas.

The boundaries of activity cells were calculated at three activity levels: 2%, 3% and 9%. The 9% activity boundary (which indicates the area where the average use of trees is approximately 9% of the 30 trees at each site) shows the areas of highest use.

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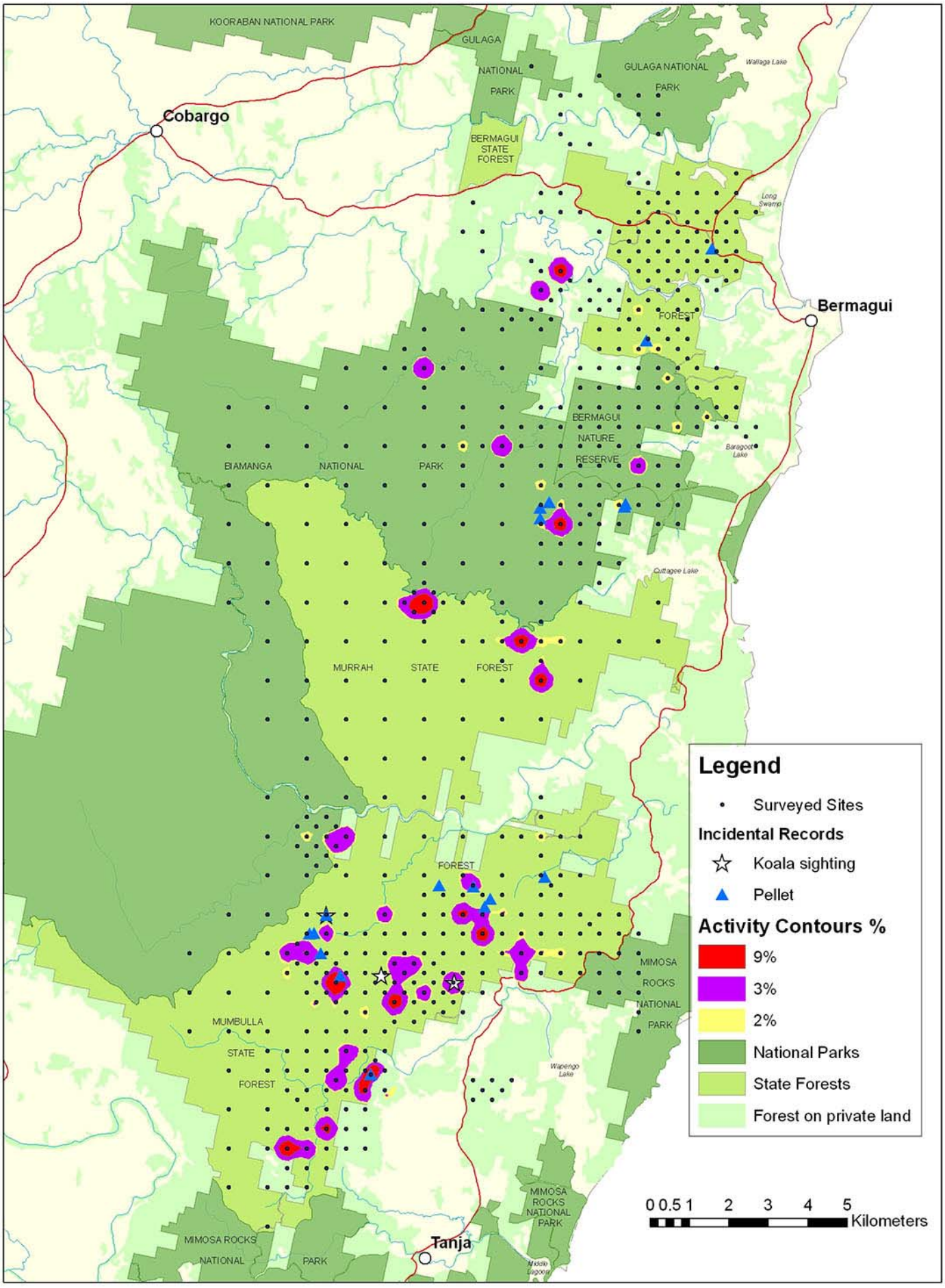
[1] Sites at 350-m intervals were sampled in the initial phase of the pilot study in the Bermagui State Forests where logging was imminent, and then where it was necessary to finely map the boundaries of active areas.

Figure 3: Distribution of the activity cells, incidental koala sightings and incidental koala pellets



Analysis of distributional data

The Department of Environment, Climate Change and Water (DECCW) undertook preliminary statistical analyses of the relationship between koala activity and the distributions of the various tree species, combinations of species and size of trees. The technique used in this initial work is known as bivariate spatial analysis (Ripley 1977; Rowlingson & Diggle 1993). A randomised subset of the data, satisfying the requirement of complete spatial randomness, was used in the analysis to account for the uneven sampling regime.

As this work is yet to be completed, only a portion of the results of the analyses is presented in this document. Further analyses are currently under way with input from independent statistical scientists and spatial modellers. There will also be a formal peer review of the analyses to ensure that they are robust.

This component of the research will be described in detail in a separate document once completed and reviewed later in 2010.

DNA study

Koala faecal pellet samples were collected and their DNA extracted at the University of Sydney. The samples were analysed to assess the levels of genetic diversity within the population, and the genetic differences between the sampled animals and those from other koala populations. This component of the study is not complete, although preliminary results are provided below.

Results

Overview

At least 200 people contributed more than 1000 person-days of fieldwork searching for koala pellets under more than 17,670 trees. Evidence of koalas was found at 66 of the 589 survey sites, giving an overall occupancy rate of 11.21%[2] (Table 1).

Table 1: Number of sites assessed, active sites and occupancy rates by land tenure

Tenure	Sites assessed	Trees searched	Sites with koala pellets	Occupancy rate
Biamanga NP	128	3,840	9	7.03%
Gulaga NP	8	240	0	0.00%
Bermagui NR	38	1,140	4	10.53%
Mimosa Rocks NP	9	270	0	0.00%
Mumbulla SF	176	5,280	38	21.59%
Murrah SF	55	1,650	8	14.55%
Bermagui SF	89	2,670	3	3.37%
Private land	72	2,160	2	2.78%
Land owned by Local Aboriginal Land Councils	14	420	2	14.29%
Total all sites	**589**	**17,670**	**66**	**11.21%**

[2] Biolink Ecological Consultants (2007) defines occupancy rate as the percentage of the sites assessed which had koala faecal pellets.

Koala activity occurred over a distance north to south of approximately 24 km. Sites with Koala activity were not random but tended to occur near other sites also used by koalas. Figure 2 shows the distribution of the sites where activity was recorded.

Groups of large and small faecal pellets at the same location indicate the presence of adult females with young. During the survey, evidence of this was found at seven separate locations (that is, those more than a kilometre apart): four in Mumbulla State Forest and one on private land adjoining it; one in Murrah State Forest; and one on land owned by the local Aboriginal Land Councils to the north of Biamanga National Park.

Figure 3 shows the distribution of the activity cells, as well as the location of koala sightings and pellet sites recorded incidentally in the survey (that is, not at the pre-defined survey sites). There was a relatively large concentration of activity cells in the southern section of the study area (mostly within Mumbulla State Forest). With the exception of three activity cells, no koala evidence was found towards the centre of the study area in Murrah State Forest. More scattered koala activity, with generally smaller activity cells, was identified to the north of the study area in Biamanga National Park, on land owned by Local Aboriginal Land Councils, small areas of Bermagui Nature Reserve and parts of the south-western section of Bermagui State Forest.

For the purposes of this report, the outer 2% boundary of activity was used to describe the areas currently occupied by koalas. A total of 1089 hectares of forest was identified as being actively used across the study area.

Eucalypt species preferences

Table 2 indicates that the species under which koala faecal pellets were most commonly found were *Eucalyptus longifolia* (woollybutt), *E. globoidea* (white stringybark), and *E. muelleriana* (yellow stringybark).

E. cypellocarpa (monkey gum), *E. bosistoana* (coastal greybox), *E. tricarpa* (red ironbark) and *E. sieberi* (silvertop ash) were less frequently encountered in the active sites, but a relatively high proportion of these species also had koala pellets underneath them.

Table 2: Commonly occurring tree species associated with koala activity

Tree species	No. of trees with pellets	No. of trees at active sites	% of species trees with koala pellets
E. longifolia	49	313	15.65
E. cypellocarpa	10	91	10.99
E. bosistoana	7	65	10.77
E. tricarpa	11	104	10.58
E. globoidea	26	319	8.15
E. muelleriana	20	307	6.51
E. sieberi	16	265	6.04
Angophora floribunda	4	96	4.17
E. agglomerata	2	71	2.82
Allocasuarina littoralis	4	188	2.13

As previously stated, statistical analyses of the relationship between the location of koala activity and various environmental variables is continuing and a formal peer review process will be undertaken. Given this, the observed relationships below should be seen as preliminary only and requiring further exploration.

Bivariate analyses of a random sub-set of the data indicated that the species under which koala pellets were located were not random. The following attributes were the strongest correlates with the presence of koala pellets in this study area:

1. *Eucalyptus bosistoana*: any number or diameter at breast height (dbh)
2. *Eucalyptus muelleriana*: > 4 trees/plot
3. *Eucalyptus longifolia*: > 276 mm dbh (> 30 percentile)
4. *Eucalyptus globoidea:*> 392 mm dbh (> 70 percentile)
5. *Eucalyptus tricarpa*: > 351 mm dbh (> 50 percentile)

The distributions of *Acacia falciformis*, *Corymbia gummifera* (red bloodwood), *Corymbia maculata* (spotted gum), *E. botryoides* (bangalay) and *Exocarpos cupressiformis* were poorly related to the presence of koalas. This does not mean that these species will never occur in areas with koalas but they are likely to be poor predictors of their distribution.

It should also be noted that the above attributes may not necessarily be correlated with koala presence in other landscapes particularly those with soils derived from granitic geology.

Relationship with tree diameter

While the distribution of koala pellets appeared to be correlated with larger trees of three species of eucalypt, it was also poorly correlated with low total plot dbh (< 10 percentile).

This observation is consistent with other studies such as that by Moore & Foley (2005) who found that koalas used trees that were on average significantly larger than expected.

Preliminary DNA analysis

DNA was extracted from approximately 30 faecal pellet samples and mitochondrial sequences and microsatellites amplified. Preliminary analysis of the samples indicated that the population is likely to contain a moderate to high level of genetic diversity. Additionally, few koalas in the study area carry the koala retrovirus, which may be significant compared with the wide spread of the virus in populations further north.

The small number of microsatellites that have been amplified from the pellet samples have alleles not seen in the Koala populations of Sydney but are related to the unique remnant gene pool of the South Gippsland/Strzelecki ranges region (Lee, T; Sydney University unpublished data; Lee et al. forthcoming).

Discussion

Figure 1 indicates that there have been few reports of koalas in other coastal and foothill forests of the Eden Region since 1996. This reduction in reporting rate suggests an overall decline in the regional population.

However, the survey shows that koalas are present in parts of Mumbulla State Forest, Biamanga National Park, Murrah State Forest, Bermagui Nature Reserve, Bermagui State Forest and on some private land.

Only one old koala pellet was found in the study area north of the Bermagui River, despite assessment of all 350-m-interval plots. From this, it is considered unlikely that there are any

koalas resident in this area. This area was known to be inhabited by koalas up to the late 1990s (Jurskis & Potter 1997; Allen 2008).

It should be noted that DECCW also undertook surveys in 2005 in Kooraban National Park which is approximately 20 km to the north-west of Bermagui (immediately to the north of the Eden FMA). Koala pellets were detected at five sites. The breeding status of that population is unknown.

The southern part of the current study area currently appears to support the greatest concentration of koalas in the Bermagui–Mumbulla area. The population may have increased recently in this area, as prior to this study, there were few koala records despite extensive surveys by wildlife ecologists in the late 1970s and early 1980s. It is acknowledged, however, that the new survey techniques are more effective than those previously used.

The study demonstrates that koalas are breeding in at least some sections of the area and the preliminary genetic analysis found no evidence of inbreeding.

However, this population is undoubtedly small, probably less than 50 mature animals.[3] Thus it will be important to ensure that the population does not experience any further loss and that provision is made for its expansion into any apparently unoccupied but suitable habitat.

Surveys are under way in the Tantawangalo–Yurramie area. Isolated pellets located in recent surveys at two sites in the Tantawangalo forests suggest a population persists there, but further surveys are required to clarify its distribution and abundance. The current detection rates suggest that the population is likely to be smaller than that in Bermagui–Mumbulla.

Further analyses are currently being undertaken. DECCW and Forests NSW are also reviewing the current prescriptions as a matter of urgency in the light of the survey results.

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[3] An occupancy rate of 11.21% in a study area of 21,000 ha suggests that approximately 2354 ha of the area is occupied by koalas. With home range areas of 50–100 ha, a population of 23–47 koalas is suggested. This is only a tentative estimate, with some factors suggesting a higher estimate is warranted (for example, koalas will have overlapping home ranges and there may be unidentified activity cells) and others that it should be smaller (for example, the area derived using the occupancy rate data overall may be larger than home range areas).

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