The *Spot Assessment Technique*: a tool for determining levels of localised habitat use by Koalas *Phascolarctos cinereus*.

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Manuscript submitted to: *Ecological Management and Restoration*

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Summary

In order to more effectively conserve koalas, the National Koala Conservation Strategy promotes development of reliable approaches to the assessment of koala habitat. This paper describes a localised, tree-based sampling methodology that utilises the presence/absence of koala faecal pellets within a prescribed search area around the base of trees in order to derive a measure of koala activity. Confidence intervals associated with koala activity data from 405 randomly selected field plots within which koala faecal pellets were recorded have been utilised to assign threshold values for three population density/habitat biomes in eastern Australia. Subject to the need for a precautionary approach to data interpretation in areas that support naturally occurring, low-density koala populations, the approach is expected to assist field-based assessments by researchers, land managers and others interested in clarifying aspects of habitat utilisation by free-ranging koalas, especially where identification of important areas for protection and management is required.

Key-words. Spot Assessment Technique, Koala, *Phascolarctos cinereus*, SEPP 44, habitat assessment, survey techniques.

Introduction

The primary aim of the National Koala Conservation Strategy (NKCS) is to conserve Koalas (*Phascolarctos cinereus*) by retaining viable populations throughout their natural range (Australian and New Zealand Environment and Conservation Council (ANZECC) 1998). In order to develop a better understanding of the conservation biology of koalas, Objective three of the NKCS promotes the need for development of consistent and repeatable approaches to assessment of koala populations, in addition to the need for survey work to establish correlates of habitat quality at both broad geographic scales and the individual-tree scale within preferred habitats (ANZECC 1998).

The primary responsibility for conservation of free-ranging koalas and their habitat rests with State, Territory and Local Government authorities. In this regard State Government authorities in New South Wales and Queensland have enacted specific planning policies and/or strategic planning measures to assist koala conservation. However, the ability of these strategies to achieve their stated conservation objectives is hindered in part by the lack of standardised and reproducible methodologies that can be applied to the task of habitat assessment in the first instance.

In this paper we present a technique that we believe contributes to the need for a reliable approach to objectively assessing koala habitat use. An unreviewed progenitor to this work (Phillips and Callaghan 1995) was originally circulated to a limited audience following the Australian Koala Foundation's 1995 conference on the status of Koalas, its purpose at that time to promulgate an approach that could potentially assist field-based assessments by ecological consultants, land managers and others interested in quantifying aspects of habitat utilisation by free-ranging koalas. Much has happened since then such that the purpose of this work is to further refine the initial approach in the light of additional field studies and in so doing, formally supersede the earlier work.

Background to the approach

Traditionally, knowledge relating to habitat utilisation by free-ranging koalas has been reliant on opportunistic observations or radio-tracking data (Robbins and Russell 1978; Martin 1985; Hindell *et al*. 1985; Hindell and Lee 1987; 1988; White and Kunst 1990; Reed *et al*. 1990; Hasegawa 1995; Melzer and Lamb 1996; Pieters and Woodhall 1996). In other instances, emphasis has been placed on benign indicators such as accumulated faecal pellet counts (Moon 1990; Munks *et al*. 1996; Pahl 1996). However, both of the preceding approaches can be problematic. Firstly, existing models for determining tree preferences by free-ranging Koalas (Hindell *et al*. 1985) require a number of assumptions to be met which do not appear to hold in heterogeneous forest communities (Phillips 1999;

Ellis *et al.* 2002). Secondly, while accumulated faecal pellet counts can elucidate issues of koala abundance (Sullivan *et al*. 2002, 2004), they have proved of limited value when used to infer the importance of various tree species, (Munks *et al*. 1996; Pahl 1996). The ability to census and interpret faecal pellet deposits can also be influenced by other variables including visibility, tree morphometrics and insect activity (Achurch 1989; Melzer *et al*. 1994; Pahl 1996; Ellis *et al*. 1998; Sullivan *et al.* 2003). Scratch marks on trees are also an unreliable indicator of habitat use – they cannot be detected on some species whereas others retain them for long periods of time, nor is it always possible to confidently distinguish Koala scratches from those of other arboreal animals.

Studies of free-ranging koalas have established that those in stable breeding aggregations arrange themselves in a matrix of overlapping home range areas (Lee and Martin 1988; Faulks 1990; Mitchell 1990). Home range areas vary in size depending upon the quality of the habitat (measurable in terms of the density of preferentially utilised food tree species) and the sex of the animal (males tend to have larger home range areas than females). Long-term fidelity to the home range area is generally maintained by adult koalas in a stable population (Mitchell 1990; Phillips 1999, Kavanagh *et al*. 2007). An additional feature of home range use is the repeated use of certain trees, some of which may also be utilised by other koalas in the population (Faulks 1990; Mitchell 1990; Phillips 1999; Ellis *et al*. 2002).

Given the preceding considerations, it follows that areas being utilised by resident koala populations must also be characterised by a higher rate of faecal pellet deposition (see Lunney *et al.* 1998). For the purposes of this paper, we propose the term "areas of major activity" to describe such localities, regarding them as synonymous with the term "*Core Koala Habitat*" as defined by the NSW Government's *State Environmental Planning Policy No. 44 (Koala Habitat Protection)*, in addition to being core elements of Koala Habitat Areas as defined by the Nature Conservation (Koala) Conservation Plan 2006 and Management

Program 2006 – 2016 (Environment Protection Agency/Queensland National Parks and Wildlife Service 2006).

The Spot Assessment Technique

The Spot Assessment Technique (SAT) is an abbreviated form of a methodology developed by the Australian Koala Foundation for purposes of the Koala Habitat Atlas project (Sharp and Phillips 1997; Phillips *et al*. 2000; Phillips and Callaghan 2000). This approach is probability-based and utilises a binary variable (presence/absence of faecal pellets within a prescribed search area around the base of trees) to determine tree species preferences, along with a commensurate measure of koala "activity" (number of trees with faecal pellets present divided by total number of trees in the plot) within a 40m x 40m (1600m^2) plot. Given that the selection of Atlas field plots is based on replication and stratification by soil landscape and vegetation associations in the first instance, the data presented for the purposes of this paper reflects a random selection of field sites within which koala faecal pellets were recorded. The SAT approach arose from observations of consistency within the four smaller (20m x 20m) sub-quadrats that otherwise comprise Atlas field plots and the consequent realisation that a smaller plot size would essentially provide the same empirical outcomes in terms of both tree species/faecal pellet associations and koala activity. However, the number of trees sampled in a smaller site is critical to any meaningful estimate of activity hence we have adopted the latter as the more important variable for the purposes of this technique.

Table 1 details results from Atlas plots that have been undertaken across a variety of habitat types and landscapes utilised by koalas in eastern Australia. To this end, while significant differences between mean activity levels from low and medium - high density Koala populations of the eastern seaboard are believed to reflect real differences in habitat quality and thus koala density (Table 1 - Southeast Forests/Campbelltown *vs* Port Stephens/Noosa: Levene's test: $F = 0.086$, $P > 0.05$; $t = -7.877$, $P < 0.001$), we submit that similar differences

between medium - high density populations of the eastern seaboard and those from more western areas (areas generally receiving less than 600mm of rainfall annually) (Port Stephens/Noosa vs Pilliga/Walgett – Levene's test: $F = 0.925$, $P > 0.05$; $t = -4.743$, $P < 0.001$), more likely reflect differences in faecal pellet longevity as a consequence of aridity than they do habitat quality *per se*.

The SAT involves an assessment of koala "activity" within the immediate area surrounding a tree of any species that is known to have been utilised by a koala, or otherwise considered to be of some importance for koala conservation and/or habitat assessment purposes. In order of decreasing priority, selection of the centre tree for a SAT site should be based on one or more of the following criteria:-

1. a tree of <u>any species</u> beneath which one or more koala faecal pellets have been observed; and/or
2. a tree in which a koala has been observed; and/or
3. any other tree known or considered to be potentially important for koalas, or of interest for other assessment purposes.

In order to establish a meaningful confidence interval for the activity level of a given SAT site, a <u>minimum</u> of thirty (30) trees must be sampled. For assessment purposes, a tree is defined as "*a live woody stem of any plant species (excepting palms, cycads, tree ferns and grass trees) which has a diameter at breast height (dbh) of 100mm or greater*" (Phillips *et al*. 2000). In the case of multi-stemmed trees, at least one of the live stems must have a diameter at breast height over bark (dbhob) of 100 millimetres or greater.

Applying the SAT

1. Locate and uniquely mark with flagging tape a tree (the centre tree) that meets one or more of the abovementioned selection criteria;
2. differentially mark the 29 nearest trees to that identified in Step 1,

3. undertake a search for koala faecal pellets beneath each of the marked trees based on a cursory inspection of the undisturbed ground surface within 100 centimetres[1] from the base of each tree, followed (if no faecal pellets are initially detected) by a more thorough inspection involving disturbance of the leaf litter and ground cover within the prescribed search area.

An average of approximately two person minutes/tree should be dedicated to the faecal pellet search. In practice, more time will be spent searching beneath larger trees than smaller trees. For assessment purposes, the search should be concluded once a single koala faecal pellet has been detected or when the maximum search time has expired, whichever happens first. This process should be repeated until each of the 30 trees in the site has been assessed. Where the location of faecal pellets falls within overlapping search areas brought about by two or more trees growing in close proximity to each other, both should be positively scored for pellet(s). For more detailed reporting purposes, information relating to the site's location (UTM co-ordinates or Lat/Long), selection criteria, tree species assessed (and their dbh), and the radial area searched should also be recorded. Faecal pellets should not be removed from the site unless some verification (i.e. that they are in fact koala faecal pellets) is necessary.

Calculation and interpretation of Koala activity levels

The activity level for a SAT site is simply expressed as the percentage equivalent of the proportion of surveyed trees within the site that had a koala faecal pellet recorded within the prescribed search area. For example, given a sample of 30 trees, 12 of which had one or more faecal pellets recorded within the prescribed search area – the resulting activity level would be determined as 12/30 = 0.4 = 40 per cent.

[1] The minimum distance within which (on average) 50% of the total number of koala faecal pellets beneath the canopy of a given tree will be located (Jones 1994).

From the data sets presented in Table 1, we propose use of mean activity levels ± 99 per cent confidence intervals to define the limits of “normal” koala activity. Based on the threshold values that result we can then recognise three categories of koala activity as detailed in Table 2. Subject to qualifications regarding the need for a precautionary approach to low activity levels in some instances (see below), where the results of a SAT site returns an activity level within the range prescribed for low use, we suggest that the current level of use by koalas is likely to be transitory. Conversely, where a given SAT site returns an activity level within the prescribed range for medium (normal) to high use - the level of use is indicative of more sedentary ranging patterns and is thus within an area of major koala activity.

A precautionary approach to activity levels in low use areas.

Ideally, SAT site activity levels should only be interpreted in the context of location-specific habitat utilisation data (e.g. Lunney *et al*. 1998; Phillips *et al.* 2000; Phillips and Callaghan 2000). Low activity levels recorded in what might otherwise be considered important koala habitat may be a result of contemporary koala population dynamics and/or historical disturbances including logging, mining, fire frequency, agricultural activities and urban development. Such considerations should not necessarily detract from the potential importance of such habitat for longer-term koala conservation, particularly if koala food trees are present and koalas are known to occur in the general area. Application of a "Koala Habitat Atlas" type methodology over the larger area in conjunction with an understanding of ecological history (e.g. Knott *et al.* 1998) would be useful to clarify such issues.

Low activity levels can also be associated with low-density koala populations. Stable, low-density koala populations occur naturally in some areas (Melzer and Lamb 1994; Jurskis and Potter 1997; Phillips and Callaghan 2000; Ellis *et al*. 2002; Sullivan *et al.* 2006). Koala density in such areas generally reflects the absence of “primary” food tree species and reliance by the population on

"secondary" food tree species only (Phillips and Callaghan 2000; Phillips 2000). While secondary food tree species will return significantly higher levels of utilisation when compared to other *Eucalyptus* spp. in the area, their level of use (as determined by field survey) will generally tend to be both size-class and/or density dependent when compared to a primary food tree species (size-class and/or density independent) (Phillips *et al.* 2000; Phillips and Callaghan 2000; Phillips 2000). Because the autecology of koalas inhabiting areas without access to "primary" food tree species remains poorly understood at this point in time, we propose a precautionary approach whereby the presence of any activity in areas occupied by naturally occurring, low density populations should be regarded as ecologically meaningful for conservation and management purposes.

Recommended Applications

The SAT can be used in conjunction with land-use planning activities and/or policies that require koalas and their habitat to be assessed, especially where identification of important areas for protection and management is required. The technique is also suitable for monitoring purposes. However, the design and detail of sampling protocols that could be developed using the SAT approach are beyond the scope of this paper. Further information and advice regarding application and use of the SAT, interpretation of activity levels, and its application to the task of determining broad-scale tree species preferences, can be supplied if required. The authors would also be thankful for any feedback regarding application of SAT methodology for any of the purposes indicated in this paper.

Acknowledgments

We are indebted to the many individuals and organisations that have generously given their time, energy and support to Koala Habitat Atlas field projects over the years. We also appreciate the constructive criticism provided by the referees who reviewed the submitted draft of this paper; the final work has benefited greatly as a result.

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Table 1. Mean activity levels and related measures of central tendency (expressed as percentage equivalents) associated with habitat utilisation by Koalas from six areas in eastern Australia. Data relates to sites within which koala faecal pellets were recorded and has been pooled to reflect three major categories of Koala activity which correspond to low and med-high density Koala populations of the tablelands and areas east of the Great Dividing Range, and those of more western areas respectively. Koala densities for the east coast, low density category are arbitrarily defined at ≤ 0.01 Koalas/ha. (Data sources: [1]South-east Forests Conservation Council, unpub. data; [2]Phillips and Callaghan 1997; [3]Phillips and Callaghan 2000; [4]Phillips *et al*. 1996; [5]Phillips *et al*. 2000; [6]AKF, unpub.data; [7]Phillips 1999; [8]AKF unpub. data; [9]AKF unpub. data).

Area	Pop. Density	No. sites	No. trees	A/level	SD	SE	99% CL
East Coast							
S/E Forests[1]	Low	111	2979	11.85	6.84	0.65	1.70
Campbelltown[2, 3]	Low	20	1194	6.52	4.72	1.06	3.02
Pooled		**131**	**4173**	**11.03**	**6.82**	**0.60**	**1.56**
East Coast							
Port Stephens[4, 5]	Med - high	76	3847	23.65	23.63	2.71	7.16
Noosa[6]	Med - high	63	1647	32.55	22.05	2.78	7.38
Pooled		**139**	**5494**	**27.68**	**23.27**	**1.97**	**5.16**
Western Plains							
Pilliga[7, 8]	Med - high	98	3656	42.52	22.78	2.30	6.05
Walgett[9]	Med - high	37	990	38.01	27.66	4.55	12.37
Pooled		**135**	**4646**	**41.28**	**24.19**	**2.08**	**5.44**

Table 2. Segregation of Koala activity into Low, Medium (normal) and High use categories based on use of mean activity level ± 99 per cent confidence intervals (nearest percentage equivalents) from each of the three area/population density categories indicated in Table 1.

Activity category	Low use	Medium (normal) use	High use
Area (density)			
East Coast (low)	< 9.47%	≥ 9.47% but ≤ 12.59%	> 12.59%
East Coast (med – high)	< 22.52%	≥ 22.52% but ≤ 32.84%	> 32.84%
Western Plains (med – high)	< 35.84%	≥ 35.84% but ≤ 46.72%	> 46.72%