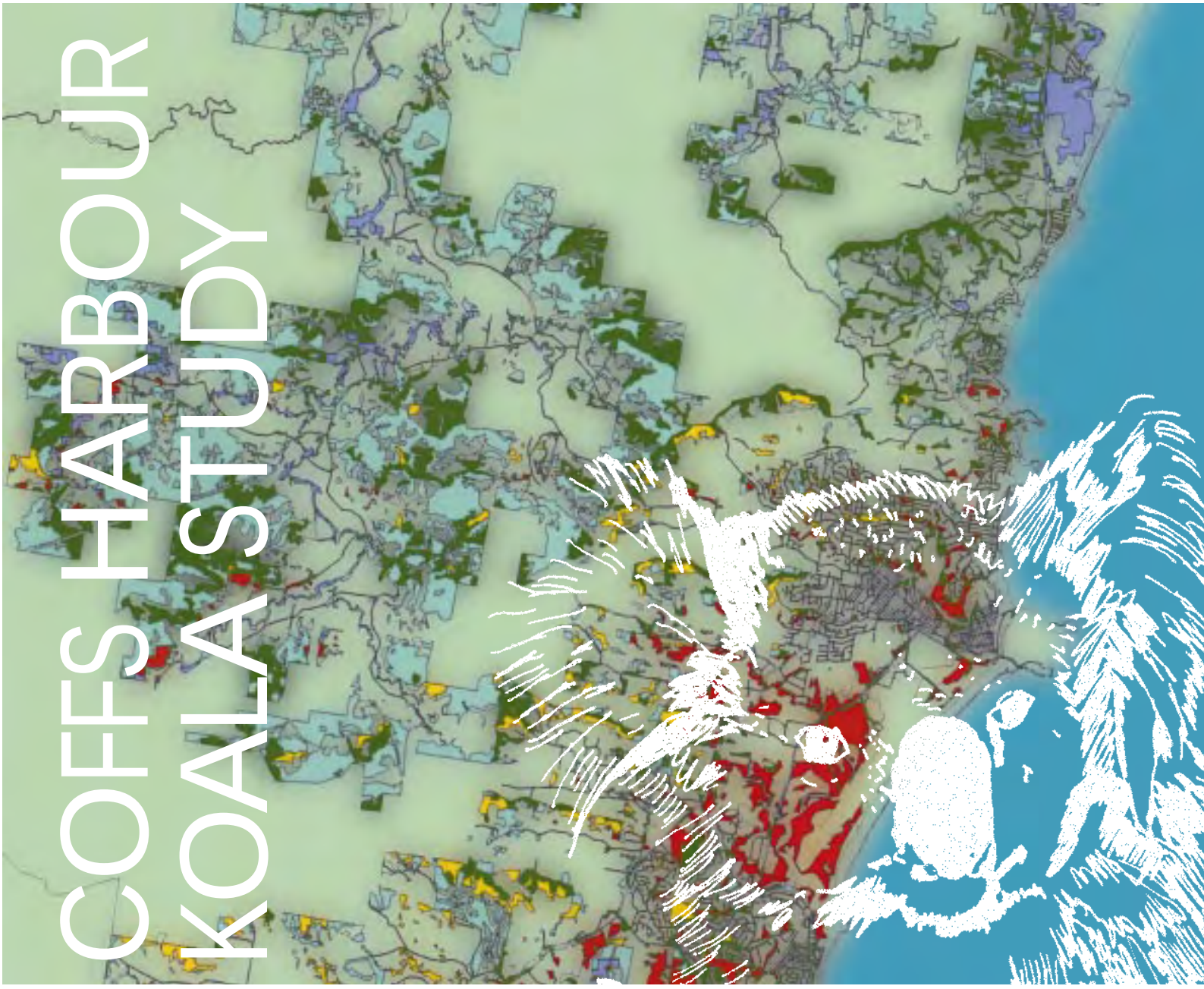
COFFS HARBOUR CITY

Koala Plan of Management

November 1999



PART B

A Joint National Parks and Wildlife Service and Coffs Harbour City Council Initiative

COFFS HARBOUR CITY

Koala Plan of Management

PART B

COFFS HARBOUR KOALA STUDY

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PREFACE

This document contains the source information for Part A (The Plan) of the Coffs Harbour Koala Plan of Management (KPoM), a comprehensive plan prepared under State Environmental Planning Policy No. 44 - Koala Habitat Protection. It provides a history to the development of The Plan, particularly the process of identification and mapping of koala habitat for the City of Coffs Harbour, as well as providing background information on the threats to koalas in the area.

This koala study was placed on public exhibition with Part A, as part of the Coffs Harbour City Council Draft Local Environmental Plan (LEP) 1998, for the period July 1998 through to the end of January 1999. Only a small number of submissions to the LEP made specific comments on the draft Comprehensive KPoM. Following consideration of the submissions, a number of amendments were made, principally to Part A, although the thrust and content remained substantially unaltered.

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1. INTRODUCTION

1.1 Aims and Objectives

The primary aim of State Environmental Planning Policy No.44 - Koala Habitat Protection (SEPP 44) is:

"*to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline*."

The primary objective of the koala study outlined in this document was to provide a basis for a Comprehensive Koala Plan of Management for Coffs Harbour under SEPP 44.

To provide an adequate basis for a CKPoM the study set out to:

- involve the community in the process of local koala conservation, at both the survey and management stages;
- identify the locations of koala populations, both past and present, in Coffs Harbour LGA through a community-based survey;
- conduct a scientific, field-based investigation of koala habitat preferences and distribution in the LGA;
- investigate the land use history of the region to assist understanding of present-day koala conservation status and distribution patterns;
- determine threats to koalas and their habitat in Coffs Harbour and investigate methods of addressing these;
- identify and map koala habitats in Coffs Harbour LGA in a way which can be used by Council for environmental planning purposes;
- determine public attitudes to koalas and a range of koala conservation measures in Coffs Harbour, through community-based survey;
- describe ways of restoring and enhancing koala habitat in Coffs Harbour;
- identify the responsibility for specific areas of management;
- provide information and support for local koala care and welfare groups;
- make recommendations, based on the results of the above investigations, towards development of a koala management plan for the whole LGA;
- provide a focus for a co-ordinated approach to koala management across the region.

Because SEPP 44 only applies to lands under Council planning control, and hence does not apply to state forests which make up over 30% of the LGA, the study could not fully investigate or make recommendations for koala management in state forests. The work aimed to be conducted in ways which could link with koala management and research in state forests in Coffs Harbour, where appropriate.

1.2 Coffs Harbour Local Government Area

1.2.1 Physical Environment

The City of Coffs Harbour, as the local government area is officially known, is situated on the north coast of New South Wales and occupies about 95,600 hectares. The City is situated between the Bellinger valley, the escarpment of the Great Divide and the sandstone ridge of the Corindi Plateau/Coast Range, which separates the area from the Clarence valley. The LGA occupies a coastal setting and has extensive coastline (51 kms).

The Great Dividing Range runs roughly parallel to the coast and extends eastward along a spur from the Dorrigo Plateau to Boambee at Coffs Harbour. The western region is an area of undulating and hilly land with an elevation to 700 metres, deeply cut by gullies, and with slopes in excess of 30 degrees on the eastern aspect. The City thus features a scenic backdrop of steep forested hills interspersed with short, fertile valleys behind a narrow coastal plain. The coastal plain is approximately 10 km wide in the south and includes the Repton and Bonville areas, it narrows in the centre where the coastal range comes within a few kilometres of the sea. In the north the Woolgoolga/ Corindi area along the coastline is less fertile with soils derived from a different geology.

From west to east the catchments of the Bobo and Little Nymboida Rivers, the Orara River, Bucca Creek, and a number of coastal creeks between Corindi Creek and the Bellinger River, as well as the bulk of the coastal plain, have largely been cleared for agriculture or settlement.

The geology of the area is mainly sedimentary rock with quaternary sandstone and alluvium along the coast and in the river valleys.

Coffs Harbour has a sub-tropical to warm temperate climate. Temperatures, on average, reach a daily maximum of 27°C in summer and 19°C in winter. Coffs Harbour experiences moderate to high rainfall of approximately 1,856 mm/year. Rain is more prevalent in the late summer to early autumn period. Variations in local climates throughout the LGA have resulted in wide variations in vegetation communities (Fisher *et al.* 1996).

1.2.2 Biotic Environment

Vegetated parts of the Coffs Harbour LGA are dominated by moist open forest communities with a coastal sclerophyll complex along the coast, dry open forest to the north, and rainforest in the south-west. Approximately 68% of the Coffs Harbour area remains tree covered, although a major part of this land is managed by State Forests of NSW. Most of the fertile river valleys and coastal plains have been cleared for agriculture and urban development; only disturbed remnant vegetation remains in these areas.

Fisher *et al*. (1996) mapped the vegetation of Council-controlled lands in the LGA and identified 10 broad vegetation types present within the Coffs Harbour LGA:

- Rainforest - Subtropical/Warm temperate, Warm temperate and Littoral
- Riparian vegetation
- Tall Open-forest
- Open forest
- Swamp forest
- Foredune complex
- Heath - Dry and Wet
- Sedgeland/Rushland
- Headland Heath and Grassland
- Mangrove/Saltmarsh

In eastern parts of the LGA banana-growing has been carried out on a total of 3316 hectares (CHCC 1998), and this has been concentrated on slopes with a northerly aspect. This has resulted in the loss of almost all native vegetation from north facing slopes near the coast (Fisher *et al.* 1996).

1.2.3 Land Use History

A picture of the progress of land-use changes is essential to establish the time frame over which changes to the Coffs Harbour koala population have taken place. The only land-use history of Coffs Harbour, by Yeates (1990, 1993), identifies times when land-uses changed, but gives no indication of the past distribution and status of koalas in Coffs Harbour. The following information has been gleaned from a variety of sources, many of them through personal interviews.

Coffs Harbour had a reputation for koalas well before Europeans arrived. The "Turgaree or Native Bear" is a key feature of one of the earliest Kumbaingerie stories (Ryan 1964) and the koala was an important local "totem" (Dick Kelly, local Aboriginal elder, pers. comm. to C. Moon 1991).

Coffs Harbour's history is unusual in that the town and much of the district was cleared and settled later than comparable nearby areas such as Bellingen, Lismore and Grafton, which were substantially cleared before 1870. Coffs Harbour was a small settlement before 1910, mainly because the large number of coastal creeks made transport difficult. A report by Commander Howard, Royal Navy Marine Surveyor, to NSW Engineer in Chief for Harbours and Rivers (*Coffs Harbour Advocate* 15/10/1907) reads: "*The southern end of the township extends over the dividing range [hospital hill] into the county of Raleigh.....only two houses in the township.....the Post and Telegraph offices being at the northern end. The innkeeper, butcher, blacksmith etc. live outside the township, on the western side of the main road, where there is also a steam sawmill which supplies the jetty works with planks.... All the available land around Coffs Harbour appears to have been selected, but little of it has been cleared and less of it cultivated*". The nearest cane mill is described as being four miles further along the road "where a considerable area is either cultivated or has been prepared for cultivation. This area is known as 'Korora'".

The building of the road from Bellingen to Grafton by 1884, the jetty by 1892, the North Coast Railway by 1915 and the harbour between 1924 and 1945 were the events which mark the opening up of the Coffs Harbour district. The widespread hunting of koalas for the fur trade, which officially ceased in NSW in 1903, does not appear to have been a feature of the district.

The impact of Europeans on local koalas can be seen as occurring in three major waves. The first, from about 1890 to 1915, was from logging for softwoods followed by clearing of most of the fertile, relatively flat river valleys and coastal plains for agriculture. This displaced koalas from their original core areas, leaving only the steeper, less fertile hills as koala habitat.

The second wave impacting on koalas came with the realisation that bananas could be grown profitably on the steep slopes of the area, particularly those with a northerly aspect. This began in the 1920s, and accelerated in the 1930s, so that 1000 acres of banana land in 1930 grew to 1815 acres (7.5 sq. kms.) in 1931, and the number of growers rose from 334 in 1931 to about 600 in 1935 (Yeates 1990). Jeeps, which became available after 1945, provided a means of access to steep areas and enabled the industry to intensify.

The third wave began in the 1970s with the rapid growth of the human population of the district. This growth accelerated through the 1970s with the suburban developments of Toormina and West Coffs (Coffs Harbour Historical Society 1988; Australian Bureau of Statistics 1992) (Figure B1). Both areas would have supported high concentrations of koalas, based on knowledge of the vegetation that was present and historical records.

In 1996 the population of Coffs Harbour stood at 59,000 and was growing at an annual rate of 3.9%. Approximately 90% of the population is located on the coastal strip (CHCC 1996a). It is estimated that the population will double by the year 2016, and that Coffs Harbour will have the highest population of any urban area in the region (Dept. of Planning 1991). The Coffs Harbour Urban Development Strategy identifies a population of up to 104,000 by 2021. It also identifies urban investigation areas where population growth is planned in the short, medium and long term.

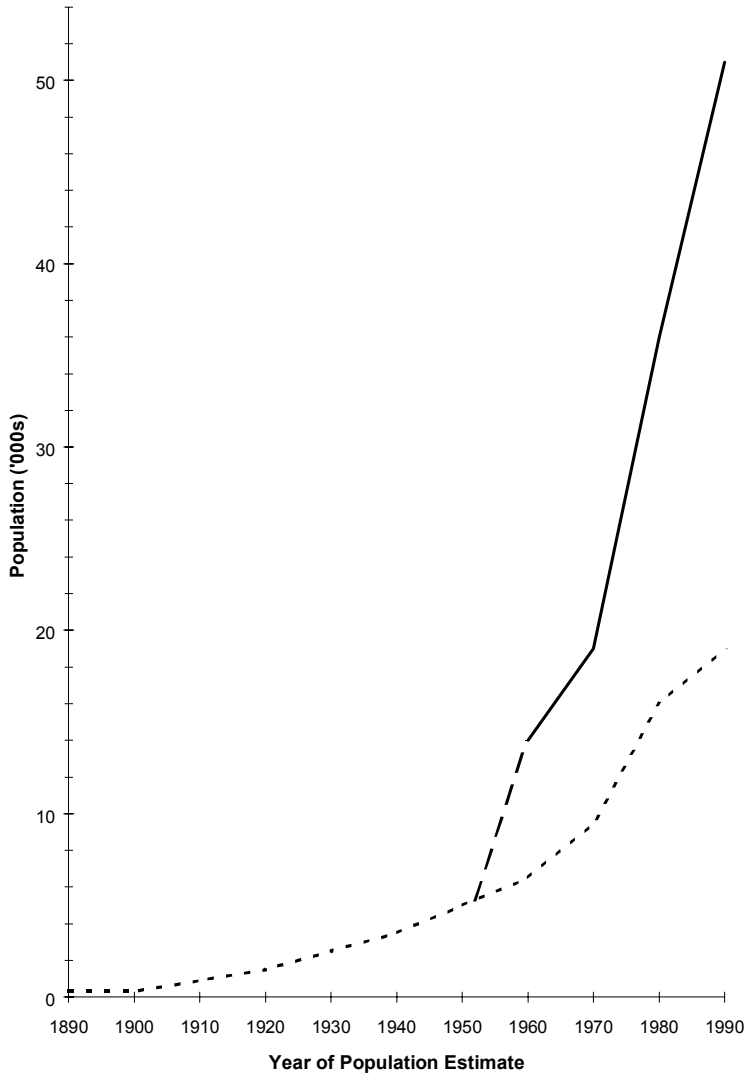


Figure B1. Human population growth in the City of Coffs Harbour

The lines show the growth of the population of Coffs Harbour from early European settlement to 1991. The dotted line is the population of the town of Coffs Harbour and the unbroken line is the population of the whole local government area from 1957 when the area became a Shire. The Shire became a City in 1987 (Sources: Coffs Harbour Historical Society 1988; Australian Bureau of Statistics 1992).

1.2.4 Regional Status of the Koala

The 1986-87 New South Wales state-wide survey of koalas found that there has been a rapid contraction and fragmentation of their distribution (Reed *et al.* 1990). Koalas in NSW now occur mainly on the north coast; in most other parts of their range they are uncommon or rare. In 1992 the koala was listed as 'Vulnerable and Rare' under the *Endangered Fauna (Interim Protection) Act* 1991 (Lunney *et al*. 1996a). This status was maintained with the passage of the *Threatened Species Conservation Act* 1995 where it is listed in Schedule 2 as 'Vulnerable'. The State of the Environment Australia report (1996) recognises that the koala in south-eastern Australia has suffered severe population declines since European settlement due to loss of habitat.

Coffs Harbour is one of only a few localities in NSW where koalas can be described as common (Reed *et al*. 1990). This population, however, is at risk from problems associated with the rapid growth and development of the Coffs Harbour area. Koala conservation has become a contentious issue in Coffs Harbour as development encroaches on areas of koala habitat (Reed and Lunney 1990). Coffs Harbour LGA is listed on Schedule 1 of SEPP 44 along with its neighbouring LGAs: Ulmarra, Nymboida and Bellingen. Thus the region as a whole is included in SEPP 44.

Recent research on the koala (e.g. Lee *et al.* 1990, Lunney *et al.* 1990, 1996b, 1997, Reed *et al*. 1990), has provided a state-wide context on which a local koala management plan can be based. Salient points include:

- the koala is being lost from the southern and western three-quarters of its range in NSW as a result of large scale habitat loss and fragmentation of populations into small isolated populations, compounded by drought, fires, road deaths and predation;

- most of the state's remaining koalas occur as a series of fragmented populations in the north coast region of NSW, from the Hunter River to Queensland.

- koalas are dependent on areas of fertile soils and either high rainfall or adequate soil moisture. Most such lands have been cleared for agriculture or settled at densities which eventually eliminate koalas;

- habitat loss is the key problem for the long-term survival of koalas in NSW, and has been the primary determinant of the present vulnerable status of the koala in NSW;

- only 24% of koala sightings obtained by the 1986-87 NSW Koala Survey were in National Parks, Nature Reserves or State Forests (Reed and Lunney 1990). The majority were on private rural lands in NSW, and their conservation is thus a community concern which largely falls within the ambit of local government jurisdiction.

Also, the ANZECC National Koala Conservation Strategy (1998) recognises that "community input and involvement is crucial to the conservation of koalas" and objective 1.3 states that "local government has a major role in the conservation of natural areas through its control over the use and development of private land". The community expectations at the Koala Forum in November 1995 included that it should be mandatory for councils to prepare shire-wide management plans in preference to *ad hoc* planning and assessing individual developments on their own (Lunney and Matthews 1997).

1.2.5 Koala Management in State Forests in Coffs Harbour

SEPP 44, the statutory basis for this koala study, only applies to lands which come under Council planning control, and hence does not apply to state forests. However, because State Forests of NSW is the largest land manager in Coffs Harbour, covering more than 30% (following transfers to NPWS estate in late 1998) of the LGA, they clearly have a major responsibility in the management of koalas across the LGA. The SEPP 44 Koala

Management Plan needs to be able to interact, and be compatible, with State Forests' koala management strategies in the LGA.

As well as managing timber production, State Forests has a statutory responsibility to manage public forests for wildlife, recreation, scientific, educational, archaeological and scenic values and catchment protection. The maintenance of koala habitat in forests undergoing logging has been the subject of public controversy in a number of areas. Such community concern about the potential impact of clearfelling on koalas within Pine Creek State Forest lead to the suspension of all harvesting operations in late 1995. The recommencement of harvesting was subject to the adoption of a joint SFNSW/NPWS koala plan of management. A series of studies have been undertaken to underpin this Koala Plan of Management and guide koala conservation and timber production. Smith and Andrews (1997), for State Forests of NSW, undertook a comprehensive review of the ecology of koalas, including distribution and abundance in relation to floristic and structural preferences, in Pine Creek State Forest. They also discussed the impact of forestry on koalas and koala habitat. Based on this and other studies, a Koala Management Plan has been prepared.

The Management Plan for the Coffs Harbour Management Area (Forestry Commission 1984) lists koalas as present on the coast and common in the Orara and Bushmans areas in wet and dry sclerophyll forest and woodland. Sources given are Bruxner Park Flora Reserve, Twelve Sixty Forest Preserve, and Kangaroo River, Wedding Bells, Conglomerate, Orara East, Orara West, Lower Bucca, Boambee, and Wild Cattle Creek State Forests. The 1995 EIS for the Coffs Harbour/Urunga forestry management areas found koalas to be locally common in the lower level coastal forests and uncommon on elevated ridges and escarpment forests in the region. State Forests recorded koalas frequently in Pine Creek State Forest (which was identified as the most important area of koala habitat) and less frequently in other coastal forests such as Conglomerate, Boambee Orara East and Way Way State Forests.

The 1990-91 community-based koala survey also provided an indication of the location of koalas in state forests. A large number of records were submitted by to this survey in many parts of Boambee, Orara East and Pine Creek State Forests, whilst Orara West, Lower Bucca and Wedding Bells State Forests had regular records in some parts. The sandstone areas of Conglomerate State Forest and the Nana Glen-Glenreagh areas, as well as the wetter forests of Tuckers Nob and Brooklana State Forests had only occasional koala sightings.

State Forests' koala records, provided in 1991 to the NPWS for the purposes of this study, indicate that in the local forests Tallowwood, Blackbutt, Flooded Gum and Forest Oak are the major koala tree species. Smith and Andrews (1997) found that Tallowwood, Small-fruited Grey Gum and Allocasuarina species were the most preferred food species in Pine Creek State Forest. Minor species recorded by State Forests of NSW as being utilised by koalas are Swamp Mahogany, Blue Gum, White Mahogany, Spotted Gum, Brush Box, Turpentine, Ironbark and Melaleuca.

State Forests apply a "koala prescription" for harvesting operations within specified Forest Types on the mid north coast, including Coffs Harbour. The prescription is part of an Integrated Forestry Operation Approval for State Forests' operations under Forestry Agreements reached through the recently adopted Forestry and National Parks Estate Act 1998.

The prescription requires a methodical survey for koalas or signs of koala presence prior to harvesting. Where koalas or their presence is detected a number of special conditions are implemented in the harvesting plan. Individual koalas are protected from tree felling operations and logging is excluded from within 20 m of high use areas which are documented and mapped in the harvesting plan. In areas considered to be intermediate

use areas, primary browse trees are retained at a minimum of 10 per hectare in the compartment.

It is recommended that Council obtain State Forests' Forest Type Maps for forests within the LGA, and identify the locations of those Forest Types which have been determined to constitute koala habitat in this study. Where a development proposal may affect koalas in adjacent forest habitat, NPWS and State Forests should be notified and invited to provide further advice if they wish.

1.2.6 Existing Planning and Legislative Requirements

A variety of laws and international agreements pertain to the management and protection of wildlife habitat in NSW. The most relevant are State laws which govern planning and development (e.g. *Environmental Planning and Assessment [E.P. & A.] Act 1979)* and wildlife protection (e.g. *National Parks and Wildlife Act 1974*, *Threatened Species Conservation Act 1995, Forestry Act 1916)*.

Section 428 (2) (c) of the *Local Government Act 1993* requires councils to produce, within five months after the end of each year a report as to the state of the environment in the area, including a report as to:

(i) areas of environmental sensitivity;
(ii) important wildlife and habitat corridors;
(iii) any unique landscape and vegetation;
(iv) development proposals affecting, or likely to affect, community land or environmentally sensitive land;
(v) threatened species and any recovery plans;
(vi) any environmental restoration projects; and
(vii) vegetation cover and any instruments or policies related to it, including any instruments relating to tree preservation."

The 1996 CHCC State of the Environment Report (CHCC 1996b) stated that "Koalas are the most prominent endangered fauna, with relatively high numbers being widely dispersed throughout the City" and the completion of the Koala Management Plan "will involve the identification of significant areas of koala habitat within the City, ...satisfy the requirements of SEPP 44 for the City, provide the research data to review LEP 1988 with regard to environmental protection, provide a management tool for Council officers and developers".

This CKPoM provides substantial material to assist Council in continuing to comply with these requirements.

At a local level wildlife habitat is potentially offered protection by provisions in the Local Environmental Plan (LEP) through powers conferred by the *E.P. & A. Act 1979*. The North Coast Regional Environmental Plan (REP) 1988 directs the writing of local environmental plans for each local municipality. Clause 29(c) states that a LEP should "include significant areas of natural vegetation including rainforest and littoral rainforest, wetlands, **wildlife habitat**, scenic areas and **potential wildlife corridors in environmental protection zones**" (emphasis added). This plan supports this approach. The LEP imposes various zones over lands within the City which regulate development. A number of activities, particularly logging in rural areas, are presently permissible without requiring Council consent under the 1999 LEP. These activities have the potential to impact on koala habitat.

Local Environmental Plans provide the opportunity for lands of high conservation value to be placed in an environmental zoning. The outcomes of the mapping of koala habitat undertaken as part of the CKPoM gives Council the opportunity to review the conservation values of these lands and zone them accordingly.

Tree Preservation Orders (TPOs) are an additional control whereby Council may regulate the removal of trees suitable for koalas. Presently there is a number of areas in Coffs Harbour which are covered by TPOs for the protection of trees of koala habitat importance. These include the North Boambee Valley, parts of Boambee near Bruce King Drive and an area near Vera Drive.

1.2.6.1 The *Environmental Planning and Assessment Act* in relation to CKPoMs

Amendments to the *Environmental Planning and Assessment Act 1979* by the TSC Act require that consent authorities, when considering a development application under Part 4 and determining authorities, when considering an activity under Part 5, must determine *inter alia* whether a development or activity is likely to have a significant effect on threatened species such as the koala. In making this decision, consent and determining authorities must take into account the matters contained in Section 5A of the EP&A Act. Generally known as the 8 part test of significance, this test requires that the likely effect of the proposal on threatened species be assessed. Assessment is undertaken by considering *inter alia* the viability of the local population, the regional distribution of known habitat and the potential for known habitat to be isolated.

The koala is listed under Schedule 2 of the *Threatened Species Conservation Act 1995* (TSC Act) as a vulnerable species The adoption of a Comprehensive Koala Plan of Management does not remove obligations under the EP&A Act as to whether there will be a significant effect on threatened species, including the koala. However, the CKPoM, by providing information of direct relevance to these matters, should significantly improve the quality and efficiency of such assessments by Council for the koala. The CKPoM should also provide general assistance in the consideration of some other threatened fauna species by providing information on the distribution of vegetation communities with the LGA.

Where an activity which is likely to result in a significant effect does not require consent approval under the EP&A Act, a Section 91 Licence may be required under the TSC Act.

Where a development or activity is found to be likely have a significant effect on threatened species, the EP&A Act requires that a SIS be prepared. As for the 8 part test of significance, the CKPoM should also significantly improve the quality and efficiency of the preparation of any SIS for the treatment of koala issues. The CKPoM will allow decisions to be based on a better understanding of both the habitat preferences and distribution of the species within a shire-wide context.

Part 3 of the EP&A Act deals with the making of environmental planning instruments. Local Environment Plans, Regional Environmental Plans and State Environmental Planning Policies are all examples of environmental planning instruments. These instruments collectively set the parameters for land-use in NSW. The TSC Act amended Part 3 of the EP&A Act to require that the Director of the Department of Urban Affairs and Planning (DUAP) or a council must consult with the Director-General of National Parks and Wildlife, where *inter alia* a threatened species will or may be affected by the draft policy, environmental study or draft plan. The CKPoM should significantly contribute to such consultations and consequently to the making of any LEP, REP or SEPP which is likely to affect the koala in the LGA. Indeed the CKPoM will have general relevance to a range of strategic planning initiatives undertaken by Council.

1.2.6.2 SEPP 44 - Koala Habitat Protection

State Environmental Planning Policy No. 44 - Koala Habitat Protection (SEPP 44), was introduced in January 1995 to augment existing legislation to conserve koalas by requiring a state-wide approach to planning. Under this Policy, proponents of development are

obliged to investigate the koala habitat values of lands of more than 1 hectare which are subject to a development application and which may involve lands considered as potential koala habitat. For areas identified through the processes of SEPP 44 as core koala habitat, a management plan must be prepared, approved by the Director of the Department of Urban Affairs and Planning (DUAP) and adopted by Council prior to consent being granted for development. Since its introduction, Coffs Harbour local government area has been subject to many SEPP 44 investigations for koala habitat on individual development applications. To date, nine individual koala plans of management have been prepared in Coffs Harbour. Not all of these have been approved by Council or DUAP. Plans prepared include the following areas:

- Marian Grove Retirement Village, prepared by Chris Moon, 24 April 1995.
- Lot 5, DP 561616, Parish of Bonville, RMB 312 South Boambee Rd, prepared by Chris Moon, 18 May 1995.
- North Boambee Valley, prepared by F. Dominic Fanning, Gunninah Consultants, August 1995.
- Rural subdivision at Red Hill, West of Coffs Harbour - D/A/234/94, prepared by Greenloaning Biostudies, August 1995.
- Coffs Harbour Education Campus, prepared by Chris Moon, September 1995.
- Proposed Residential Development, Lots 1002, 1003, 1004, 1005, DP 787947, Lady Belmore Drive, Boambee, prepared by F. Dominic Fanning, Gunninah Consultants, October 1995.
- Proposed Subdivision of Lot 321, DP 624474, James Small Drive, Korora, prepared by David Page, Ecosense, February 1996, revised April 1996.
- Englands Road Waste Management Facility, prepared by C. Moon, 1996.
- CSR Ready Mix North Boambee Quarry, prepared by C. Moon
- Coffs Harbour Base Hospital Site, Pacific Highway, Boambee. C. Moon, 1998

Preparing individual koala assessments for every development is a patchy, uneconomic and undesirable approach to planning and management of koala habitat in the LGA. SEPP 44 encourages the approach that koala plans of management be prepared for a whole LGA. When a 'comprehensive plan', ie. prepared for the whole of the local government area, has been adopted by Council and approved by the Director of the Department of Urban Affairs and Planning, individual plans of management need not be required to accompany development applications applying to lands with core koala habitat.

SEPP 44 states that in order to give effect to the aims of the Policy, Council should "make or amend a local environmental plan" and "give consideration to preparing an appropriate development control plan for land that is or adjoins a core koala habitat". This study supports the approach of including protection and management of koala habitat into the review of the Coffs Harbour City Local Environmental Plan 1988 to effect changes (outlined in Part A) which:

1) aim to implement the highest level of protection afforded in the LEP over lands identified as important koala habitat in Coffs Harbour;
2) implement planning controls which require adequate levels of assessment and careful consideration of the impacts of koalas of any development or activity on land identified as, or adjacent to, koala habitat; and
3) implement management strategies which minimise threats to koalas for activities in and adjacent to areas of koala habitat.

2. ECOLOGICAL SURVEY OF KOALAS AND KOALA HABITAT

The guidelines for preparing CKPoMs (DUAP 1998) recommend that a community-based koala survey and a field-based koala survey be undertaken as two complementary yet independent survey techniques to identify koala habitat. A vegetation survey of the LGA was recommended to help identify the nature and extent of koala habitat. All three survey techniques were used in the development of this CKPoM to provide a firm basis for management and planning. The scientific basis for the identification and mapping of koala habitat, as outlined below, is condensed in Lunney *et al.* (submitted).

2.1 Community-based Koala Survey

The City of Coffs Harbour has been identified as having one of NSW's largest koala populations (Reed *et al*. 1990). Prior to the preparation of this plan little was known about the status and distribution of koalas in the Coffs Harbour LGA, nor had there been a study of the level of local support for koala conservation measures. It was recognised that a detailed local survey of the distribution of koalas was essential if planning was to be effective and site-specific. Consequently, a detailed local community-based survey of koalas was initiated in 1990 as a joint undertaking by National Parks and Wildlife Service and Coffs Harbour City Council.

The primary aim of the community-based survey was to determine the distribution of koalas in the Coffs Harbour LGA. The secondary aim was to establish the level of support for various options for conserving koalas in the LGA.

The values of a community survey are that it provides both current and historical records of koala populations, it enables records on private land to be identified without being intrusive and it enables members of the local community to become involved at the first phase of planning - that of information gathering. The identification of areas where koalas were once present, but do not occur now, is relevant for management and planning options where habitat regeneration and corridor linkage is to provide the greatest benefit for koalas (Principle 8, Coffs Harbour Urban Development Strategy 1996).

Community-based survey also permits community attitudes to be investigated and comments on koala conservation to be elicited. This provides a greater community awareness of the issues and support for conservation initiatives (Lunney *et al*. in press). There can be, however, bias towards collecting greater levels of records in areas of highest population or visitation by the public, with records in remoter areas less likely.

2.1.1 Methods

The National Parks and Wildlife Service and Coffs Harbour City Council reached agreement in April 1990 on a joint, community-based, koala survey in the Coffs Harbour local government area. It was recognised that a joint approach was more likely to elicit a broader response from the community because it reflected a co-operative effort to establish the facts before discussing management options. Further, the explicit support of the then Forestry Commission (now State Forests) further widened the likelihood of a broad community response.

The postal survey was designed to answer questions on koala sighting locations, changes in numbers, health, death, and breeding and the degree of support for various conservation options. Since an objective of the study was to assist land-use planning and day-to-day management considerations, a desired outcome was to produce a map-based picture of the local koala distribution, and respondents were asked to mark a map. The questionnaire is shown in Figure B2. The map of the entire LGA was produced on the reverse side of the questionnaire page. A detailed map of Coffs Harbour and Sawtell/Bayldon was placed adjacent to the questionnaire. The map and questionnaire were large, on A3 format, and

folded neatly for postage following the prescribed post office layout. The map used in the survey was user-friendly in that it looked like a familiar road map so that residents would be confident about marking locations. A free-post return was marked on the survey form. In October 1990 18,600 Koala Survey forms, signed by NPWS researchers and the Coffs Harbour Town Clerk, were delivered to every household in Coffs Harbour Local Government Area. The postal schedule included business addresses (e.g. private boxes, particularly Coffs Harbour, Coffs Jetty and Coffs Plaza), which were not able to be separated from households and other categories such as visitors (e.g. Poste Restante).

Each koala location marked by respondents on the map was given an Australian Map Grid (AMG) reference number, which assigned each koala record within a 4 ha grid cell. This was achieved by using a plastic overlay on the returned survey sheets and reading the AMG number from the overlay. The AMG numbers were logged on to a computer and transferred to E-RMS (Environmental Resource Mapping System), a software package developed by NPWS (Ferrier 1988) to allow complex sets of geographical information to be expressed and analysed in a map-based form.

Follow-up occurred when a respondent's sightings were likely to influence the overall result, i.e. if the respondent reported seeing: koalas very often (weekly or monthly); many koalas over the years or in many locations; female koalas carrying young or koalas in unusual locations. Follow-up also occurred if respondents' answers were inconsistent or incomplete, if they lived in an area selected for field work, or if confirmation of sightings was sought (e.g. North Bonville). The follow-up allowed the authors to become familiar with areas of koala habitat in the LGA, particularly tree species used by koalas, tree composition and adjacent land uses, and to be satisfied as to the level of reliability of the data. Trees where koalas had been seen were inspected and the following information obtained: tree species, diameter at breast height over bark (DBHOB), breeding status of the koala and location (given as Coffs Harbour area - principally Mackays Road area, North Boambee - including Middle Boambee and Kratz Drive area, Toormina/Bayldon/North Bonville, Korora, Upper Orara including Mount Browne Road, Bucca and Pine Creek State Forest). This validation process was a major component of the time taken in this study.

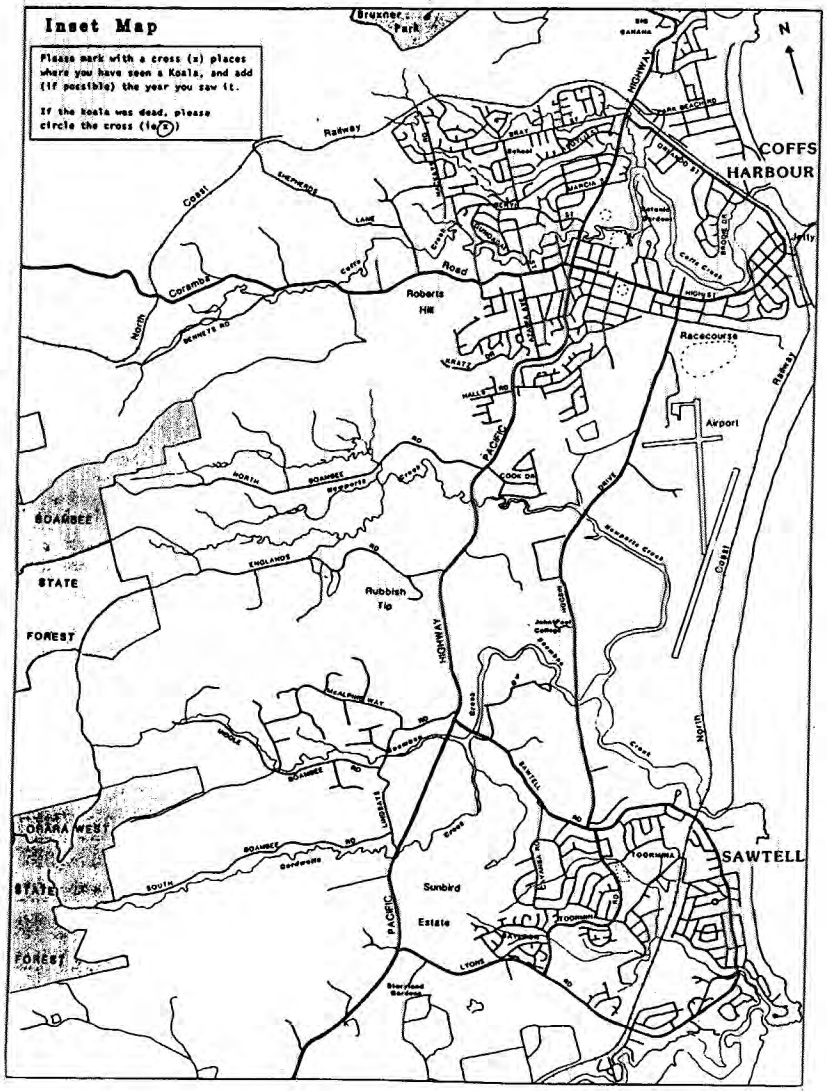
Figure B2. The postal koala survey form.

KOALA SURVEY

POSTAGE PAID TO THE HOUSEHOLDER AUSTRALIA

Please fold and return to:

Coffs Harbour Koala Survey
FREEPOST No. 62
Coffs Harbour, 2450



COFFS HARBOUR KOALA SURVEY

OCTOBER 1990

DEAR HOUSEHOLDER

The National Parks and Wildlife Service is carrying out a survey of Koalas in Coffs Harbour with assistance from Coffs Harbour City Council, the Sun Herald Koala Fund and the Forestry Commission.

We want to collect detailed information on Koalas so that future planning decisions can help to conserve them in Coffs Harbour.

To be successful, the survey needs your support. We ask you to fill out and return this questionnaire, even if you have never seen a Koala near Coffs Harbour. All replies will be confidential.

Please return the completed form to the collection box at Coffs Harbour City Council's Office or post it (no stamp required) to reach us by 26 October 1990.

Thank you for your help.

Chris Moon and Dan Lunney - National Parks and Wildlife Service
PR Harvey - Town Clerk, CHCC

Enquiries phone: 522 555

Please circle the closest answer.

1. WHAT IS YOUR LOCAL AREA?
   (1) Coffs Harbour (2) Glenreagh/Nana Glen (3) Boambee
   (4) Lower/Central Bucca (5) Karangi/Coramba/Red Hill (6) Sawtell/Bayldon Toormina
   (7) Corindi/Woolgoolga (8) Ulong/Lowanna (9) Bonville
   (10) Korora/Moonee (11) Dairyville/Fridays Creek (12) Repton/Raleigh

2. ON AVERAGE, HOW OFTEN DO YOU SEE KOALAS IN YOUR LOCAL AREA?
   (1) Weekly (2) Monthly (3) Quarterly
   (4) Yearly (5) Rarely (6) Never

3. HOW MANY KOALAS HAVE YOU SEEN IN YOUR LOCAL AREA IN THE LAST TWELVE MONTHS?
   .....

4. IN THE TIME YOU HAVE LIVED IN YOUR LOCAL AREA HAS THE NUMBER OF KOALAS:
   (a) Increased (b) Stayed the same (c) Decreased
   (d) Don't know
   If you have noticed a change, what year did this begin? .....

5. HAVE YOU SEEN SICK KOALAS IN YOUR LOCAL AREA? Yes / No
   (eg with infected eyes or a wet, dirty tail)

6. HAVE YOU SEEN KOALAS WITH YOUNG IN YOUR LOCAL AREA? Yes / No

7. WHERE HAVE YOU EVER SEEN KOALAS IN THE COFFS HARBOUR DISTRICT?
   On the large map overleaf, or the inset map on this page, pleas show all the locations and, if possible, the year you saw it.

8. HAVE YOU EVER SEEN ANY DEAD KOALAS IN THE COFFS HARBOUR AREA? Yes / No
   If Yes, was the Koala dead on a road? Yes / No

   Please mark these on the maps.

9. HAVE YOU SEEN KOALAS IN A STATE FOREST NEAR COFFS HARBOUR? Yes / No
   Were you working in that State Forest? Yes / No

   Were you visiting or driving through that State Forest? Yes / No

Conserving Koalas in Coffs Harbour might involve some restrictions trade-offs or other costs. We would like to know which actions would have your support.

10. WOULD YOU SUPPORT ANY OF THE FOLLOWING ACTIONS TO HELP CONSERVE KOALAS IN COFFS HARBOUR?
    (1) Traffic Restrictions (eg speed limits at night in areas with Koalas) Yes / No
    (2) Restrictions on dogs (eg to stop dogs roaming at night) Yes / No
    (3) Tree Preservation Orders (to protect Koala food trees) Yes / No
    (4) Tree-planting Programmes (to increase Koalas' food supply) Yes / No
    (5) Employ a Wildlife Specialist in Coffs Harbour Yes / No
    (6) Environment Protection Zones (to control development in areas used by Koalas) Yes / No
    (7) Use public money (from rates or taxes) to buy land for Koala Reserves Yes / No

11. HOW MANY YEARS HAVE YOU LIVED IN COFFS HARBOUR? .....

12. YOUR STREET NAME .....

13. STATISTICAL INFORMATION (CONFIDENTIAL)

    YOUR AGE ..... SEX: Male / Female

14. MAY WE CONTACT YOU FOR MORE DETAILS? Yes / No

    Name .....

    Phone No. ..... House No. .....

15. DO YOU HAVE ANY COMMENTS?

    .....

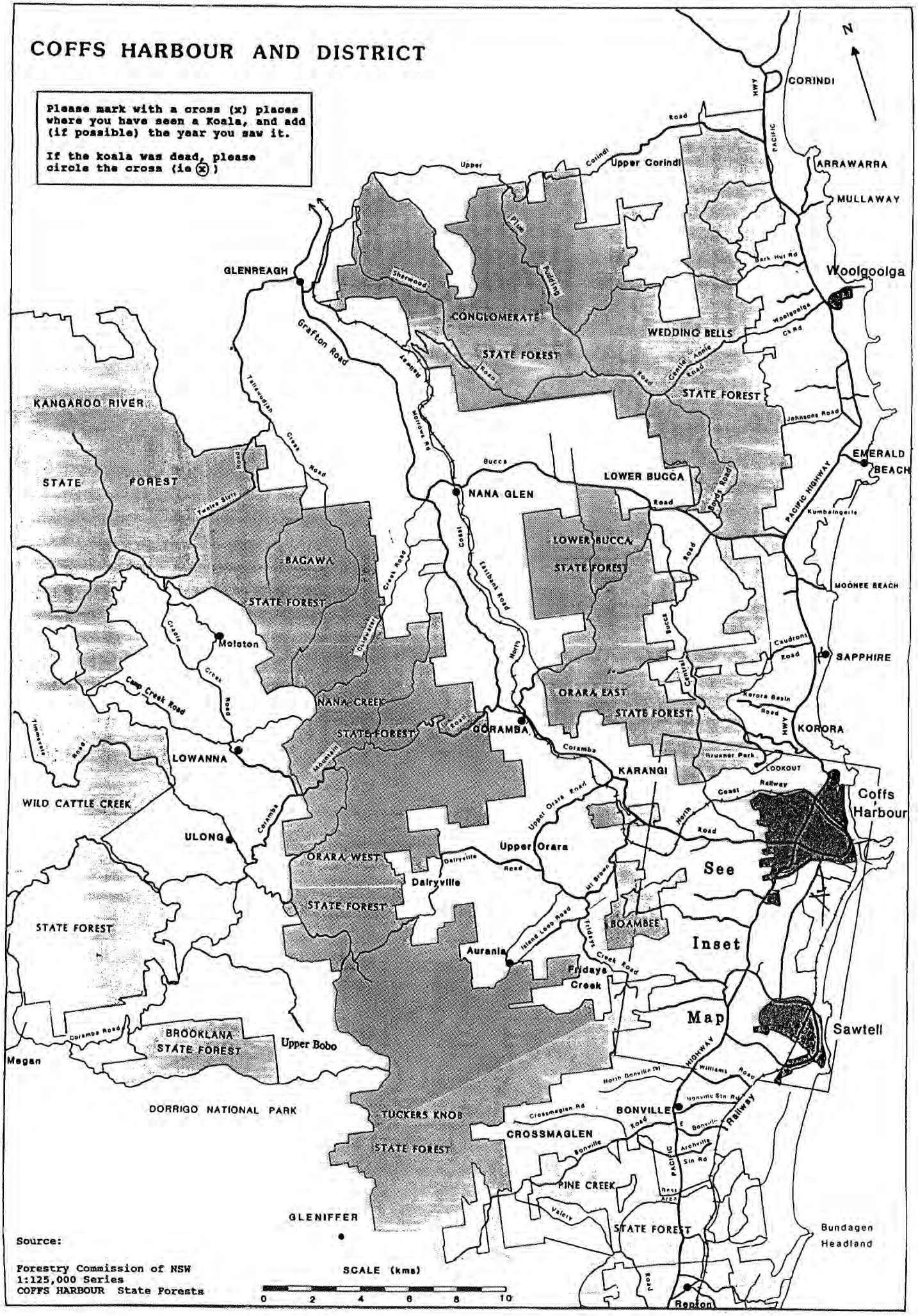
    .....

    .....

COFFS HARBOUR AND DISTRICT

Please mark with a cross (x) places where you have seen a Koala, and add (if possible) the year you saw it.

If the koala was dead, please circle the cross (ie ⊗)



Source:

Forestry Commission of NSW
1:125,000 Series
COFFS HARBOUR State Forests

2.1.2 Results

There were 2018 replies to the survey (10.8 % return). The survey results fall into three distinct categories: tabular information derived from the questions; map-based results derived from the survey form maps; and field data collected through the follow-up process.

2.1.2.1 Questionnaire results

The following tables present the results to the questions of the 1990 community koala survey form. Not all questions were answered by all respondents.

Q1: What is your local area?

Local area	No. of Respondents	Percentage (%)
Coffs Harbour	610	31
Glenreagh/Nana Glen	55	3
Boambee	109	5.5
Lower/Central Bucca	6	0.5
Karangi/Coramba/Red Hill	80	4
Sawtell/Bayldon/Toormina	436	22
Corindi/Woolgoolga	304	15
Ulong/Lowanna	10	0.5
Bonville	106	5
Korora/Moonee	189	9.5
Dairyville/Fridays Creek	39	2
Repton/Raleigh	44	2
Total	**1988**	**100**

Respondents to the survey came from all areas, but there was a higher percentage return from the areas of Coffs Harbour, Sawtell/Bayldon/Toormina and Corindi/Woolgoolga, which are the major centres in the LGA.

Q2: On average, how often do you see koalas in your local area?

Local area	Week	Month	Quart	Year	Rare	Never	Total
Coffs Harbour	9	16	24	33	166	345	593
Glenreagh/Nana Glen	0	0	0	2	13	40	55
Boambee	7	11	14	11	31	32	106
Lower/Central Bucca	1	0	0	0	0	5	6
Karangi/Coramba/Red Hill	2	4	11	10	34	18	79
Sawtell/Bayldon/Toormina	7	4	21	37	131	220	420
Corindi/ Woolgoolga	0	1	1	4	34	256	296
Ulong/Lowanna	1	0	0	3	4	1	9
Bonville	3	4	7	12	32	44	102
Korora/Moonee	1	2	11	18	61	88	181
Dairyville/ Fridays Creek	1	2	5	9	13	8	38
Repton/Raleigh	3	2	3	7	13	16	44
Total	**35**	**46**	**97**	**146**	**532**	**1073**	**1929**

Koalas were observed frequently in many areas except for Corindi/Woolgoolga, Lower/Central Bucca and Glenreagh/Nana Glen.

Q3: How many koalas have you seen in your local area in the last twelve months?
Since estimates of abundance appeared to be unreliable, and would have included double counting, the logical division of "seen koalas" and "not seen koalas" in the last 12 months was adopted. (The percentage response is given in brackets.)

Local area	Seen koalas	Not seen koalas	Total
Coffs Harbour	167 (29)	402 (71)	569
Glenreagh/Nana Glen	7 (13)	46 (87)	53
Boambee	57 (57)	43 (43)	100
Lower/Central Bucca	2 (50)	2 (50)	4
Karangi/Coramba/Red Hill	46 (60)	31 (40)	77
Sawtell/Bayldon/Toormina	152 (37)	260 (63)	412
Corindi/Woolgoolga	24 (9)	255 (91)	279
Ulong/Lowanna	6 (67)	3 (33)	9
Bonville	42 (46)	50 (54)	92
Korora/Moonee	67 (37)	116 (63)	183
Dairyville/Fridays Creek	30 (81)	7 (19)	37
Repton/Raleigh	22 (50)	22 (50)	44
Total	**622 (33%)**	**1237 (67%)**	**1859**

A majority of respondents had seen koalas in the past 12 months in the areas of Dairyville/Fridays Creek, Ulong/Lowanna, Karangi/Coramba/Red Hill and Boambee. The

majority of respondents in the areas of Corindi/Woolgoolga, Glenreagh/Nana Glen and Coffs Harbour had not seen koalas in the past 12 months.

Q4: In the time you have lived in your local area has the number of koalas: (a)Increased, (b)Stayed the same, (c)Decreased, or (d)Don't know?

Local area	Increase	Same	Decrease	Don't know	Total
Coffs Harbour	11 (2)	40 (7)	94 (16)	430 (75)	575
Glenreagh/Nana Glen	1 (2)	1 (2)	4 (8)	43 (88)	49
Boambee	6 (6)	17 (16)	24 (23)	59 (56)	106
Lower/Central Bucca	0 (0)	2 (33)	0 (0)	4 (67)	6
Karangi/Coramba/Red Hill	2 (3)	8 (10)	14 (18)	55 (70)	79
Sawtell/Bayldon/Toormina	3 (1)	30 (7)	70 (17)	301 (75)	404
Corindi/Woolgoolga	1 (0)	15 (5)	13 (5)	245 (89)	274
Ulong/Lowanna	0 (0)	1 (13)	1 (13)	6 (75)	8
Bonville	3 (3)	11 (11)	20 (21)	62 (65)	96
Korora/Moonee	3 (2)	23 (13)	28 (16)	125 (70)	179
Dairyville/ Fridays Creek	1 (3)	3 (8)	8 (21)	26 (68)	38
Repton/Raleigh	3 (7)	4 (10)	9 (21)	26 (62)	42
Total	**34 (2%)**	**155 (8%)**	**285 (15%)**	**1382 (75%)**	**1856**

Most respondents to the survey replied that they did not know whether the koala population had increased, decreased or stayed the same. Of those that did have an opinion, most said that the population had decreased.

Q5: Have you seen sick koalas in your local area? (eg. with infected eyes or a wet, dirty tail)

Local area	Seen a koala	Seen a sick koala	% sick
Coffs Harbour	248	28	11
Glenreagh/Nana Glen	15	1	7
Boambee	74	14	19
Lower/Central Bucca	1	1	100
Karangi/Coramba/Red Hill	61	9	15
Sawtell/Bayldon/Toormina	200	22	11
Corindi/Woolgoolga	40	10	25
Ulong/Lowanna	8	5	63
Bonville	58	10	17
Korora/Moonee	93	7	8
Dairyville/Fridays Creek	30	6	20
Repton/Raleigh	28	2	7
Total	**856**	**115**	**13%**

Sick koalas were observed by respondents in all areas. The highest was in Lower/Central Bucca and Ulong/Lowanna, however the response from these areas was low.

Q6: Have you seen koalas with young in your local area?

Local area	Seen a koala	Seen a young koala	% young
Coffs Harbour	248	77	31
Glenreagh/Nana Glen	15	2	13
Boambee	74	25	34
Lower/Central Bucca	1	0	0
Karangi/Coramba/Red Hill	61	18	30
Sawtell/Bayldon/Toormina	200	32	16
Corindi/Woolgoolga	40	13	33
Ulong/Lowanna	8	2	25
Bonville	58	20	34
Korora/Moonee	93	18	19
Dairyville/Fridays Creek	30	4	13
Repton/Raleigh	28	6	21
Total	**856**	**217**	**25%**

Koalas with young were observed in all areas except for Lower/Central Bucca. The highest percent of koalas with young was recorded in Boambee, Bonville, Corindi/Woolgoolga, Coffs Harbour and Karangi/Coramba/Red Hill.

Q8: Have you ever seen any dead koalas in the Coffs Harbour area?

Seen a koala	Seen a dead koala	% dead
856	333	39%

If yes, was the koala dead on a road?

Seen a dead koala	Dead koala on road	% of dead koalas on road
333	254	76%

Thirty-nine percent of respondents that had seen koalas in Coffs Harbour had seen a dead koala and most of those were seen dead on a road.

Q9: Have you seen koalas in a State Forest near Coffs Harbour?

Seen a koala	Seen a koala in a SF	% in SF
856	301	35%

Koalas had been observed in State Forests near Coffs Harbour with the percentage of respondents being sufficiently large to point to their local importance in koala conservation.

Q10: Would you support any of the following actions to help conserve koalas in Coffs Harbour?

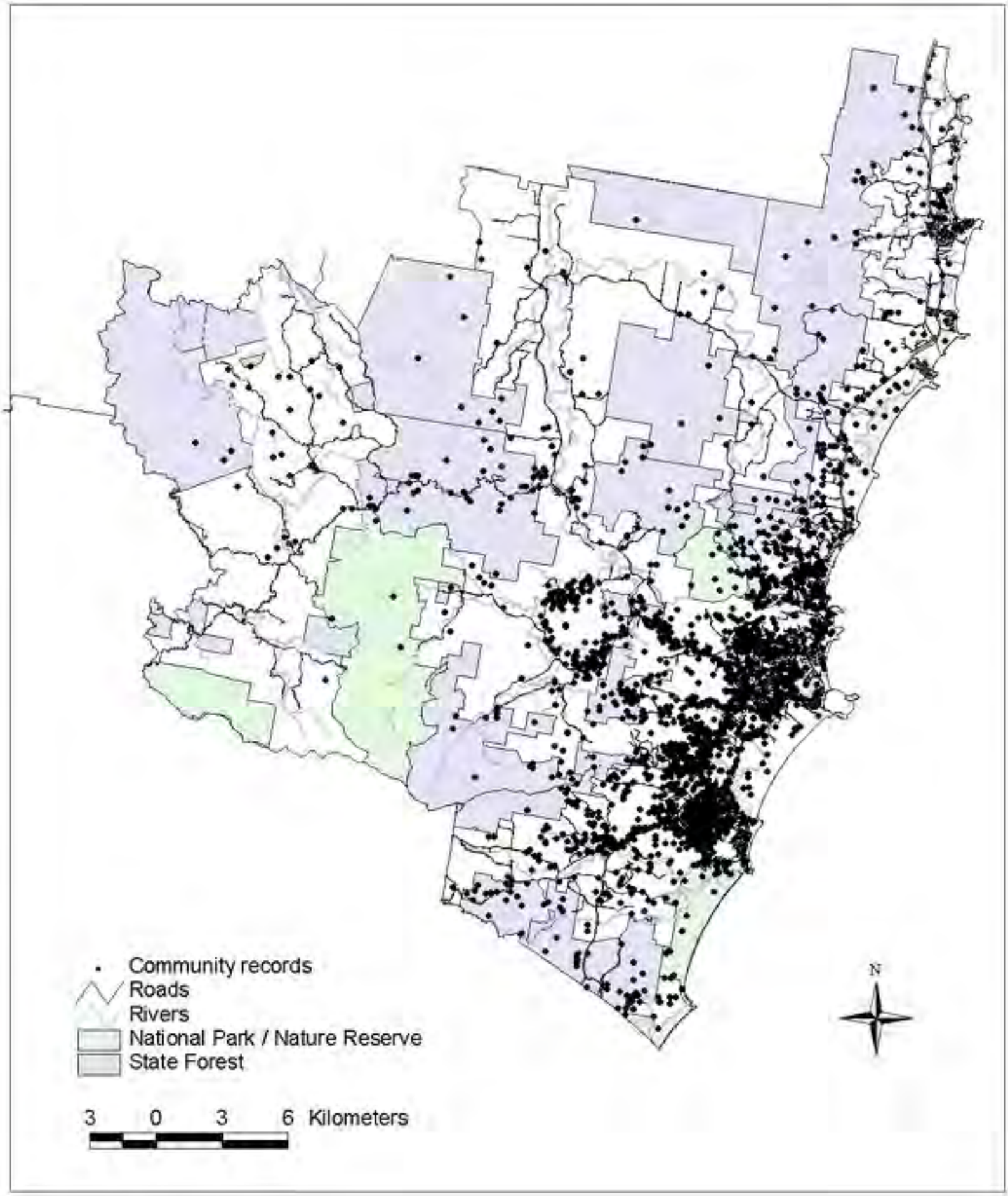
	Yes	No	Total
Tree planting programs (to increase koalas' food supply)	1874 (97%)	47 (3%)	1923
Restrictions on dogs (eg. to stop dogs roaming at night)	1806 (95%)	86 (5%)	1892
Tree preservation orders (to protect koala food trees)	1746 (93%)	134 (7%)	1880
Environment protection zones (to control development in areas used by koalas)	1646 (89%)	206 (11%)	1852
Traffic restrictions (eg. speed limits at night in areas with koalas)	1599 (87%)	229 (13%)	1828
Employ a wildlife specialist in Coffs Harbour	1386 (78%)	380 (22%)	1746
Use public money (from rates or taxes) to buy land for koala reserves	1250 (71%)	499 (29%)	1749

The three most popular options for koala conservation action are tree planting, restrictions on dogs and tree preservation orders. The employment of a wildlife specialist and the use of public money to buy land for koalas were the least preferred options, although even 71% support is a convincing majority endorsement.

All comments recorded by respondents on their survey forms to Question 15 - "Do you have any comments?" were typed and collated into a separate document which is too large (143 pages containing 1011 comments) to reproduce here. This document was lodged with and is available from Coffs Harbour City Council, Coffs Harbour Library and the National Parks and Wildlife Service Dorrigo District and Northern Zone offices. Each respondent's sex, age and local area, where available, but not any names, were included with the comment. The comments are unedited, except for standardisation of spelling and grammar and the removal of information which might identify the respondent. Of the 1011 comments, 474 (47%) were supportive of koala conservation, 54 (5%) were hostile and 483 (48%) were neutral. A selection of comments is provided in Appendix B1 to demonstrate some of the themes and original contributions to the debate. They have been selected to give a representative sample of the comments and to convey a tone and level of concern and feeling which is not readily apparent from the numerical data.

Map B1. Koala records.

The location of every koala sighting reported to the 1990/91 postal koala survey of Coffs Harbour is shown as a black dot.



Map B2 (a- g). Local areas selected for detailed presentation of koala records: a) Korora, b) Coffs Harbour, c) Sawtell/Bayldon/Toormina, d) Boambee, e) Upper Orara, f) Bonville, and g) Moonee.

2.1.2.2 Map-based results

A total of 3309 records of koala sightings was obtained from the maps included with the survey forms. These records are captured by 1570 grid cells (of 4 ha) in the Coffs Harbour LGA. Their distribution shows that they are concentrated around Coffs Harbour on a coastal strip of about 20 km and about 15 km in an east-west direction (Map B1). This concentration indicates that koalas are away from the beach zone and clustered into a number of identifiable pockets.

Of the 1570 cells containing koala records, 254 (16%) are in State Forests, 7 (0.5%) are in National Parks and Nature Reserves, 23 (1.5%) are in Vacant and Reserved Crown Land and the majority, 1286 (82%) are in freehold land. Based on the area of these tenures, there were more cells than expected containing koala records in freehold land and there were less than expected in State Forests (χ^2 = 440.66, 4 d.f., $p<0.05$).

Seven areas were selected for detailed analysis and some overlap between them was used to clarify presentation (Map B2 (a-g). The seven local maps are: 1. Korora; 2. Coffs Harbour; 3. Sawtell/Bayldon/Toormina; 4. Boambee; 5. Upper Orara; 6. Bonville; and 7. Moonee.

The distribution of koala records in Korora (Map B2a) shows that they were focused on the south-eastern corner of this local area particularly around Korora Nature Reserve and on the eastern side of the Pacific Highway between Korora and Diggers Beach. Records are also prominent around the edge of Orara East State Forest and Bruxner Park Flora Reserve to Sealy Lookout. In the south-west corner of this area, records are prominent in the remnant bush surrounding Vera Drive and the Hospital grounds between MacKays Road and Dutton Crescent. Koalas were recorded to the north particularly in an area along the Pacific Highway from just south of Maccues Road north to Cunninghams Creek and 1 km west. There are few records to the east of the highway north of Korora Basin. The locations of breeding females were few and scattered and koala deaths were concentrated near the road, particularly in three easily-defined locations: 1. along the road to Diggers Head, 2. on the Pacific Highway near Korora Nature Reserve, and 3. on the Pacific Highway just south of Maccues Road.

The distribution of koala records in and around the town of Coffs Harbour shows a pattern of 8 or 9 clusters, many of them linked, with a scattering of isolated records (Map B2b). The overlap of this area with Korora now reveals a marked concentration of koala records in West Coffs Harbour through the bushland adjacent to Vera Drive and MacKays Road and a line of records stretching east to the Pacific Highway which is associated with the strip of riparian vegetation under the Joyce Street bridge and along Wentworth Avenue. There is a cluster of records to the east of the highway around Coffs Creek and along Hogbin Drive to Newports Creek. There is an almost continuous line of records following Coramba Road up to Red Hill in the north-west corner of the map, with a concentration around Roberts Hill and into the North Boambee Valley, particularly near the highway and along North Boambee Road. A dense cluster of records can be seen in the south-west of the map in the area from the Englands Road Waste Management Facility to Middle Boambee, including Boambee Creek. Breeding is concentrated in two areas: 1. in the bush adjacent to MacKays Rd and 2. in the Boambee Valley along Kratz Drive, although there is also a general scattering of breeding locations. The pattern of dead koalas points to 6 locations, 4 of which are strung out along roads: 1. along MacKays Road, 2. along Kratz Drive, 3. along the length of Coramba Road west from McCanns Road, 4. along the Pacific Highway to the north of Englands Road, 5. along the Pacific Highway to the south of Englands Road through Lindsays Cutting, and 6. along Hogbin Drive from the airport road to the Harry Jensen Bridge over Newport Creek.

The distribution of koala records in Sawtell/Bayldon/Toormina shows a distinct clustering in the centre of the map in the Bayldon/Toormina area and a paucity on the coast around Sawtell (Map B2c). Koalas were also recorded in this area along the Pacific Highway and in a fairly continuous line along Lyons Road. This map also shows a scattering of records

along the length of Bonville Creek. The few breeding female records are concentrated into the main cluster, particularly in the bush surrounding Jane Circuit and Cavanba Road and associated with the creek behind Playford Avenue and on the opposite side of Toormina Road. The pattern of dead koalas reveals an association with primary roads, namely the Pacific Highway, Lyons Road, Sawtell Road and Hogbin Drive. Dead koalas were also recorded through the network of roads in Bayldon and Toormina.

The Boambee area map shares much with the two preceding areas but also shows koala records distributed throughout the length of the Boambee Valley to Boambee State Forest (Map B2d). In Boambee State Forest there is a concentration of records which extends west to the freehold land bounded by the Mount Browne and Fridays Creek Roads. There is a scatter of breeding female records with a concentration in Middle Boambee particularly along Alice Road. The line of dead koala records along the highway is pronounced, with an identifiable 2 km black stretch from Sawtell Road to Newports Creek, south of North Boambee Road. There is also a line of records of dead koalas on Hogbin Drive from John Paul College to south of the Fred Hansen Bridge over Boambee Creek.

The Upper Orara area map (Map B2e) shows the records behind Boambee State Forest form a loop which follows Upper Orara Road but which ends just past the Karangi Dam. Records extending up the Coramba Road also end at the cleared land of Karangi. Koalas with young were recorded along the Coramba Road and particularly along the Mount Browne Road. The distribution of records of dead koalas reflects the pattern of roads from the Coramba Road and around the loop of the Mount Browne Road and Upper Orara Road.

The distribution of all koala records in the Bonville area (Map B2f) shows a linear pattern associated with the highway but which ends where the highway crosses Bonville Creek. Records are also concentrated in North Bonville and extend along the North Bonville Road and along Cassidys Road to Tuckers Knob State Forest. Records are scattered east of the highway between Bonville Creek and Pine Creek. Records for breeding females indicate a few scattered localities with no particular concentrations. The picture of the distribution of dead koala records follows the highway, particularly in the mid-portion of the map. This identifies a black spot from North Bonville Road for approximately 1.5 km to the north.

Records of koalas in the Moonee area are much sparser than in the other areas (Map B2g) but are still associated with the Pacific Highway. A few records extend west along the Bucca Road, and along Moonee Creek, with a cluster along Johnsons Road towards Wedding Bells State Forest. There were only two locations with records of breeding females, one in the area between MacCues Road and Cunningham Creek and the other in Orara East State Forest. The distribution of dead koala records shows a pattern primarily associated with the Pacific Highway.

2.1.2.3 Follow-up results

A total of 205 trees where koalas had been seen were inspected, and information on tree species, diameter at breast height over bark (DBHOB) and sightings of females with young were recorded for specific locations (Appendix B2). Follow-up to the survey determined that koalas were sighted in the following trees:

1.	Tallowwood	*Eucalyptus microcorys*	77 (38%)
2.	Flooded gum	*E. grandis*	52 (25%)
3.	Blackbutt	*E. pilularis*	26 (13%)
4.	Forest Oak	*Allocasuarina torulosa*	9 (4%)
5.	Grey Gum	*E. propinqua*	7 (3%)
6.	Red Gum	*E. tereticornis*	5 (2%)
7.	Bloodwood	*Corymbia intermedia*	5 (2%)
8.	Coast Apple	*Angophora costata*	4 (2%)
9.	Brush Box	*Lophostemon confertus*	4 (2%)

Koalas were also recorded occasionally in Turpentine *Syncarpia glomulifera,* Red Mahogany *E. resinifera,* White Mahogany *E. acmenoides* and Red Ironbark *E. crebra,* and once each in Swamp Mahogany *E. robusta,* Grey Ironbark *E. siderophloia*, Lemon-scented Gum *E.citriodora*, Camphor Laurel *Cinnamomum camphora* and a *Melaleuca*.

Tallowwood stands out clearly from this follow-up to the community-based survey in Coffs Harbour as the most common tree in which koalas were observed.

2.1.3 Discussion

A distinct pattern of koala distribution emerged for Coffs Harbour. The principal feature is that the predominant number of records were in the south-eastern sector, from Moonee to Bonville. This is the most urbanised area, and also the area of increasing urban expansion and an increasing number of road links between the business district of Coffs Harbour and the nearby satellites of Bayldon and Toormina.

An examination of the seven detailed local area maps shows that Coffs Harbour's main koala population extends from the southern half of the Korora area, south through Coffs Harbour town area to Bayldon/Toormina and through to Boambee and the northern part of the Bonville local area. The density of koalas appears to decrease with distance from there. To the immediate west of Coffs Harbour there is a number of records indicating an important population in the Upper Orara area.

Koalas were identified in urban reserves, remnant forests in rural areas, scattered trees throughout the district, and, to a much lesser extent, in the substantial forest areas of the hinterland. Koalas mainly occurred on privately owned rural lands, but were also located on lands owned by a wide variety of bodies, such as State Forests, Council lands, Crown Lands, creek and roadside reserves, resorts, golf courses, hospitals and urban house blocks.

Most rural areas in Coffs Harbour have recorded koala sightings, but some, particularly North Boambee, West Bonville, Mount Browne/Upper Orara, Korora and Red Hill are clearly significant. Some areas (e.g. Moonee and Coramba) contain some good koala populations or appear to contain only scattered or occasional koalas (e.g. Woolgoolga, Nana Glen), while others (e.g. Lowanna, Fridays Creek, Bobo) are not as well surveyed, because of the low number of people resident in the area, but on the basis of habitat and some records, may contain some important koala populations. Koala conservation measures need to be spread across the range of the koala in Coffs Harbour.

The number of koalas seen dead was considerable, although births are still occurring. An apparent decline in numbers and distribution can be taken to reflect a reduction in total area of suitable habitat, and a fragmentation of what remains. The further loss of existing koala habitat will hasten the process of decline.

This community-based survey found overwhelming community support for the conservation of the koala locally. Respondents endorsed, almost unanimously, tree-planting programs, Tree Preservation Orders, dog and traffic controls and implementation of Environmental Protection Zones to help conserve local koalas. There was also strong support for purchase of public land for koalas and the employment of a local wildlife specialist.

Tallowwood *Eucalyptus microcorys* was found to be the local tree species where most koalas were observed. Flooded Gum *E. grandis* and Blackbutt *E. pilularis* are commonly used, and Forest Oak *Allocasuarina torulosa* is also often browsed by koalas. Forest Red Gum *E. tereticornis* and Grey Gum *E. propinqua* are uncommon but are eaten where they are available. Swamp Mahogany *E. robusta* is also recorded as a local koala food tree, and Sydney Blue Gum *E. saligna* was recorded as one in 1989 in North Boambee (Moon 1989).

The results from this survey lead to the conclusion that, without management of the population of Coffs Harbour, koalas will be reduced within a generation to small, isolated pockets facing a bleak future confronted by urban development pressures such as cars, dogs and a lack of suitable trees.

2.2 Vegetation Survey

A significant initiative by Coffs Harbour City Council was to undertake the classification and mapping of the vegetation of the LGA. A full report of this vegetation identification and mapping of Coffs Harbour City can be found in: Fisher, M., Body, M. and Gill, J. 1996. *North east vegetation surveys. The Vegetation of the Coffs Harbour City Council LGA.* Report to the Coffs Harbour City Council. The mapping entailed aerial photograph interpretation and ground truthing at a scale of 1:25,000 covering all lands in the LGA with the exception of state forests and national parks and nature reserves. All remnant vegetation greater than 0.5 hectare was mapped. The vegetation units from this report have been used as the basis for mapping koala habitat in the Coffs Harbour City LGA.

2.3 Field-based Koala Survey

Field-based surveys provide an objective assessment of the current habitat preferences of koalas by employing a systematic sampling strategy that is unbiased by proximity to roads or areas of human concentration where people's observations are more frequent.

Many site-specific koala field surveys have been conducted in the LGA, including private land (eg. Moon 1989, 1995a,b and 1997.) and State Forests (Smith and Andrews 1997). Most have been in the south-east sector of the LGA where development issues arise. To date there had been no comprehensive survey of koala distribution over the shire or region.

The objective of this survey was to determine the distribution of koala habitat in Coffs Harbour City LGA in relation to particular vegetation communities, tree species or other environmental factors, such as geology. This was achieved independently from the community-based survey.

2.3.1 Methods

Searches for both koala presence and koala scats (ie. faeces, Figure B3) were employed during the field-based survey. Koala scats generally persist in the environment well after the koala has left the site and are therefore a useful indicator of habitat use by koalas. This is particularly important in an area where koalas are in low abundance and in sclerophyll forest where they are often hard to see (such as in Coffs Harbour). Surveys were conducted in January, March, October and November 1996 and January 1997. However, data from the March field work were mostly discarded because there had been heavy rain and a high degree of scat decay was likely.

Site Selection

Sites were selected from the vegetation communities (map units) from Fisher *et al*. (1996) and stratified, when appropriate, by aspect and topography (e.g. ridge, slope, gully). The number of replicates per vegetation community reflected the proportional area of each community. Sites were located using the vegetation map on E-RMS and chosen to ensure representative distribution of the LGA was sampled. Each was verified on-ground that it

contained a representative sample of the indicator species of the vegetation type to be sampled. At each site records were made of:

- Site Position (Australian Map Grid coordinates, description)
- Vegetation Type
- Topography (ridge, slope, gully)
- Aspect
- Name(s) of recorders
- Date
- Time
- Weather conditions

Sampling Strategy

At each site a 20x20m quadrat was randomly selected and marked out. For each tree in each quadrat the following attributes were recorded:

- Tree number
- Tree species
- DBHOB (Diameter at Breast Height Over Bark)
- Koala present/absent
- Scratches on tree trunk present/absent
- Presence/absence of koala scat in a 1m radius around the base of the tree
- Presence/absence of koala scat in a 1x1m quadrat randomly located under the canopy of the tree

Searches for koala scats involved a thorough examination of the leaf litter. A sample of koala scats from each positive quadrat was collected and retained for verification. A tree was defined as any live woody stem of any plant species (except palms, cycads, treeferns and grass trees) with a DBHOB of at least 10 cm.

Figure B3. Koala scats are characteristically cylindrical with longitudinal ridges and a groove on the 'ventral' surface and sometimes with a bulge at one end. They average one to three centimetres long and less than one centimetre wide. Fresh scats have a shiny mucous coat, smell of eucalyptus and are composed of short, coarse fragments of leaves.

Analyses

Surveyed sites were classed as active (ie. showing evidence of koala activity by the presence of one or more scats) or not active. To determine the extent to which vegetation units were being used by koalas at each active site, the proportion of all trees with scats was calculated in relation to the number of trees sampled. These proportions were termed "activity levels".

To determine which tree species were preferred, the number of trees of each species with scats was expressed as a proportion (p) of the total number (n) of that species sampled. These proportions were termed "utilisation rates" and were calculated on a site by site basis, for active sites only, and then pooled to give an overall utilisation rate for each species (denoted P*i*). Only those species where 1) both n*i*P*i* and n*i* (1-P*i*) were greater than or equal to 5, and 2) the proportion was calculated from at least 5 independent active sites, were used in analyses (Moore and McCabe 1993).

Activity levels of survey sites were correlated with eastings and northings grid references to determine if there was any distributional variation of koala activity within the LGA. Data were divided into two geological types, quaternary deposits and other geological substrates from the broad-scale geology map available as a base layer on E-RMS, and analysed separately. Quaternary deposits along the floodplains of major rivers and creeks are alluvial and of high fertility (Fisher *et al*. 1996). Tree species growing on quaternary deposits are often favoured by koalas to those same species growing on other geologies (S. Phillips, *pers. com.* 1997).

Utilisation rates were analysed for differences between tree species using the z test, for the comparison of two proportions as outlined in Moore & McCabe (1993), to identify preferred trees for koalas:

$z = P_1 - P_2 / S_p$

where standard error $S_p = \sqrt{P(1-P)\ (1/n_1 + 1/n_2)}$

and pooled estimate $P = X_1 + X_2 / n_1 + n_2$

with sample size n*i*
count of successes X*i*
sample proportion P*i* = X*i*/n*i*

Cumulative utilisation rates (calculated from active sites only) were determined and plotted to show the separation between utilisation rates for different species. Significant differences within utilisation rates for a species were analysed using a chi-square test. Utilisation rates were also analysed for differences within species at different sites using a chi-square test. A t-test was undertaken to examine the relationship between activity levels at sites with preferred species compared with activity levels at sites without preferred species.Other factors such as tree size class, aspect and topography were analysed using a chi square test.

2.3.2 Results

A total of 119 sites were surveyed for koalas (Map B3) including 42 different vegetation types (map units) with a total of 2458 trees sampled. A summary of the results obtained at each survey site are provided in Appendix B3. Of the 119 sites surveyed, 37 (31%) were active (showing evidence of koala activity). Only koala scats were located; no koalas were seen.

Vegetation units showing evidence of koala activity included: RF53, N44/N20, RV1, N2b, N44a, SF62, N27, N52a, N27/N34a, N7, N56a, SF60, N20, N20a, N50, N55a, N52, N26a, N3, N7a and SF49 (Appendix B3). These vegetation units fall within the following vegetation communities: Brushbox, Dry Blackbutt, Dry Blackbutt/Paperbark, Coastal Riparian Vegetation, Dry Grey Ironbark/Grey Gum, Flooded Gum, Flooded Gum/Dry Blackbutt, Moist Blackbutt, Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany, Paperbark, Scribbly Gum, Swamp Mahogany, Swamp Oak, Sydney Blue Gum, Tallowwood and Turpentine (Appendix B3).

These active sites were mainly in the south-east sector of the LGA (Map B3) with 28 (76%) occurring on the Coffs Harbour 1:25000 mapsheet (Appendix B3). Activity levels of each plot surveyed showed a significant ($r = 0.446$, 103 d.f., $p<0.01$) negative correlation with northings, that is, activity levels dropped significantly from a point generally north of Korora. Koala scats were detected on approximately 60 % of survey sites in the south-east sector and on approximately 10 % of survey sites in other parts of the LGA.

Activity levels ranged from 2. 8 - 47.4 % with a mean of 16.9 %. The highest activity level was recorded in the vegetation unit N20 Paperbark. Other vegetation units with high activity levels included RV1 Coastal Riparian Vegetation, N7A Tallowwood, N56A Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany, N20A Paperbark and N52A Flooded Gum. These vegetation units with high activity levels all occurred in the Coffs Harbour and Raleigh areas. Activity levels were significantly different for geological type ($t=2.53$, 35 d.f., $p=0.02$). On quaternary deposits, mean activity level was 23.6 % compared with 12.9 % on other geological types. On quaternary deposits, 10% of all trees sampled had scats beneath them compared to 3 % in other geological types.

Only active plots were used in analyses of tree preferences. Thus, of the 2458 trees sampled, 760 (31%) were used for detailed analyses. A total of 32 different species occurred in these active plots. Table B1 lists those species that were recorded with koala scats.

Map B3. Field survey sites for koalas in Coffs Harbour.

Red triangles are active sites (where evidence of koala was found).
Black dots are non-active sites (where no evidence of koala was found).
No koalas were seen at any site, so all analyses are based on locations of scats.

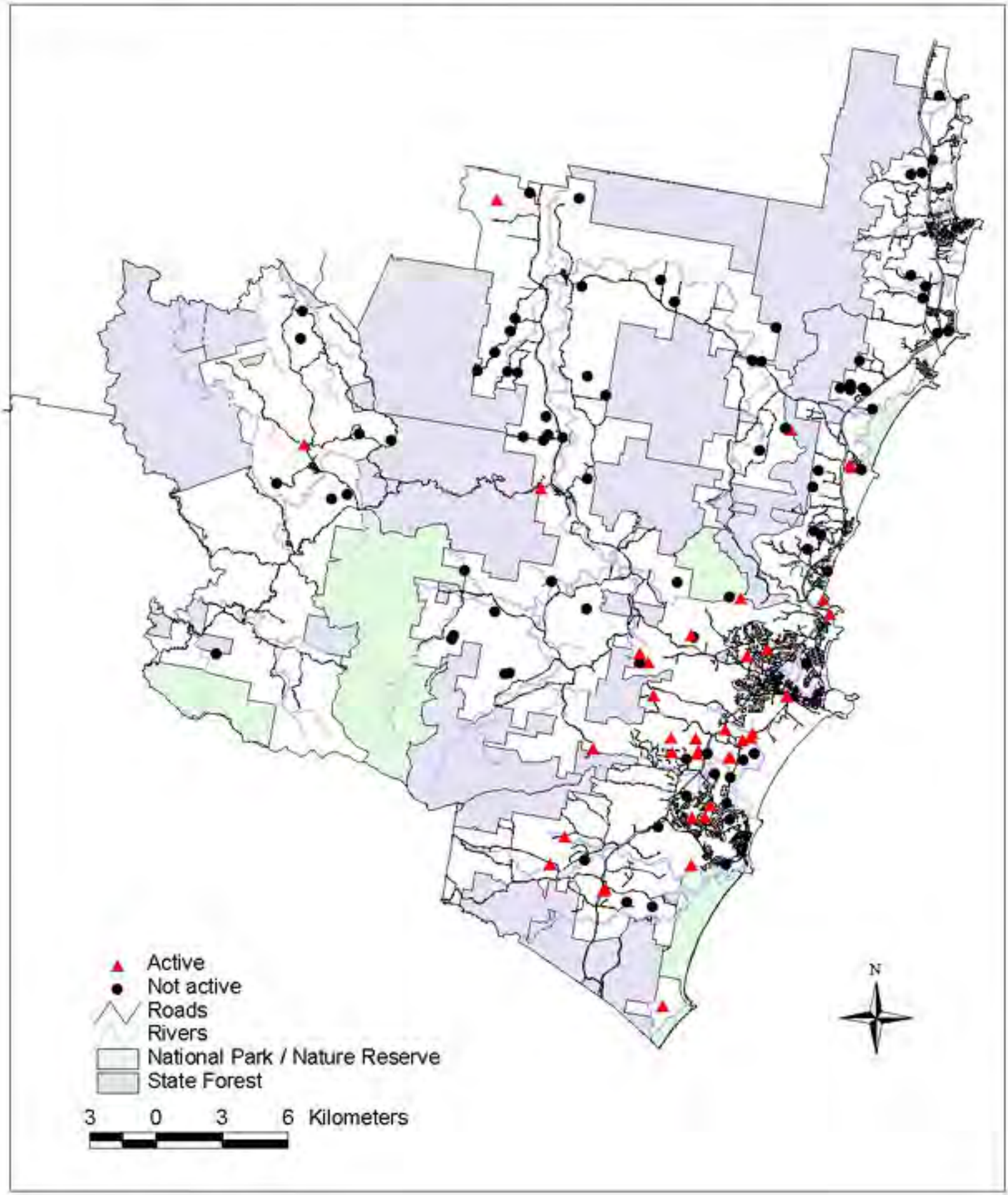


Table B1. Tree species from active sites observed with koala scats (in descending order). The numbers in brackets are number of trees with scats expressed as a percentage of the total number of trees of the same species sampled (%total) and a percentage of the number of trees of the same species sampled in active sites only (%active).

Common name	Scientific name	Number of trees with scats (%total; %active)
Tallowwood	*Eucalyptus microcorys*	43 (11; 34)
Swamp mahogany	*Eucalyptus robusta*	13 (11; 23)
Camphor laurel	*Cinnamomum camphora*	9 (13; 36)
Blackbutt	*Eucalyptus pilularis*	7 (3; 11)
Broad-leaved paperbark	*Melaleuca quinquenervia*	7 (6; 16)
Flooded gum	*Eucalyptus grandis*	6 (5; 18)
Pink bloodwood	*Corymbia intermedia*	5 (5; 13)
Grey ironbark	*Eucalyptus siderophloia*	4 (5; 18)
Swamp oak	*Casuarina glauca*	4 (5; 11)
Swamp turpentine	*Lophostemon suaveolens*	3 (9; 30)
White mahogany	*Eucalyptus acmenoides*	3 (4; 43)
Red mahogany	*Eucalyptus resinifera*	2 (3; 10)
Forest oak	*Allocasuarina torulosa*	2 (1; 4)
Turpentine	*Syncarpia glomulifera*	2 (1; 4)
Scribbly gum	*Eucalyptus signata*	1 (5; 8)
White stringybark	*Eucalyptus globoidea*	1 (20; 20)
Grey gum	*Eucalyptus propinqua*	1 (1; 5)
Sydney blue gum	*Eucalyptus saligna*	1 (1; 3)
Large-fruited grey gum	*Eucalyptus biturbinata*	1 (9; 11)
Smooth-barked apple	*Angophora costata*	1 (1; 5)
Willow bottlebrush	*Callistemon salignus*	1 (3; 5)
Water gum	*Tristaniopsis laurina*	1 (14; 50)

When separated for geological types (Appendix B4 a,b), only *E. microcorys, E. robusta, E. grandis, E. pilularis* and *M. quinquenervia* met the criteria for analyses. The other species were either not common (occurring in less than 5 of the active plots) and/or had less than 5 trees with scats.

For those species where only 1 tree was recorded with scats, only *Angophora costata* was independent of any other tree species in the site. For all other species, the site contained other preferred trees with scats (Appendix B4 a,b).

Utilisation rates were low except for *E. microcorys* on quaternary deposits (61 % utilisation rate). This utilisation rate was significantly greater ($z = 3.26, 3.64$ respectively) than for either *E. robusta* or *M. quinquenervia*. *E. robusta* (22.8 % utilisation rate) and *M. quinquenervia* (16.67 %) did not have significantly different utilisation rates ($z = 0.75$). *E. microcorys* also had the highest utilisation rate on other geological types (28 % compared with *E. grandis* 15% and *E. pilularis* 10%). There was no significant difference within utilisation rates for any species.

Cumulative utilisation rates were determined and plotted for species on quaternary deposits (Figure B4a) and species on other geological types (Figure B4b).

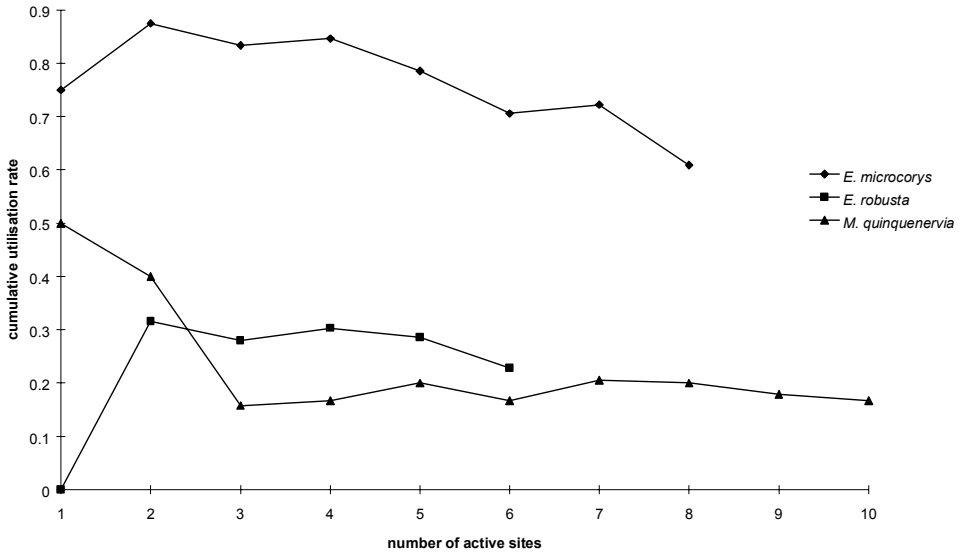


Figure B4a. Cumulative utilisation rates of species on quaternary deposits.

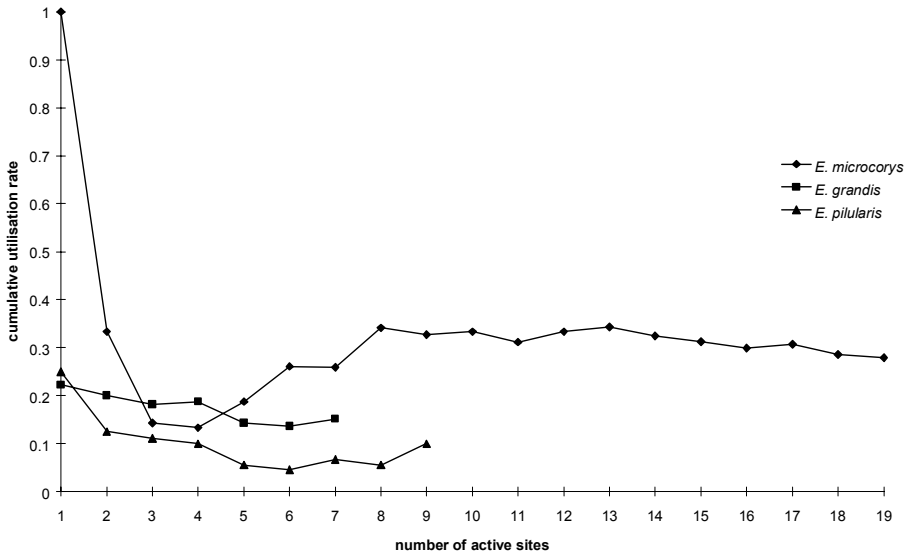


Figure B4b. Cumulative utilisation rates of species on other geological types.

Activity levels at sites containing *E. microcorys* were not significantly different to activity levels at sites without *E. microcorys* (t = -0.32, 35 d.f., p=0.75). However, *E. microcorys* was utilised in 87.5 % of active sites where it occurred on quaternary deposits and in 84.2 % of active sites where it occurred on other geological types. Also, on quaternary deposits *E. robusta* was utilised in 83.3 % of active sites where it occurred (Table B2).

Table B2. Tree species utilisation on active sites.

a) quaternary deposits

Species	# active sites where species occurred (>3)	# active sites where species utilised	% utilised
Eucalyptus microcorys	8	7	87.5
Eucaluptus robusta	6	5	83.3
Casuarina glauca	4	3	75.0
Melaleuca quinquenervia	10	6	60.0
Syncarpia glomulifera	4	2	50.0
Eucalyptus resinifera	5	2	40.0
Corymbia intermedia	6	2	33.3
Eucalyptus pilularis	4	1	25.0
Allocasuarina torulosa	4	1	25.0
Callistemon sallignus	6	1	16.7

b) other geological types

Species	# active sites where species occurred (>3)	# active sites where species utilised	% utilised
Eucalyptus microcorys	19	16	84.2
Eucalyptus pilularis	9	4	44.4
Eucalyptus grandis	7	3	42.9
Eucalyptus siderophloiea	3	1	33.3
Cinnamomum camphora	3	1	33.3
Corymbia intermedia	7	2	28.6
Eucalyptus propinqua	4	1	25.0
Angophora costata	6	1	16.7
Eucalyptus saligna	7	1	14.3
Allocasuarina torulosa	17	1	5.9
Syncarpia glomulifera	10	0	0.0

The diameter at breast height over bark (DBHOB) of trees was a significant (chi square = 21.14, 10 d.f., $p < 0.05$) factor in the distribution of koala scats (Figure B5). Although scats occurred under trees of almost all size classes, they occurred more often than expected under trees with a DBHOB of 50-60 cm and greater than 120 cm. There was also a tendency for scats to occur more often than expected under trees with DBHOB of 70-80 cm.

Aspect was also a significant (chi square = 50.97, 9 d.f., $p < 0.05$) factor in the distribution of koala scats (Figure B6). Scats occurred more often than expected on southern and eastern aspects while they occurred less often than expected on south-western, north-western and north-eastern aspects.

Topography was also a significant (chi square = 31.23, 3 d.f., $p < 0.05$) factor in the distribution of koala scats (Figure B7). Scats occurred more often than expected in gullies and showed a tendency to occur less than expected on ridges.

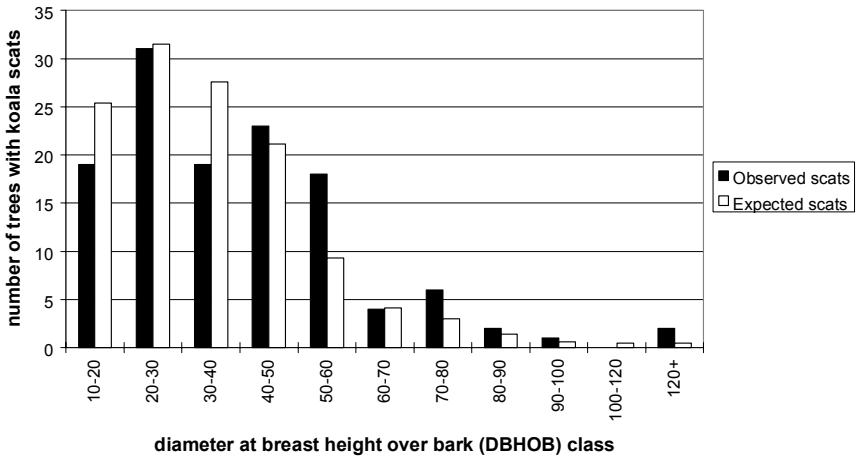


Figure B5. Frequency of koala scats by tree DBHOB class.

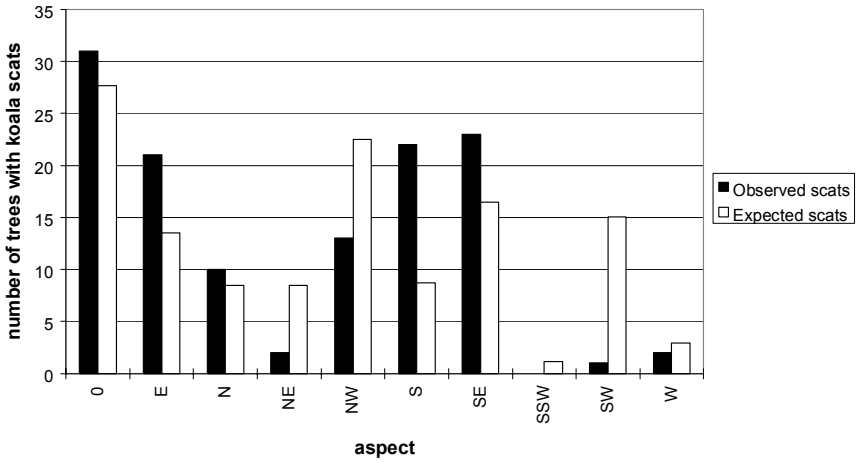


Figure B6. Frequency of koala scats by aspect.

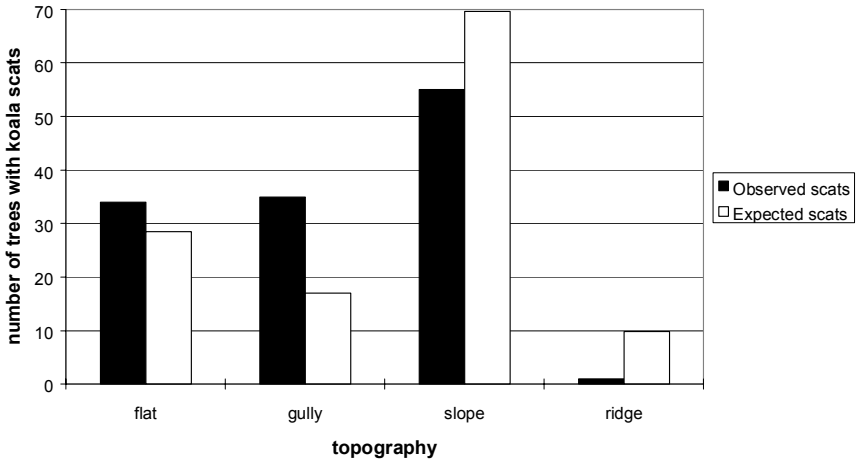


Figure B7. Frequency of koala scats by topography.

2.3.3 Discussion

The field-based survey for koalas was primarily based on searches for koala scats. At each site, the canopy of each tree was scanned for koalas but no koalas were seen. This shows the difficulty of locating individual koalas in the Australian bush and why searches for koala scats provide a more reliable way of identifying their distribution and habitat.

The distribution of active field sites (where evidence of koalas was found) in Coffs Harbour was mainly in the south-east sector of the LGA. In this area, about 60 % of the sites surveyed found evidence of koalas. This is the same area where the community-based survey identified the major population of koalas. There was less evidence of koala activity around Moonee and to the west of the LGA indicating that koalas do occur in these areas but probably at a lower density. In these areas only about 10 % of sites surveyed found evidence of koalas.

Koala scats were found in 21 different vegetation units. Those with the highest activity levels all occurred in the Coffs Harbour and Raleigh areas, again in the south-east sector of the LGA. It was also identified that vegetation units on quaternary deposits averaged significantly higher activity levels than units on other geological types.

Phillips and Callaghan (1995) suggest that, for their spot assessment technique, "activity levels of approximately 30 % or greater are likely to be within areas containing home range trees and/or areas of major activity currently being utilised by koalas with well defined home range areas; such animals are likely to be members of a socially stable breeding aggregation." Many sites on quaternary deposits showed activity levels greater than 30 %. For such areas the koala population may be interpreted as being resident. However, there were many sites where activity levels were found at much lower levels than 30 %. This may be due to presence of less suitable habitat, an infrequently used part of a koala's home range or alternatively an area of suitable habitat, which at the time of the survey was not supporting a stable population which may be due to a number of factors including drought, disease, fire or other threats as a result of pressures associated with development.

Tallowwood *Eucalyptus microcorys* was identified as the tree species most preferred by koalas. This is consistent with other site-specific koala surveys (Moon 1989, Smith and Andrews 1997) and follow-up to the community-based survey. Also, Tallowwood has been identified as the preferred feed species when offered to captive koalas by koala carers in the Coffs Harbour region (Smith and Andrews 1997). However, *E. microcorys* was not the only species contributing to the distribution of koalas and to activity levels at survey sites. Other species identified as preferred trees were Swamp Mahogany *E. robusta*, Broad-leaved Paperbark *Melaleuca quinquenervia*, Flooded Gum *E. grandis* and Blackbutt *E. pilularis*. Swamp Mahogany and Flooded Gum also rated highly as palatable species when offered to captive koalas but Blackbutt and Broad-leaved Paperbark were only eaten occasionally or rarely (Smith and Andrews 1997). Whilst Blackbutt and Broad-leaved Paperbark are often used as rest trees they may be eaten occasionally and can be important to individual koalas in particular locations. Moon (1997) recorded many instances of koalas, including females with joeys, feeding in Blackbutts at night.

Other tree species used at lower levels by koalas during the study include White Mahogany *Eucalyptus acmenoides*, White Stringybark *Eucalyptus globoidea*, Swamp Turpentine *Lophostemon suaveolens*, Grey Ironbark *Eucalyptus siderophloia* and Camphor Laurel *Cinnamomum camphora*. It is most likely that Camphor Laurel is used only as a rest tree in habitats where other preferred trees occur. Scats were found only beneath Camphor Laurel at sites of Coastal Riparian Vegetation where other preferred trees, such as Tallowwood and Flooded Gum, occurred. White Mahogany and Grey Ironbark are

known to be utilised by koalas in the Coffs Harbour area and occur on the interim list of tree species utilised by koalas found in Fisher *et al*. (1996). White Mahogany was also recorded by one koala carer as a species eaten sometimes but not consistently, while Grey Ironbark was shunned or eaten only rarely (Smith and Andrews 1997). For White Stringybark and Swamp Turpentine there are no data at present to comment on their value to koalas.

A surprising result was the low level of scat occurrence beneath Small-fruited Grey Gum *Eucalyptus propinqua*. This species has been shown from local studies to be a preferred species (Moon 1989, Smith and Andrews 1997) in the area and is also eaten relatively consistently by captive koalas in the area (Smith and Andrews 1997). There is some indication that use of this species may be seasonal, (e.g. Moon [1997] only recorded use in July and August), and was therefore not identified in this survey because field work was not conducted in these months. Also, Forest Red Gum *Eucalyptus tereticornis* is a species that is preferentially utilised state-wide, and is listed on Schedule 2 of SEPP 44. No koala scats were found under this species during this survey. The Forest Red Gum community in Coffs Harbour is very small and in isolated patches which may be the reason for this result. Koalas have been recorded in the past utilising Forest Red Gum in the area around Boambee Creek and in coastal Korora. Forest Oak *Allocasuarina torulosa* has also been identified as being utilised by koalas in the Coffs Harbour area (Fisher *et al*. 1996, Smith and Andrews 1997) and although there was some evidence of utilisation, it was not considered a preferred species. Smith and Andrews (1997) found it only to be important where it occurs in association with Tallowwood and Grey Gum. In these areas it was evident in scat analysis, possibly due to its potential for high nitrogen content as well as its ability to fix soil nitrogen and therefore potentially increase soil fertility and leaf nutrient in surrounding trees. Further research into the use of this species by koalas in the LGA is warranted. Sydney Blue Gum *E. saligna* has also been found to be a significant koala food tree in Pine Creek State Forest (State Forests 1997), but was not identified as a significant tree in this study.

Koalas appear to be selecting for trees with DBHOB of 50-60 cm, greater than 120 cm and possibly also 70-80 cm. Smith and Andrews (1997) also found tree size classes of 40-50, 60-70, 70-80 and 80-100 cm to have more scats than expected beneath them in Pine Creek State Forest. In their study, scats occurred significantly less often than expected under trees of 10-20 cm DBHOB, and this finding is consistent with the results of the study reported here.

The importance of southern and eastern aspects and also gully topographies for the distribution of koala scats is probably linked to the distribution of preferred trees and vegetation types. For example, Tallowwood (map unit N7a) is most common on southern aspects along the coastal plain between Bundagen and Korora and Flooded Gum (map unit N27) generally occurs in protected gullies with easterly to south-easterly aspects (Fisher *et al*. 1996).

2.3.4 Conclusion

Prior to this study the importance of particular areas of the LGA to koalas was not known. Many site-specific koala field surveys have been conducted in the south-east sector of the LGA where development issues arise. In this area a good picture had already been developed of the distribution of koalas, their tree preferences and the threats to them. The community-based survey also identified koalas as largely occurring in this area. The field-based survey employed a systematic sampling strategy and thus avoided the potential bias in the community-based survey towards urban human population centres. The results of these surveys have allowed the distribution of koalas and koala habitat to be related to the

vegetation map of the LGA. By combining these two independent survey techniques with the vegetation map, it has been possible to define the distribution of koalas and their habitat with confidence. The results show that the urban and coastal areas contain the preferred tree species for koalas, that some of these particular species occur in this area and not in other parts of the LGA and that the activity and abundance of koalas is generally greater in this area. The largest areas of primary habitat are concentrated around the urban areas of Coffs Harbour and Sawtell/Bayldon/Toormina, generally in the area south of Korora and east of the coastal range down to Pine Creek State Forest.

3. MAPPING KOALA HABITAT

The vegetation communities from Fisher *et al*. (1996) were transferred to the NPWS geographical information system (GIS) called E-RMS (Environmental Resources Mapping System) for analysis.

3.1 Mapping Potential Koala Habitat

Potential koala habitat is defined in SEPP 44 as "areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component".

Of the ten koala feed tree species listed on Schedule 2 of SEPP 44, four occur in the Coffs Harbour LGA. These are:

Eucalyptus tereticornis	(Forest Red Gum)
Eucalyptus microcorys	(Tallowwood)
Eucalyptus signata	(Scribbly gum)
Eucalyptus robusta	(Swamp mahogany)

Fisher *et al.* (1996) also identified other koala feed trees for the Coffs Harbour LGA in Table 4: Interim list of Tree Species Utilised by Koala. These include:

Eucalyptus propinqua	(Small-fruited Grey Gum)
Eucalyptus grandis	(Flooded Gum)
Allocasuarina torulosa	(Forest Oak)
Eucalyptus acmenoides	(Narrow-leaved White Mahogany)
Eucalyptus saligna	(Sydney Blue Gum)
Eucalyptus pilularis	(Blackbutt)
Eucalyptus resinifera	(Red Mahogany)
Eucalyptus crebra	(Narrow-leaved Ironbark)
Corymbia intermedia	(Pink Bloodwood)
Eucalyptus maculata	(Spotted Gum)
Eucalyptus biturbinata	(Large-fruited Grey Gum)
Eucalyptus siderophloia	(Grey Ironbark)
Eucalyptus eugenioides	(Thin-leaved Stringybark)
Eucalyptus seeana	(Narrow-leaved Red Gum)
Melaleuca quinquenervia	(Broad-leaved Paperbark)
Casuarina glauca	(Swamp Oak)

Potential koala habitat was identified and mapped by mapping the vegetation communities that contain koala food trees as part of the dominant canopy species. This was achieved by utilising the dominant species listed in any strata for each vegetation community mapped by Fisher *et al.* (1996) where dominant species were defined as those species which comprised greater than 15 percent of all species in the community sampled (Fisher *et al*. 1996).

Potential koala habitat was identified and mapped through this process for 1) the tree species listed on Schedule 2 of SEPP 44, and 2) the tree species listed for the LGA in Table 4 from Fisher et al. (1996).

The vegetation communities comprising potential koala habitat in Coffs Harbour LGA, based on SEPP 44 Schedule 2 species, were identified (Appendix B5a) and mapped (Map B4). These 31 vegetation communities cover 9,432 ha of freehold and leasehold land in the Coffs Harbour LGA, which is approximately 18% of this land and 37.5% of the vegetation (mapped by Fisher *et al.* 1996) on this land.

The vegetation communities comprising potential koala habitat in Coffs Harbour LGA, based on the full LGA list of trees which may be utilised by koalas, were identified by Fisher *et al*. (1996) and the map units flagged with a koala icon. These are listed in Appendix B5b. The vegetation communities in Appendix B5b that are extra to those in Appendix B5a have been mapped in Map B4. The 61 vegetation communities flagged by Fisher *et al.* (1996) as potential koala habitat cover 19,224 ha of freehold and leasehold land in the Coffs Harbour LGA, which is approximately 36% of this land. This doubles the amount of land covered by potential koala habitat based on SEPP 44 Schedule 2 species alone. It also represents 76.5% of the total area of vegetation mapped for the Coffs Harbour LGA by Fisher *et al.* (1996).

3.2 Mapping Koala Habitat from Community-based Survey

Koala records obtained from the community-based survey were overlayed with the Fisher *et al*. (1996) vegetation map on E-RMS. The number of koala records per area of each vegetation unit was calculated. This resulted in a relative density of koala records for each vegetation unit, as shown in Figure B8. The vegetation units were ranked according to the relative density of koala records and then grouped into three categories using natural discontinuities in the data: Community rank 1 (high relative density), Community rank 2 (moderate relative density) and Community rank 3 (low relative density).

Map B5 shows koala habitat mapped through the process of community-based survey. The vegetation units in Community rank 1 were along the coastal strip, particularly around the major creeks. The vegetation units in Community rank 2 were also concentrated along the coast but are also scattered throughout the rest of the LGA. The vegetation units in Community rank 3 were mostly concentrated away from the coast to the west of the LGA. The vegetation units containing no koala records were assumed not to be habitat for koalas and were excluded from the mapping process. Cleared land was also excluded from the mapping process even though there were many community-based records on this land category. However, it was recognised that these areas may contain scattered trees which were not picked up in the process of mapping the vegetation, and the exclusion of these areas does not discount their potential importance for koalas, particularly for dispersing animals or for those moving through parts of their home range.

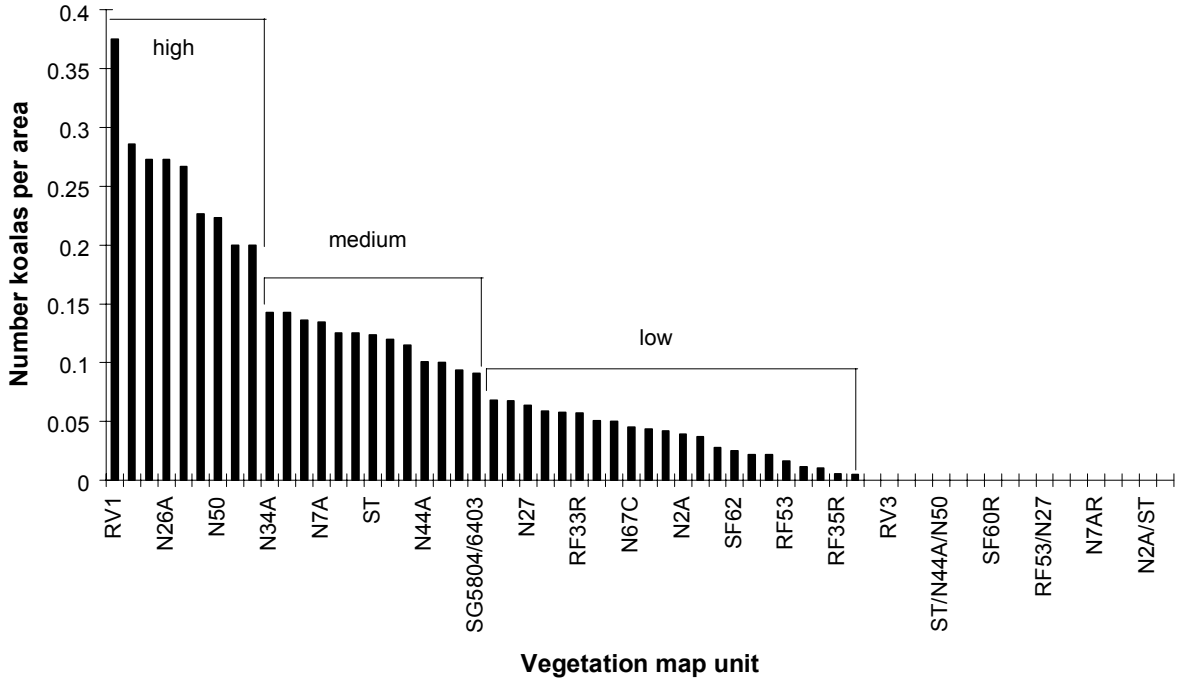


Figure B8. Ranked vegetation units according to relative density of koala records.

3.3 Mapping Koala Habitat from Field-based Survey

The field-based survey was designed to determine which vegetation types and tree species were being used and preferred by koalas. This information, together with information such as the distribution of activity and other preferences for geology, aspect and topography, were used to delineate three areas of ranked koala habitat.

The following results obtained from the field-based survey were taken into consideration in the ranking of koala habitat:

1. Activity levels showed a significant negative correlation to northings. The point at which activity levels dropped off was near Korora at Australian Map Grid (AMG) reference 6652000 N.
2. Activity levels were significantly higher on a geology of quaternary deposits compared to other deposits.
3. Tallowwood *Eucalyptus microcorys* was the most common tree identified with koala scats and had the highest utilisation rate on both quaternary deposits and other geological types.
4. *E. microcorys* was utilised at almost all sites where there was koala activity and where it occurred.
5. Other trees species used regularly by koalas often occur in association with *E. microcorys*.
6. The significant relationship of koala activity with aspect and topography is likely to be related to the distribution of preferred vegetation types.

Koala habitat was then ranked into three categories using the following criteria:

Field rank 1 - the vegetation units containing the preferred tree species and the highest level of use by koalas. This was identified and mapped as any vegetation unit on quaternary deposits which contains *E. microcorys* except where it occurs north of AMG 6652000 N.

Field rank 2 - the vegetation units containing a high percentage of preferred tree species and a moderate level of use by koalas. This was mapped as any vegetation unit on other geological types where *E. microcorys* occurs as more than 35 % (Phillips [1995] considers an area to be "critical habitat" (not as defined in the TSC Act) where a species known to be preferentially utilised by koalas constitutes 35 % or greater of the standing live stems) plus any vegetation unit on quaternary deposits in the north of the LGA that contains *E. microcorys*.

Field rank 3 - the vegetation units containing a lower percentage of preferred tree species and with a low level of use by koalas. This was mapped as any other vegetation unit on other geological types that contains *E. microcorys* (less than 35 %).

Map B6 shows koala habitat mapped through the process of field-based survey. Field rank 1 habitat was concentrated along the coast, particularly to the east of the Pacific Highway in the south-east of the LGA surrounding the major creeks. Field rank 2 habitat was also concentrated along the coastal strip, but was also scattered throughout the rest of the LGA. Field rank 3 habitat was largely concentrated in the west of the LGA.

3.4 Overlaying Koala Habitat Maps from Community-based and Field-based Surveys

The outcome of both the community-based and field-based surveys was the identification of three ranked categories of koala habitat in each survey. These were combined to produce a Combined rank for each vegetation map unit and these units were then used to produce a final mapped delineation of Habitat types. This map was transferred to another geographical information system called ARC-Info for greater definition of vegetation boundaries.

When the categories of koala habitat from the community-based survey were overlaid, using E-RMS, with those from the field-based survey there was considerable similarity in area (Table B3). Approximately 60 % of the area of habitat with the highest relative density of koala records identified by the community survey (Community rank 1) was also identified as the primary habitat from the field survey (Field rank 1). Another 30 % of the area of habitat with the highest relative density of koala records identified by the community survey (Community rank 1) was identified as a secondary habitat in the field survey (Field rank 2).

Table B3. Overlap of koala habitat categories (in decreasing order of quality for koalas) mapped from the community and field surveys.

Habitat Category	Field rank 1	Field rank 2	Field rank 3	TOTAL
Community rank 1	60 %	30 %	10 %	908 ha
Community rank 2	10 %	30 %	60 %	4984 ha
Community rank 3	0 %	0 %	100 %	11236 ha
TOTAL	1180 ha	2116 ha	13832 ha	17128 ha

3.5 Final Mapping of Koala Habitat

Core koala habitat is defined in SEPP 44 as "an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population".

The koala habitat map (Map B7) was derived from results of the community-based survey combined with the results of the field-based survey. Each vegetation unit was given a Combined rank based on its rank within the community-based and the field-based results (See Appendix B6).

The vegetation units were then pooled into Habitat types defined by Combined rank, geological type (either quaternary deposits or other geological types) and their location in the LGA as belonging to either the northern or southern domain (division at AMG 652000 N, near Korora). From a potential list of 16 habitat types, a decision was made, on practical grounds, to merge those habitat types with similar values which resulted in five distinct Habitat types, defined as:

Preferred habitat - type A: vegetation units on quaternary deposits ranked 1 in the southern domain of the LGA

Preferred Habitat - type B: vegetation units on other geological types ranked 1 or 2 in the southern domain of the LGA

Supplementary Habitat - type A: vegetation units on quaternary deposits ranked 3 or 4; vegetation units on quaternary deposits ranked 1 in the northern domain of the LGA

Supplementary Habitat - type B1: vegetation units on other geological types ranked 3; vegetation units on other geological types ranked 1 in the northern domain of the LGA

Supplementary Habitat - type B2: vegetation units on other geological types ranked 4

The final map of koala habitat is shown in Map B7. The vegetation units that make up these habitat types are listed in Appendix B7. Much (78.3 %) of the vegetation remaining on private land in the LGA was identified as koala habitat. Most of this area, however, was identified as being only supplementary habitat for koalas and occurs mainly to the west of the coastal areas in the rural areas of the LGA. The area of preferred habitat in the LGA occurs mainly in the south-east sector from Diggers Head to Bundagen and is associated with the major creeks of the area. The habitat is largely fragmented with many isolated patches surrounded by cleared or developed land. Preferred Habitat (types A and B) total only 10.9 % of all koala habitat identified.

Due to the limitations of the 1:25,000 vegetation mapping by Fisher *et al*. (1996), where only vegetation remnants greater than 0.5 hectares were mapped, areas of koala habitat comprising open woodlands or scattered trees have not been identified in the koala habitat mapping process. These areas, such as the Coffs Harbour Golf Course, can provide significant habitat for koalas and should be recognised through the CKPoM. Protection and management of these areas is discussed in Part A.

3.6 Discussion

Koala habitat was identified by two independent methods, namely community-based survey and field-based survey. Both were analysed independently with the vegetation of the LGA, and both were based on the identification of koala presence to produce maps, which when combined, resulted in a final map of core koala habitat. The procedure also enabled the core habitat to be separated and ranked to reflect koala density. Both the community survey and the field survey produced similar patterns of ranked categories of koala habitat. A similar finding has been obtained in Port Stephens LGA (Lunney *et al*. 1998), showing that the limitations associated with each survey technique can be addressed by the strengths of the other.

Potential koala habitat comprises a high proportion of the vegetation in the Coffs Harbour LGA due to the presence of preferred trees. Core habitat has been identified to comprise a high proportion of this potential habitat. The ranking of core habitat is a valuable procedure which will enable planners to identify priority areas for protection.

The Preferred Koala Habitat is highly fragmented due to coastal development and agriculture in this area. The developed area of Sawtell, Bayldon and Toormina largely bisects the area of preferred habitat. Also, the Pacific Highway generally splits the Preferred Habitat - type A on the coast from the Preferred Habitat - type B to the west.

The fragmentation, loss and destruction of habitat can be readily identified from the habitat map as the principal threat to the koala population in Coffs Harbour. The decline in the koala population is reflected by the degree of habitat loss and present fragmentation and isolation of remaining habitat. This decline will continue unless remedial action is taken. This study has identified actions that will need to be implemented. They include the retention and management of koala habitat, and reduction of additional threats of cars, dogs, disease and fire. Loss of habitat was identified at a state level as the main threat to koalas (Reed and Lunney 1990) and nationally it was recognised as the major threat to koalas and the main factor responsible for declining populations (ANZECC 1998). The problems in Coffs Harbour can benefit from both state and national initiatives to identify, conserve and restore habitat. This study is one example of that process.

Clearing for urban development, pastoral expansion, bananas and grazing leads to the continued degradation of koala habitat, as does clearing or thinning of timber during property development, selective logging, regular burning, pollution and the proliferation of weeds.

In a resident population koalas have home ranges within which they feed and raise their young. They occasionally move outside these for short periods. Within a home range certain key trees will be regularly browsed, while others are only browsed occasionally, or are used as a daytime refuge. Koalas change trees every day or two, or may visit two or three different trees in one night. Koalas are generally solitary and well dispersed in available habitat. Populations generally require a variety of tree species in a variety of

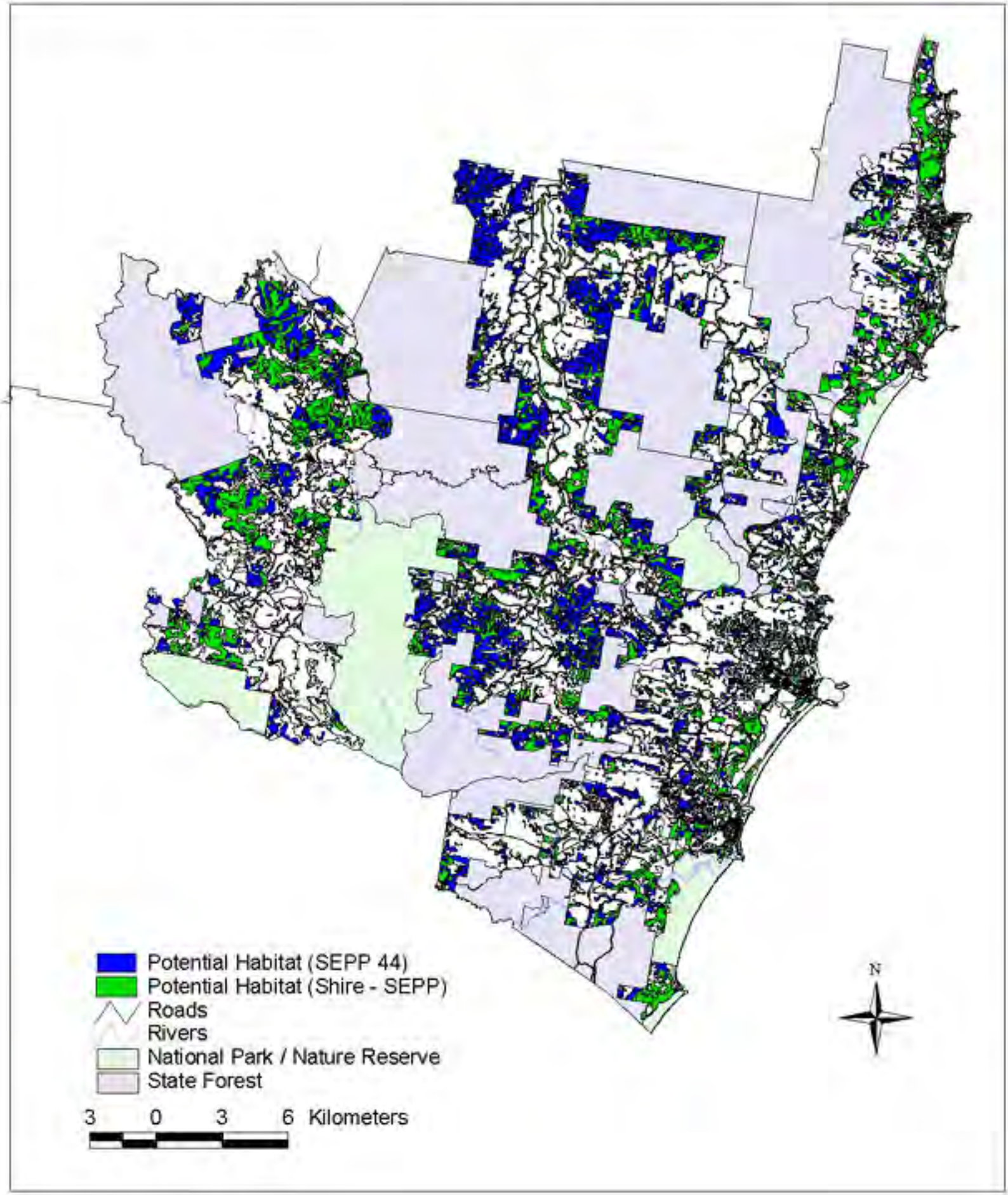
physical situations, e.g. gullies, ridges, moist areas. This provides alternate food sources between seasons and refuge from drought, fire and declines in food resource availability. Koalas are mobile animals that must move across the ground to go from one place to another to feed, rest, breed, disperse and interact with other koalas. Conserving a koala population needs to take account of these aspects of their ecology. Consequently, the area needed to conserve a local population must be sufficient to provide for all these components to ensure a viable breeding population. This requires strategic planning, a shirewide approach and community support. This support was shown in the results of the community questionnaire that canvassed issues and options concluding that there was overwhelming support from the community for council to take decisive and positive action to identify koala habitat across the shire.

Many areas of koala habitat are situated within or adjacent to developed areas. Other koala habitat occurs in areas identified for development which are either presently zoned for such purpose, or have been earmarked in the Coffs Harbour Urban Strategy Five Year Plan 1996 - 2001, as requiring future urban investigation and rezoning. The findings and recommendations of this plan with regard to the conservation and restoration of koala habitat and management of threatening processes on koalas will need to be taken into account as part of any investigation for urbanisation of these areas.

The fragmented nature of the remaining koala habitat in the LGA has already been identified and discussed above. The present tenuous links of habitat which exist in many areas as either small broken remnants or scattered trees form regionally important movement corridors which are fundamental to maintaining viable koala populations. The protection and, in some cases, restoration of these links, together with management of threats which may impede the free movement of koalas is considered an essential strategic planning objective and is discussed further in Part A.

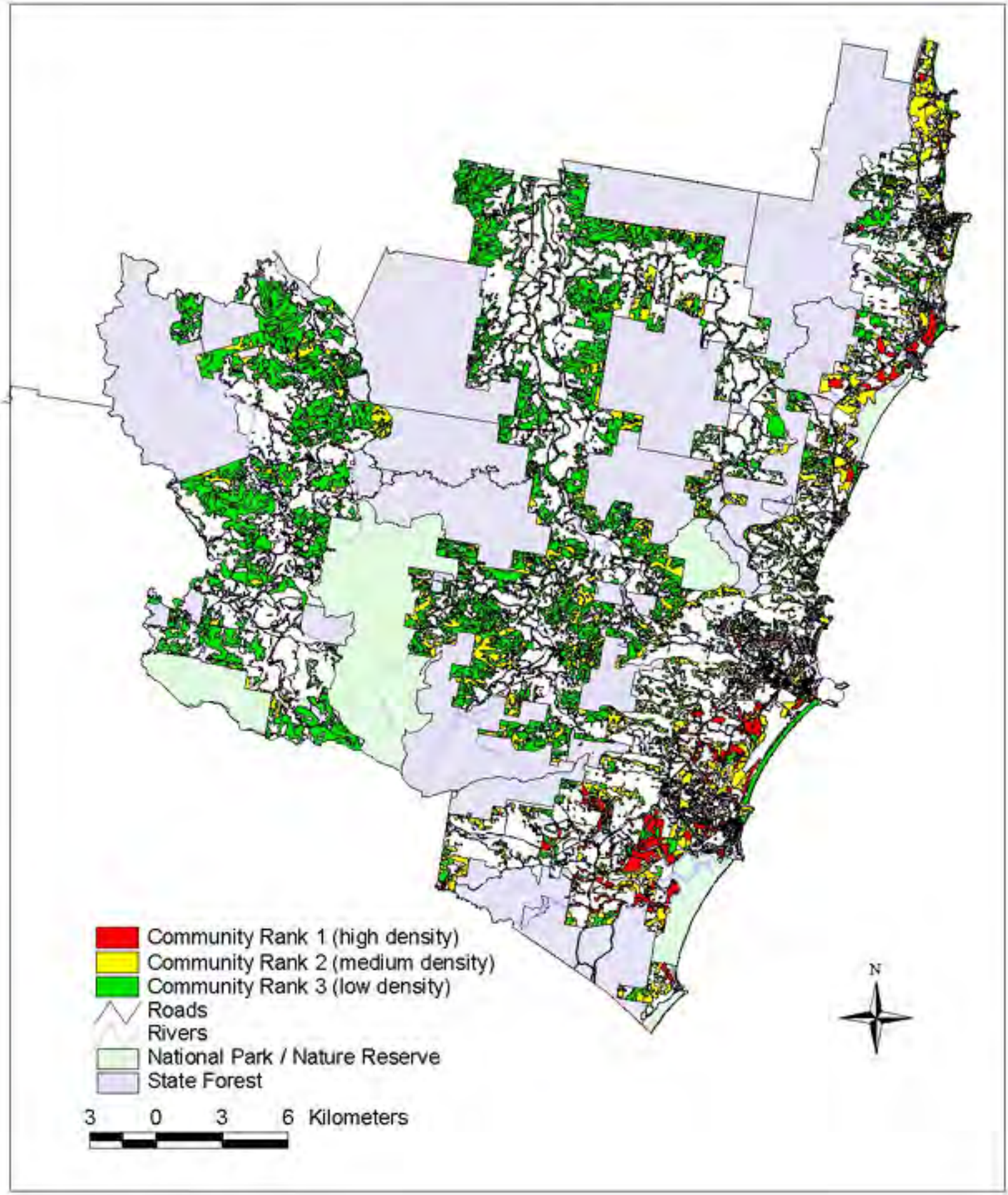
Map B4. Potential koala habitat in Coffs Harbour Shire.

The area of potential koala habitat based on SEPP 44 Schedule 2 species
and the extra area of potential koala habitat based on the Shire list of species.



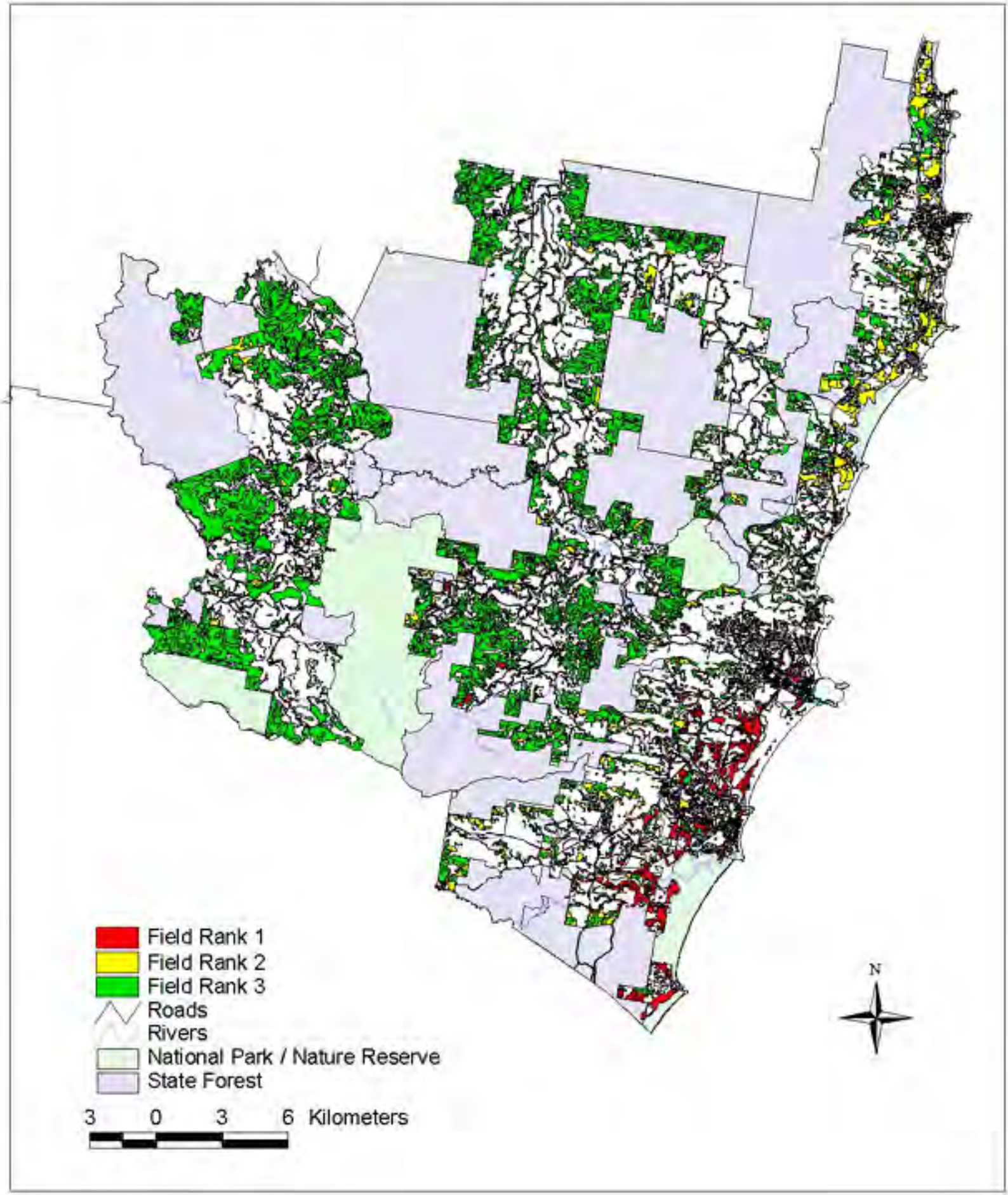
Map B5. Koala habitat derived from community-based koala survey.

This map shows three levels of koala habitat derived from the community-based survey, including areas of high, medium and low density koala habitat.

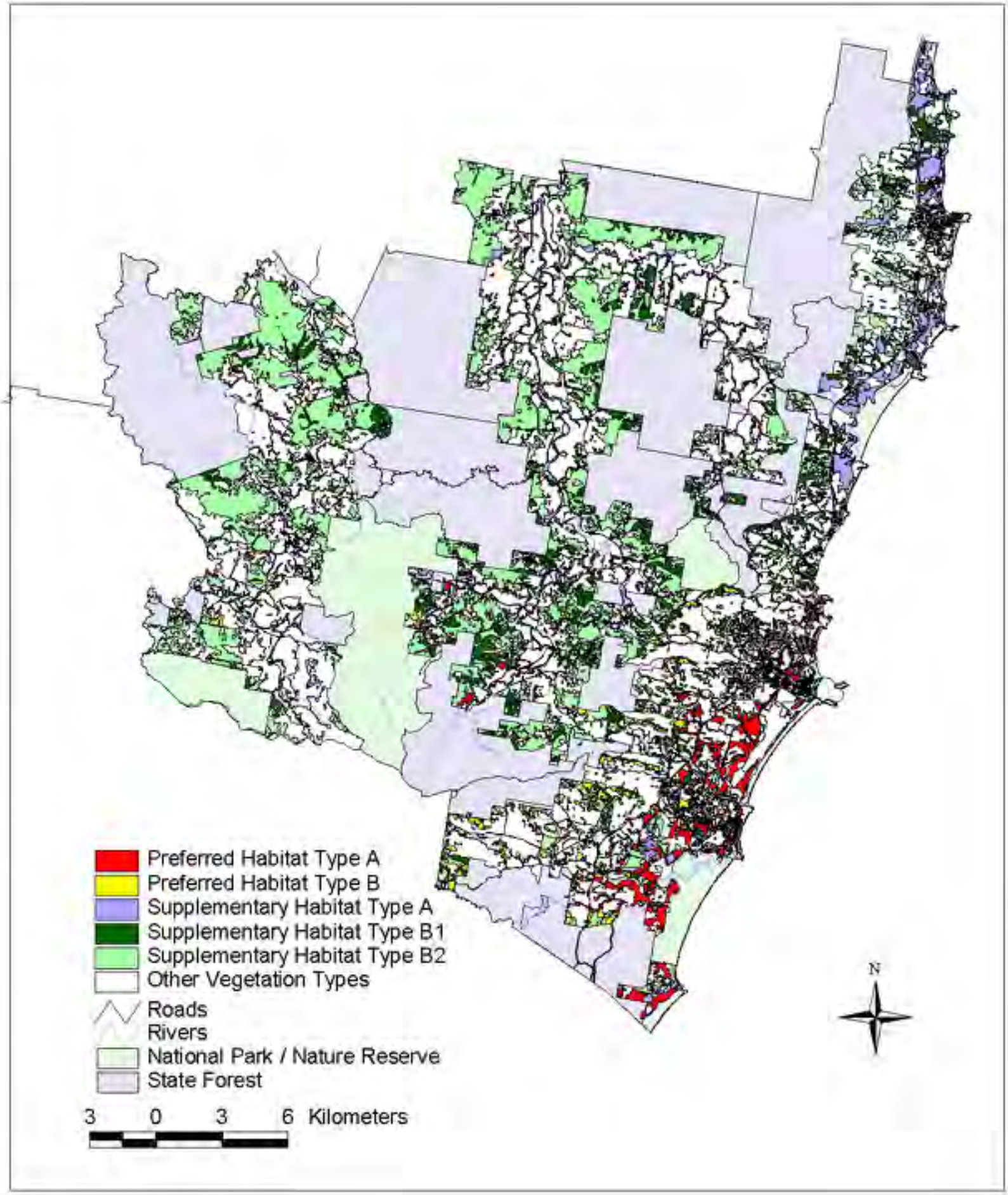


Map B6. Koala habitat derived from field-based koala survey.

This map shows three levels of koala habitat derived from the field-based survey. Field Rank 1 is the highest quality koala habitat, and is concentrated along the coast in the south-east of the LGA.



Map B7. Koala Habitat Map.



4. MANAGEMENT OF KOALA HABITAT

4.1 Introduction

The conservation of koalas relies on the protection and appropriate management of identified habitat and adjoining areas. Inappropriate development in and adjacent to areas identified as koala habitat places pressure on the existing koala population. These pressures either directly, through the removal of habitat, or indirectly, through such factors as increased mortality by dogs and motor vehicles, increase potential for stress-related disease and the creation of barriers to movement patterns and can lead to the disintegration of population structure and the displacement of resident animals. It is this combination of impacts which leads to the continuing decline in koala populations.

The protection of the remnant koala habitats in Coffs Harbour is vital to koala management. Koala habitat can be defined as an area of trees regularly utilised by koalas for food, social interaction and/or shelter. In accordance with the provisions of SEPP 44, koala habitat has been identified and mapped for the Coffs Harbour LGA. This process is described in Section 3. The Habitat Map which depicts five habitat types (Map B7) illustrates the fragmented nature of the remaining habitat, particularly in the south-east of the LGA. As a direct result of this widespread loss of vegetation and the fragmented nature of habitat remnants, the management of koalas is problematic. Planning mechanisms for protection and management of koalas within the LGA must consider remnant areas of habitat and also take account of adjoining landuses such as urban development, roads, agricultural activities and forestry. In particular, careful consideration must be given to activities that are incompatible with the movement and health of free ranging koalas. A holistic approach to planning is, therefore, required for the conservation and management of koala habitat in the LGA.

In the above context, linkages between koala habitat remnants become a vital component of management. The use of corridors is widely advocated as a management tool to link habitat remnants, thereby potentially helping to maintain biodiversity. They contribute to the connection of isolated wildlife populations by allowing a degree of immigration and recolonisation of otherwise isolated populations. Maintaining links between areas of koala habitat in the LGA is, therefore, important and needs to be addressed in the planning process.

The maintenance of viable koala populations in the LGA relies on an integrated strategy which incorporates a number of layers as described below:

- protection of important koala habitat through the highest level of protection in the Coffs Harbour City Local Environmental Plan;
- planning controls which require adequate levels of assessment and careful consideration of the impacts on koalas of any development or activity on land identified as, or adjacent to, koala habitat;
- identification of important habitat links; and,
- management strategies for activities in and adjacent to areas of koala habitat which minimise threats to koalas.

4.2 Koala Habitat Mapping for Planning Purposes

The Coffs Harbour City Local Environmental Plan (LEP) 1988 has been reviewed by Council through a Local Environmental Study. A draft Local Environmental Plan was

exhibited for public comment. This process allowed an opportunity for the results of the koala habitat mapping and associated planning controls to be incorporated into the LEP review process. An appropriate mechanism for incorporating the scientifically based habitat mapping into the planning process is described below.

In Section 3 koala habitat was identified and mapped for the Coffs Harbour City LGA. As a result a Koala Habitat Map (Map B7) was produced which distinguishes five categories described as follows:

	Map Colour
Preferred Habitat Type A	Red
Preferred Habitat Type B	Yellow
Supplementary Habitat Type A1	Blue
Supplementary Habitat Type B1	Dark Green
Supplementary Habitat Type B2	Light Green

The five categories in the Koala Habitat Map distinguish koala habitat preferences across the LGA. In general terms habitat types A and B and A1 and B1 respectively represent similar quality koala habitat on different geological types. For the purposes of planning the five categories have been amalgamated to form three rankings of koala habitat described as follows.

Primary Koala Habitat
Secondary Koala Habitat
Tertiary Koala Habitat

Each of the five koala habitat categories (preferred A1 through to supplementary B2) have been placed into one of the three planning categories (primary, secondary or tertiary) to produce the Koala Habitat Planning Map (Map B8). This process took into account the location of the area within the LGA, the quality of habitat and level of koala usage of each area, the nature and intensity of threats to koalas within the surrounding landscape and the existing and proposed landuse.

Reference to the Koala Habitat Map illustrates that the majority of the important koala habitat in the LGA is concentrated in the south-east, generally south of Korora and east of the coastal range. Because of the concentration of koala habitat in this area and the level of existing and proposed development, this area has been treated as a separate planning precinct to the remaining parts of the LGA and is referred to as the South East Planning Precinct.

The method for placing each of the five koala habitat types (preferred A1 through to supplementary B2) into the three planning categories (primary, secondary or tertiary) for the South East Planning Precinct and the remaining parts of the LGA is described below.

4.2.1 The South East Planning Precinct

The south-east section of the LGA contains the majority of the preferred koala habitat. It also supports koala populations at levels not found elsewhere in the LGA. The area is bordered in the north by Korora and generally in the west by the coastal range through Red Hill, the eastern edge of Boambee and Tuckers Knob State Forests down to the southern boundary of the LGA at Pine Creek State Forest. The vegetation in the south-east is fragmented, and the koala population is subject to a number of threats associated with

urban expansion and other development, which are concentrated more in this part of LGA than in the northern and western parts.

Koala density in the remaining fragmented vegetation is generally higher in the south-east than the rest of the LGA. The importance of preserving these remaining areas of koala habitat is critical to securing the koala population. In the South East Planning Precinct, the protection of both Preferred Habitat Types A and B and Supplementary Habitat Types A and B1, was considered essential and accordingly, for planning purposes, all these were incorporated into the Primary Koala Habitat.

Supplementary Habitat Type B2 in the South East Planning Precinct, whilst being less important as koala habitat on its own, plays an important role in linking primary habitat areas. As such, these areas warrant protection and management to ensure any development is compatible with koala conservation. They were, accordingly, categorised for planning purposes as Secondary Koala Habitat. This process is summarised below.

Koala Habitat Map	**Koala Habitat: Planning Map**
Preferred Habitat Type A and B and Supplementary Habitat Type A and B1	Primary Koala Habitat
Supplementary Habitat Type B2	Secondary Koala Habitat

4.2.2 Other Areas Within the LGA

Outside the South East Planning Precinct, areas of Preferred Habitat Types A and B occur to a lesser degree due to a number of factors relating to geology, soil fertility and associated habitat quality. Although koalas are widespread across this area and significant populations occur in many areas, they generally occur at lower densities than in the south-east. With the exception of the coastal village/town areas north of Coffs Harbour to Arrawarra, large areas of this part of the LGA are rural with threats to koalas mostly linked to agricultural activities such as clearing and logging. In this larger part of the LGA the three koala habitat planning categories were derived directly from the Koala Habitat Map as follows.

Koala Habitat Map	**Koala Habitat: Planning Map**
Preferred Habitat Type A and B	Primary Koala Habitat
Supplementary Habitat Type A and B1	Secondary Koala Habitat
Supplementary Habitat Type B2	Tertiary Koala Habitat

4.2.3 Summary

Table B4 summarises the process of deriving the three planning categories for the South East Planning Precinct and remaining areas of the LGA.

Table B4. Derivation of planning categories for the Koala Habitat: Planning Map

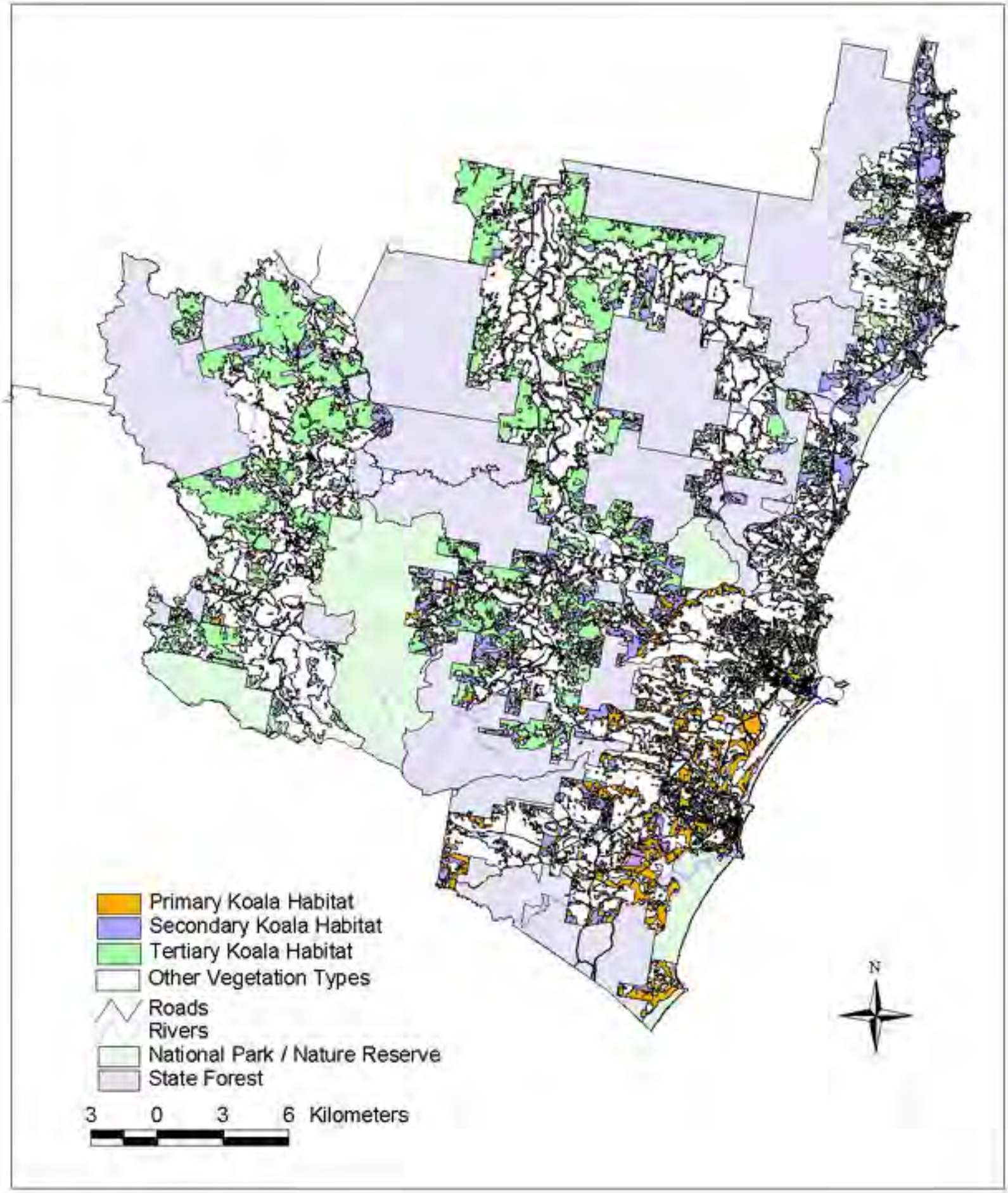
	Preferred Habitat Type A	Preferred Habitat Type B	Supplementary Habitat Type A	Supplementary Habitat Type B1	Supplementary Habitat Type B2
South - east	Primary	Primary	Primary	Primary	Secondary
other areas of LGA	Primary	Primary	Secondary	Secondary	Tertiary

Table B5 details the amount of area of land covered by these habitat planning categories and the the proportions on the various zonings under LEP 1988. The area of Primary Koala Habitat covers 14 % of the total habitat mapped, and the majority of this falls within current (LEP 1988) rural, open space and environmental protection zones.

Table B5. Area of koala habitat planning categories on current LEP zones

	Primary Koala Habitat	Secondary Koala Habitat	Tertiary Koala Habitat
Total Area (ha)	**2,745**	**5,221**	**11,120**
Rural (1)	1,672 (61 %)	4,298 (82 %)	10,965 (99 %)
Residential (2)	181 (7 %)	386 (7 %)	29 (0 %)
Business (3)	2 (0 %)	0 (0 %)	0 (0 %)
Industrial (4)	80 (3 %)	10 (0 %)	0 (0 %)
Special Uses (5)	121 (4 %)	30 (1 %)	37 (0 %)
Open Space (6)	346 (13 %)	176 (3 %)	7 (0 %)
Environmental Protection (7)	323 (12 %)	294 (6 %)	72 (1 %)

Map B8. Koala Habitat: Planning Map



5. KOALA ROAD RISK

5.1 Introduction

Road kills are a major cause of the loss of koalas from areas of otherwise adequate habitat (e.g. Lee and Martin 1988; Hume 1990; Canfield 1990; Pahl *et al*. 1990; Starr *et al*. 1990; Summerville 1990; Smith 1990; Andrews 1990; Moon 1995a). This occurs when death rates exceed birth rates and when key individuals are killed (e.g. breeding females, dominant males). The risk is particularly high when a road passes through, between or adjacent to core habitat.

Koala road death, as opposed to injury and possible rehabilitation, seems to be directly related to such factors as vehicle speed limits, lighting of roadway, driver visibility (related to the type of vegetation on the road verge) and driver awareness. Statistics on road hits from Redlands Shire in south-east Queensland showed that koalas were more likely to survive from a car travelling at 60 km/h than at higher speeds (Bruce *et al*. 1996).

Koala road risk is also higher during the breeding season from August to November (Moon 1995a) when individuals are moving around and figures from Port Macquarie show that males suffer the most road kills (62% of records).

Coffs Harbour has a major highway bisecting the principal area of koala habitat. For this reason, koala road kill is considered a major threat to the conservation of the Coffs Harbour koala population.

Between 1990 and 1995 Coffs Harbour WIRES took calls about 85 koalas involved in a road accident. Of these, 73 (86 %) died (Moon 1995a). Boambee and Toormina (including Lindsays Cutting and Hogbin Drive) were identified as the worst areas for koala road accidents and Coffs Harbour urban area, Bonville, Korora and Red Hill also had major records. The worst months were September, with 17% of records, and October (27%), followed by August (11%), July (10%) and June, February and November (all 7%). Of all recorded koala road accidents, 78% occurred in late winter and spring. These figures are probably an understatement of the real impact on the population due to koalas being hit and dying off the side of the road where they are not visible from the road, or dying later in the bush from injuries.

5.2 Traffic statistics in Coffs Harbour

Average weekday traffic counts on the Pacific Highway (CHCC figures, 6/96) range from about 8,000 vehicles/day at Arrawarra (one vehicle every 11 seconds), 21,000 vehicles/day at Korora (one vehicle every 4 seconds), 23,600 vehicles/day at Park Beach Rd (one vehicle every 3.6 seconds), 20,000 vehicles/day in the CBD and at Englands Rd (one vehicle every 4.3 seconds) and 12,500 vehicles/day south of Bonville (through Pine Creek State Forest) (one vehicle every 7 seconds).

Daily traffic counts on other roads, where koalas occur, include 3,000 vehicles/day at Karangi School on Coramba Road; 14,350 vehicles/day on Hogbin Drive near the airport and 12,500 vehicles/day on Hogbin Drive near Hi-tech Drive; 7,000 vehicles/day on Coramba Rd near Murdock St; 4,500-5,000 vehicles/day on Lyons Rd; 1,500-3,500 vehicles/day on Linden Avenue and 6,100 vehicles/day on Sawtell Rd.

These figures are weekday counts in winter. Vehicle movements would be greater during tourist visitation times, particularly Christmas and Easter holidays. Also, there is considerable variation in traffic densities over the course of a 24 hour day. Commuter roads such as the Pacific Highway, Coramba Road and Hogbin Drive carry high numbers of vehicles in the morning and evening and most roads except the Pacific Highway are relatively quiet late at night. Figure B9 shows the opportunities available for koalas to cross

the road over one 24 hour period (25/6/91) at the Pacific Highway at Lindsays cutting, Boambee and at Coramba Road at Red Hill, both "black spots" for koalas (data supplied by RTA). The figures indicate that there is almost no opportunity for koalas to cross the Pacific Highway safely.

5.3 Areas of risk in Coffs Harbour

The main areas of risk for koalas attempting to cross roads in the Coffs Harbour area are shown in Map B9. The map is based principally on information provided to the postal survey, but also takes into account reliable records from NPWS files, WIRES and vets. Each black spot has been rated according to number, frequency and persistence of koala road deaths.

The community-based survey identified the following areas as black spots for koalas:

1. The Pacific Highway from the Big Banana to Opal Cove
2. The Pacific Highway near Coffs Harbour Zoo
3. The Pacific Highway from Englands Road to Sawtell Road
4. Hogbin Drive from the airport road to the Harry Jensen Bridge
5. The Pacific Highway near Duttons Estate
6. Hogbin Drive from John Paul College to south of the Fred Hansen Bridge
7. The Pacific Highway north of Bonville Creek
8. The Pacific Highway through Pine Creek State Forest
9. Coramba Road from Robin Street to Karangi

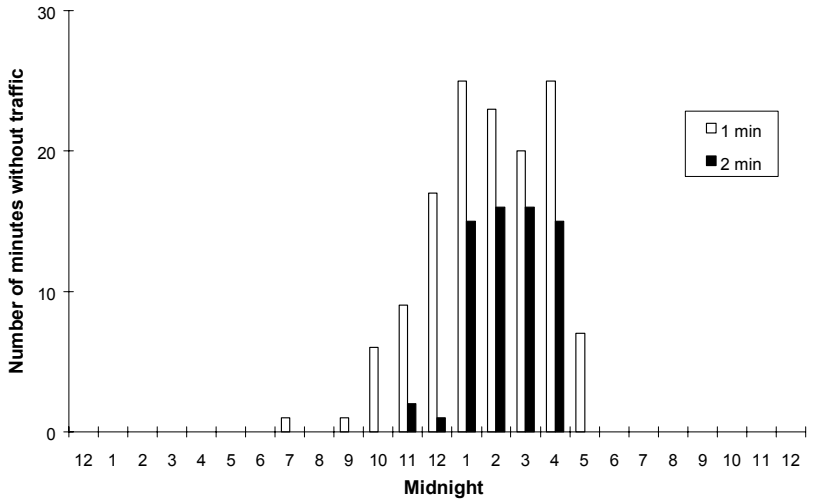
Other roads with a history of koala road accidents include Mount Brown Road, Orara Road, North Boambee Road, Englands Road, Sawtell Road, Lyons Road, Toormina Road, Cavanbah Road, Donn Patterson Drive and Gleniffer Road. Some koala "black spots" have a significant history of koala road kills, but few recent records. This is most likely because the local koala population has been reduced or eliminated. Coastal Korora, Cavanbah Road and the Highway at Moonee are areas where fewer koala road kills now occur.

Figure B9. Road crossing opportunity for koalas at two black spots in Coffs Harbour.

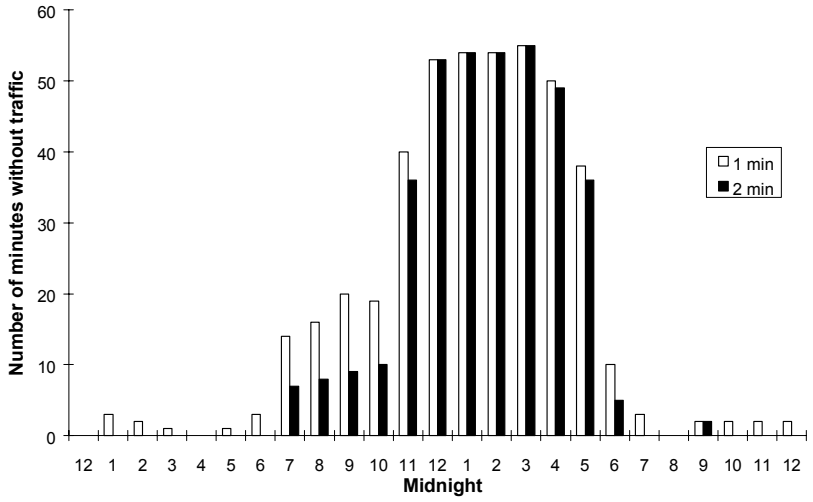
The histograms show the opportunities for koalas to cross the road, per hour, during a 24 hour period (Tuesday 25.6.91) at the Pacific Highway at Lindsay's cutting, Boambee, and Coramba Road at Red Hill - both major koala road kill sites. Data is from a minute by minute count of traffic movements in both directions, for Tuesday 25.6.91, carried out by the Roads and Traffic Authority of NSW.

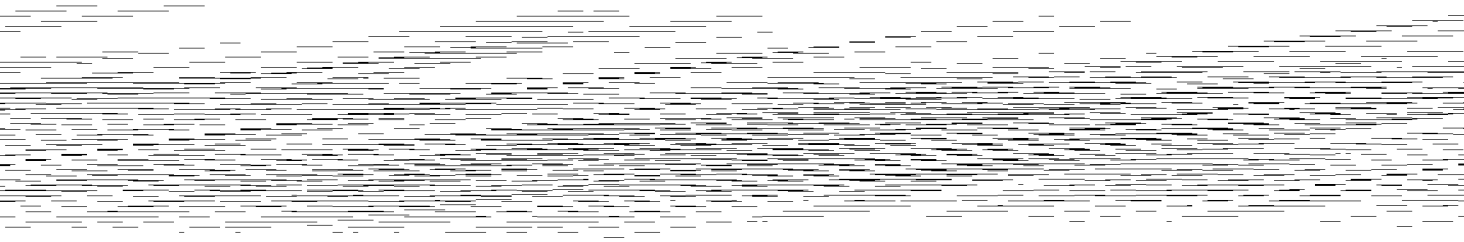
Key: 1 min = number of periods of one minute without traffic
2 min = number of minutes without traffic which are part of a period of two minutes
or more with no traffic

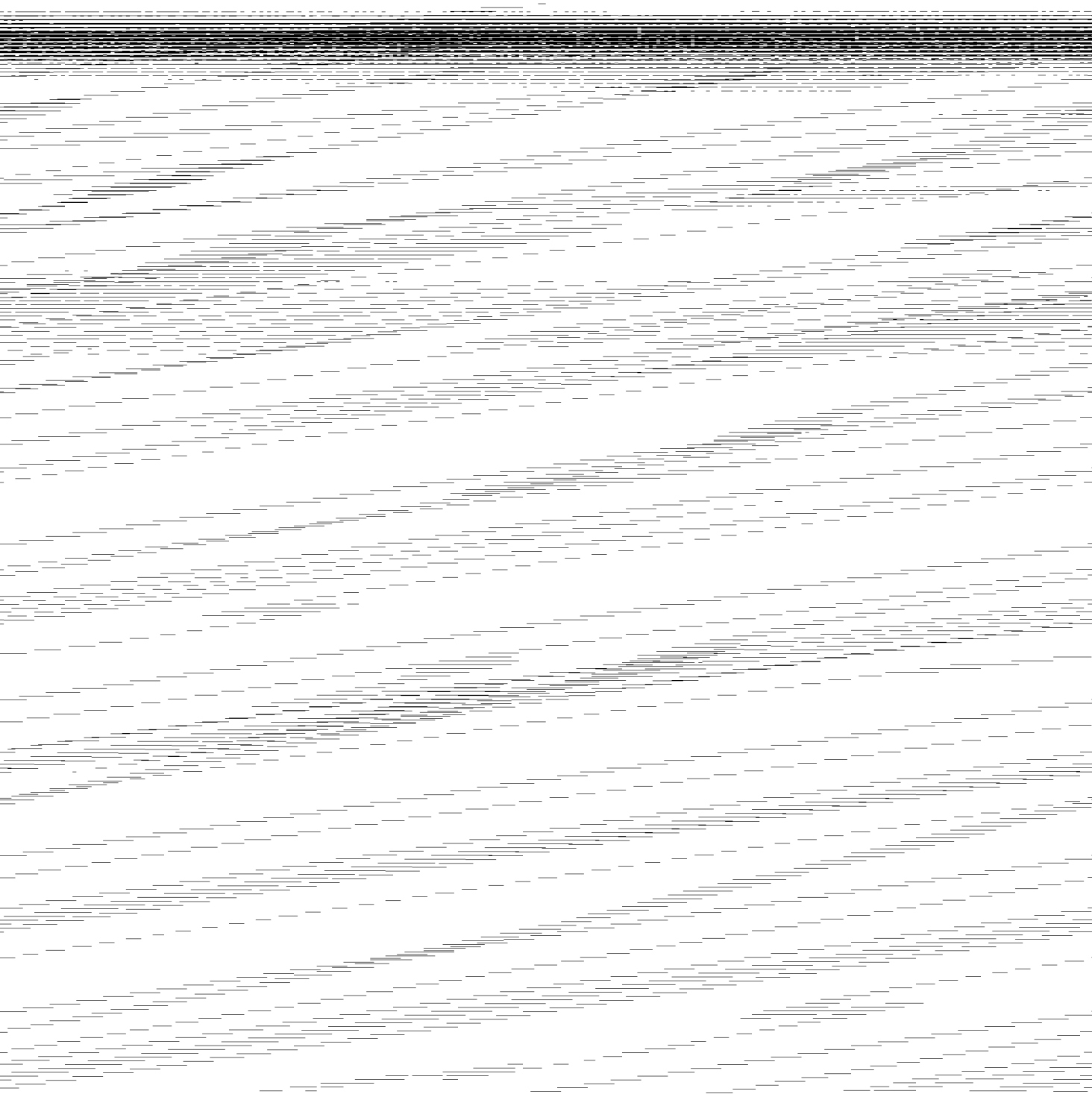
a. Crossing opportunities for koalas - Pacific Highway (Lindsay's Cutting)



b. Crossing opportunities for koalas - Coramba Road at Red Hill







6. IMPACT OF DOGS ON KOALAS

6.1 Introduction

Dog attack is a major threat to the survival of koala populations in urban and rural areas. Dogs may kill, injure or stress koalas (by chasing, barking or restricting normal ranging behaviour). This is exacerbated when dogs have the opportunity to form pairs or packs, when dogs can roam widely outside their home properties and where large and aggressive breeds are common (ANZECC 1998). Dog attack may also result in anxiety stress which can cause nutritional stress or even failure to mate. Stress can result in onset of disease (*Chlamydia*) which causes death or infertility in koalas.

A current radio-tracking study in Port Stephens (Lunney *unpubl*.) has demonstrated that dogs kill large numbers of koalas (60% of collared koalas considered to be killed as a result of dog attack). They are now recognised as the 'silent killers' of koalas, attacking at night and in areas of bush not frequented by people. Statistics from Port Macquarie show that more dogs are impounded during the spring period (50% increase) which suggest that more dogs may be roaming and potentially impacting on koalas during their breeding season when they are also active on the ground.

Many dogs owners underestimate the potential impact of their dog on koalas. Even normally quiet domesticated dogs may feel threatened by koalas which enter their yard. The simple action of restricting dogs to fenced yards (preferably impermeable to koalas) and restraining dogs between dusk and dawn can greatly reduce koala attacks.

Between 1990 and 1995 Coffs Harbour WIRES took 33 calls for koalas which were attacked or harassed by dogs. Of these, 5 died but the majority (12 koalas) were relocated (Moon 1995a). The number of reports of dog attacks on koalas is of great concern. The impact of dogs on koalas is under-reported: attacks happen at night away from populated areas; people are reluctant to incriminate their own dog if they witness an attack; and it is often unclear what may have caused a particular injury to a koala, particularly if the carcase is old.

While records exist for cats attacking koalas (R. Natrass, QNPWS, pers. comm. 1992), and their impact on other fauna is known to be devastating, there is no research evidence that cats threaten the survival of koala populations. Foxes are likely to be significant predators of koalas, particularly young koalas, though local evidence is lacking. Further research in this area is required.

6.2 Dog Statistics in Coffs Harbour

Council staff estimated in 1996 that there were over 10,000 dogs in the Coffs Harbour LGA, of which less than half are registered (1996 figure 5,321). Some dogs are unconfined at night and these represent the greatest threat to wildlife, particularly when packs of dogs roam at night in rural areas. There are no regulations applying to the free movement of dogs on their owner's properties, including rural holdings.

With the exception of "overgrown land" in the late summer period, Coffs Harbour Council in 1996 received more complaints (over 1000/year) about dogs than any other issue. The offence of "dog roaming" constituted over 40% of complaints and "dog attacks" made up about 13% of complaints.

6.3 Penalties and Restrictions on Dogs

Penalties for certain offences under the *Companion Animals Act 1998*, which replaced the *Dog (Amendment) Act 1988* apply to attacks by dogs on people or animals, and on control

of dogs in public places. The increased penalties are intended to act as an incentive both to owners to control dogs and to authorities to prosecute breaches.

The NSW government is currently revising animal welfare legislation. A proposal for a new Companion Animals Act is currently with State Cabinet and a white paper draft exposure bill is anticipated to be circulated late in 1997. The intention of the new legislation is to actively promote the welfare of companion animals and responsible ownership. It is also suggested that it should take account of the environment and help reduce attacks on native wildlife by cats and dogs. The bill may create new offences and is also likely to create new statutory mechanisms for regulation of dogs and other pets.

SEINS (Self Enforcement of Infringement Notice System) is a procedure for applying regulations by authorities. Coffs Harbour is now one of a growing number of councils to have joined this system. As applied to the management of dogs in a district, Council's "dog-catchers" are classified as Ordinance Officers, with the authority to impose on-the-spot infringement notices, usually requiring payment of a fine, to people who allow their dogs to behave so as to breach a regulation. If this fine remains unpaid after a set period, the matter is handed to the Police Collections Section, who pursue the payment using normal police procedures, and impose a levy. The system has resulted in a high recovery rate for fines and makes enforcement of regulations a viable strategy for dog control.

7. KOALA HEALTH AND WELFARE PROBLEMS

7.1 Introduction

Koalas can be found sick, injured, orphaned, disoriented or in inappropriate places. This section deals with the issues raised when koalas need assistance.

The *National Parks and Wildlife Act 1974* applies controls on handling and holding fauna, such as koalas. It is illegal to move, handle, injure, harass or relocate a koala without authority. NPWS guidelines now govern koala handling and caring in NSW. While people occasionally relocate koalas which they find in unusual locations, research by Queensland NPWS (R. Natrass, pers. comm. 1991) and data from Port Macquarie (Starr *et al*. 1990) and the Richmond/Tweed areas (Steve Phillips, NSW NPWS, pers. comm. 1990) clearly indicate that this greatly increases the risk to the animal as it will try to return to its territory and thus spend a lot of time on the ground, vulnerable to predation, vehicles and stress.

Koalas are subject to a number of diseases, including mange, anaemia, organ failure, cancer and infections. The most widely reported disease in koalas is *Chlamydia* which appears to be endemic - that is, most, if not all, koalas carry the organism. Many koalas appear to carry *Chlamydia* without showing clinical symptoms. Recent research has shown there to be two genetically different types of *Chlamydia* that infect koalas, *C. pecorum* and *C. pneumoniae* (Glassick *et al.* 1995, Timms *et al.* 1996). *C. pneumoniae* results in unsightly outbreaks of conjunctivitis (pink-eye) and *C. pecorum* causes conjunctivitis as well as uro-genital tract infection (dirty-tail, wet-bottom). It is uncertain how either of these strains are transmitted between koalas but it is assumed that the major mode of transmission is through sexual contact. However, it is thought that *C. pneumoniae* may also be spread by non-sexual means.

Chlamydia symptoms arise in koalas following stresses, typically droughts, loss of habitat, dog attacks, injury and situations which prevent adequate intake of nutrition and/or moisture. Some symptoms can be treated, but if the koala has no home range to return to, or is left weakened by the experience, the condition usually recurs within months. Females are often rendered infertile by the infection, so that even if symptoms clear, the infertile female koala can reduce the reproductive potential of a population by occupying a core territory at the expense of a young fertile female.

Between 1990 and 1995 Coffs Harbour WIRES took 76 koalas into care that were diseased, mainly from *Chlamydia*, and of these 26 (34 %) died and 25 (33 %) were rehabilitated (Moon 1995a).

7.2 Koala Care Groups and Facilities in Coffs Harbour

At present the Wildlife Information and Rescue Service (WIRES) Coffs Harbour Branch undertakes the majority of care and rescue of wildlife in the Coffs Harbour area. There are six active, trained koala carers with WIRES, as well as some trained but non-active carers. WIRES is able to obtain advice from the koala hospital run by the Koala Preservation Society of NSW at Port Macquarie, and Friends of the Koala in the Lismore area, and there is a high level of interest in koalas among local veterinarians. Other help comes from the RSPCA, Council, NPWS, Australians for Animals and the Australian Koala Foundation.

There is a need for more trained carers for busy times (spring and summer) and more facilities in Coffs Harbour, particularly for intensive care. Data on the diseases and injuries which typically occur in this district are inadequate, and there is a need for standard reporting and post-mortem presentation. There is not yet a systematic way of meeting the high costs of caring, medication, veterinary attention and provision of facilities. Suitable leaf for koalas in care is hard, and very time-consuming, to find.

A "half-way house" would also be of benefit for koalas which need a staged approach to full release to the wild (e.g. orphans) and for the occasional otherwise healthy koala which cannot be released because of a critical disability (e.g. blindness, amputees).

There has been only limited support for a koala hospital in Coffs Harbour due mostly to the considerable commitment of resources required for establishment and annual running (e.g. Port Macquarie koala hospital cost approx. $70,000/year) and also because of the high level of success of the existing arrangement. The Coffs Harbour area cares for some 30-40 koalas a year, and a half-way house and other facilities would ensure a standard of response and care appropriate to the level of the problem. Further investigation towards funding to achieve these facilities should be undertaken by the koala steering committee to be set up by Council under the recommendation of this CKPoM.

Koalas in captivity for commercial display are regulated by the Zoological Parks Board and are outside the scope of this plan, which deals with the management of wild koala populations. It is recognised that zoos with koalas serve a valuable role in education, as was identified at the Koala Summit (Lunney *et al*. 1990).

7.3 Conditions for Koala Care in NSW

Carers and carer groups in NSW require licences from the NPWS (Wildlife Licensing Unit, NPWS, PO Box 1967, Hurstville NSW 2220) Phone (02) 9585-6481, FAX (02) 9585-6401. The following conditions now apply to the care of koalas in NSW. These are the formal conditions attached to applications for licences and need to be met by carer groups prior to, or to maintain, accreditation. These conditions have accompanying guidelines in a document entitled "*Guidelines and Conditions for Koala Care in New South Wales*" prepared by D. Lunney and A. Matthews, June 1997. Coffs Harbour WIRES has met these conditions and obtained accreditation under the Guidelines.

Conditions:

1. *New carers must be trained by an accredited carer or group.*

2. *New carers must be registered in a licensed group. The group must provide a detailed training program and a list of all registered carers as requirements to gain or continue to hold a licence.*

3. *An independent Accreditation Committee, established by the National Parks and Wildlife Service, and consisting of at least a carer, veterinarian and a Service officer, will undertake the accreditation of organisations applying for accreditation. A carer group is to set up an accreditation committee, keeping all appropriate records (such as minutes and correspondence). The formal procedures for accreditation need to be listed by each committee and this must be used in the accreditation of each carer or carer group.*

4. *All facilities for each stage of care must be available within a group. A detailed list of facilities must be prepared as part of the accreditation process. Each carer must have their facilities checked for suitability by the group co-ordinator and a record kept.*

5. *Carers must advise the vets in the area of their existence, what information is available and the best procedures for koala care. Carers must respect the vet's professional rights and responsibilities.*

6. *Only koalas which have a poor chance of survival from obvious signs of injury or disease, or that are orphaned, or that are in a dangerous location, may be rescued. No koala known to be covered by an Animal Research Authority may be rescued without consent of the researcher.*

7. *Procedures for catching and retrieving koalas must be specified by the carer groups in seeking accreditation. Procedures should include methods of catching, holding and securing for transportation. Koalas may only be handled by an authorised person.*

8. *Each koala care group is to establish detailed criteria under which koalas are to be transported.*

9. *The decision to take a koala into care or to euthanase is to be made by the carer and a veterinarian and/or group co-ordinator. The carer group must review each decision to assist in refining the decision making process. A record of the reasons for decision must be kept on a standard record form.*

10. *Detailed specifications, record sheets, inspection procedures and care protocol need to be formally established for koalas in long-term care as a requirement for accreditation.*

11. *The health status of the koala must be assessed to decide what treatment the koala requires. A decision must be made and recorded by the carer as to whether the koala is to be released within 48 hours or to go into long-term care.*

12. *The minimum standards for enclosure design and management must be prepared by each carer group as a requirement for accreditation. This must include housing requirements for koalas under intensive care as well as non-intensive care, temporary holding and long-term care.*

13. *The diet, method of feeding and source and species of leaves must be codified by the carer group as a requirement for accreditation.*

14. *The age or weight at release of orphaned koalas must not be greater than the age or weight at which the koala would normally be independent of its mother. Carer groups must establish criteria for identifying, caring for and releasing an orphan, including a weight that is appropriate for the local area, as a requirement for accreditation.*

15. *Koalas in care undergoing rehabilitation must not be placed on public exhibition or be used for educational purposes.*

16. *Koalas must be released at the earliest opportunity, after having satisfied the criteria for release.*

17. *Koalas in long-term care or hand-reared must be placed in a rehabilitation area for a period of tree climbing under normal weather conditions prior to release.*

18. *Koalas must be ear tagged prior to release by an appropriately trained person and records kept. The record form needs to part of the submission for accreditation.*

19. *The site of release of koalas must be as close to the initial encounter site as possible except for koalas being relocated out of immediate danger. In the case of possible short-term danger, the release of koalas must be made in consultation with the district office of the National Parks and Wildlife Service.*

20. *Koalas deemed to be non-releasable must be either euthanased or, following the recipient obtaining an appropriate authority or licence, be placed in a licensed zoo or fauna park, kept in a "safe area" and/or used for teaching and research.*

21. *Autopsies must be undertaken where possible, a protocol established, and animals or tissues made available to researchers.*

22. *A standard record sheet must be prepared for each rescued koala. Each koala rescued must be given an identifying code. The record sheet must accompany the koala and a copy kept in a central record system of the carer group. The care group must develop a detailed standard record form(s) for individual carers as a requirement for accreditation.*

8. KOALAS AND FIRE

Bushfires can cause high koala mortality and can have a significant effect on local populations both in the short term and long term. In particular, high intensity fires can cause death and injury from both fire scorch and smoke and ash inhalation. Where habitat is highly fragmented and isolated this can cause localised extinction of koalas with little chance of repopulation. Following bushfire, it is known that koalas will recolonise an area within a year of regeneration where there is a sufficient amount of nearby forest that supports breeding koalas (Lunney unpubl. data). Frequent low intensity prescribed burns may suppress eucalypt regeneration resulting in a simplified forest age structure and a dense ground stratum which inhibits koala movements. The creation of fire trails may facilitate the entry of dogs into habitat areas. The need for developed areas to be protected from bushfire, through fire radiation zones and fuel reduction strategies may create conflict with management of koala habitats. Fire reduction strategies must, therefore, take into account the likely impacts which may occur on koalas and their habitat.

Koalas may be killed, injured or detrimentally affected by hazard reduction operations and regenerating trees may be killed. Fire trails may also require the clearing of koala habitat. Criteria and guidelines at present do not exist for optimum fuel reduction regimes with respect to the maintenance of natural values, including koala habitat management, for various vegetation types.

Current management of bush fires in bushland areas is principally through ground fuel reduction, assisted by the establishment of control lines (fire trails) which may be internal or perimeter. Bush fire management across local government areas is through a Fire Coordination Plan under s.41 of the *Bush Fire Act 1949*. Implementation is through the local Bush Fire Management Committee. A fuel reduction burn is considered necessary when ground fuel reaches 15 tonnes/hectare. Priority for management is given to the protection of property and developed areas. Fire managers may consider it desirable to break-up, with trails and open areas, tracts of continuous bushland. “Sacrifice strips” may be burnt in bushland areas in order to contain fires in larger bush areas. Fire trails are constructed to the Department of Land and Water Conservation standards, and consultation with the National Parks and Wildlife Service regarding protection of natural and cultural heritage is standard procedure.

It is not practical to create hard and fast fire management prescriptions in koala habitat areas, as management of fires is regulated by the Bush fires Act, which can override other protocols where a perceived fire threat exists. A more flexible system would be the provision of a set of principles for fire management in koala habitat to be provided to bush fire authorities, and for mechanisms for negotiation on a case by case basis where a conflict may occur. The Koala Habitat maps should also be provided to bush fire authorities, with a request that the Koala Advisory Committee or the National Parks and Wildlife Service be notified if fire management actions which may contravene the principles are proposed in koala habitat areas.

The set of principles should include:

- tallowwoods should be retained and protected
- avoidance of hot fires and crown scorch in koala habitat areas
- a check for likelihood of koalas prior to undertaking potentially damaging actions
- preferential use of mechanical means for “underscrubbing” where a cool burn cannot be guaranteed
- Creation of fire access trails should avoid removing koala preferred food tree species

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APPENDICES

Appendix B1. Comments from respondents to the Coffs Harbour Postal Koala Survey October 1990.

Support for the koala survey:

> *This is the first time all of Coffs has been involved in protecting our koalas. A step in the right direction.* (Male/Female.....61/50.....Coffs Harbour)
>
> *This survey - an excellent thing.* (Female.....76.....Woolgoolga)
>
> *Pleased to see local Government taking an interest in wildlife. Keep up the good work.* (Male.....36.....Red Hill)

Concern at the loss of koalas:

> *This survey seems about 10 years too late. There are houses and roads where I used to see koalas.* (Male.....32.....Coffs Harbour)
>
> *We feel the reason the koalas have left our area is because of dogs.* (Female.....66.....Upper Orara)
>
> *There were more koalas around when I was young, especially around Korora school.* (Female.....36.....Korora)

Concern at roaming dogs:

> *Why are dogs allowed on the streets unless under control? I thought this was the law, and why dogs are registered. If a few fines were imposed, the money could be spent helping the koala.* (Female.....61.....Coffs Harbour)

Hostility towards conservationists:

> *Just watch that the 'greenies' don't take over.* (Male.....61.....Coffs Harbour)
>
> *Too much publicity regards koalas. They should be moved to State Forests away from development.* (Male.....70.....Bonville)

A special attachment to koalas:

> *We Love KOALAS* (Female.....28.....Coffs Harbour)
>
> *It was a unique experience for me to actually see a koala outside a zoo or sanctuary area.* (Female.....55.....Coffs Harbour)
>
> *We must preserve the koala as a national heritage.* (Male.....60.....Coffs Harbour)

A few comments were angry and partisan:

> *Put people before koalas. Stop mass hysteria by environmentalist greenies. Sack all NPWS officers. Employ forestry officers who have sensible ideas.* (Female.....54.....Karangi/Coramba)
>
> *STOP Council and Forestry MISMANAGEMENT NOW. Give less rights to developers. Stop the rule of big money.* (Male.....29.....Moonee)

However, the vast majority of comments were supportive of sensible koala conservation measures in Coffs Harbour:

> *There must be a balance between development and conservation. We need both. Please try to find a practical solution to preserve the koalas.* (Female.....70.....Toormina)

Although I have rarely seen koalas I am interested in conserving koalas in Coffs Harbour. (Female.....50.....Bonville)

Where the koalas are found in colonies they should be put before everything else. (Male.....32.....Bucca)

I would be more than happy to pay a levy on my rates to support our koalas. (Female.....56.....Coffs Harbour)

Developers' contribution to support fund to acquire land of high koala habitat. (Male.....43.....Bonville)

I would like to know which trees to plant as koala food for the future. (Female.....63.....Moonee)

My husband and I both feel that more protection for koalas is necessary to ensure their survival. (Female.....35.....Bayldon)

I would like to see more trees saved for the koala and my children's future in being able to see koalas wild as GOD meant them to be. (Female.....40.....Bayldon)

I would like to see more tree corridors along the top of Coffs Harbour's hills and through banana plantations, so the koalas have safe passage from one area to another. Also I think your koala survey is a great idea. Thank you for asking the public for their input. (Female.....32.....Coffs Harbour)

Appendix B2. **Follow-up to the community-based survey**.

Trees observed with koalas by respondents to the community-based survey, identified during follow-up visits.

a/ Coffs Harbour Area - Mackays Road and Coffs Creek areas

Tree Species	**Number (%)**	**Sightings of females with young**	**Mean diameter**
Tallowwood	20 (38)	16	55
Flooded Gum	20 (38)	12	50
Blackbutt	4 (8)	3	80
Forest Oak	3 (6)	2	21
Turpentine	2 (4)	2	92
Brushbox	2 (4)	2	45
Other	1 (2)	1	32
Total	**52**	**38**	

b/ North Boambee - including Middle Boambee and Kratz Drive

Tree Species	**Number (%)**	**Sightings of females with young**	**Mean diameter**
Tallowwood	25 (33)	7	53
Flooded Gum	26 (34)	3	51
Blackbutt	8 (11)	3	51
Bloodwood	4 (5)	1	33
Forest Oak	3 (4)	0	18
Grey Gum	2 (3)	0	75
Angophora	2 (3)	0	52
Brushbox	1 (1)	1	26
Grey Ironbark	1 (1)	0	36
Lemon-scented Gum	1 (1)	0	30
Turpentine	1 (1)	1	69
Melaleuca	1 (1)	0	34
Camphor laurel	1 (1)	1	26
Total	**76**	**17**	

c/ Toormina/Bayldon/North Bonville - including Bonville Beach Hardwood Land and Duttons Estate

Tree Species	**Number (%)**	**Sightings of females with young**	**Mean diameter**
Tallowwood	11 (41)	4	51
Blackbutt	8 (30)	6	50
Red Mahogany	3 (11)	0	48
Angophora	2 (7)	1	35
Forest Oak	1 (4)	0	45
Swamp Mahogany	1 (4)	1	36
White Mahogany	1 (4)	0	106
Total	**27**	**12**	

d/ Korora

Tree Species	Number (%)	Sightings of females with young	Mean diameter
Tallowwood	7 (33)	1	44
Red Gum	5 (24)	0	52
Flooded Gum	3 (14)	0	38
Grey Gum	2 (10)	0	46
Red Ironbark	2 (10)	0	75
Bloodwood	1 (5)	0	45
Brushbox	1 (5)	0	60
Total	**21**	**1**	

e/ Upper Orara - including Mount Browne Road

Tree Species	Number (%)	Sightings of females with young	Mean diameter
Tallowwood	8 (47)	0	58
Blackbutt	4 (24)	0	50
Flooded Gum	3 (18)	2	36
White Mahogany	1 (6)	0	56
Forest Oak	1 (6)	0	12
Total	**17**	**2**	

f/ Bucca

Tree Species	Number (%)	Sightings of females with young	Mean diameter
Tallowwood	4 (57)	2	44
Blackbutt	2 (29)	0	49
Forest Oak	1 (14)	1	10
Total	**7**	**3**	

g/ Pine Creek State Forest - west

Tree Species	Number (%)	Sightings of females with young	Mean diameter
Tallowwood	2 (40)	0	30
Grey Gum	3 (60)	1	31
Total	**5**	**1**	

Appendix B3. Field survey site summary

Map Unit	Community	Mapsheet	Easting	Northing	Datasheet	Scat	Koala	Tree sample	Trees scat	Activity Level (%)
RF53	Brushbox	Moonee Beach	514400	6657800	15	yes	no	20	1	5.00
RF53	Brushbox	Coffs Harbour	513200	6651650	102	yes	no	15	2	13.33
RF53	Brushbox	Moleton	491600	6656400	154	no	no	21	0	0.00
N1A	Coastal Forest Red Gum	Raleigh	508800	6639600	71	no	no	16	0	0.00
N1A	Coastal Forest Red Gum	Moonee Beach	514950	6657550	87	no	no	19	0	0.00
N1c	Coastal Forest Red Gum	Moonee Beach	501400	6659000	141	no	no	21	0	0.00
RV1	Coastal Riparian Vegetation	Coffs Harbour	501450	6640900	92	yes	no	18	8	44.44
RV1	Coastal Riparian Vegetation	Coffs Harbour	509750	6649100	95	yes	no	17	8	47.06
RV1	Coastal Riparian Vegetation	Coffs Harbour	510650	6649400	96	yes	no	16	2	12.50
RV1	Coastal Riparian Vegetation	Coffs Harbour	507000	6642700	161	no	no	19	0	0.00
RV1	Coastal Riparian Vegetation	Coffs Harbour	502400	6639800	169	no	no	18	0	0.00
N44a	Dry Blackbutt	Moonee Beach	514500	6657650	16	yes	no	22	1	4.55
N44a	Dry Blackbutt	Moonee Beach	515150	6661100	17	no	no	14	0	0.00
N44a	Dry Blackbutt	Moonee Beach	515050	6661250	18	no	no	8	0	0.00
N34a	Dry Blackbutt	Coffs Harbour	508950	6651750	1	no	no	15	0	0.00
N2a	Dry Blackbutt	Woolgoolga	517200	6670950	19	no	no	20	0	0.00
N2a	Dry Blackbutt	Moonee Beach	514450	6661400	21	no	no	11	0	0.00
N2A	Dry Blackbutt	Coffs Harbour	510100	6644650	75	no	no	17	0	0.00
N2B	Dry Blackbutt	Coffs Harbour	508100	6642300	76	yes	no	27	5	18.52
N2A	Dry Blackbutt	Woolgoolga	518200	6671600	80	no	no	31	0	0.00
N44a	Dry Blackbutt	Moonee Beach	515450	6660300	86	no	no	19	0	0.00
N2A	Dry Blackbutt	Moonee Beach	513000	6657500	88	no	no	28	0	0.00
N34A	Dry Blackbutt	Moonee Beach	512800	6654750	101	no	no	17	0	0.00
N2a	Dry Blackbutt	Moonee Beach	502500	6657100	144	no	no	20	0	0.00
N34a	Dry Blackbutt	Moleton	489500	6663500	150	no	no	22	0	0.00
N2a	Dry Blackbutt	Moleton	492150	6659150	152	no	no	20	0	0.00
N44/N20	Dry Blackbutt/Paperbark	Coffs Harbour	508900	6644450	11	yes	no	28	2	7.14
N67B	Dry Grey Ironbark/Grey Gum	Moonee Beach	517750	6665300	82	no	no	30	0	0.00
SF62	Dry Grey Ironbark/Grey Gum	Moonee Beach	513100	6654600	100	no	no	24	0	0.00
SF62	Dry Grey Ironbark/Grey Gum	Coffs Harbour	506300	6645400	115	yes	no	20	3	15.00
N38B	Dry Grey Ironbark/Grey Gum	Glenreagh	499900	6670100	116	no	no	24	0	0.00
Map Unit	**Community**	**Mapsheet**	**Easting**	**Northing**	**Datasheet**	**Scat**	**Koala**	**Tree**	**Trees**	**Activity**

								sample	scat	Level (%)
N11B	Dry Grey Ironbark/Grey Gum	Moleton	499200	6664400	118	no	no	25	0	0.00
N67C	Dry Grey Ironbark/Grey Gum	Moleton	499000	6663800	119	no	no	24	0	0.00
N88	Dry Grey Ironbark/Grey Gum	Moleton	497500	6662050	121	no	no	27	0	0.00
N67C	Dry Grey Ironbark/Grey Gum	Moleton	499350	6661950	125	no	no	20	0	0.00
SF62	Dry Grey Ironbark/Grey Gum	Moonee Beach	500700	6659100	140	no	no	21	0	0.00
SF62	Dry Grey Ironbark/Grey Gum	Moonee Beach	500650	6659950	142	no	no	25	0	0.00
SF62	Dry Grey Ironbark/Grey Gum	Moonee Beach	502250	6665850	147	no	no	24	0	0.00
N46a	Dry Grey Ironbark/Grey Gum	Moleton	489550	6664750	149	no	no	21	0	0.00
N27	Flooded Gum	Moonee Beach	512500	6653900	4	no	no	14	0	0.00
N52a	Flooded Gum	Coffs Harbour	507975	6644650	9	no	no	17	0	0.00
N27	Flooded Gum	Coffs Harbour	507000	6644400	10	no	no	11	0	0.00
N52A	Flooded Gum	Coffs Harbour	505700	6641300	108	no	no	24	0	0.00
N52A	Flooded Gum	Raleigh	503200	6638450	109	yes	no	17	6	35.29
N27	Flooded Gum	Coffs Harbour	504900	6648750	112	no	no	21	0	0.00
N27	Flooded Gum	Brooklana	496950	6652950	130	no	no	23	0	0.00
N27	Flooded Gum	Moonee Beach	500400	6656700	138	yes	no	18	1	5.56
N27	Flooded Gum	Moleton	498900	6662000	146	no	no	21	0	0.00
N27	Flooded Gum	Raleigh	505900	6633200	26	yes	no	17	3	17.65
N27R	Flooded Gum Regrowth	Moonee Beach	511100	6664000	135	no	no	23	0	0.00
N27/N34a	Flooded Gum/Dry Blackbutt	Coffs Harbour	507200	6650050	14	yes	no	14	1	7.14
N27/N7a	Flooded Gum/Tallowwood	Coffs Harbour	507325	6649925	13	no	no	12	0	0.00
N7	Moist Blackbutt	Coffs Harbour	509475	6651725	2/3	yes	no	36	1	2.78
N7	Moist Blackbutt	Coffs Harbour	507450	6644650	7	yes	no	23	1	4.35
N7	Moist Blackbutt	Woolgoolga	517700	6671000	79	no	no	32	0	0.00
N7	Moist Blackbutt	Moonee Beach	514850	6662500	84	no	no	23	0	0.00
N7	Moist Blackbutt	Coffs Harbour	506350	6644700	106	yes	no	22	1	4.55
N7	Moist Blackbutt	Coffs Harbour	505250	6648800	111	yes	no	18	1	5.56
N7	Moist Blackbutt	Moonee Beach	511750	6659350	133	yes	no	20	1	5.00
N7	Moist Blackbutt	Moonee Beach	510400	6662450	136	no	no	21	0	0.00
N7b	Moist Blackbutt	Moleton	493600	6658850	153	no	no	23	0	0.00
N11A	Moist GI/GG/T/WM	Moonee Beach	517850	6665850	81		no	26	0	0.00
SF60	Moist GI/GG/T/WM	Moonee Beach	517200	6666350	164	no	no	16	0	0.00
Map Unit	**Community**	**Mapsheet**	**Easting**	**Northing**	**Datasheet**	**Scat**	**Koala**	**Tree sample**	**Trees scat**	**Activity Level (%)**

N56A	Moist GI/GG/T/WM	Coffs Harbour	513500	6651000	98	yes	no	19	7	36.84
N56A	Moist GI/GG/T/WM	Coffs Harbour	513400	6652900	99	no	no	24	0	0.00
SF60	Moist GI/GG/T/WM	Glenreagh	498400	6669800	117	yes	no	25	1	4.00
N11A	Moist GI/GG/T/WM	Moleton	498300	6662850	120	no	no	23	0	0.00
N38A	Moist GI/GG/T/WM	Woolgoolga	502150	6669850	122	no	no	23	0	0.00
SF60	Moist GI/GG/T/WM	Brooklana	498300	6651100	129	no	no	25	0	0.00
SF60	Moist GI/GG/T/WM	Moonee Beach	500500	6658850	139	no	no	24	0	0.00
SF60	Moist GI/GG/T/WM	Moonee Beach	502500	6661800	148	no	no	24	0	0.00
SF60R	Moist GI/GG/T/WM	Moleton	499600	6659050	143	no	no	19	0	0.00
RV2	Orara/Bucca Riparian Vegetation	Moonee Beach	510350	6658400	163	no	no	21	0	0.00
RV2	Orara/Bucca Riparian Vegetation	Coffs Harbour	500900	6652450	166	no	no	17	0	0.00
N50	Paperbark	Raleigh	504300	6637900	6	no	no	26	0	0.00
N20	Paperbark	Coffs Harbour	509000	6644450	12	yes	no	19	9	47.37
N20a	Paperbark	Moonee Beach	514450	6661150	20	no	no	12	0	0.00
N20A	Paperbark	Coffs Harbour	510000	6645600	73	yes	no	30	11	36.67
N20	Paperbark	Coffs Harbour	508850	6642400	77	no	no	19	0	0.00
N20A	Paperbark	Moonee Beach	514000	6661250	85	no	no	31	0	0.00
N50	Paperbark	Coffs Harbour	508750	6645750	89	yes	no	26	6	23.08
N50	Paperbark	Coffs Harbour	509550	6645250	90	yes	no	22	6	27.27
N20	Paperbark	Moonee Beach	518400	6663750	104	no	no	23	0	0.00
N50	Paperbark	Woolgoolga	518500	6674500	165	no	no	17	0	0.00
N50	Paperbark	Coffs Harbour	507200	6639600	167	yes	no	20	3	15.00
N50	Paperbark	Raleigh	505450	6637700	168	no	no	18	0	0.00
N55C	Scribbly Gum	Coffs Harbour	508950	6641650	72	no	no	14	0	0.00
N55A	Scribbly Gum	Coffs Harbour	511550	6647250	74	yes	no	22	2	9.09
SG6402	Sedgeland/Rushland	Coffs Harbour	509600	6644350	93	no	no	5	0	0.00
N52	Swamp Mahogany	Coffs Harbour	509000	6643550	78	no	no	19	0	0.00
N52	Swamp Mahogany	Coffs Harbour	507400	6645350	160	yes	no	18	3	16.67
N52	Swamp Mahogany	Coffs Harbour	507850	6641750	162	yes	no	20	2	10.00
N26A	Swamp Oak	Moonee Beach	518900	6663800	83	no	no	31	0	0.00
N26A	Swamp Oak	Coffs Harbour	509900	6645400	94	yes	no	21	2	9.52
N26A	Swamp Oak	Coffs Harbour	512450	6648700	97	no	no	19	0	0.00
Map Unit	**Community**	**Mapsheet**	**Easting**	**Northing**	**Datasheet**	**Scat**	**Koala**	**Tree sample**	**Trees scat**	**Activity Level (%)**
N3A	Sydney Blue Gum	Coffs Harbour	506600	6652400	110	no	no	20	0	0.00

N3	Sydney Blue Gum	Coffs Harbour	502750	6644900	114	yes	no	23	5	21.74
N3a	Sydney Blue Gum	Brooklana	496450	6650000	131	no	no	21	0	0.00
N3	Sydney Blue Gum	Brooklana	496350	6649850	132	no	no	23	0	0.00
N3a	Sydney Blue Gum	Moonee Beach	511500	6659400	134	no	no	24	0	0.00
N3	Sydney Blue Gum	Moonee Beach	510000	6662500	137	no	no	20	0	0.00
N3	Sydney Blue Gum	Moleton	489650	6658700	151	yes	no	21	1	4.76
N3	Sydney Blue Gum	Moleton	488400	6656900	156	no	no	21	0	0.00
N3a	Sydney Blue Gum	Brooklana	485650	6649150	157	no	no	21	0	0.00
N3aR	Sydney Blue Gum Regrowth	Moonee Beach	503350	6660900	145	no	no	22	0	0.00
N7a	Tallowwood	Raleigh	503300	6638500	0	yes	no	15	2	13.33
N7a	Tallowwood	Coffs Harbour	507555	6644800	8	yes	no	17	3	17.65
N7A	Tallowwood	Coffs Harbour	507250	6641750	69	yes	no	17	3	17.65
N7A	Tallowwood	Moonee Beach	512750	6656750	103	no	no	21	0	0.00
N7A	Tallowwood	Coffs Harbour	505500	6647300	105	yes	no	18	7	38.89
N7A	Tallowwood	Coffs Harbour	500800	6639650	107	yes	no	19	3	15.79
N7A	Tallowwood	Moonee Beach	506450	6665150	123	no	no	21	0	0.00
N7A	Tallowwood	Moonee Beach	505850	6666150	124	no	no	35	0	0.00
N7a	Tallowwood	Coffs Harbour	502450	6651200	126	no	no	21	0	0.00
N7a	Tallowwood	Brooklana	498950	6648300	128	no	no	27	0	0.00
N7a	Tallowwood	Moleton	490900	6656200	155	no	no	21	0	0.00
SF49	Turpentine	Coffs Harbour	504900	6649200	113	yes	no	20	1	5.00
SF49	Turpentine	Brooklana	498750	6648250	127	no	no	25	0	0.00
SG5502	Wet Heath/Shrubland	Coffs Harbour	508300	6643700	91	no	no	3	0	0.00

Appendix B4. Utilisation rates.

Utilisation rates for species on a/ quaternary deposits, and b/ other geological types.

Sites are active plots only. Species codes are: 1. Eucalyptus microcorys, 2. E. resinifera, 3. E. grandis, 4. E. tereticornis, 5. E. robusta, 6. E. signata, 7. E. pilularis, 8. E. globoidea, 9. E. propinqua, 10. E. siderophloia, 11. Corymbia intermedia, 12. Allocasuarina torulosa, 13. Lophostemon confertus, 14. Melaleuca quinquenervia, 15. M. sieberi, 16. Angophora costata, 17. Callistemon sallignus, 18. Casuarina glauca, 19. Syncarpia glomulifera, 20. Lophostemon suaveolens, 21. Allocasuarina littoralis, 22. E. acmenoides, 23. Cryptocarys microneura, 24. Cinnamorum camphor, 25. E. saligna, 26. Dendrocnide excelsa, 27. Glochichion ferdenandi, 28. Banksia integrifolia, 29. E. biturbinata, 30. E. carnea, 31. unknown non-eucalypt, 32. Elaeocarpus reticulatus, 33. Trochocarpa laurina, 34. Archirhodomyrtus bekkleri, 35. Melaleuca armnilaris, 36. Sloanea australis, 37. Tristaniopsis laurina, 38. Caldeluvia paniculosa, 39. Ficus coronata, 40. E. umbra, 41. Corymbia maculata, 42. E. rummeryi, 43. Endriandra mulleri, 44. Endriandra sieberi, 45. Ficus sp., 46. E. tindaliae, 47. E. campanulata, 48. Argyrodendron actinophyllum, 49. Acacia melanoxylon, 50. E. saligna * E. grandis, 51. Melaleuca stypheloides, 52. E. planchienia, 53. Casuarina cunninghamia, 54. Ligustrum

a/ Quaternary deposits

Site\Speci	1	2	3	5	7	8	10	11	12	13	14	16	17	18	19	20	21	22	24	25	31	35	36	37	38	51
73	4 (3)	1 (0)						1 (1)			2 (1)		6 (1)	6 (2)		9 (3)	1 (0)									
90	4 (4)					1 (1)					3 (1)		5 (0)	9 (0)												
98	4 (3)						14 (3)	1 (1)																		
11				6 (0)	1 (0)				1 (0)		14 (1)										6 (1)					
16					2 (0)			9 (0)	6 (0)		5 (1)															
89		1 (0)		13 (6)									6 (0)			1 (0)						5 (0)				
95			1 (1)							3 (0)								3 (3)	7 (3)				1 (0)	2 (1)		
102	1 (1)							2 (0)		5 (0)					1 (1)						1 (0)				5 (0)	
94	1 (0)										1 (1)			19 (1)												
167		1 (0)		6 (1)							5 (0)		2 (0)	4 (1)	1 (1)											1 (0)
12									4 (1)		4 (2)										3 (1)					
15	3 (1)				2 (0)			1 (0)	6 (0)		1 (0)	2 (0)			4 (0)			1 (0)								
109	1 (1)	1 (1)		8 (3)	1 (1)			2 (0)					1 (0)		1 (0)					2 (0)						
160	5 (1)			9 (2)							4 (0)															
162		1 (1)		15 (1)							3 (0)		1 (0)													
n	23	5	1	57	6	1	14	16	17	8	42	2	21	38	7	10	1	4	7	2	10	5	1	2	5	1
p	0.61	0.4	1	0.228	0.167	1	0.214	0.125	0.059	0	0.167	0	0.048	0.105	0.286	0.3	0	0.75	0.429	0	0.2	0	0	0.5	0	0
np	14	2	1	13	1	1	3	2	1	0	7	0	1	4	2	3	0	3	3	0	2	0	0	1	0	0
n(1-p)	9	3	0	44	5	0	11	14	16	8	35	2	20	34	5	7	1	1	4	2	8	5	1	1	5	1

b/ Other geological types

Site\Speci	1	2	3	6	7	8	9	10	11	12	13	14	16	19	22	24	25	26	27	29	31	40
74				12 (1)	4 (1)								5 (0)	1 (0)								
92	1 (1)															9 (6)	7 (1)	1 (0)				
96			9 (2)								2 (0)					4 (0)			1 (0)			
0	5 (1)						3 (0)			1 (1)				5 (0)							1 (0)	
2	8 (0)				12 (1)					3 (0)			6 (0)									
3	1 (0)				2 (0)								4 (0)									
7	1 (1)	11 (0)							5 (0)					6 (0)								
8	7 (3)								4 (0)	2 (0)	2 (0)										2 (0)	
14	4 (1)				2 (0)		3 (0)			2 (0)			3 (0)									
105	14 (7)									1 (0)				3 (0)								
106					16 (0)					1 (0)			1 (1)	2 (0)			2 (0)					
107	11 (3)		1 (0)						4 (0)	1 (0)							2 (0)					
111	2 (1)				8 (0)					4 (0)				2 (0)			2 (0)					
113	7 (1)									1 (0)				12 (0)								
114	8 (4)		1 (0)		1 (1)					2 (0)				7 (0)			4 (0)					
115	1 (1)							4 (1)		2 (0)										9 (1)		4 (0)
117	4 (0)		5 (1)				2 (0)	3 (0)	1 (0)	3 (0)	2 (0)		1 (0)		3 (0)							1 (0)
69	6 (1)	4 (0)							4 (2)	2 (0)	1 (0)											
133	7 (1)				9 (0)					2 (0)				2 (0)								
138	1 (1)		5 (0)						1 (0)	1 (0)	1 (0)			2 (0)		5 (0)	2 (0)					
151	10 (1)		1 (0)							1 (0)	1 (0)						8 (0)					
76	6 (1)				6 (3)	4 (0)			5 (1)	5 (0)		1 (0)										
26			11 (2)				4 (1)	1 (0)			1 (0)											
n	104	15	33	12	60	4	12	8	24	34	10	1	20	42	3	18	27	1	1	9	3	5
p	0.279	0	0.152	0.083	0.1	0	0.083	0.125	0.125	0.029	0	0	0.05	0	0	0.333	0.037	0	0	0.111	0	0

Appendix B5. Vegetation communities comprising potential koala habitat in Coffs Harbour.

a. Vegetation communities comprising potential koala habitat in Coffs Harbour LGA, based on SEPP 44 Schedule 2 species

Map Unit	Vegetation Community	Dominant Trees
N7	Moist Blackbutt	E. pilularis, E. microcorys
N7A	Tallowwood	E. microcorys
N3	Tallowwood/Sydney Blue Gum	E. microcorys, E. saligna
N52A	Flooded Gum	E. grandis, E. robusta
SF62	Dry Grey Ironbark/Grey Gum	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N11A	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany	E. propinqua, E. microcorys
N52	Swamp Mahogany	E. robusta
SF60	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N55A	Scribbly Gum	E. signata
N55C	Scribbly Gum	E. signata
N1A	Coastal Forest Red Gum	E. tereticornis
N27R/N7R	Flooded Gum Regrowth/Moist Blackbutt Regrowth	E. grandis, E. pilularis, E. microcorys
N67C	Dry Grey Ironbark/Grey Gum	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides, Corymbia maculata
N3R	Tallowwood/Sydney Blue Gum Regrowth	E. microcorys, E. saligna
N11B/ST	Dry Grey Ironbark/Grey Gum/Scattered Trees	E. microcorys, E. propinqua
N11B	Dry Grey Ironbark/Grey Gum	E. microcorys, E. propinqua
N56B	Dry Grey Ironbark/Grey Gum	E. siderophloia, E. microcorys
N7/ST	Moist Blackbutt/Scattered Trees	E. pilularis, E. microcorys
N1C	Coastal Forest Red Gum	E. tereticornis
N1B	Coastal Forest Red Gum	E. tereticornis
N38B	Dry Grey Ironbark/Grey Gum	E. microcorys, E. acmenoides
SF62/ST	Dry Grey Ironbark/Grey Gum/ Scattered Trees	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N7A/ST	Tallowwood/Scattered Trees	E. microcorys
SF62R	Dry Grey Ironbark/Grey Gum Regrowth	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides

N11AR	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany Regrowth	E. propinqua, E. microcorys
N7R	Moist Blackbutt Regrowth	E. pilularis, E. microcorys
SF60R	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany Regrowth	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N7AR	Tallowwood Regrowth	E. microcorys
N55B	Scribbly Gum	E. signata
N7B	Moist Blackbutt	E. pilularis, E. microcorys
N7BR	Moist Blackbutt Regrowth	E. pilularis, E. microcorys

b. Vegetation communities comprising potential koala habitat in Coffs Harbour LGA, based on the Shire list of koala feed tree species

Map Unit	Vegetation Community	Dominant Trees
N7	Moist Blackbutt	E. pilularis, E. microcorys
N7A	Tallowwood	E. microcorys
N27	Flooded Gum	E. grandis
N50	Paperbark	Melaleuca quinquenervia
N3A	Sydney Blue Gum	E. saligna
N3	Tallowwood/Sydney Blue Gum	E. microcorys, E. saligna
N44A	Dry Blackbutt	E. pilularis
N20	Paperbark	Melaleuca quinquenervia
RV1	Coastal Riparian Vegetation	Cinnamomum camphora, Lophostemon confertus, E. grandis
N2A	Dry Blackbutt	E. pilularis
N52A	Flooded Gum	E. grandis, E. robusta
SF62	Dry Grey Ironbark/Grey Gum	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N20A	Paperbark	Melaleuca quinquenervia
N3AR	Sydney Blue Gum Regrowth	E. saligna
N11A	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany	E. propinqua, E. microcorys
N26A	Swamp Oak	Casuarina glauca
N52	Swamp Mahogany	E. robusta
SF60	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N56A	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany	E. siderophloia
N2B	Dry Blackbutt	E. pilularis, E. globoidea
N34A	Dry Blackbutt	E. pilularis
N67A	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany	E. siderophloia, E. propinqua
N67B	Dry Grey Ironbark/Grey Gum	E. siderophloia, E. propinqua
N55A	Scribbly Gum	E. signata
N55C	Scribbly Gum	E. signata
N12A	Dry Grey Ironbark/Grey Gum	E. siderophloia, E. carnea
N1A	Coastal Forest Red Gum	E. tereticornis
N27R/N7R	Flooded Gum Regrowth/Moist Blackbutt Regrowth	E. grandis, E. pilularis, E. microcorys
N67C	Dry Grey Ironbark/Grey Gum	E. siderophloia, E.

		propinqua, E. microcorys, E. acmenoides, Corymbia maculata
N38A	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany	E. acmenoides
N3R	Tallowwood/Sydney Blue Gum Regrowth	E. microcorys, E. saligna
RF53	Brushbox	Lophostemon confertus
N27R	Flooded Gum Regrowth	E. grandis
RV2	Orara/Bucca Riparian Vegetation	Cinnamomum camphora, Casuarina cunninghamiana, E. grandis
N11B/ST	Dry Grey Ironbark/Grey Gum/Scattered Trees	E. microcorys, E. propinqua
N11B	Dry Grey Ironbark/Grey Gum	E. microcorys, E. propinqua
N56B	Dry Grey Ironbark/Grey Gum	E. siderophloia, E. microcorys
N7/ST	Moist Blackbutt/Scattered Trees	E. pilularis, E. microcorys
N1C	Coastal Forest Red Gum	E. tereticornis
N56A/N20	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany/Paperbark	E. siderophloia, Melaleuca quinquenervia
ST/N44A	Scattered Trees/Dry Blackbutt	E. pilularis
ST/N44A/N50	Scattered Trees/Dry Blackbutt/Paperbark	E. pilularis, Melaleuca quinquenervia
N1B	Coastal Forest Red Gum	E. tereticornis
N38B	Dry Grey Ironbark/Grey Gum	E. microcorys, E. acmenoides
N2AR	Dry Blackbutt Regrowth	E. pilularis
SF62/ST	Dry Grey Ironbark/Grey Gum/ Scattered Trees	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N7A/ST	Tallowwood/Scattered Trees	E. microcorys
SF62R	Dry Grey Ironbark/Grey Gum Regrowth	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N11AR	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany Regrowth	E. propinqua, E. microcorys
N46A	Dry Grey Ironbark/Grey Gum	E. resinifera, E. tindaliae
N7R	Moist Blackbutt Regrowth	E. pilularis, E. microcorys
SF60R	Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany Regrowth	E. siderophloia, E. propinqua, E. microcorys, E. acmenoides
N88	Dry Grey Ironbark/Grey Gum	E. rummeryi, Corymbia

		maculatus
N2A/ST	Dry Blackbutt/Scattered Trees	E. pilularis
N20/ST	Paperbark/Scattered Trees	Melaleuca quinquenervia
N7AR	Tallowwood Regrowth	E. microcorys
N55B	Scribbly Gum	E. signata
N7B	Moist Blackbutt	E. pilularis, E. microcorys
N7BR	Moist Blackbutt Regrowth	E. pilularis, E. microcorys
N27/EP	Flooded Gum/Eucalypt Plantation	E. grandis
N20B	Paperbark	Melaleuca quinquenervia
RF53/N27	Brushbox/Flooded Gum	Lophostemon confertus, E. grandis

Appendix B6. Ranking system employed for mapping koala habitat

The following ranking system was employed*:

Community rank	*Field rank*	*Combined rank*
1	1	1
1	2	1
1	3	1
1	0	1
2	1	1
2	2	2
2	3	3
2	0	3
3	1	1
3	2	3
3	3	4
3	0	4
0	1	1
0	2	4
0	3	4
0	0	0

*Notes

1. Exceptions are as follows:

- the vegetation units that are not recognised as koala habitat (eg. heath, mangroves, rainforest), that require other management attention (eg. scattered trees, pine plantations) or are not under Council's jurisdiction (eg. Nature Reserves) were given a combined rank of 0 despite other rankings from community and field surveys to eliminate errors from mapping. These included NR, SG6402, SG2502, PP, SG6402/6502, SG5502, ST, SG3513, SG5804/6403, unlabelled, N75A, RF33R, R, SG6502, RF33, RF35R, RF35, SG6302, SG6302/3513, SG5502/6004, Coramba NR, ST/Livistonia, SG6003.
- Eucalypt Plantation (map unit EP) was given a combined rank of 4 because of its potential to be used by koalas and it was ranked 1 in the community survey.

2. The decision to recognise only one combination of community and field survey in the "Combined rank 2" was a practical one in that it reflects the fact that a vegetation community it contained was much larger than the others so it was not merged with other communities.

Appendix B7. Vegetation units included in Habitat types

The vegetation map units from Fisher *et al*. (1996) used to map koala Habitat types.

Preferred Habitat Type A

Includes the following vegetation units where they occur in the southern domain on quaternary sand and alluvium:

Brushbox (RF53)
Brushbox/Flooded Gum (RF53/N27)
Coastal Forest Red Gum (N1a)
Coastal Riparian Vegetation (RV1)
Dry Blackbutt (N2a, N44a, N2b)
Dry Blackbutt/Paperbark Scattered Trees (ST/N44a/N50)
Dry Grey Ironbark/Grey Gum (SF62/ST, N38b)
Flooded Gum (N27, N27R, N52a)
Moist Blackbutt (N7, N7R)
Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany (SF60, N38a, N11a, N11aR, N56a)
Paperbark (N20, N20/ST, N20a, N50)
Swamp Mahogany (N52)
Swamp Oak (N26a)
Sydney Blue Gum (N3a, N3R)
Tallowwood (N7a)

Preferred Habitat Type B

Includes the following vegetation units where they occur in the southern domain on other geological types:

Coastal Forest Red Gum (N1a)
Coastal Riparian Vegetation (RV1)
Tallowwood (N7a)

Supplementary Habitat Type A

Includes the following vegetation units where they occur in the northern domain on quaternary sand and alluvium:

Brushbox (RF53)
Brushbox/Flooded Gum (RF53/N27)
Coastal Forest Red Gum (N1a)
Coastal Riparian Vegetation (RV1)
Dry Blackbutt (N2a, N44a, N2b)
Dry Blackbutt/Paperbark Scattered Trees (ST/N44a/N50)
Dry Grey Ironbark/Grey Gum (SF62/ST, N38b)
Flooded Gum (N27, N27R, N52a)
Moist Blackbutt (N7, N7R)
Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany (SF60, N38a, N11a, N11aR, N56a)
Paperbark (N20, N20/ST, N20a, N50)
Swamp Mahogany (N52)
Swamp Oak (N26a)
Sydney Blue Gum (N3a, N3R)
Tallowwood (N7a)

Plus the following vegetation units where they occur on quaternary sand and alluvium:

Dry Grey Ironbark/Grey Gum (SF62)
Eucalypt Plantation (EP)
Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany (N67a)
Orara/Bucca Riparian Vegetation (RV2)
Sydney Blue Gum (N3)

Supplementary Habitat Type B1

Includes the following vegetation units where they occur in the northern domain on other geological types:

Coastal Forest Red Gum (N1a)
Coastal Riparian Vegetation (RV1)
Tallowwood (N7a)

Plus the following vegetation units where they occur on other geological types:

Dry Blackbutt (N44a, N34a)
Dry Grey Ironbark/Grey Gum (N67b)
Moist Blackbutt (N7)
Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany (N67a)

Supplementary Habitat Type B2

Includes the following vegetation units where they occur on other geological types:

Brushbox (RF53)
Dry Blackbutt (N2a, N2b)
Dry Grey Ironbark/Grey Gum (N67c, SF62, N38b, N46a, N88)
Dunn's White Gum (N73)
Eucalypt Plantation (EP)
Flooded Gum (N27, N27R)
Flooded Gum/Moist Blackbutt (N27R/N7R)
Moist Blackbutt (N7b)
Moist Grey Ironbark/Grey Gum/Tallowwood/White Mahogany (N38a, N11a, SF60, SF60R, N56a)
Needlebark Stringy Bark (N42a)
Orara/Bucca Riparian Vegetation (RV2)
Scribbly Gum (N55a)
Sydney Blue Gum (N3, N3R, N3a, N3aR)
Turpentine (SF49)