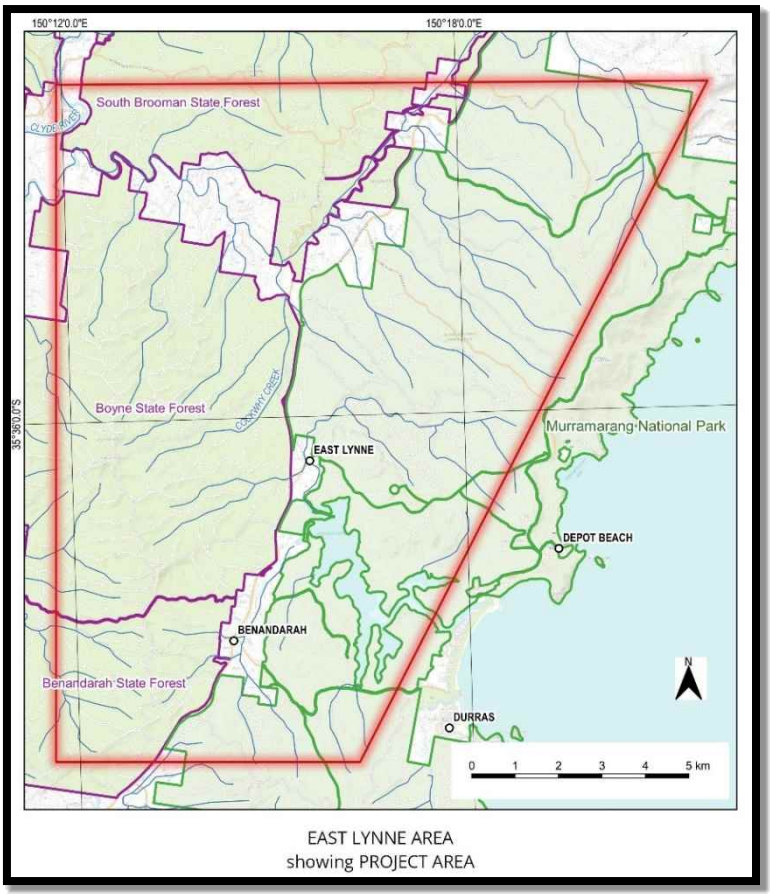
VOLUNTEER EUROBODALLA KOALA PROJECT

CARRYING CAPACITY STUDY OF THE EAST LYNNE AREA

2021



EAST LYNNE AREA
showing PROJECT AREA

Contents

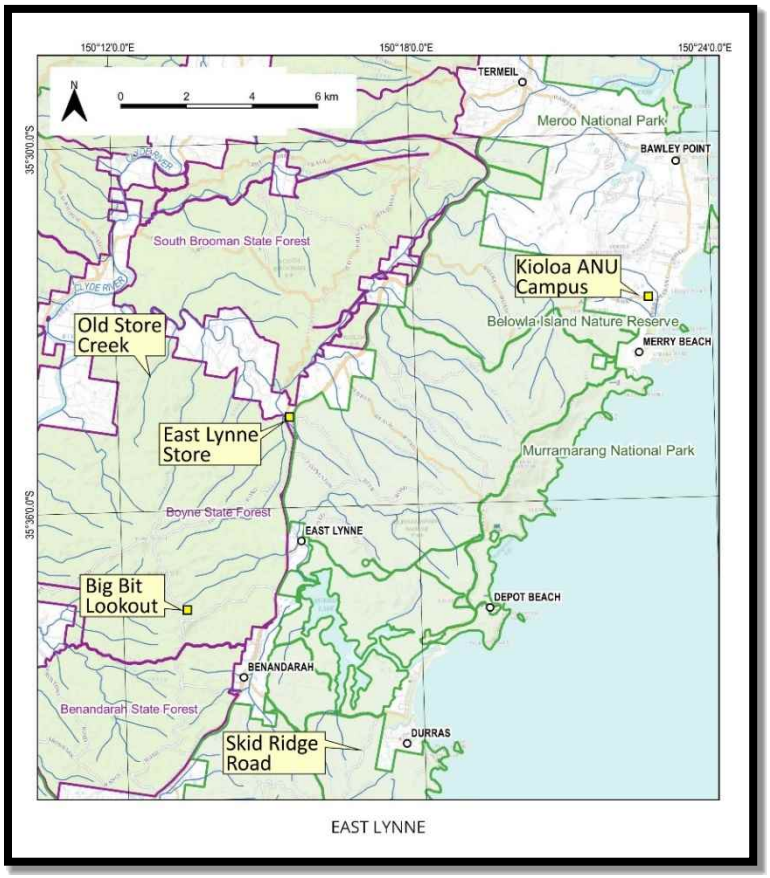
Background

In December 2019, at the height of the Currowan wildfire, a koala was seen entering Murramarang National Park ahead of the fire on the eastern edge of the Princes Highway, just south of East Lynne Store.

In May 2020, a store employee reported hearing koala roars nearby. Also in May, koala roars were heard for several nights at Old Store Creek, suggesting surviving koalas might have used unburnt or lightly burnt patches to see out the pre-epicormic famine period. At this same property, a koala had walked across the back yard on Christmas Day 2000.

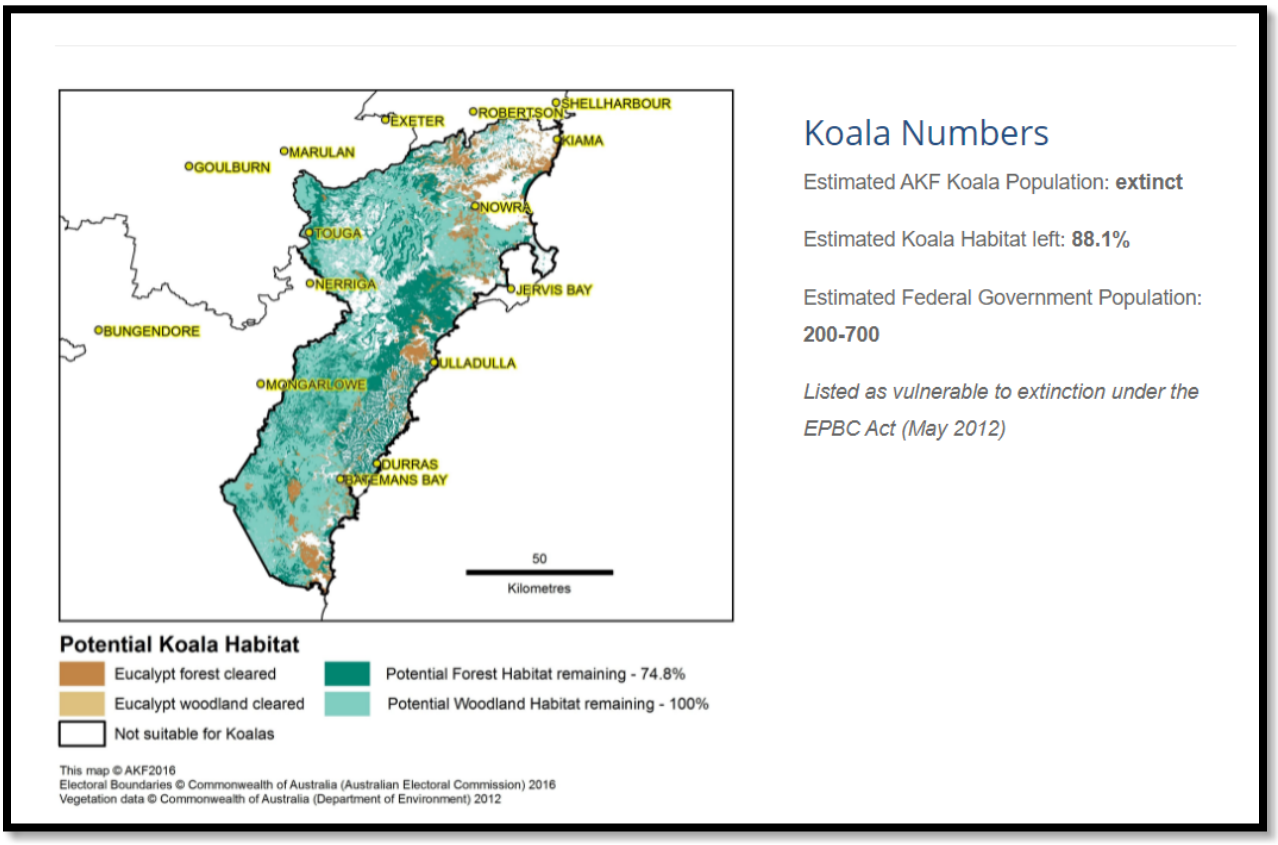
Other modern sightings around the area included Benandarah, Skid Ridge Road and Big Bit Lookout between 2001 and 2005. The OEH Wildlife Atlas mapped three records in the area between 2002 and 2009.

Koalas were known to be at the Kioloa ANU campus during the 1970s, and motorists were known to see koalas crossing the highway somewhere near Termeil, at night.



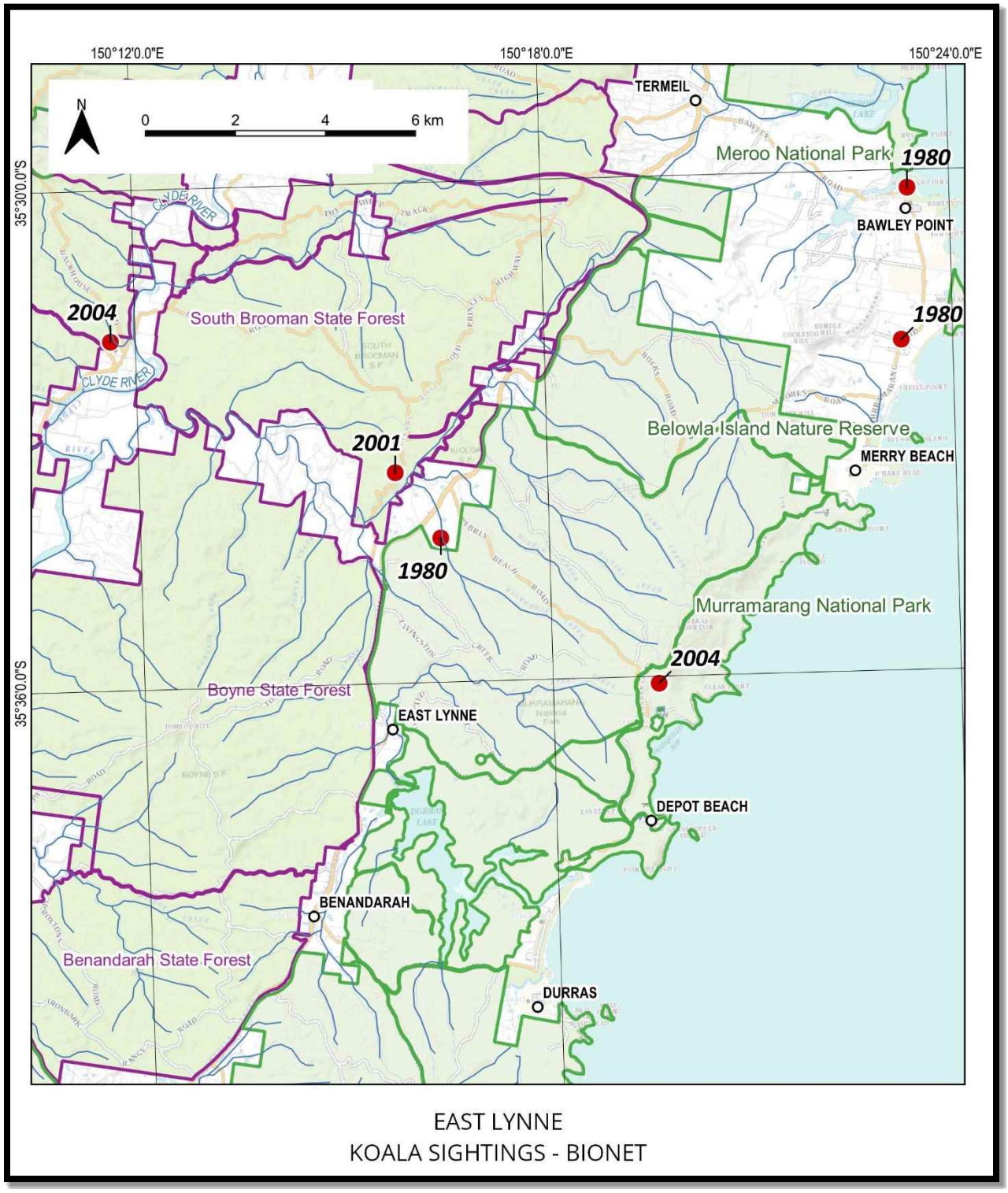
CRA koala habitat mapping (used for the Regional Forest Agreements in the late 20th Century) rates the area as Marginal, however the scientific basis for these decisions is criticized in the Eurobodalla Koala Project Pilot Study.

The Australian Koala Foundation issued a press release on 20th September 2021, reporting its findings about national koala decline in the previous few years, listing the species as extinct in the Gilmore Electorate.



Australian Koala Foundation map (Gilmore Electorate) September 2021

The history of modern sightings (albeit quite rare), the forested connectivity from East Lynne to other places in the Eurobodalla, Shoalhaven and Queanbeyan/Palerang Shires, new knowledge about koala tree use, improved mapping, and interest in habitat and possible revival shown by local landholders, has prompted this study of the koala carrying capacity of the East Lynne area.



EAST LYNNE
KOALA SIGHTINGS - BIONET

Method

Readers are invited to criticize and contribute to this study.

[NOTE: Assertions are made about the importance of soil nutrients and topography to koala habitat potential. These are based on research from as long ago as the 1980's. Current research at the Australian National University is addressing the possibility that local soil nutrients are not necessarily correlated with koala tree species use. Similarly, ANU researchers are finding koalas using very steep country at Peak View, for example, where the animals might be found at the bottom of a cliff-like incline one day and at the top another day. Altitude is also included in habitat assumptions, based on historical koala records up to 1,000 metres. ANU researchers are now working with koalas in Kosciusko National Park, at 1,200+ metres.]

The main technique is perusing GIS mapping, to display the distribution of forest types, judge other relevant habitat factors therein (eg slope, soils, watercourses) and permit measurement of potential home range areas and connectivity spaces.

This is supplemented by analysis of Forestry Corporation NSW Harvest Plans, data obtained from habitat plot surveys conducted between 2012 and 2021, information about Murramarang National Park and advice from local landholders on their properties' eucalypt species.

A conclusion about carrying capacity is drawn by reference to research on koala occupancy rates in south east NSW, with attention paid to possible independent variables such as urban development, agri-industry and climate change.

This report keeps referencing and some detail to a minimum, but they can be provided on request.

Probably the best previous local study specifically addressing koalas, is Hammond, Graham, ANU Thesis, 1997, "Explaining the Gap in the Sightings of the Koala *Phascolarctos cinereus* on the mid-south coast of NSW – Identification of High Quality Potential Habitat for the Koala Through Spatial Analysis". Hammond concluded the main reason for the low number of sightings was the historical clearing of the small minority of fertile spaces, which are scattered amongst the wider forested landscape that has less fertile soils.

A Summary of Pre-Study Expected Tree Species in the Area

Most common

- Spotted Gum (Corymbia maculata)
- Messmate (Eucalyptus obliqua)
- Red Bloodwood (E gummifera, or Corymbia gummifera)

Reasonably common

- White Stringybark (E globoidea)
- Yellow Stringybark (E muelleriana)
- Sydney Blue Gum x Bangalay [Southern Mahogany] (E saligna x botryoides)
- Sydney Peppermint (E piperita)

Also found

- Rough-barked Apple (Angophora floribunda)
- Coast Grey Box (E bosistoana)
- Mountain Grey Gum [Monkey Gum] (E cypellocarpa)
- Blackbutt (E pilularis)
- Grey Ironbark (E paniculata)

Near creek beds

- River Peppermint (E elata)

On ridges

- Red Ironbark (E tricarpa)

Extracts from the NSW Koala Tree Use Study 2018

"An evidence-based review of koala tree use across New South Wales

This review was commissioned under the Science Division's Koala Habitat Suitability Map project and was reviewed by its Peer Review Panel (PRP)

South Coast KMA – 22 tree species used, including 16 eucalypts (21% of 77 with >9 BioNet VIS records) and six non-eucalypts. High use species from Symphyomyrtus (5) and Eucalyptus (2) sub-genera.

"BioNet VIS" - OEH's BioNet Vegetation Information System database, the standard repository for plot-based vegetation species data (September 2017)

This statewide habitat suitability map - It will complement koala habitat information at local scales (e.g. for local government areas) as well as information at the state and regional scale about likely koala occurrence or occupancy (see Predavec et al. 2015)

Actual koala occurrence is mediated within potentially suitable habitat by many factors including habitat quality and the presence and severity of threats such as predators, disease, and roads (e.g. Dique et al. 2003, McAlpine et al. 2006, DECC 2008, AMBS 2012); these threats generally require consideration, mapping and accounting for at more localised scales.

Table 3 (Pp16ff) graphically shows the evidence-based tree species used by koalas in the South Coast KMA

It is noted that use levels of many tree species also varied within KMAs, typically in response to different soil landscapes (e.g. Phillips and Hopkins 2008, Phillips et al. 2011, Phillips 2013) and likely nutrient availability – eg E. pilularis (high use in KMA 2; significant use in KMA 1; no evidence in KMA 3, the South Coast)

Particularly in locations of lower site quality - In these locations, the concept of preferred tree species may be less well-defined. It may be the case that, above a minimum habitat quality threshold, koalas in these locations persist by occupying relatively large home ranges supporting a diverse range of tree species and topography and the opportunity to access a variety of leaf nutrient and moisture levels while off-setting leaf toxin loads to meet nutritional needs along with shelter and social needs (e.g. Stalenberg et al. 2014, Chris Allen (OEH Merimbula) and K Madden (OEH Wollongong) pers. comm.).

4.4 South Coast (KMA 3)

Koalas in the South Coast KMA (Figure 9) are distributed in patchy and sparse populations from the Shoalhaven Gorge region in the north to the Murrah flora reserves, between Bermagui and Tathra, and the Eden area in the south. Surveys and tree use studies have been ongoing in this KMA for some time (see references in Table 1) and have confirmed the persistence of small but important koala populations in reserves, state forests and private lands, and provide important information for habitat management across these tenures. Summarised results of collated koala tree use evidence for the South Coast KMA (Figure 9) are tabulated in Appendix 1 (Tables 13–15) to indicate tree species use patterns and relative use levels (Table 13), tree use levels within eucalyptus sub-genera relative to total records held within the NSW BioNet VIS (Table 14) and an evidence-based ranking of tree species for the South Coast KMA (Table 15). Brief annotation is included within Table 13 to help summarise the sourced evidence. Figure 9 South Coast Koala Management Area (after Phillips 2000; DECC 2008) Evidence of koala use was found for 22 tree species in the South Coast KMA (Tables 13 and 14); these included 16 Eucalyptus species (comprising 21% of 76 species with >9 records within the BioNet VIS database and six non-eucalyptus 'species', the latter including two groupings of 'Acacia species' and 'Banksia species' (also see Table 2 and Figure 6 for summary figures and graph)). These figures are low in comparison with the other two coastal KMAs (KMAs 1 and 2), possibly in reflection of the overall low-density and patchy koala populations remaining on the South Coast.

<u>39 Key summary points and patterns from the tree species evidence collation and review for KMA 3 are:</u>

• The collated tree use evidence shows that koalas use a relatively lower diversity of tree species overall, and of eucalypt species particularly (16 documented) in KMA 3 than any other.
• Four species, woollybutt (E. longifolia), mountain grey gum (E. cypellocarpa), red ironbark (E, tricarpa) and white stringybark (E, globoidea) were identified as regional high use species, based upon the sourced tree use evidence, in as much as they were high use species in more than two reported studies from KMA 3. An additional seven species, six eucalypts and rough-barked apple (Angophora floribunda), were high use species in one or two studies (Table 13).
• Species from two eucalypt sub-genera were used, in overall low but similar proportions – Symphyomyrtus (9 species used of 39 with >9 BioNet VIS records in the KMA) and Eucalyptus (monocalypts) (8 species used of 37 with >9 BioNet VIS records) (Figure 6, Tables 2 and 14a).
• Of seven eucalypt species identified as regional high or high use species in the KMA, five were from sub-genus Symphyomyrtus and two from sub-genus Eucalyptus (Tables 13 and 14a).
• High use symphyomyrtle eucalypts were from three sections: Similares (woollybutt), Maidenaria (the white, manna and ribbon gums and apple boxes) and Adnataria (the boxes and ironbarks) (Table 13).
• High use monocalypts (sub-genus Eucalyptus) were both stringybarks (Section Capillulus) (Table 13).

• Evidence of widespread use across KMA 3, at varying use levels, was sourced for many species including E. longifolia, E. cypellocarpa, coastal grey box (E. bosistoana), E. globoidea, silvertop ash (E. sieberi) and rough-barked apple (Angophora floribunda).
• Evidence was lacking, or at least was not sourced, for koala use of many eucalypt species known to occur within KMA 3, some reasonably extensively (Table 14a). These included symphyomyrtle eucalypts considered to be koala feed trees in the South Coast KMA by Phillips (2000) and DECC (2008) – (e.g. cabbage gum (E. amplifolia), swamp gum (E. ovata), brittle gum (E. mannifera) and apple box (E. bridgesiana)). There was also a lack of collated evidence for koala use of several stringybark species including brown stringybark (E. baxteri), another brown stringybark (E. capitallata) and southern white stringybark (E. yangoura) (Table 15a). Reasons for this evident non-use are discussed below (Section 5.1).
• Evidence of use of non-eucalypts was restricted to four species (including 'Acacia sp.'), with rough-barked apple (Angophora floribunda) used at significant to moderate levels in several studies across the KMA.
• Evidence was lacking, or at least was not sourced, for koala use of many non-eucalypt tree species within genera that include koala use species. BioNet VIS records (Table 14b) indicate some of these to be reasonably widespread and abundant within KMA 3 (e.g. species of Angophora, Corymbia, Callitris).

4.4.1 South Coast KMA summary

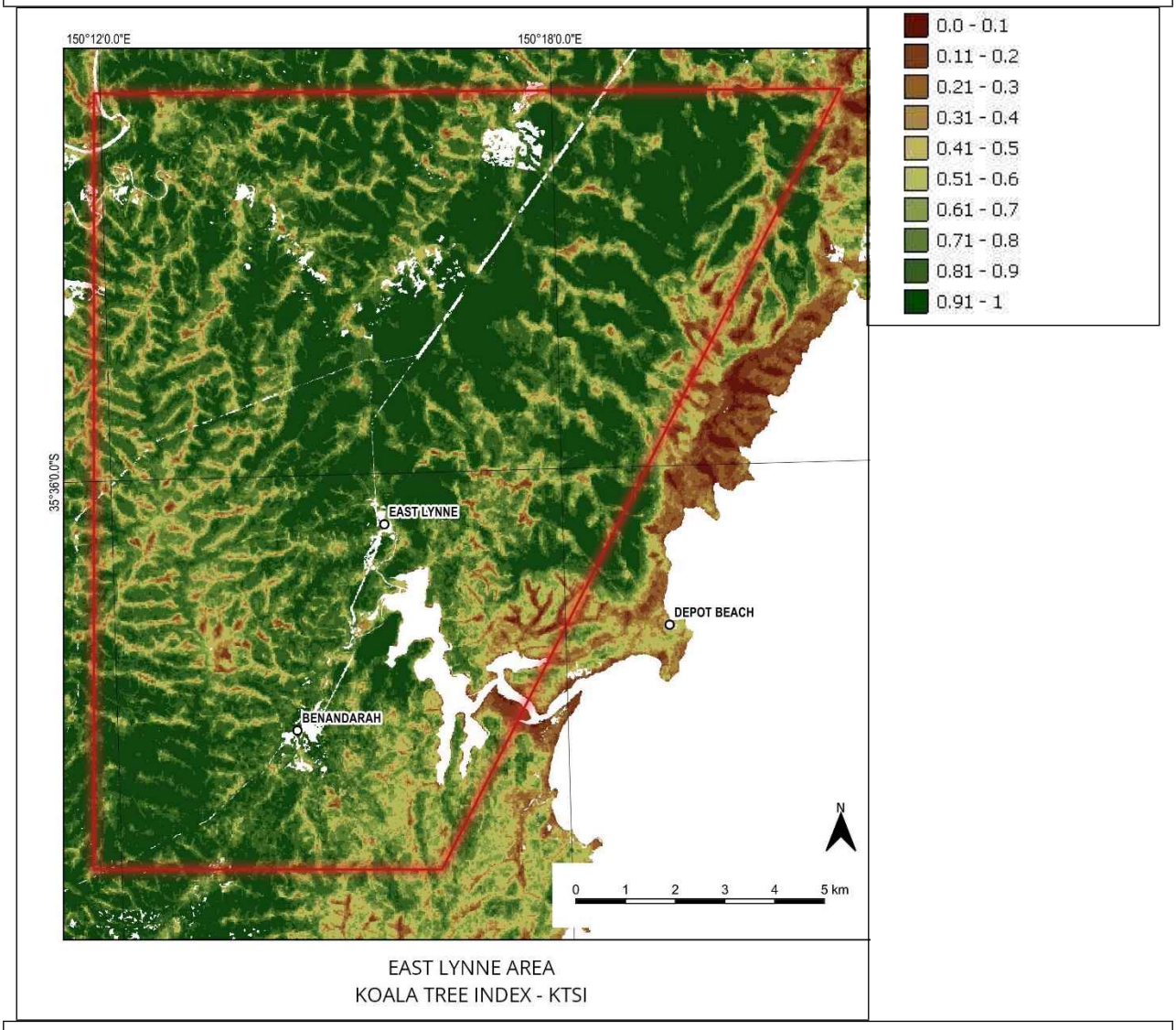
The low numbers of tree species with evidence of koala use in this KMA reflects the overall low koala numbers and the relatively localised and sparse character of the known koala populations in this region. Remnant koala populations of the South Coast KMA appear to make use of a relatively low number of tree species within low-density populations (e.g. Allen 2010; Allen et al. 2010, 2014; Gow-Carey 2012; Jurskis et al. 1994; Jurskis & Potter 1997; Lunney et al. 1997)

40 occupying habitats that have been impacted by human disturbance to varying degrees.

Based on these studies, three species from the eucalypt sub-genus Symphyomyrtus were designated regional high use species (woollybutt E. longifolia, mountain grey gum E. cypellocarpa, red ironbark E. tricarpa) along with one from the sub-genus Eucalyptus (white stringybark E. globoidea). These species appear to be regionally important as potential indicators of koala habitat quality and their presence may elevate the use of associate species in their neighbourhood. However, recent work by Stalenberg et al. 2014 suggests that in some parts of this KMA, particularly locations of low site quality, the concepts of preferred koala tree species, and eucalypt sub-genera, may be less well-defined. In such locations, and similarly to suggestions for koala tree use in parts of KMA 2, tree diversity and quality appear to become increasingly important and koalas may be trading and balancing between leaf nutrients and leaf toxins and spreading tree use across a diverse range of available species (e.g. Stalenberg et al. 2014, Chris Allen (OEH Merimbula) pers. comm.).

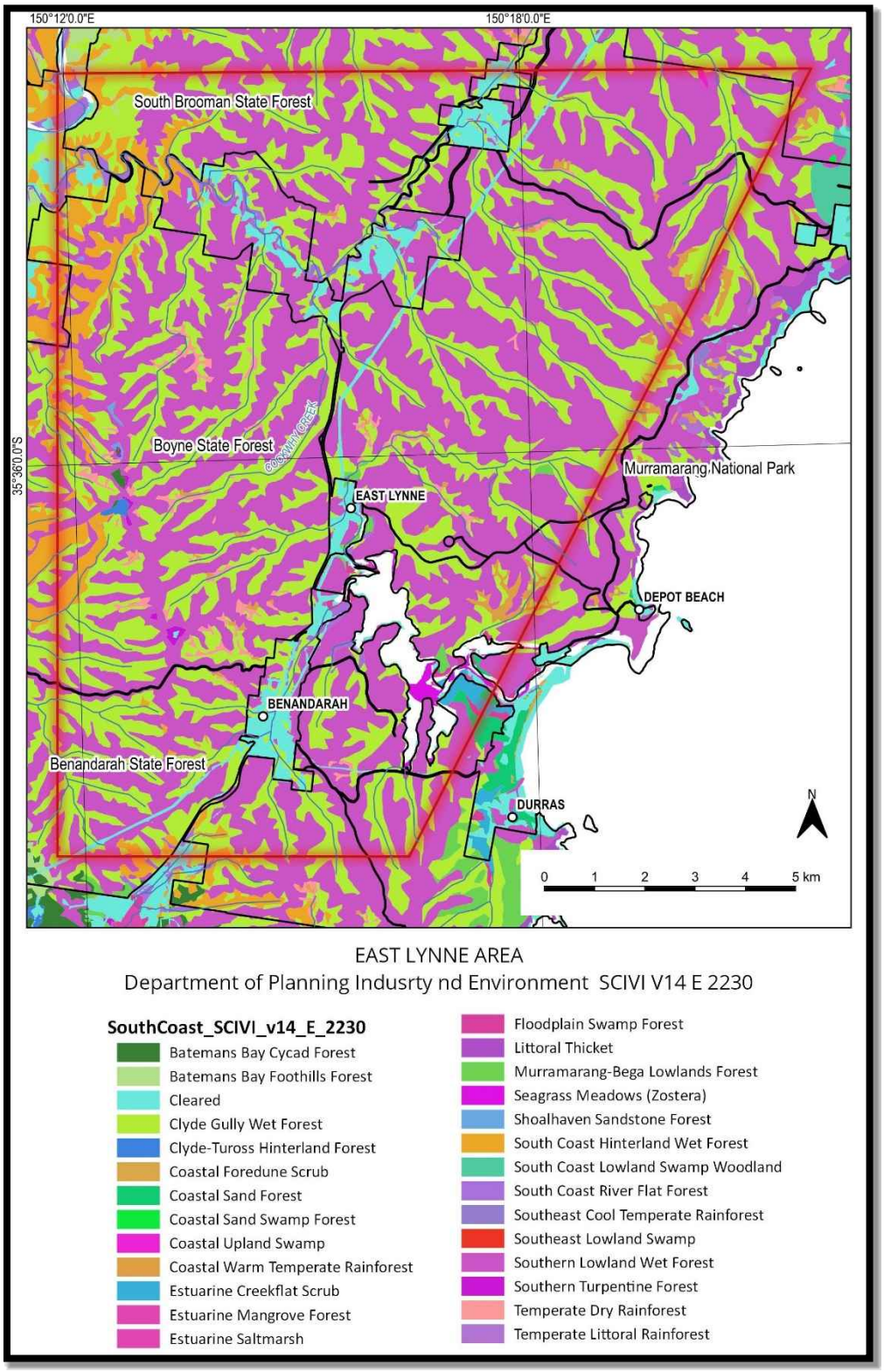
APPENDIX 1 Tables 13-15 (Pp77-79) graphically display species use and rankings for the South Coast KMA."

Suitability of local trees for koalas



EAST LYNNE AREA
KOALA TREE INDEX - KTSI

Forest Types (SCIVI) in the Area



Main Forest Types (SCIVI) in the East Lynne Area, and their Eucalypt Species (ratings High, Significant, Irregular or Low, extrapolated from NSW Govt Review of Koala Tree Use 2018 – for caveats, see Wamban/Nerrigundah Study Report https://eurokoalas.files.wordpress.com/2021/03/report_wamban-nerrigundah-project_gilmore-electorate.docx.pdf)

p103 Clyde Gully Wet Forest
Indicative Diagnostic Species

- Spotted Gum **I**
- Grey Ironbark (E paniculata subsp. paniculata) **H** (although *Forestry Koala Code of Practice* rates Epan as "Secondary Feed Species")
- Blackbutt **S**
- Sydney Peppermint **S**

Others Also Occurring

- Angophora floribunda **S**
- Red Bloodwood **I**
- Blue-leaved Stringybark **I**
- Bangalay **S**
- Monkey Gum **H**
- River Peppermint **L**
- White Stringybark **H**
- Woollybutt **H**
- Yellow Stringybark **H**
- Sydney Blue Gum x Bangalay **S**
- Red Mahogany (E scias subsp. callimastha) **S**

p104 Southern Lowland Wet Forest
Indicative Diagnostic Species

- Red Bloodwood **S**
- Spotted Gum **I**
- White Stringybark **H**
- Grey Ironbark **H**
- Blackbutt **S**
- Sydney Blue Gum x Bangalay **S**
- Red Mahogany (E scias subsp. callimastha) **S**

Others Also Occurring

- Angophora floribunda **S**
- Blue-leaved Stringybark **I**
- Coast Grey Box **H**

- Bangalay **S**
- Yertchuk **S**
- Monkey Gum **H**
- Thin-leaved Stringybark **I**
- Broad-leaved Red Ironbark **S**
- Woollybutt **H**
- Red Stringybark (unlikely in East Lynne) **H**
- Yellow Stringybark **H**
- Sydney Peppermint **S**
- Silvertop Ash **S**

To the West and in higher Eastern patches…….
n183 South Coast Hinterland Wet Forest
Indicative Diagnostic Species

- Monkey Gum **H**
- Brown Barrel **L**
- Woollybutt **H**
- Yellow Stringybark **H**
- Sydney Blue Gum x Bangalay **S**
- Red Mahogany (E scias subsp. callimastha) **S**
- Gully Peppermint/Blackbutt Peppermint (E smithii) **L**

Others Also Occurring

- Angophora costata **L**
- Blue-leaved Stringybark **I**
- Apple-topped Box **Not rated**
- Blue Box **I**
- Coast Grey Box **H**
- Bangalay **S**
- River Peppermint **L**
- White Stringybark **H**
- Maiden's Gum **H**
- Messmate **S**
- Grey Ironbark (E paniculata subsp. paniculata) **H**
- Blackbutt **H**
- Sydney Peppermint **S**
- Narrow-leaved Peppermint **S**
- Silvertop Ash **S**

There are small patches near our study area of p86 Murramarang-Bega Lowlands Forest

Indicative Diagnostic Species

- Allocasuarina littoralis **L**
- Spotted Gum **I**
- Bangalay **S**
- Woollybutt **H**
- Grey Ironbark **H**
- Blackbutt **H**

Others Also Occurring

- Angophora floribunda **S**
- Red Bloodwood **I**
- Blue-leaved Stringybark **I**
- Blue Box **I**
- Coast Grey Box **H**
- Mountain Grey Gum **H**
- Thin-leaved Stringybark **I**
- Broad-leaved Red Ironbark **S**
- White Stringybark **H**
- Yellow Stringybark **H**
- Swamp Gum **Not rated**
- Sydney Peppermint **S**
- Silvertop Ash **S**
- Forest Red Gum **H**

An alternative classification to SCIVI is available, but little used. Here is an example.

Related Biometric Descriptors

Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin	Blackbutt (Eucalyptus pilularis), Bangalay (Eucalyptus botryoides), Eucalyptus salignaXbotryiodes, Turpentine (Syncarpia glomulifera)	Grey Ironbark (Eucalyptus paniculata subsp. paniculata), Cabbage-tree Palm (Livistona australis)	Occurs from the Hacking River catchment along the Illawarra scarp south to Mt Keira, on coastal lowlands near Berry, and scattered through coastal foothills and lowlands from Nowra south to Batemans Bay.
Red Bloodwood - Blackbutt - Spotted Gum shrubby open forest on coastal foothills, southern Sydney Basin	Red Bloodwood (Corymbia gummifera), Blackbutt (Eucalyptus pilularis), Spotted Gum (Corymbia maculata)	White Stringybark (Eucalyptus globoidea), Hard-leaved Scribbly Gum (Eucalyptus sclerophylla), Grey Ironbark (Eucalyptus paniculata subsp. paniculata), Thin-leaved Stringybark (Eucalyptus eugenioides)	Occurs on coastal lowlands below 100m between Kangaroo Valley and Batemans Bay.

See also Forestry Corporation NSW classifications, below.

GIS Maps

Factors confounding koala habitat mapping at multiple decision-making scales

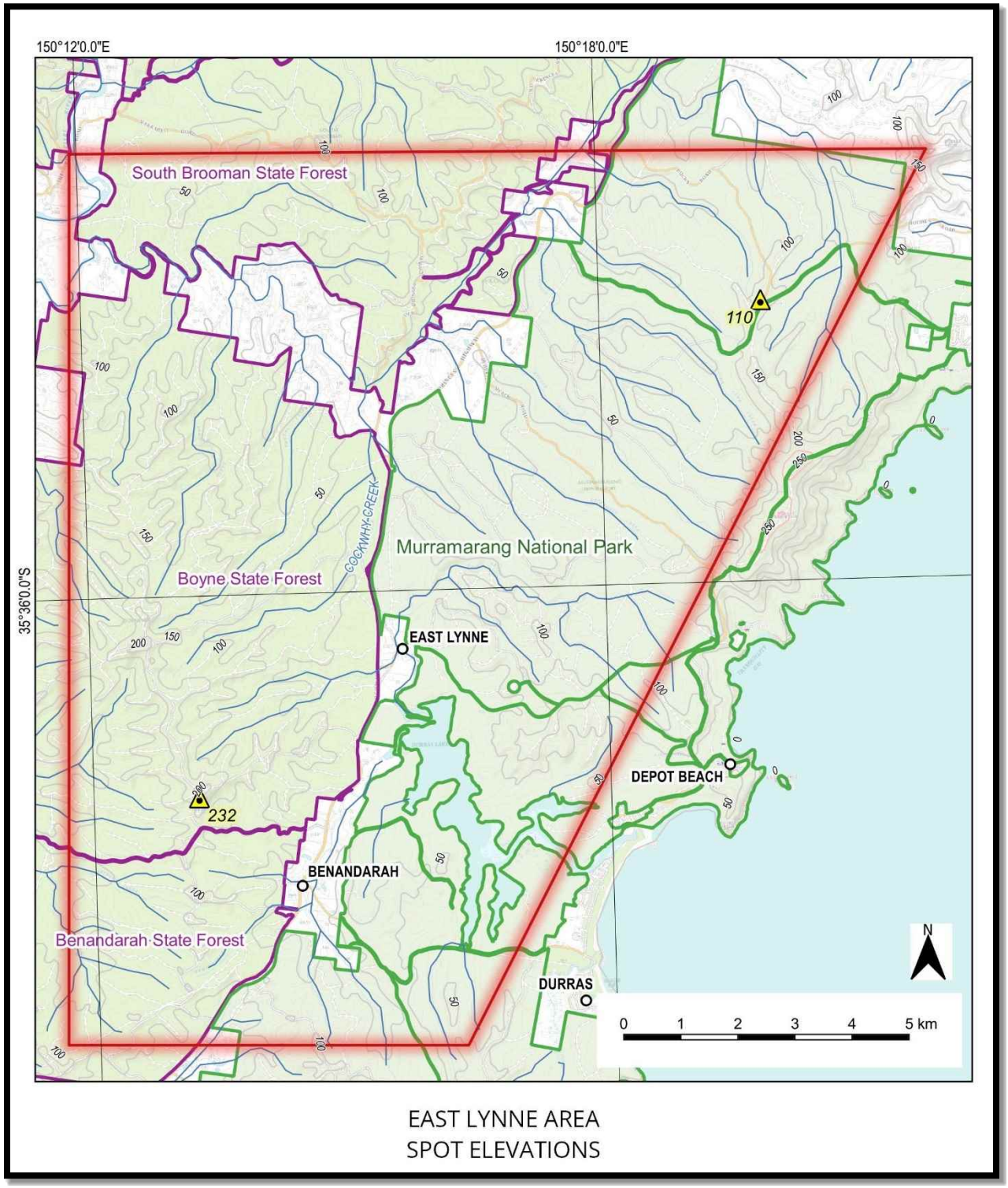
Dave L. Mitchell, Mariela Soto-Berelov, William T. Langford, Simon D. Jones

First published: 16 March 2021

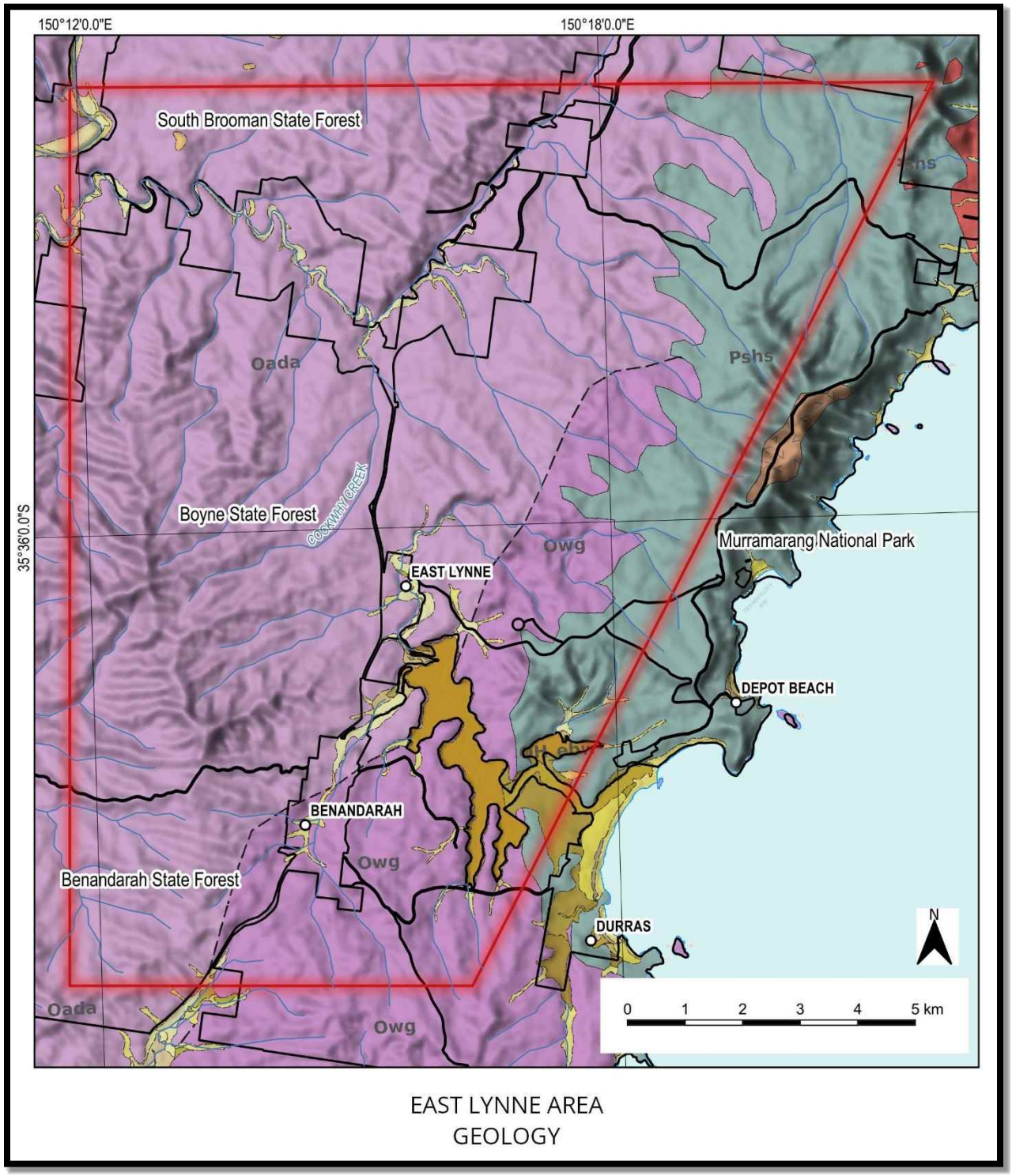
"Summary

The Koala (*Phascolarctos cinereus*) is an arboreal marsupial found throughout southeastern Australia. A high risk of extinction in some areas requires adherence to legislation mandating protection of high-quality habitat. The Koala primarily eats leaves of the *Eucalyptus* genus and wildlife managers are, in most cases, currently dependent on habitat maps depicting food resource availability derived from low-resolution regional-extent (~100,000 hectares) vegetation maps. These maps might not capture resource variability at planning extents (0.1–300 ha), or at resolutions where Koala ecology processes operate (5–50 ha). Consequently, potentially high-quality habitat may not be considered in planning decisions. Whether low-resolution habitat mapping adequately captures food resource variability is therefore relevant to map users at non-regional extents. We examined four different broad-scale low-resolution habitat maps within a small area (150 ha) in southeast Queensland and compared the classifications of each. Map units were generally ranked in the same hierarchical order; however, differences in methodologies meant that, between maps, some units varied widely in assigned habitat quality. Two maps were assessed using quantitative Queensland Herbarium data, and field data we collected. Assessment using overstorey species emphasised habitat quality differences between habitat map units better than the alternative whole-of-canopy method. Maps relying on interpretation of vegetation descriptions for habitat class definition sometimes overestimated food tree cover proportions and stakeholders need to be cognisant of these limitations. One method assigned Very Low Suitability to a 60-ha focal study site containing evidence of Koala use, and we strongly recommend that field validation should be an integral part of habitat management at these scales. We conclude that, rather than mapping approaches encompassing several habitat attributes within a single map, layered datasets, each with specific attributes, would provide greater utility for stakeholders by allowing them to use layers individually or in combination as required."

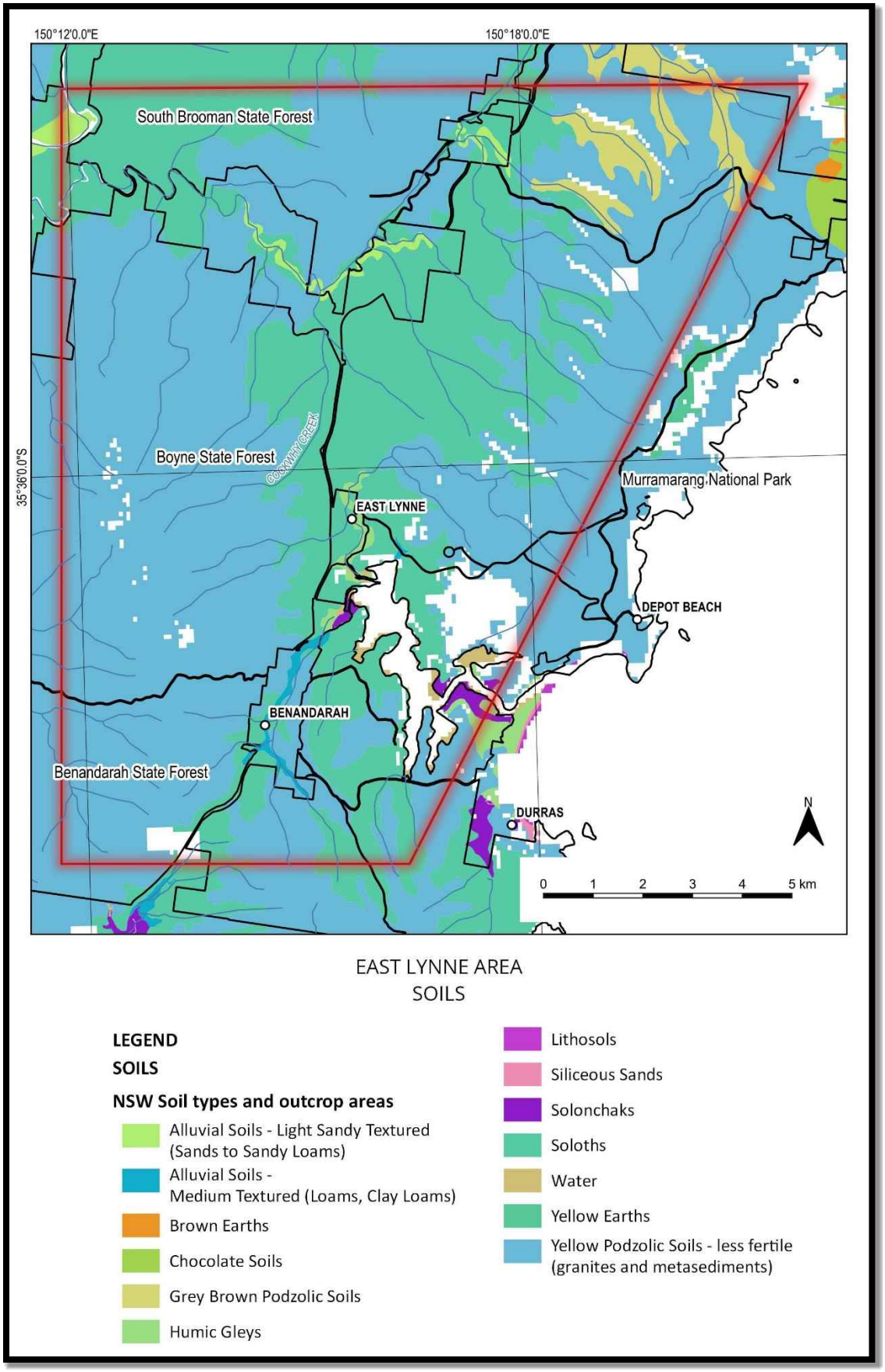
Topography is a factor in koala habitat quality.



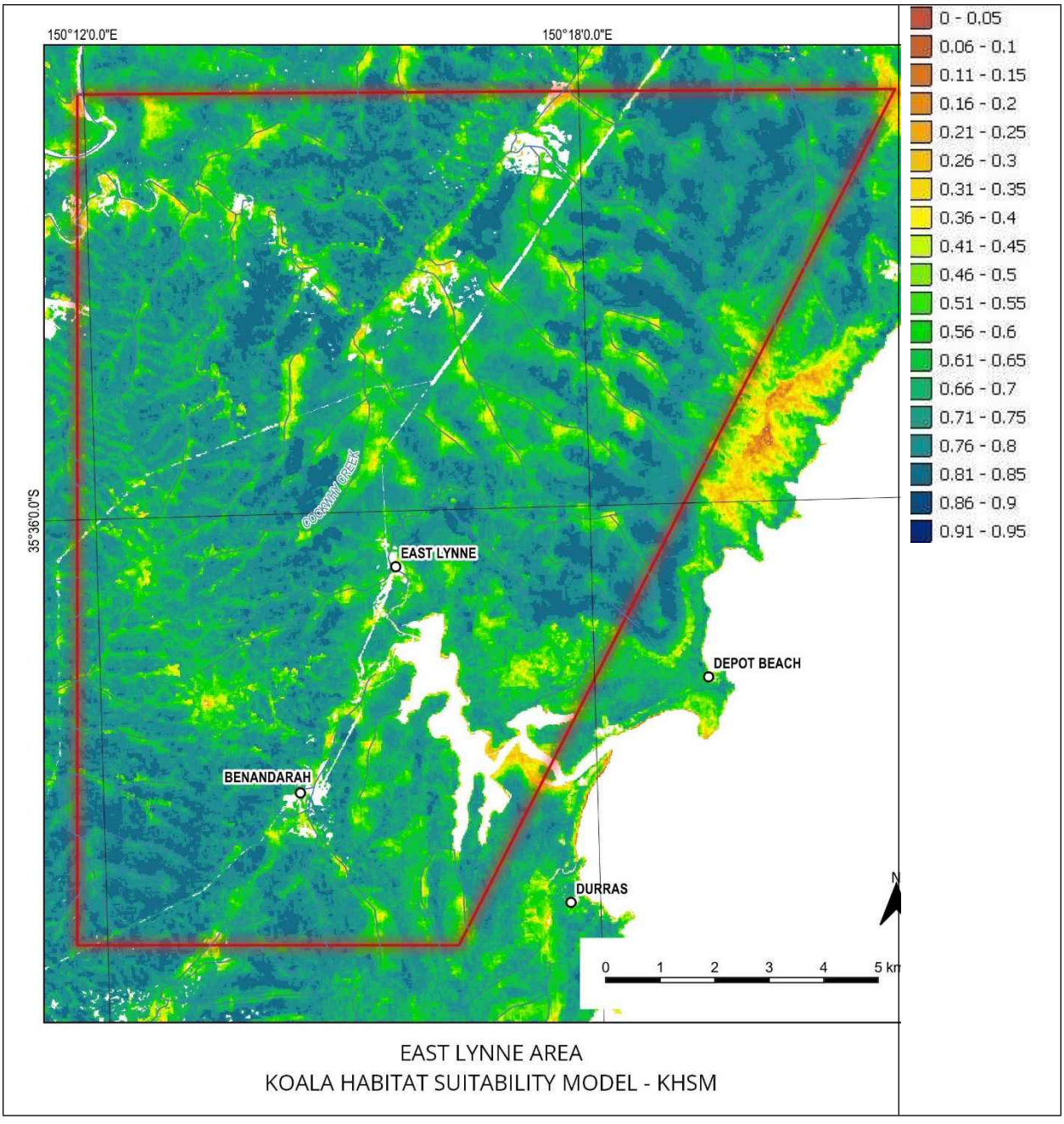
Underlying geology plays a role in soil type and ultimately leaf nutrients.



EAST LYNNE AREA
GEOLOGY

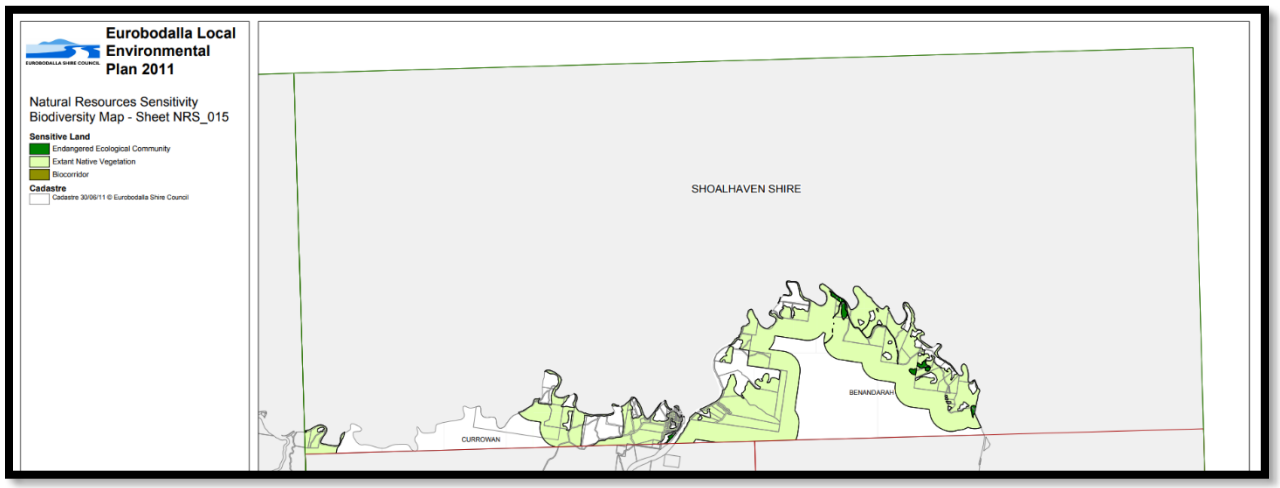

150°12'0.0"E
150°18'0.0"E
35°36'0.0"S
South Brooman State Forest
Boyne State Forest
COCKATHY CREEK
EAST LYNNE
Murramarang National Park
DEPOT BEACH
BENANDARAH
Benandarah State Forest
DURRAS
N
0 1 2 3 4 5 km
EAST LYNNE AREA
SOILS
LEGEND
SOILS
NSW Soil types and outcrop areas
Alluvial Soils - Light Sandy Textured (Sands to Sandy Loams)
Alluvial Soils - Medium Textured (Loams, Clay Loams)
Brown Earths
Chocolate Soils
Grey Brown Podzolic Soils
Humic Gleys
Lithosols
Siliceous Sands
Solonchaks
Soloths
Water
Yellow Earths
Yellow Podzolic Soils - less fertile (granites and metasediments)

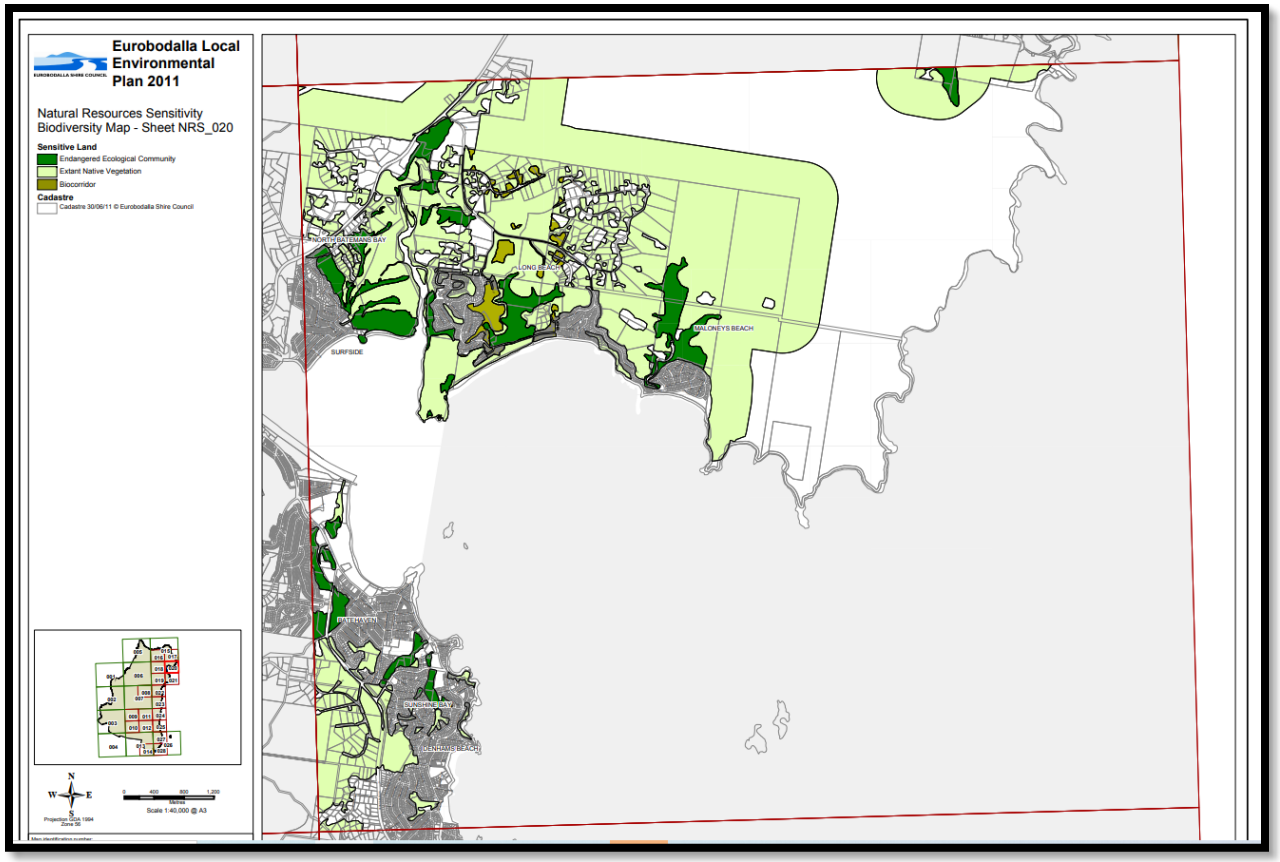
Based on the above factors, koala habitat suitability can be modeled.

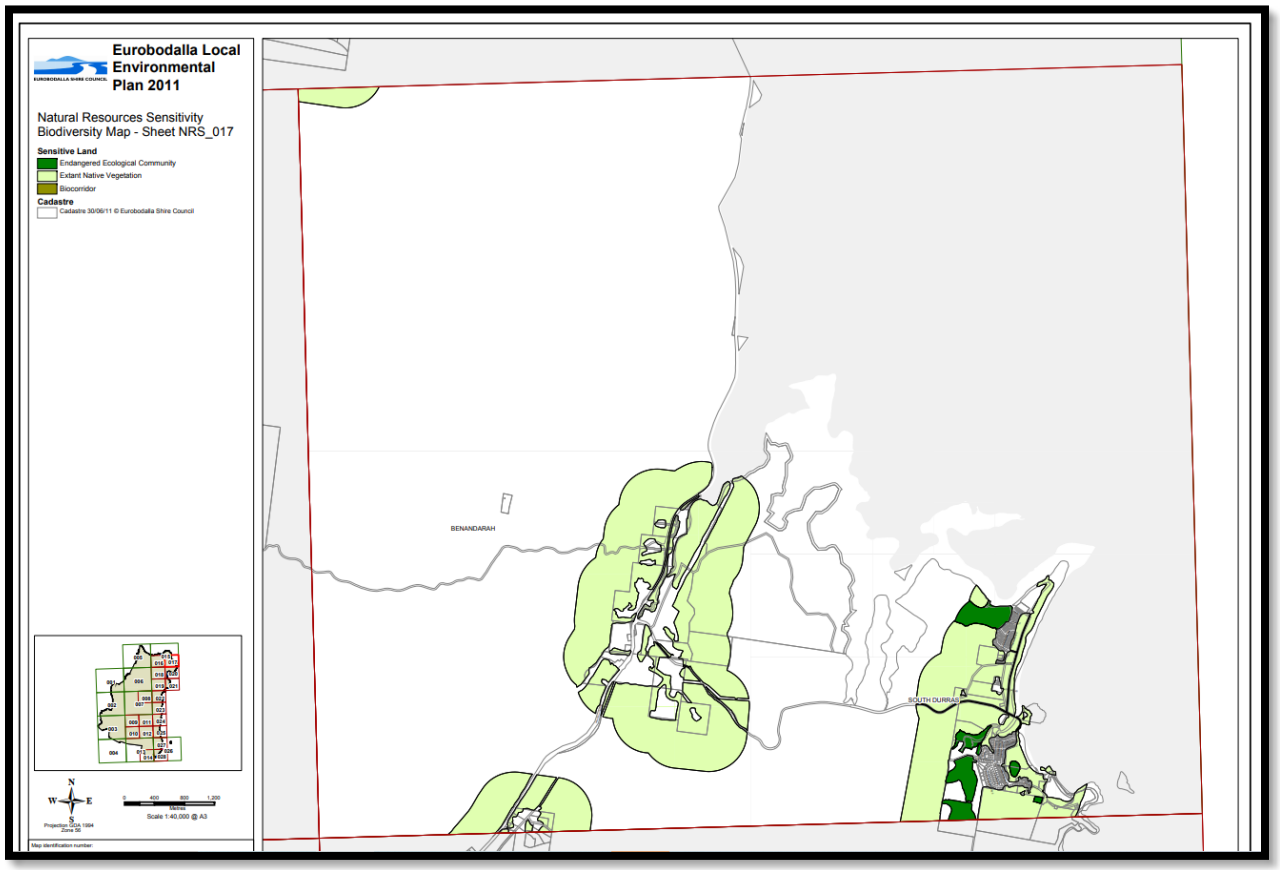


EAST LYNNE AREA
KOALA HABITAT SUITABILITY MODEL - KHSM

Eurobodalla Shire Council Local Environment Plan 2011 Sensitivity Biodiversity Maps






Eurobodalla Local Environmental Plan 2011
Natural Resources Sensitivity Biodiversity Map - Sheet NRS_017
Sensitive Land
Endangered Ecological Community
Extant Native Vegetation
Biocorridor
Cadastre
Cadastre 30/06/11 © Eurobodalla Shire Council
BENANDARAH
SOUTH DURRAS
Scale 1:40,000 @ A3

Forestry Corporation NSW GIS Mapping

The link is https://data-fcnsw.opendata.arcgis.com/datasets/nsw-forest-types?geometry=149.595%2C-36.288%2C150.638%2C-36.094

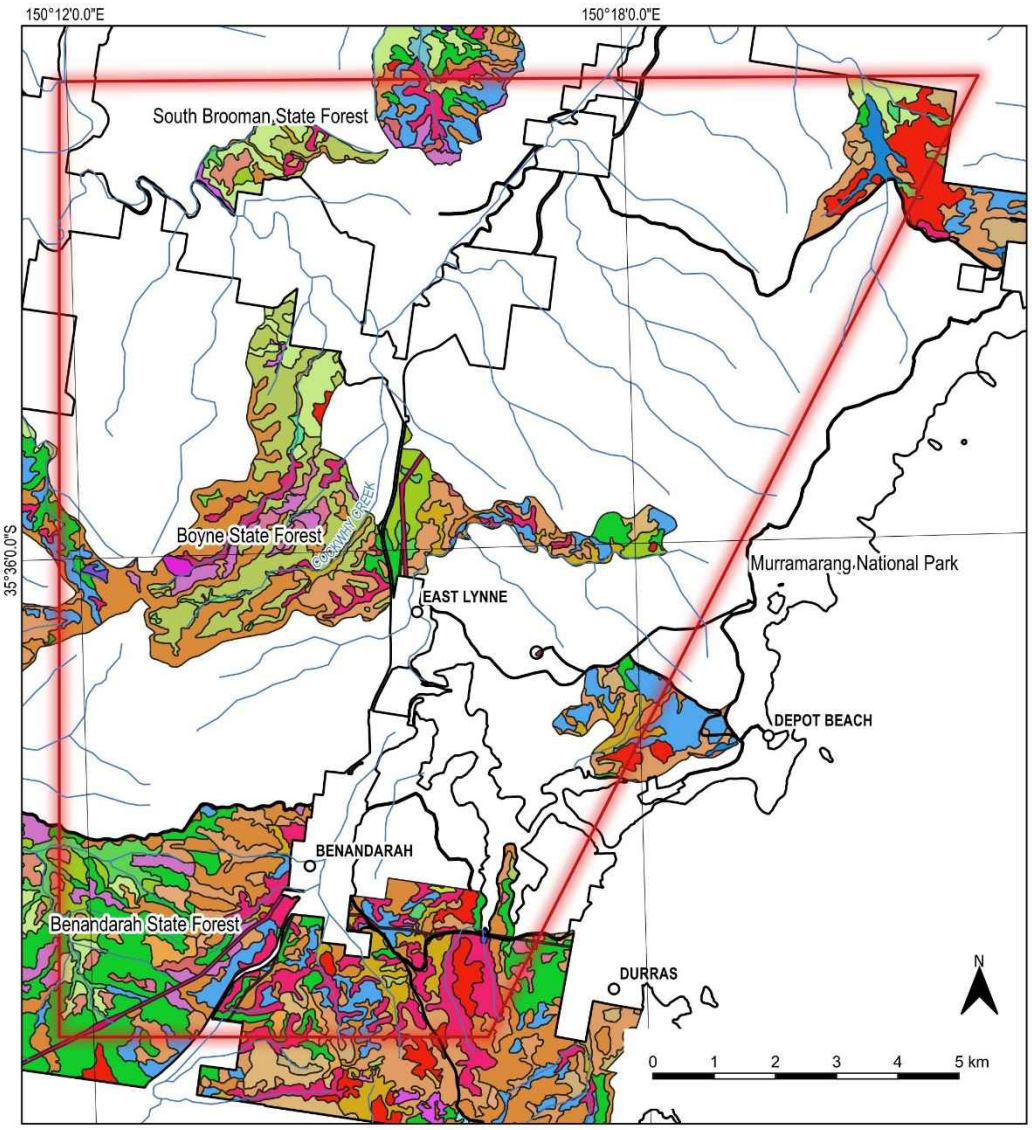
A random selection of three Forestry Corporation NSW GIS mapping polygons displays:

- Spotted Gum (documented Irregular Koala Use Tree), Sydney Peppermint (Significant Use, Central Coast), Blue Gum (Significant Use, North Coast) x Bangalay (Significant Use, Central Coast) and Blackbutt (High Use, Central Coast) **at Cockwhy**;
- Spotted Gum and Blackbutt **at Kioloa**, and; Stringybark (High Use, South Coast) **further north towards Termeil, in line with Bawley Point**.

The following is a more comprehensive, structured selection of Forest Types from polygons across South Brooman, Boyne and Benandarah State Forests, giving an overview of potential koala-use trees, rated according to the NSW Review of Koala Tree Species (2018).

In the table below, the koala-use ratings are for the South Coast Koala Management Area (KMA), unless otherwise specified. The latter is usually because data do not exist for the South Coast, so ratings for another KMA are used to suggest a possible best likelihood for our region. Ratings vary from region to region.

Pending a GIS version, initially a screen-shot was captured of the map at link https://data-fcnsw.opendata.arcgis.com/datasets/nsw-forest-types/explore?location=-36.199587%2C150.013682%2C12.00 then printed in hard copy.



EAST LYNNE AREA
FORESTRY TYPE

NSW_Forest_Types

- 102
- 112r
- 114
- 115
- 12
- 123
- 126
- 128
- 128/46
- 130
- 14
- 214
- 219
- 220
- 224
- 23
- 231
- 32
- 37
- 39
- 41
- 42
- 46
- 46/23
- 46/92
- 50
- 63
- 66
- 70
- 70/23
- 70a
- 70b
- 70r
- 72
- 73
- 73+23
- 73B
- 74
- 74/75r
- 75
- 76
- 82
- 84

A grid was drawn over the hard copy, using 10 vertical axes and 10 horizontal axes.
This produced 24 intersection points, to be selected separately for their polygon and its forest type.

Precinct	***Forest Type***	***Description***	***Koala Rate of Use***
Cockwhy	70a	Spotted Gum	Irregular
Cockwhy	73	Spotted Gum-Sydney Blue Gum/Bangalay	Irregular-Irregular (Central Coast)/Significant (Central Coast)
Cockwhy	102	Yertchuk	Significant
Cockwhy	74	Spotted Gum-Ironbark/Grey Gum *[adjacent to a Sydney Peppermint polygon]*	Irregular-High (Central Coast)/Irregular *[Significant (Central Coast)]*
Kioloa	37	Dry Blackbutt	High (Central Coast)
Kioloa	76	Spotted Gum-Blackbutt	Irregular-High (Central Coast)
Kioloa	37	Dry Blackbutt *[adjacent to a Bangalay polygon]*	High (Central Coast) *[Significant (Central Coast]*
Kioloa	37	Dry Blackbutt	High (Central Coast)
Kioloa	70a	Spotted Gum	Irregular
South-West	70/23	Spotted Gum (Myrtle)	Irregular (N/A)
South-West	74	Spotted Gum-Ironbark/Grey Gum	Irregular-High (Central Coast)/Irregular
South-West	70	Spotted Gum	Irregular
South-West	74	Spotted Gum-Ironbark/Grey Gum	Irregular-High (Central Coast)/Irregular
South-West	70	Spotted Gum	Irregular
South-West	70	Spotted Gum	Irregular
South-West	74	Spotted Gum-Ironbark/Grey Gum	Irregular-High (Central Coast)/Irregular
South-West	74	Spotted Gum-Ironbark/Grey Gum	Irregular-High (Central Coast)/Irregular
South	115	Sydney Peppermint-Stringybark	Significant (Central Coast)-High
South	70b	Spotted Gum	Irregular
South	76	Spotted Gum-Blackbutt	Irregular-High (Central Coast)
South	70b	Spotted Gum *[adjacent to a Blackbutt-Bloodwood/Apple polygon]*	Irregular *[High (Central Coast)-Irregular/Significant]*

Durras North	70b	Spotted Gum	Irregular
Durras North	On the border of 46 & 37	Sydney Blue Gum & Dry Blackbutt	Irregular (Central Coast) & High (Central Coast)
Durras North	70a	Spotted Gum *[adjacent to a Spotted Gum-Blackbutt polygon]*	Irregular *[Irregular-High (Central Coast]*

These samples display the heavy dominance of Spotted Gum throughout Forestry Corporation NSW Compartments in the East Lynne area, but the co-presence of Blackbutt, Sydney Peppermint, Ironbark and small stands of Yertchuk are a positive for koala browse potential, probably supporting those few koalas recorded.

Harvest Plans and History of Logging Compartments
Relevant Koala Habitat Features by Compartment

The link is https://www.forestrycorporation.com.au/operations/harvest-plans/south-coast

Another useful link is the *Hardwood Forests Division Forest Management Plan*, with forest types described at pp17ff:
https://www.forestrycorporation.com.au/__data/assets/pdf_file/0011/669008/hardwood-forests-forest-management-plan.pdf

The Eurobodalla Koala Project's focus is on the potential for low-density koala revival, evidence having pointed to a regional decline since the mid-20th Century and earlier.
When studying these Harvest Plans, we are looking in particular for:

- Potential koala habitat patch size (eg home range areas and corridors – we find Compartment sizes tantalizingly close to South Coast home range sizes)
- Reserves, exclusion zones and other protections
- Eucalypt species, especially the proportion of high-use koala trees in the mix
- Types and intensity of historic and planned disturbance
- Steepness of slopes
- Recorded koala evidence

"Coastal Dry Forest" is often mentioned in these Harvest Plans. This is a catch-all definition for forest types that occur throughout coastal NSW, described as follows:
Dry coastal hardwoods are the most widely distributed forest communities in coastal NSW and stands comprise mosaics of different species. The most commonly occurring species are grey gum (Eucalyptus propinqua), grey ironbark (E. paniculata), coastal grey and steel box (E. moluccana, bosistoana, rummeryi), red/white mahogany (E. resinfera, E. acmenoides/umbra), stringybarks (E. globoidea, cameronii, sparsifolia) and smooth-barked apple (Angophora costata).
"Coastal Moist Forest" is also mentioned in Harvest Plans, described as follows:
Moist coastal hardwood forests generally comprise Sydney blue gum (Eucalyptus saligna) and tallowwood (E. microcorys). A range of species such as white mahogany (E. acmenoides), turpentine (Syncarpia glomulifera) and some stringybark species are also regularly associated with this forest type. This forest type is found on fertile sites, mainly in the hinterland escarpment zone of the north coast from Dungog through to Queensland, and is usually associated with the occurrence of rainforest which may occupy the more sheltered and moister sites. This hardwood forest type produces sought after timbers such as tallowwood, which is highly regarded for its durability. These sites present some challenges to successful regeneration due to the capacity for dense mesic understorey to regenerate prolifically and shade disturbed

areas. As with other eucalypts, because these species favour moist, productive sites, more intensive silviculture is necessary to establish regeneration. Forestry Corporation will review requirements on a site by site basis to determine the most suitable silviculture.

For the East Lynne area specifically, read E paniculata, E bosistoana and E globoidea, plus others like yellow stringybark (E muelleriana) and rough-barked apple (Angophora floribunda), messmate (E obliqua) and blackbutt (E pilularis) in the Dry Forest, Sydney blue gum (E saligna x botryoides), forest red gum (E tereticornis) and river peppermint (E elata) in the Moist Forest and yertchuk (E consideniana).

Cpt 119 (Approved 2012)
(This Compartment is just outside our polygon of study, but close enough to warrant inclusion)
Exclusion Zones x nil.
Forestry Type (RN17) and Gross Area (Ha)
(The map shows Resource Unit 1 is largely amongst the Spotted Gum dominated stands and the larger Woollybutt stand.
The map shows Resource Unit 2 is largely amongst the Sydney Peppermint and Yertchuk stands. Compare Species Composition text, below.)
Type 46 Sydney Blue Gum 4ha
Type 63 Woollybutt 7ha
Type 70 Spotted Gum 102ha
Type 75 Spotted Gum-Yellow/White Stringybark 8ha
Type 76 Spotted Gum-Blackbutt 1ha
Type 102 Yertchuk 42ha
Type 115 Sydney Peppermint-Stringybark 27ha
Type 123 Coastal Stringybark 9ha
Type 126 Stringybark-Bloodwood 1ha
Type 128 Sydney Peppermint 24ha
Type 130 Red Bloodwood 4ha
TOTAL 229ha
Gross Harvest Area
230ha
Net Harvest Area
181ha
History and Stand Condition:
"The STS tract (181ha) is a predominantly mixed age mature forest and will be harvested under a heavy single tree selection (STS) regime. The objective within the 181ha Net Harvest Area for this operation (Resource Units 1 & 2) is to remove 45% of commercially mature and defective trees to create canopy openings for regeneration, whilst retaining and minimizing damage to young regenerating stems, seed trees, habitat and recruitment trees. It is envisaged that the next harvesting operation in this compartment would be on average 30 years' time."

Resource Unit 1
Species Composition: Sydney Peppermint, Yertchuk, Spotted Gum, Stringybark and Bloodwood.
Stand History: Highly selective harvesting targeting high quality sawlogs occurred in 1990. Much lighter harvesting targeting mine props occurred in the 1980s.
A number of fires have occurred in the compartment.
Stand Structure and Condition: Mostly mature and over mature with patches of poles and regrowth. Condition can be described as being highly variable across the compartment ranging from poor to average.
Resource Unit 2
Species Composition: Dominated by Spotted Gum with Stringybark and Bloodwood.
Stand History: Highly selective harvesting targeting high quality sawlogs occurred in 1990. Much lighter harvesting targeting mine props occurred in the 1980s.
A number of fires have occurred in the compartment.
Stand Structure and Condition: Mostly over mature. Condition ranges from poor to fair.
Slope %age
Not listed
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpts 112 and 113 (Approved 2014)
Exclusion Zones (Informal Reserve adjacent to Cpt 113 southern boundary; probable EEC River Flat Forest on Coastal Floodplains at Cpt 112 north-west corner) x2
Apiary sites x7
Broad Forest Type
Coastal Moist Forest: 93 ha
Spotted Gum: 211.6 ha
Coastal Dry Forest: 110.1 ha
Low Quality Forest: 11.5 ha
Non-Eucalypt Forest: 0.2 ha
Species
Overstorey dominated by spotted gum (Corymbia maculata), grey ironbark (Eucalyptus paniculata), woollybutt (E. longifolia), blackbutt (E. pilularis), white stringybark (E. globoidea). Other overstorey species include: red bloodwood (C. gummifera), Sydney peppermint (E. piperita), rough-barked apple (Angophora floribunda), red mahogany (E. resinifera), coast grey box (E. bosistoana), Yerchuk (E. consideniana).
Gross Area
Cpt 112: 240.3 ha
Cpt 113: 192.2 ha
Total: 432.5 ha
Harvest Area

Cpt 112: 168.4 ha
Cpt 113: 91.7 ha
Total: 260 ha
History and Stand Condition:
Cpt 112: Wildfires in 1938, 1955 and 1986. Logging 1975 (1484 m3) and 1976 (122 m3).
Cpt 113: Logging 1968 (unrecorded m3), 1972 (166 m3) and 1977 (2876 m3).
Resource Unit 1:
Ridge tops and gently sloping areas in eastern end of the resource unit have undergone light selective logging, targeting mining timber, in the 60's and 70's and sawlogs in late 1970s within Cpt 113.
The resource unit is a mature\over mature dominated forest with limited potential for further growth.
Predominantly even aged mature forest and will be harvested under a heavy single tree selection (STS) regime. The objective within the 188.2 ha harvest area for this operation is to remove 45% of the basal area whilst retaining and minimising damage to stems with the best potential to produce future high quality products, to create canopy openings for regeneration and minimising damage to seed trees, habitat and recruitment trees.
Resource Unit 2:
Ridge tops and gently sloping areas in eastern end of the resource unit have undergone light selective logging, targeting mining timber, in the 60's and 70's.
The resource unit is predominately even-aged regrowth dominated forest, with a minor mature component.
Predominantly even aged regrowth forest, with a minor mature component and will be harvested under a medium single tree selection (STS) regime. The objective within the 71.8 ha harvest area for this operation is to remove 35% of the basal area, whilst retaining an even distribution of stems with the best potential to produce future high quality products and minimising damage to habitat and recruitment trees.
Resource Unit 3:
Even aged regrowth forest. Excluded from harvesting.
No evidence of past harvesting due to slope and rock which have restricted access.
The resource unit is predominately even-aged regrowth dominated forest. Limited commercial value due to low sawlog yield.
Slope %age
0-20 degrees: Cpt 112 (97.2%) Cpt 113 (99.9%)
20-25 degrees: Cpt 112 (2.7%) Cpt 113 (0.1%)
25-30 degrees: Cpt 112 (0.1%) Cpt 113 (0.0%)
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpts 114 and 116 (Approved 2018)

Exclusion Zones (River Flat Eucalypt TEC) x5
Rainforest (small) x4
Care to be taken with historic tramlines for logging.

Broad Forest Type

Spotted Gum (majority)
Coastal Stringybark
Grey Ironbark-Stringybark
Dry Blackbutt
Red Bloodwood

Forestry Type (YA) and Gross Area (Ha)

37 Dry Blackbutt 16.4ha
46 Sydney Blue Gum 4.3ha
66 Grey Ironbark-Stringybark 4.9ha
73 Spotted Gum-Sydney Blue Gum/Bangalay 46.1ha
74 Spotted Gum-Ironbark/Grey Gum 64.5ha
75 Spotted Gum-Yellow/White Stringybark 23.2ha
76 Spotted Gum-Blackbutt 67.6ha
123 Coastal Stringybark 10.1ha
130 Red Bloodwood 1.1ha
70a Spotted Gum 71.9ha
70b Spotted Gum 109.5ha

Analysis - here's a way of visualising the browse potential of these two Compartments:
The whole patch is big enough for a home range area, but….
There's only a total of 36.8ha of "pure non-Spotted Gum koala browse" (at various koala usage ratings).
You could add 155.3 ha of Spotted Gum which has other "good" species mixed in.
So, at best (excluding any purely Spotted Gum portions) there's 192.1ha of potential koala browse across the whole Cpts 114/116 patch.

Species and Species Mix (Sawlog)

Spotted Gum 90%
Ironbark 5%
Stringybark 3%
Blackbutt 2%

Gross Harvest Area (ha)

Cpt 114: 193ha
Cpt 116: 239ha
Total: 432ha

Net Harvest Area

Cpt 114: 175ha
Cpt 116: 160ha
Total: 335ha
History and Stand Condition:
The harvest area is comprised of predominately mature to over mature (RU1) Spotted Gum, Ironbark, Blackbutt and Stringybarks in mixed aged stands. There is regeneration and regrowth throughout the area. The objective is to harvest all commercially available trees to create canopy openings and ensure mechanical disturbance creates a suitable seedbed for regeneration of the stands.
Slope %age
0-20 degrees: Cpt 114 95.6%; Cpt 116 91.2%; Total 93.5%
20-25 degrees: Cpt 114 4.5%; Cpt 116 8.8%; Total 6.5%
25-30 degrees: Cpt 114 0.2%; Cpt 116 0.3%; Total 0.2%
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpt 100 (Approved 2018)
Exclusion Zones (Rainforest and River Flat Eucalypt Forest TEC) x2
Forestry Type (YA) and Gross Area (Ha)
Coastal Dry Forest 82ha
Coastal Moist Forest 16ha
Rainforest 9ha
Spotted Gum 386ha
TOTAL 494ha
Species and Species Mix (Sawlog)
Spotted Gum 50%
Ironbark 35%
Other 15%
So there's 172.9ha of Ironbark in here – not too bad.
Gross Harvest Area
494Ha
Net Harvest Area
369ha
History and Stand Condition:
The stands within the compartment are predominately comprised of Spotted Gum, Ironbark, Blackbutt, Bloodwood and Sydney Peppermint. Mahogany, Blue Gum and Rough Barked Apple also occur. Predominately mature to over mature trees with little potential for future value growth. Some patches of advanced regrowth with potential future growth. The objective is to harvest all commercially available trees to create canopy openings and ensure mechanical disturbance creates a suitable seed bed for regeneration of the stands.

Slope %age
0-20 degrees: 90%
20-25 degrees: 9%
25-30 degrees: 1%
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpt 103 (Approved 2018)
Exclusion Zones
(Warm Temperate Rainforest and Eucalypt River Flat Forest) x5
(Old Growth Forest) x1
Species and Species Mix (Sawlog)
Spotted Gum 68%
Ironbark 11%
Blackbutt 20%
Red Bloodwood 2%
Gross Harvest Area
464 ha
Net Harvest Area
289 ha
History and Stand Condition:
The stands within the compartment are predominately comprised of Spotted Gum, Ironbark, Blackbutt, Bloodwood and Sydney Peppermint. Mahogany, Blue Gum and Rough Barked Apple also occur. Predominately mature to over mature trees with little potential for future value growth. Some patches of advanced regrowth with potential future growth. The objective is to harvest all commercially available trees to create canopy openings and ensure mechanical disturbance creates a suitable seed bed for regeneration of the stands.
Slope %age
0-20 degrees: 90.6%
20-25 degrees: 6.8%
25-30 degrees: 2.1%
>30 degrees: 0.4%
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpt 104 (Approved 2012)
Exclusion Zones
(Rainforest) x3
(Old Growth Forest) x1 (small)

Species and Species Mix (Sawlog)
Overstorey dominated by Spotted Gum, Grey Ironbark and Blackbutt.
Other Species include Yellow Stringybark
Gross Harvest Area
293.7 ha
Net Harvest Area
224.8 ha
History and Stand Condition:
Predominantly mixed age mature forest.
(Resource Unit 1: Uneven aged. Mostly fully stocked. Highly variable over short distances. Mostly mature and overmature with some advanced pole/small sawlog sizes and clumps of sapling regrowth. Small areas of thick regeneration in disturbed areas such as old roads and dumps. The stand is in good condition with a viable lignotuber growing stock available to regenerate. A grassy/shrub understorey is present.
Resource Units 2 and 3: Regrowth and early mature trees. Scattered over remnant overstorey. The stand is well stocked with good form trees. Stands to be retained until sufficient volume is obtained for a commercial operation.)
Next harvesting operation average 30 years' time.
Previous logging: 1953 (262ha); 1975 (145ha); 1980 (10030ha).
Hazard Reduction Burning 1989, 1999, 2010.
Wildfire 1989.
Slope %age
One small patch >30deg
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpt 105 (Approved 2013)
Exclusion Zones (FMZ 2, FMZ 3A, Small Old Growth, Small Rainforest & Buffer) x5
Forestry Type (YA) and Gross Area (Ha)
Type 23 Myrtle 1.5 Ha
Type 41 Blackbutt-Bloodwood/Apple 0.9 Ha
Type 46 Sydney Blue Gum 2.2 ha
Type 70 Spotted Gum 94.4 Ha
Type 72 Spotted Gum-Grey Box 3.7 Ha
Type 73 Spotted Gum-Sydney Blue Gum/Bangalay 55.2 Ha
Type 74 Spotted Gum-Ironbark/Grey Gum 151.1 Ha
Type 75 Spotted Gum-Yellow/White Stringybark 62.4 Ha
Type 76 Spotted Gum-Blackbutt 7.2 Ha
Type 115 Sydney Peppermint-Stringybark 2.8 Ha
Type 126 Stringybark-Bloodwood 31.8 Ha

TOTAL 413.2 Ha

Species and Species Mix (Sawlog)

"Overstorey dominated by Spotted Gum, Blackbutt, Ironbarks and Stringybarks. Rough-barked Apple also occurs in the overstorey."

Gross Harvest Area

415 ha

Net Harvest Area

335 ha

History and Stand Condition:

Wildfires 1987 and 2000.

Logging 1959 (10200 m3), 1976 (9 m3), 1978 (570 m3), 1983 (111 m3), 1992 (760 m3) and 1995 (45 m3).

TSI 1928, 1966, 1968 and 2002.

50% mixed age overmature and 50% even aged regrowth.

Next harvesting on average 30 years' time.

Slope %age

0-20 degrees: 96.1%

20-25 degrees: 3.6%

25-30 degrees: 0.4%

Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?

No

Cpt 106 (Approved 2014)

Exclusion Zones (FMZ 4, FMZ 3A, small Rainforest etc) x6

High Conservation Old Growth & Special Management FMZ 2, adjacent to Cpt)

Forestry Type (YA) and Gross Area (Ha)

23 Myrtle 12.2 Ha

46 Sydney Blue Gum 17.6 Ha

70 Spotted Gum 197.7 Ha

73 Spotted Gum-Sydney Blue Gum/Bangalay 31.1 Ha

74 Spotted Gum-Ironbark/Grey Gum 140 Ha

75 Spotted Gum-Yellow/White Stringybark 0.1 Ha

76 Spotted Gum-Blackbutt 79.3 Ha

115 Sydney Peppermint-Stringybark 1.2 Ha

128 Sydney Peppermint 0.3 Ha

TOTAL 479.5 Ha

Species and Species Mix (Sawlog)

"Overstorey dominated by spotted gum (Corymbia maculata), grey ironbark (Eucalyptus paniculata) and blackbutt (E. pilularis).

Other overstorey species include: Sydney blue gum (E. saligna), Sydney peppermint (E. piperita), white stringybark (E. globoidea), monkey gum (E. cypellocarpa), roughbarked apple (Angophora floribunda) and woollybutt (E. longifolia)."

Gross Harvest Area

483.4 ha

Net Harvest Area

354.8 ha

History and Stand Condition:

Resource Unit 1: Multi-aged forest, dominated by the mature/over mature component.
Resource Units 2 and 3: Predominantly even aged regrowth forest with a minor mature component.
Resource Unit 4: Even aged regrowth forest. Excluded from harvesting.
Wildfires 1944, 1954, 1960's and 2001.
Logging 1975, 1977, 1988 (248 m3), 1990 (21,092 m3).
TSI 1920's, 1930's and 1960's.

Slope %age

0-20 degrees: 98.6%
20-25 degrees: 1.3%
25-30 degrees: 0.1%

Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?

No

Cpt 107 (v3 Approved 2016)

Exclusion Zones (TEC, FMZ 7, 3A, EEC River Flat Eucalypt Forest, small Rainforest) x8

Species and Species Mix (Sawlog)

Spotted Gum 531.6 Ha
Rainforest 16.5 Ha
Non-forest 4.4 Ha

Resource Unit 1:

Overstorey dominated by spotted gum (Corymbia maculata) with scattered grey ironbark (Eucalyptus paniculata), blackbutt (E. pilularis), white stringybark (E. globoidea), yellow stringybark (E. muelleriana), Yetchuk (E. consideniana), and bloodwood (C. gummifera)

Resource Unit 2 (excluded from harvesting):

Overstorey dominated by spotted gum (C. maculata) with scattered white stringybark (E. globoidea), Yetchuk (E. consideniana) and Sydney peppermint (E. piperita) with scattered areas of Sydney blue gum (E. saligna)

Resource Unit 3:

Overstorey dominated by spotted gum (Corymbia maculata) with scattered grey ironbark (Eucalyptus paniculata), blackbutt (E. pilularis), white stringybark (E. globoidea), yellow stringybark (E. muelleriana), Yetchuk (E. consideniana), and bloodwood (C. gummifera)

Gross Harvest Area
552 ha
Net Harvest Area
417 ha
History and Stand Condition:
Resource Unit 1:
Stand is a mixed age forest. Majority of area contains sufficient retained volume from the previous harvesting events to warrant another viable operation. Occasional pockets of thick regeneration occur on previously disturbed areas such as old road and dumps.
Resource Unit 2 (excluded from harvesting):
Stand is a mixed aged forest. Majority of area contains sufficient retained volume from the previous harvesting events to warrant another viable operation. However, for operational reasons, this area will be excluded from harvesting.
Resource Unit 3:
Stand is a mixed age forest. Majority of area contains sufficient retained volume from the previous harvesting events to warrant another viable operation. Occasional pockets of thick regeneration occur on previously disturbed areas such as old road and dumps.
Wildfire: 1944, 1954, 1967 and 2009.
Logging: 1974, 1990, 1997 and 2008.
TSI: 1926, 1927, 1928, 1937, 1963, 1964, 1966 and 1981.
Next harvesting approx. 30 years.
Slope %age
0-20 degrees: 95%
20-25 degrees: 4%
25-30 degrees: 1%
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpts 93 and 94 (Approved 2011)
Exclusion Zones (Rainforest, EEC River Flat Eucalypt Forest, Subterranean Roost Protection around Cultural Heritage Tower Creek Mine) x3
Forestry Type (YA) and Gross Area (Ha)
Broad Forest Types:
Spotted Gum 366.1 Ha
Coastal Dry Forest 114.6 Ha
Coastal Moist Forest 7.5 Ha
Rainforest 11.6 Ha
TOTAL 499.8 Ha
Species and Species Mix (Sawlog)
Resource Unit 1:

Overstorey dominated by Spotted Gum, Blackbutt and Grey Ironbark.
Resource Unit 2:
Overstorey dominated by Spotted Gum and Grey Ironbark.
Resource Unit 3:
FMZ 4 (Retained BA exclusion. Not available for harvest this operation.)
Overstorey dominated by Blackbutt, Silvertop Ash, Red Bloodwood and Sydney Peppermint.
Contains a section of Spotted Gum/Grey Ironbark advanced regrowth.
Gross Harvest Area
Cpt 93: 203.7 ha
Cpt 94: 297.8 ha
Net Harvest Area
Cpt 93: 108.9 ha
Cpt 94: 236.3 ha
History and Stand Condition:
Primarily mature/ over mature mixed age stands.
Cpt 93:
TSI - 2002.
Wildfire – 1968.
Logging – 1975 (1717 m3) and 1978 (177 m3).
Thick regeneration on disturbed areas. Much less regeneration elsewhere.
Cpt 94:
TSI – 1987.
Wildfire – 1968.
Logging – 1953 (380 m3), 1975 (2280 m3) and 1987 (9036 m3).
"Very good early mature component."
This unit generally not impacted by the 1968 fire.
Both Cpts:
Next harvesting on average 30 years' time.
Resource Unit 3:
FMZ 4 (Retained BA exclusion. Not available for harvest this operation.)
Heavily impacted by past wildfire (probably 1968).
Large proportions of advanced regeneration.
To act as a Basal Area Bank, allowing Resource Unit 1 to be harvested more intensively.
Slope %age
Not listed.
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpt 95 (Approved 2015)
Exclusion Zones (Small Rainforest) x3

Forestry Type (YA) and Gross Area (Ha)

Broad Forest Types

Spotted Gum 278.3 Ha

Coastal Dry Forest 1.0 Ha

Rainforest 18.7 Ha

Non-Forest 0.7Ha

TOTAL 298.7

Species and Species Mix (Sawlog)

Resource Unit 1 (226 Ha):

Overstorey dominated by spotted gum (Corymbia maculata) with scattered white stringybark (E. globoidea), grey ironbark (Eucalyptus paniculata), blackbutt (E. pilularis), Yertchuk (E. consideniana), and bloodwood (C. gummifera).

Resource Unit 2 (4 Ha):

Overstorey dominated by bloodwood (C. gummifera), white stringybark (E. globoidea), Yertchuk (E. consideniana) and Sydney peppermint (E. piperita) with scattered areas of Sydney blue gum (E. saligna).

Gross Harvest Area

299 ha

Net Harvest Area

226 ha

History and Stand Condition:

Wildfire – 1947, 1968 and 2002

Logging - 1987 (7484 m3)

TSI – 1968

The compartment (NHA 226 Ha) is divided into two resource units:

Resource Unit 1 (222Ha)

Sufficient retained volume from the 1987 harvesting event to warrant another viable operation. Area logged in 1987 is a predominantly mature age forest (BA range 14-32m2 /ha). Stand has reached endpoint with limited further growth potential.

Occasional pockets of thick regeneration on disturbed areas.

Resource Unit 2 (4Ha) is a predominantly mature forest that will be excluded from harvesting due to viability and access constraints. Area logged in 1987 in average to poor condition. Few areas of regrowth or potential 'growers'. Limited commercial value due to access issues, low sawlog yields and species mix. Exclude from harvest.

Next harvesting:

It is envisaged that the next harvesting operation in Cpt 95 would be in approximately 30 years' time.

Slope %age

0-20 degrees: 94.95%

20-25 degrees: 4.6%

25-30 degrees: 0.4%

Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpt 57 (Approved 2010)
Exclusion Zones (Rainforest) x1
Cultural Heritage – scattered artifacts.
Forestry Type (YA) and Gross Area (Ha)
Resource Unit 1:
Dominated by Sydney Peppermint and Spotted Gum, with Stringybark, Blackbutt and Ironbark.
Resource Unit 2:
Dominated by Spotted Gum, with Stringybark, Ash and Ironbark.
Species and Species Mix (Sawlog)
37 Dry Blackbutt 3 Ha
41 Blackbutt-Bloodwood/Apple 6 Ha
46 Sydney Blue Gum 12 Ha
66 Grey Ironbark-Stringybark 3 Ha
70 Spotted Gum 154 Ha
73 Spotted Gum-Sydney Blue Gum/Bangalay 53 Ha
74 Spotted Gum-Ironbark/Grey Gum 32 Ha
75 Spotted Gum-Yellow/White Stringybark 26 Ha
76 Spotted Gum-Blackbutt 54 Ha
114 Silvertop Ash-Stringybark 3 Ha
123 Coastal Stringybark 9 Ha
128 Sydney Peppermint 139 Ha
214 Wattle 3 Ha
Gross Harvest Area
497 ha
Net Harvest Area
433 ha (87%)
History and Stand Condition:
Resource Unit 1:
Uneven aged, mostly fully stocked. Highly variable over short distances. Mostly mature and over mature with some advanced pole/small sawlog sizes and some clumps of sapling regrowth.
Mesic understorey – mostly open (native grass, burrawangs, litter/humus, logs & limbs, ferns, Acacias, Casuarina, Native Cherry, Bracken Fern, Kangaroo Grass and Bladey Grass).
Resource Unit 2:
Semi-stocked with infrequent gaps. The predominant cohorts consist of regrowth and/or early mature trees with a scattered over mature remnant overstorey.
Understory as per Resource Unit 1.

Wildfires: 1968.
Logging: 1966 (5,000 m3), 1985 (20 m3), 1993 (20 m3) and 2004 (20,000 m3).
TSI: 1966, 1985 and 1993.
Next harvesting operation approx. 30 years.
Slope %age
Not listed
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Cpt 65 (Approved 2016)
Exclusion Zones (EEC River Flat Eucalypt Forest, FMZ 3A, Streamlines, Golden Tipped Bat, Eastern Pygmy Possum) x8.
No snigging along public-use walking track.
Care to be taken on historic coach trail.
Forestry Type (YA) and Gross Area (Ha)
Coastal Moist Forest (1.1 Ha)
Spotted Gum (169 Ha)
Coastal dry Forest (28.7 Ha)
Non-Forest (0.05 Ha)
TOTAL 198.85 Ha
Species and Species Mix (Sawlog)
Predominately consists of Blue gum, Spotted gum, lronbark, Silvertop Ash, Sydney Peppermint, White Stringybark, Blackbutt, Rough barked apple. River Peppermint, some Bangalay and Forest Red Gum occurs within the flats adjacent to Cockwhy Creek.
Gross Harvest Area
205 ha
Net Harvest Area
146 ha
History and Stand Condition:
The compartment underwent an AGS harvesting operation in 2009. Except for on the ridge tops, lower slopes adjacent to Cockwhy Creek and the northerly facing aspects, regeneration in the AGS plots has not been successful. Throughout the compartment vine has encroached nearly the entire compartment (except for in the dry northerly aspects). The timber stand is overmature and has reached growth potential.
“It is recommended that during the operation FCNSW staff pick enough seed from the fallen heads to sow the coupe in case there is insufficient natural regeneration after this planned harvest event.”
Wildfires: 1964, 1965, 1968/72 and 1980.
Logging: 1968/72 (240 m3), 1978 (140 m3), 1989 (1500 m3), 1990 (6000 m3) and 2010 (7000 m3).

TSI: Nil.
Slope %age
0-20 degrees: 93.6%
20-25 degrees: 5.7%
25-30 degrees: 0.7%
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
Yes (previous reliable surveys done in 2009).

Cpt 67 (Approved 2016)
Exclusion Zones (FMZ 3A, small EEC River Flat Eucalypt Forest, large Excluded Forest) x3
Forestry Type (YA) and Gross Area (Ha)
Spotted gum, lronbark, White Stringy bark, Brown bloodwood, Sydney Peppermint, Silvertop Ash and Large Fruited Red Mahogany.
Species and Species Mix (Sawlog)
46 Sydney Blue Gum (13.6 Ha)
63 Woollybutt (5.0 Ha)
70 Spotted Gum (39.5 Ha)
73 Spotted Gum-Sydney Blue Gum/Bangalay (12.2 Ha)
74 Spotted Gum-Ironbark/Grey Gum (13.7 Ha)
75 Spotted Gum-Yellow/White Stringybark (0.01 Ha)
76 Spotted Gum-Blackbutt (2.0 Ha)
102 Yertchuk (20.9 Ha)
115 Sydney Peppermint-Stringybark (6.6 Ha)
128 Sydney Peppermint (73.8 Ha)
46/92 Sydney Blue Gum/Bangalay (9.7 Ha)
Gross Harvest Area
203.8 ha
Net Harvest Area
157 ha
History and Stand Condition:
Predominantly mixed aged stand which is mature to overmature, with some sparse/scattered regrowth. Generally the stand has reached its end point in terms of value adding growth, however is in good health. Generally the majority of the sawlog is on the ridges and just off the ridges and thins out towards the drainage lines. The viability of the harvest areas around the drainage lines will be dependent on firewood markets at time of harvest.
Wildfires: 1944, 1965, 1968, 1972, 1980, 1982, 1991, 1994 and 2001.
Logging: 1991 (8,000 m3).
TSI: 1982.
Next harvesting approx. 30 years.
Slope %age

0-20 degrees: 96.4%
20-25 degrees: 3.5%
25-30 degrees: 0.1%
Koala records at the plot site, scats, scratches or individuals listed under Known or Potential Habitat?
No

Compartments Planned for 2021/2022 (Harvest Plans not published as at 7th December 2021)
Map File available on request:

Logging Cpts
Brooman Shallow Cro

Benandarah SF:
109A (230 Ha) suspended
114A (238 Ha)
Benandarah and Boyne SFs:
108A (313 Ha)
South Brooman SF:
52A, 53A and 54A (total 480 Ha)
66A (354 Ha)

Analysis of Compartment Harvest Plan Features

Reserves, exclusion zones and other protections:
These are specified and numerous. Whether they are large enough is a matter for a future research project.
Maintenance of connectivity is apparent, especially along creek lines.
Potential EEC's (River Flat Eucalypt Forest, suited to koalas) are protected.

Historic Disturbance:
Wildfires and forestry operations are the main apparent disturbance.
Wildfire impact is variable across and within Compartments.
Generally, harvesting is listed as occurring every 30 years. Whether this is too frequent is a matter of contention between conservationist researchers such as Lindenmayer, and forestry industry research pointing to koala use of young or burnt trees in other regions. The *"Breachwatch"* group https://www.breachwatch.org.au/, which monitors Forestry Corporation NSW operations from a community environmental perspective, disputes the 30-year figure, citing:

- South Brooman Cpt 66 was last logged in 2001 and is now proposed again (20 year gap).
- South Brooman Cpt 59 was logged last year after only being last logged in 2008 (12 year gap).
- Cpt 65 was last logged in 2016, 66 in 2001, and 63 in 2010, although none of these is proposed at this stage.
- Nadgee Cpts 158/161/162 active now, last logged 2007, 14 years ago in Eden region.
- Tallanganda Cpt 2451 near Braidwood active now, last logged 15 years ago.
- Mogo Cpt 146 active now, last logged 2006, 15 years ago.
- Bolaro Cpts 242/243 last logged 2005, 16 years ago.

Logging yields appear to have increased markedly in the past 30 years or so, prompting speculation that increased logging intensity might play a part in the apparent decline of nearby koala sightings since the 1970's, and the scarcity of koala records since 2009.

Slopes:

Within harvesting areas, slopes of 0-20 degrees (optimum for koalas) heavily dominate the percentages (mid 90%s). The net harvesting areas are the overwhelming majority of the gross areas for Compartments.

Water:

Stream exclusion zones proliferate across Compartments, and there are creeks mentioned (eg Cockwhy, which is substantial).

Patch Size, Eucalypt Species and Koala Records:

Most Compartments are large enough for a koala home range on their own (estimated at 50 Ha to 350 Ha for low-density koalas in the NSW South East, depending upon which research is consulted), if they were all good habitat. Slopes and access to water appear favourable, a degree of connectivity is maintained by exclusion zones, wildfire impact varies and the impact of the intensity of logging is unclear, so the main feature that remains to indicate carrying capacity potential, is the distribution and density of suitable eucalypt species (for ratings, refer *NSW Review of Koala Tree Use 2018*).

Cpt Number	***Spotted Gum only (Ha)***	***Spotted Gum dominant with High/Signif Koala Use Other Species (Ha)***	***High/Signif Other Species only (Ha)***	***Recorded Koala Evidence (# and Date)***
119	102	9	114	0
112 & 113	211.6	11.5	203.1	0
114 & 116	181.4	410.2	36.8	0
100	386		98	0
103	315.5		153.1	0

104		293.7		0
105	94.4	279.6	37.7	0
106	197.7	250.5	19.1	0
107		531.6		0
93 & 94	366	122.1		0
95		226	4	0
57	154	165	175	0
65	169		29.8	1 (Year 2009)
67	39.5	27.91	129.6	0
TOTALS	***2,217.1***	***2,327.11***	***1,000.2***	***1***

Findings from Harvest Plans (Only) Analysis

Eucalypt Species distribution:

The table above clearly demonstrates the dominance of Spotted Gum (Irregular Use Koala Tree). Half of the Compartments contain stands of pure Spotted Gum.

On the other hand, also in half of the Compartments, there are stands of Spotted Gum dominance with one or usually multiple High Use Koala Trees mixed in.

In addition, 11 of the 14 Compartments have stands of varying Hectares which are made up purely of High or Significant Use Koala Trees. In 4 Compartments, these are the largest stands.

Note: When rating tree use by koalas, caution is required. For example, [a contact] reported that he used to have koalas in captivity in Sydney, and they loved Spotted Gum (rated "Irregular" by the NSW Review) in October, November & December, but went off it the rest of the year. He has lots of experience working with animals, and says they typically browse on what's available – they adapt when their favourite food isn't available.

Let's say the stands of pure High Use Koala Trees are all accessible to any local koalas and High Use koala trees in other regions are also High Use here. That would provide 1,000.2 Hectares of high quality browse.

At the most conservative NSW South East koala home range estimate (350 Hectares), that amount of browse would carry 2.86 "breeding associations" (each with a dominant male, a breeding female and a few others).

At the more optimistic home range estimates of 100 and 50 Hectares, that total browse would carry 10 and 20 breeding associations respectively.

On the optimistic estimate, only 2 Compartments (Cpts 112/113 & 103) might carry a couple of breeding associations each, on their own.

One could argue there is sufficient browse and connectivity amongst the Spotted Gum dominated mix (2,327.11 Ha) and the pure Spotted Gum stands (2,217.1 Ha) to generate a carrying capacity, across the whole State Forests component of the study patch, of at least one breeding association.

That would seem to correlate with the May 2020 Old Store Creek roar reports (the only post-fire evidence) and the history of rare but persistent sightings up to 2009, then the one during the 2019 fire.
On the other hand, if the whole State Forests component of the study patch can carry only one breeding association, the future of the resident group is threatened if there are no other breeding associations elsewhere, accessible to dispersing animals, hence the importance of connectivity from the State Forests component to other promising places in the study patch. Only one Compartment (Cpt 65) has a koala record.

Positives for a carrying capacity estimate:

- Whole State Forests patch size - total forest stands of all Compartments is 5,544.41 Hectares, which would carry at least 15.84 NSW South East breeding associations if it was all good habitat
- Gentle slopes
- Reasonable access to water in non-drought periods
- Surviving vegetation connectivity
- High Use Koala Eucalypt species exist amongst the Spotted Gum dominance
- One koala record (2009) reinforcing the contextual non-Harvest Plan East Lynne reports of 2019/20 and prior

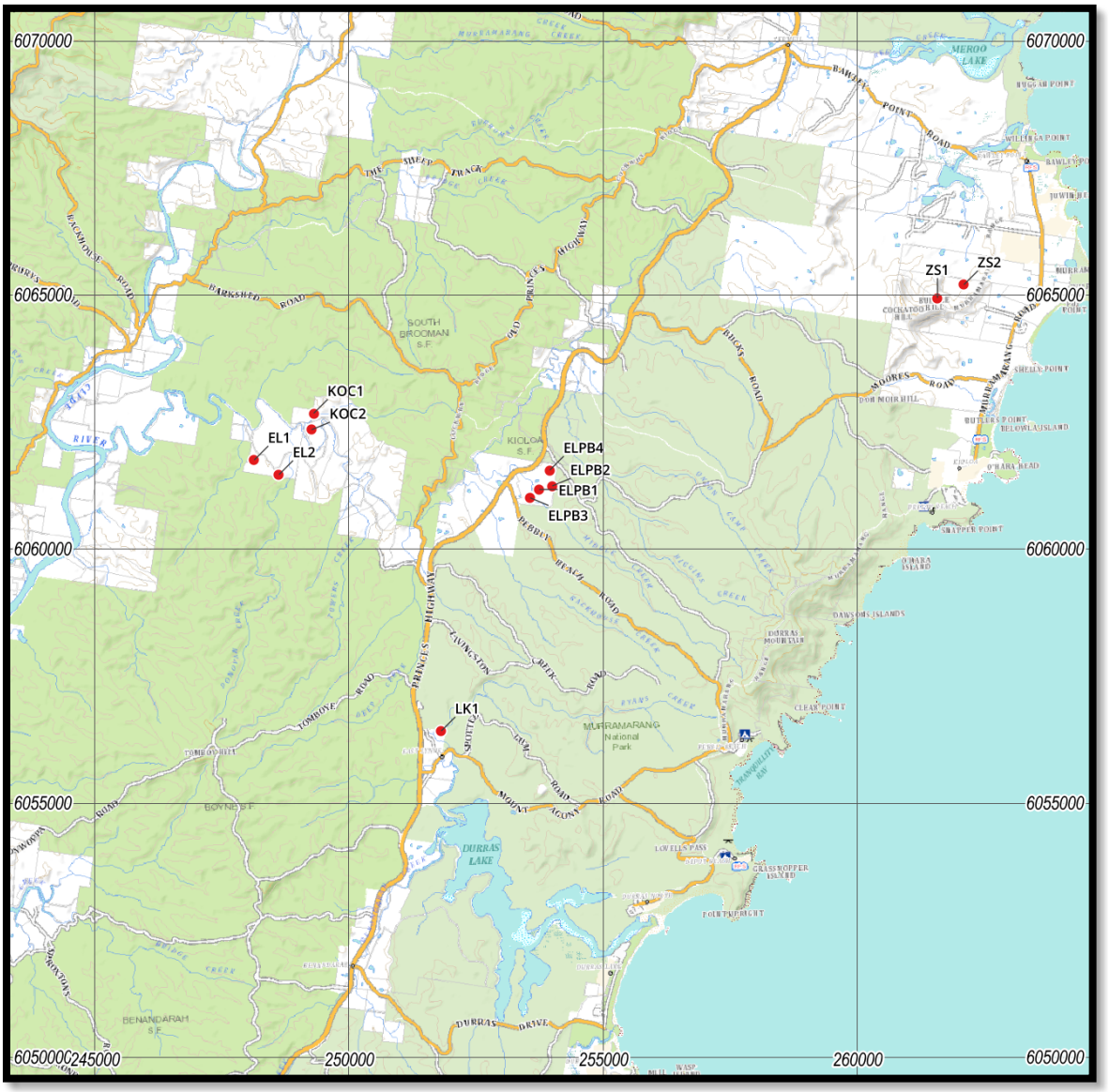
Negatives, to be applied as discounts to the carrying capacity estimate:

- Patch sizes/Compartments with insufficient dominance of High & Significant Koala Use tree species
- High Use Koala Tree species are a minority, in total, of a Spotted Gum dominated landscape
- Effects of the 2019 wildfire (worst in history, after a particularly severe one in 1968)
- Ongoing climate change
- Continuing development/clearing on adjacent private acreages

Not designated here as applicable to koalas, but contested:
30-year logging cycle

Plot Surveys

Eleven plot surveys have been undertaken on private properties around East Lynne. These surveys help provide advice to owners about the suitability of their properties as part of a local koala habitat landscape. They also serve to build the Eurobodalla Koala Project database, are submitted to the NSW Government for its comprehensive database, and are useful as ground-truthing samples when considering the wider habitat in which they sit. Each plot contains 30 live trees of DBH 150mm and greater. Data for multiple habitat factors including tree species and sizes, soil, slope, aspect, shade and disturbance history, are collected on a spreadsheet adapted from the widely-used habitat and population estimation RGBSAT method.



The eleven surveys suggest viability of the local low-density habitat, including diversity amongst available browse species, especially around creek flats such as Cockwhy.

Plot Number	*Location and Date*	*Species and # Found*	*Comments*
EL1	Donovan Creek Road. 24/10/2012	**Epip x13** **Eglo x10** **Ecyp x3** **Cgumm x4**	Koala seen in year 2000. Large Ecyps & smaller EsalxBots adj to plot. Euc ID difficulty. Messmates known locally.
EL2	Old Store Road, adj to Boyne SF Cpt 832. 24/10/2012	**Cgumm x12** **Ecyp x1** **Eglo x12** **Cmac x2** **Epip x3**	Euc ID difficulty. Messmates known locally.
ELPB1	Pebbly Beach Road. 21/7/2017	**Eobliq x18** **Eela x3** **Cgumm x8** **Angflo x1**	Euc ID difficulty re Obliq fruit? Euc ID difficulty: Eela or Esalxbot? Good local knowledge.
ELPB2	Pebbly Beach Rd, higher up, adj to Murramarang NP. 21/7/2017	**Eobliq x20** **Angflo x9** **Cmac x1**	
ELPB3	Pebbly Beach Rd, nearer creek. 9/9/2017	**Eobliq x17** **Esaligxbot x5** **Angflo x1** **Ebos x7**	Euc ID difficulty: Ebos, Ebau or Epip?
ELPB4	Pebbly Beach Rd, higher up, adj to Murramarang NP. 9/9/2017	**Eobliq x17** **Angflo x3** **Emue x8** **Ebos x2**	
LK1	Old Sawmill Lane. 18/9/2020	**Cmac x8** **Epan x12** **Eglo x4** **Esalxbot x2** **Eobliq x2** **Etere x2**	Above creek on black loam – historic Etere location. Etere still adjacent to plot.
KOC1	Sheas Creek. 23/6/21	**Esalxbot x15** **Cmac x1**	More Etere near plot.

		Ecyp x4 **Angflo x6** **Eela x1** **Epip subsp urc x2** **Etere x1**	Euc ID difficulty: Etere or Ecyp – found fruits for both. At neighbours', on Cockwhy Ck: Etere, Esalxbot, Eela, & Angflo; plus higher up Epan, Cgumm, Cmac & Angflo.
KOC2	West-facing hillside above Cockwhy Creek. 2/6/21	**Emue x16** **Epip subsp urc x3** **Angflo x10** **Esalxbot x1**	Euc ID difficulty: Emue.
ZS1	Bawley Point (hillside). 13/6/2021	**Epan x14** **Cmac x14** **Emue x1** **Cgumm x1**	Outside the study polygon, but nearby and connected by vegetation southward to Murramarang NP. Signif stand of Etere on other ridge (granite).
ZS2	Bawley Point (creekside). 13/6/2021	**Epil x16** **Cmac x14**	Location as for ZS1. Euc ID difficulty – settled on Epil.

Murramarang National Park

Murramarang National Park follows the coastline from Long Beach north to Merry Beach near Ulladulla. It is surrounded by three state forests, Kioloa, South Brooman, and Benandarah. The park forms part of the Ulladulla to Merimbula Important Bird Area, identified as such by *BirdLife International* because of its importance for swift parrots.

Some Events Selected from a History of the "Greater" Murramarang National Park

1976 The NSW National Parks Association proposed a much enlarged *Murramarang National Park* for inclusion on the Register of the National Estate. The extended National

Park of approximately 18,000 ha. was to include Benandarah and Kioloa State Forests with Tabourie Point its boundary to the north, Batemans Bay the southern boundary and the western boundary, the Princes Highway. Termeil, Meroo and Durras Lakes were within the expanded National Park.

1983 The forests of the "Greater" *Murramarang National Park* (and much of Benandarah and Boyne State Forests, west of the Princes Highway) were placed on The Register of the National Estate, "significant for both natural and cultural values."

1985 Friends of Durras commissioned Mr P.J. Craven, Bachelor of Natural Resources (Hons.) to research and publish an *Environmental Survey of the South Durras District*.

1986 The Friends of Durras applied to have an Interim Conservation Order placed over all undeveloped lands adjacent to Durras Lake.

1986 On environmental and economic grounds the Friends of Durras prevented the introduction of reticulated water to South Durras.

1987 After a successful campaign by the Friends of Durras, the then Minister for Planning, Mr Bob Carr, disallowed the Urban Expansion Zone re-zoning. The NSW Department of Planning noted the high conservation value of the area.

1987 The Forestry Commission of NSW released plans to harvest 61.6% of Benandarah State Forest Compartment 128 which abuts Durras Lake.

1987 Friends of Durras commissioned Mr P.J. Craven to research and publish a *Review of Forest Management within the Durras Lake Catchment Area*.

Friends of Durras negotiated with the Forestry Commission over the extent of the proposed logging and its potential to degrade Durras Lake.

1987 The Forestry Commission agreed to reduce the harvesting area of Compartment 128 to 52% and to avoid some particularly ecologically sensitive areas (rainforest gullies).

1996 The IDFA process deferred almost all Kioloa State Forest compartments, from logging. Compartments in the Benandarah State Forest were not deferred. The Friends of Durras decided to undertake their own forest assessment of the area.

1996 (October) The Forestry Commission of NSW (State Forests) posted an Intent to Harvest for Compartment 133, Benandarah State Forest, and remove up to 50% of the canopy cover. Friends of Durras objected and the logging plan was dropped. The Friends of Durras continued negotiations with State Forests over future logging in the "Greater" *Murramarang National Park.* State Forests agreed not to harvest in any

"Greater" *Murramarang National Park* compartments during 1997, 1998 and 1999.

1998 (February) Friends of Durras and the NSW National Parks Association conducted a biodiversity survey in Benandarah State Forest. Seventy volunteers gathered data over four days. The results were added to the NSW National Parks and Wildlife Service's comprehensive assessment of the forests of the RFA Southern Zone.

Vegetation

Extract from Murramarang National Park Plan of Management 2002

"The most common vegetation association in the park is open forest/tall open forest dominated by spotted gum Eucalyptus maculata, with an understorey of burrawang Macrozamia communis and various shrubs. Other common tree species include E. paniculata, E. pilularis, E. longifolia, E. agglomerata, E. botryoides, E. globoidea, Angophora floribunda, Allocasuarina verticillata and Allocasuarina littoralis. In sheltered locations a rainforest understorey occurs. Adjacent to the coast the spotted gum forms a low forest. A forest of hybrid E. botryoides/E. saligna with a rainforest understorey occurs on the higher slopes of Durras Mountain and on lower areas close to Durras Lake. Small areas of E. botryoides woodland occur along the coastline in the northern part of the park while south of Durras Lake the bangalay is replaced by Casuarina glauca, E. paniculata, E. agglomerata and E. globoidea. The woodland is closely interlinked with areas of scrub and heath."

Topography

https://en-au.topographic-map.com/maps/np83/Murramarang-National-Park/

The main areas (away from the seashore and Durras Lake) are gentler slopes at altitude 55 metres to 95 metres.

The steeper central eastern ridge (topped by Durras Mountain) rises through 118 metres to 367 metres, with a similar height at Bundle Hill to the north east.

Geology

Murramarang National Park encompasses two major geological provinces - the Permian Sydney Basin and the much older Ordovician beds of the Lachlan Fold Belt. The geological features of the park are of considerable scientific importance. Durras Mountain is capped by basalt. The link for full detail is http://www.geomaps.com.au/scripts/murramarang.php.

Environmental Factors

Report of South Coast Walk Study, Mentioning Koala Tree Species Including Forest Red Gum in the Southern Sector:

https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-management-other/murramarang-south-coast-walk-draft-review-environmental-factors.pdf
"Koala browse species: Scattered presence of a Primary Koala Feed Tree, Forest Red Gum, mostly in the southern sections of the study area, being rare elsewhere (p.65).

The study area has a range of nectar sources, including: Banksia ericifolia (Heath-leaved Banksia), Coast Banksia, Old-man Banksia, Corymbia maculata (Spotted Gum), E. globoidea (White Stringybark), E. paniculata (Grey Ironbark) and E. tereticornis (Forest Red Gum). Includes key wintering flowering nectar sources for seasonal migrants such as Lathamus discolor (Swift Parrot).

Lerps are common in eucalypt species found within the study area. Eucalypts with lerps preferred by Swift Parrot.

Range of canopy nectar sources preferred by arboreal mammals including threatened species such as Petaurus australis (Yellow-bellied Glider), Petaurus norfolcensis (Squirrel Glider), Eastern Pygmy Possum, and Pteropus poliocephalus (Grey-headed Flying-fox).

The study area has sap trees eg Spotted Gum and Forest Red Gum. Preferred sap source trees for Squirrel Glider and Yellow-bellied Glider are present, although no typical incisions were observed during field surveys."

The SCIVI Type Named After the Location

p86 Murramarang Lowlands Forest (see above), featuring:

- E paniculata
- E longifolia
- C maculata

More on Flora

Description of Greater Murramarang NP
http://www.morning.com.au/fod/part1a.htm

FLORA

Australia has the second-highest number of plant species threatened by extinction of any country in the world. About 14.4% of Australia's 15 638 known plant species are listed in the World Conservation Union (IUCN)'s Red List of Threatened Plants (Hogarth, 1998).
The "Greater" Murramarang National Park has over 400 recorded plant species (Appendix 1).

OVERSTORY

The forests of the south coast of New South Wales are synonymous with Spotted Gum (C. maculata), the dominant forest overstory species in the "Greater" Murramarang National Park. Around 35% of the total forest area is Spotted Gum. Stands of Spotted Gum associated with Sydney Blue Gum (E. saligna), Blackbutt (E.pilularis), Bloodwood (C. gummifera), Stringybark (E. globoidea), Bangalay (E. botryoides) or Grey Ironbark (E. paniculata) account for a further 57% (State Forests, 1996). The Spotted Gum forests of the present Murramarang National Park are the largest by area in any New South Wales national park (Wright, 1996).

In his studies of forest communities of the Batemans Bay region, Dr R.G. Florence (1996) of the Australian National University's Department of Forestry, found that landform relief, soil fertility and soil properties all play an important part in delimiting the different species of overstory species. Rainforest was found on soils of highest fertility and better physical soil conditions, followed by high quality vegetation communities dominated by Spotted Gum. The high productivity of the Spotted Gum communities was reflected in their leaves and litter with phosphorus and foliar calcium levels markedly higher than those communities dominated by Sydney Peppermint (E. piperita), Blackbutt or Bloodwood. Sydney Peppermint is uncommon in the park.

This confirmed the results of a study of land use allocation and biological conservation in the Batemans Bay Forests by CSIRO scientists Braithwaite, Belbin, Ive and Austin (1993). They examined a wide range of forest values in national parks, state forests and on freehold land and from them classified forest sites as to their 'site productivity.' 'Site productivity' they suggested was a direct measure of the value of a piece of land for timber production as well as for other forms of primary production. They found that the four vegetation associations characteristic of sites of maximum productivity were, (i) Spotted Gum (ii) Spotted Gum with Sydney Blue Gum (iii) rainforest and (iv) Spotted Gum with Stringybark. These associations dominate the "Greater" Murramarang National Park and represent a wealth of timber resource. The dilemma is that they are also prime biodiversity habitat.

Site productivity is a crucial issue in ensuring a genuine Comprehensive, Adequate and Representative reserve system. Too often sites of low biological productivity are reserved at the expense of high productivity sites.

Braithwaite, Belbin, Ive and Austin also discovered that the most productive forest sites and their vegetation associations were the least represented in National Parks and the most extensively disturbed by logging or clearing. In fact only 3.5% of the area's Spotted Gum forest was in national park, 55.7% under State Forest tenure and 40.8% freehold - and only 8% of the Spotted Gum forest type was 'minimally disturbed.' In contrast, of the three vegetation associations which dominate poorer sites, more than 38% by area was in national park and of each association, more than 74% remained in a minimally disturbed or undisturbed condition.

"The flora is predominantly wet eucalypt forest comprising spotted gums with an understorey of burrawangs leading to banksia, she-oaks and heath on the beaches and headlands. There are small areas of rainforest in sheltered gullies, particularly around Durras Mountain."
…and…
"Eucalypt Trail
The aim of the Eucalypt Trail is to help people identify eleven different species of eucalypt which are common on the South Coast. If you are attentive you will see Blackbutt, Sydney Blue Gum, Grey Ironbark, Monkey Gum, Rough Barked Apple, Sydney Peppermint, Red Bloodwood, Spotted Gum, Woollybutt, White Stringy Bark, and Bangalay."

Miscellaneous Contextual Information About the Surrounding Area

Dave Bulman's GIS modelling for our Pilot Study project showed the general East Lynne area as having "low" potential as koala habitat, but with small patches of "high" and "nil" potential along the Clyde River & tributaries, plus a bigger patch of "high" potential further east inside the Murramarang National Park.

During the pilot study, a potential location of interest was identified as the "blue gum gullies" near East Lynne and Benandarah (report of a sighting at "Big Bit" Lookout) and based on topography, apparent tree species (Monkey Gums) and the history of the "Eucalypt Trail" (now in Murramarang National Park) near the Princes Highway North Durras (Mt Agony Road) turnoff.

Potential sites identified were the private properties at East Lynne (Cockwhy Creek, Old Store Creek, Donovans Creek Road), 94 hectares total, with potential access to 2 other adjacent properties (additional 90 hectares).
All share boundaries with South Brooman State Forest (Murramarang National Park and Kioloa ANU Research Field Station are nearby).
Forest type is Southern Lowland Wet Forest (eg Messmate, Yellow Stringybark, Red Stringybark, Manna Gum/Ribbon Gum, Sydney Blue Gum, Forest Red Gum).

Blue Gum (E. saligna) favours gullies too moist for Spotted Gum.
The forest around the approach to Pebbly Beach (Kioloa Forest Drive) was heavily logged in the 1930s, then ringbarked to encourage regeneration, a method no longer used.
On the approach to Pebbly Beach, the forest around was logged "earlier this (20th) Century" and the timber hauled by bullocks to a sawmill near the beach. Sawn timber was then taken on a tramline to the Northern end of the beach, offloaded into the rocks, then winched aboard a ship. Winching pole was still there as at 1989.

This section was again logged in 1969, allowing the smaller trees to grow larger and new seedlings to become established.
There's an area set aside for forestry research. Plots were established in 1970 to examine how various logging practices affected the behavior of trees after the millable timber was removed, and to observe the general regeneration of the forest.

Interpretation of Material on Murramarang National Park

Most of the topography is suitable.
35% of the forested area is Spotted Gum. 57% of the area is Spotted Gum associated with other koala-suitable species, but high-use species like Forest Red Gum and White Stringybark are not dominant.
This seems to suggest Murramarang National Park offers viable but non-optimum low-density koala habitat similar to what is available in the Forestry Compartments.
One might speculate, as a best-case scenario, the National Park could carry a couple of breeding associations, given its overall size.

Local Landholder Observations

Landholder 1, May 2011:

Provided detailed material including topographic map, native vegetation map report, and the property's (Burrawang Co-op) management plan.

The veg types are South Coast River Flat Forest (Cockwhy), Clyde Gully Wet Forest, Southern Lowland Wet Forest and Flood Plain Swamp Forest.

The CRA map shows the veg & wildlife there need to be surveyed – there's a big white patch right where Burrawang Co-op is, and there are koala records along Cockwhy Creek.

About 33% cleared for human footprint, remainder post-logging regrowth, plus one section of approx. 33 hectares Clyde Gully Wet Forest placed in formal protection

Extant Greater Glider & Yellow-bellied Glider; nearby Grey-headed Flying Fox camp; last firm Koala sighting 2000; Extant Glossy Black-Cockatoo; Forests NSW records for Powerful Owl, Masked Owl, Sooty Owl, Pink Robin, Regent Honeyeater & Brown Treecreeper.

Landholder 2, July 2011:

(Birdland Wildlife Park had two koalas then, but no longer. Landholder was head koala keeper.)

At the Birdland feeding demonstration the landholder showed how the koalas seek out the tips, because they're after the moisture ("koala" – Aboriginal word for "no drink"). She mentioned Messmate (E. obliqua) as a particular favourite, as well as Tallowwood (E. microcorys) and Blue Gum (E. globulus).

The Birdland boys (*Boris & Macca*) will eat 22 of the 80+ Australian eucalyptus species. They are active and eating for about half an hour, then they sleep for 3 or 4 hours at a time.

Birdland has about 2000 small trees in its on-site plantations, on drip-feed with timers, fertilised every two months. It's difficult because the soil is sandy loam and needs a lot of water. (*The soil on her property at home is better – clayey and hard*).

The trees in the Birdland plantations are:

- Swamp Mahogany/Swamp Messmate (E. robusta)
- Yellow Stringybark (E. muelleriana)
- Red Gum (E. tereticornis)
- Sydney Blue Gum (E. saligna)
- Southern Blue Gum (E. globulus)
- Manna (E. viminalis)
- Grey Gum (probably E. punctata)
- Tallowwood (E. microcorys)
- Silvertop Ash (E. sieberi)
- Swamp Gum (E. ovata)

The landholder brings in browse from home for the koalas at Birdland.

Original species growing on her property at Donovans Creek Road, East Lynne are:

- Messmate
- Yellow Stringybark

- Red Stringybark
- Gum/Ribbon Gum
- Sydney Blue Gum
- River Red Gum (landholder and her sister have alluvial river flats and it grows on them)

Species the landholder has planted at home (she has tube stock) are:

- "Silverton" (Red Gum)
- Swamp Mahogany
- Manna Gum
- Tallowwood

Landholder 3, 2012:

Property is adjacent to state forest, its geology is Ordovician Metasediments and the vegetation progresses through a dry Stringybark and Casuarina patch, to Yellow and White Stringybarks, Messmate, Cabbage Gum and then to Mountain Grey Gum and Ironbark.

Landholder 2 (17th May 2020 – six months after Currowan Fire)
38.5 Hectares along Cockwhy Creek, plus another 447.5
Coming back well.
Leaves are low, so species are easy to identify.
Feed has come back phenomenally – it's abundant.
Yellow Stringybark, Messmate, Bloodwood, Blue Gum, Ribbon Gum.
In the plantation: Mahogany, Manna Gum and Red Gum (E tereticornis).

Landholder 4, early 2020:

Monitored tree recovery after Currowan fire.
Particularly mentioned Blue Gums.

Landholder(s) 5, Old Sawmill Lane, September 2020:

Pointed to their recovering Etere and wish to plant more.
Described ferocity of wildfire.

Landholder(s) 6, Landholder 1's neighbours, June 2021:

Along Cockwhy Creek, they have Eucalyptus elata and Eucalyptus saligna x botryoides.
On the flat, they have Eucalyptus tereticornis and Angophora floribunda.
Up higher they have more Angflo, plus Grey Ironbark (Eucalyptus paniculata – High Use, Central Coast), Corymbia gummifera (Red Bloodwood – Irregular Use, South Coast but Significant Use, Central Coast) and lots of Corymbia maculata.
Their neighbours Landholders 7, want us to look at their "Valley of the Giants".

Landholder(s) 8, Bundle Hill, Bawley Point, June 2021:

Eastwards, there are two paddocks, with Spotted Gum, Bangalay and some Forest Red Gum.

In the higher “bowl” behind the house, on granite, is a substantial dominant stand of Forest Red Gum (we walked through there and found plenty growing up on that ridge).
Further down, near the creek, there is more diversity.
Then up the other side, where it becomes Sandstone, there are Bloodwood, Yellow Stringybark and some Ironbark (remnants left from the historical logging).
A couple of big, hollow Spotted Gum were burnt out in the fire, including one that was probably 300 years old.

Connectivity Beyond the East Lynne Area

In terms of the broader landscape for a revived, sustainable NSW South Coast koala population, connectivity beyond the East Lynne area is important.

One avenue is to koala places in the Queanbeyan/Palerang and Shoalhaven Shires, via the Budawangs and Nerriga, even as far as Wollondilly Shire, where koala use species offering potentially unbroken vegetation connectivity include E tereticornis, E moluccana, E radiata, E saligna, E viminalis and E obliqua.

Eucalypts North West of Braidwood – Facebook Contributor

"Eucalyptus mannifera is one of the most common native species in that area (I'm assuming Warri/Cronins Crossing area), definitely not introduced. On the granite country you get lots of the typical southern tablelands species though the particular assemblage in any given spot is often determined by the topography - mannifera, rossii, dives, pauciflora, melliodora, rubida, sieberi and viminalis are all reasonably common in that area. You get the odd aggregata, a rarer threatened species, along the Shoalhaven near Bombay as well."

A contact's Remarks About Araluen Area Connectivity

"We are in the Araluen Valley, prime koala habitat till they were shot out in the 1930's, with several habitat species. We are a Conservation Area adjacent to the Major's Creek Conservation Area and with wildlife corridors to the Deua and Monga National Parks. The land here is steep and difficult for humans and ferals to access, which is why so many endangered species have survived here. There is no written, oral or charcoal evidence this end of the valley has ever been burnt, as the updraft and terrain has so far kept it a refuge, though this is no longer secure with changing climate. We're in Palerang ..."

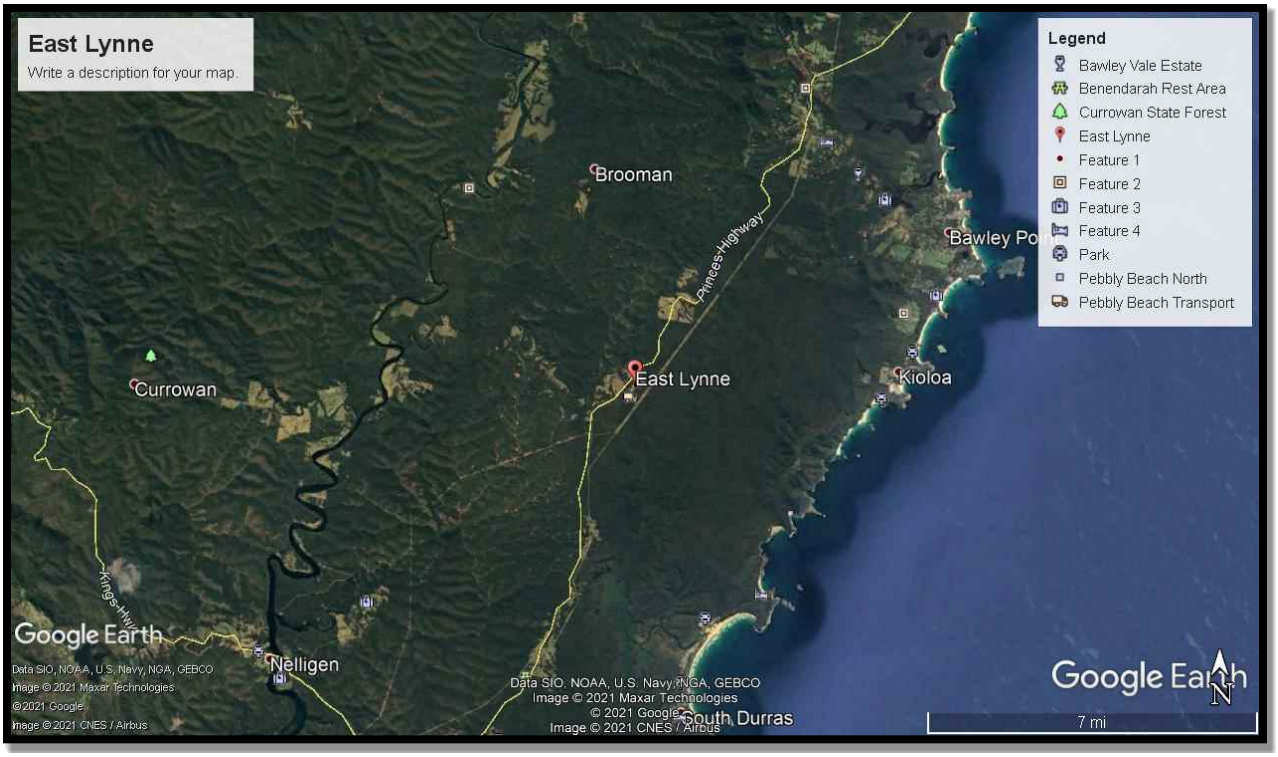
The Bungonia/Shoalhaven Grey Box is probably E moluccana (also called Gum-topped Box). It only occurs south as far as Jervis Bay, but there's possibly habitat connectivity from Bungonia right down into our region via the Forest Red Gum and Manna Gum studied by Hammond.

The other avenue is to the Eurobodalla Shire, via the State Forests, the nearby Clyde River NP, Runnyford etc, all the way to Deua, Dampier and Bodalla koala hotspots like Wamban, Nerrigundah and those in the northern Bega Valley Shire, discussed in our other projects.

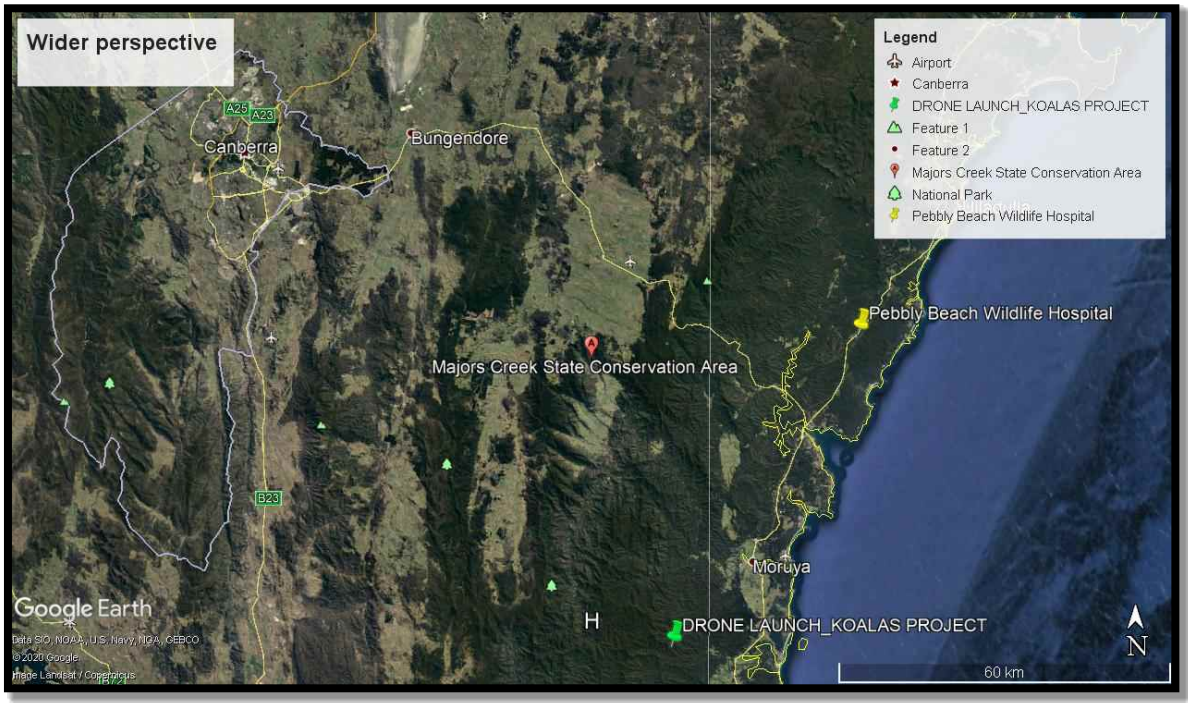
Extract on Vegetation from Clyde River National Park Management Plan 2012, suggesting viable browse connectivity

"A vegetation survey of the eastern section of the park (Douglas and Bell 2003) found a total of eight vegetation communities on park, plus another on adjacent Crown land along the river. The communities can be generally categorised as dry and moist open forests and estuarine forests. The survey updated vegetation modelling undertaken under the Southern CRA. The most extensive community is Coastal Lowlands Cycad/Shrub Dry Forest, dominated by spotted

gum (Corymbia maculata) with white stringybark (Eucalyptus globoidea) and grey ironbark (E. paniculata). Understorey elements include a small tree layer of black sheoak (Allocasuarina littoralis) and a shrub layer of burrawang (Macrozamia communis), Persoonia linearis, Leucopogon lanceolatus, Hibbertia aspera and Platysace lanceolata. The community occurs on the ridge lines and slopes of most of the eastern section of the park, on spur ridges in the western section and on the higher parts of the two islands. Logging substantially disturbed the eastern section immediately prior to gazettal of the national park and many areas are floristically modified. There are recognisable variants and ecotonal complexes within the community and it is possible that the vegetation mapping and classification will be modified as the park recovers from the effects of logging. Northern Coastal Hinterland Moist Shrub Forest occurs extensively in lower areas west of the river and at Chinamans Point. Blackbutt (E. pilularis) and spotted gum generally dominate the canopy but the Chinamans Point stand is almost pure blackbutt. Rough-barked apple (Angophora floribunda) and Sydney blue gum-bangalay (E. saligna-E. botryoides) may occur in more sheltered situations. Mesic elements such as blueberry ash (Elaeocarpus reticulatus), bastard rosewood (Synoum glandulosum) and native olive (Notelaea longifolia) are found in the understorey with sclerophyll shrubs like Persoonia linearis and Acacia longifolia. Vines and ferns are common. The stand at Chinamans Point has been logged. Two areas of tall open forest dominated by Sydney blue gum-bangalay occur in north-facing gullies in the eastern part of the park. The community has a sparse midstorey of black sheoak, cheesetree (Glochidion ferdinandi) and blueberry ash over a ground stratum dominated by sedges and bracken (Pteridium esculentum). It has similarities to Northern Coastal Hinterland Moist Shrub Forest but was considered sufficiently distinctive to map separately. Further survey may find additional patches of this community and it is possible that rainforest elements will increase as the forests regenerate from logging. A combination of Hinterland Heath Shrub Dry Forest and Northern Plateau and Escarpment Heath Shrub Dry Forest occurs on an exposed ridgeline south of Sheep Station Creek. This community is a low forest of red bloodwood (C. gummifera) and yertchuk (E. consideniana), with black sheoak and a sclerophyll shrub understorey. The community has been significantly affected by logging and burning. Areas of Forest Red Gum Open Forest/Woodland occur on both sides of the Clyde River near Little Island and Sheep Station Creek. Forest red gum is co-dominant with swamp oak (Casuarina glauca) in some places, with Goodenia ovata in the understorey. A stand south of Sheep Station Creek has been significantly degraded by camping. An area of Woollybutt/Forest Red Gum Forest occurs along a tributary of Sheep Station Creek. The community is an open to tall forest dominated by woollybutt (E. longifolia), forest red gum (E. tereticornis) and rough-barked apple, with a moist understorey. Most of this community has not been logged and it contains old growth canopy trees."

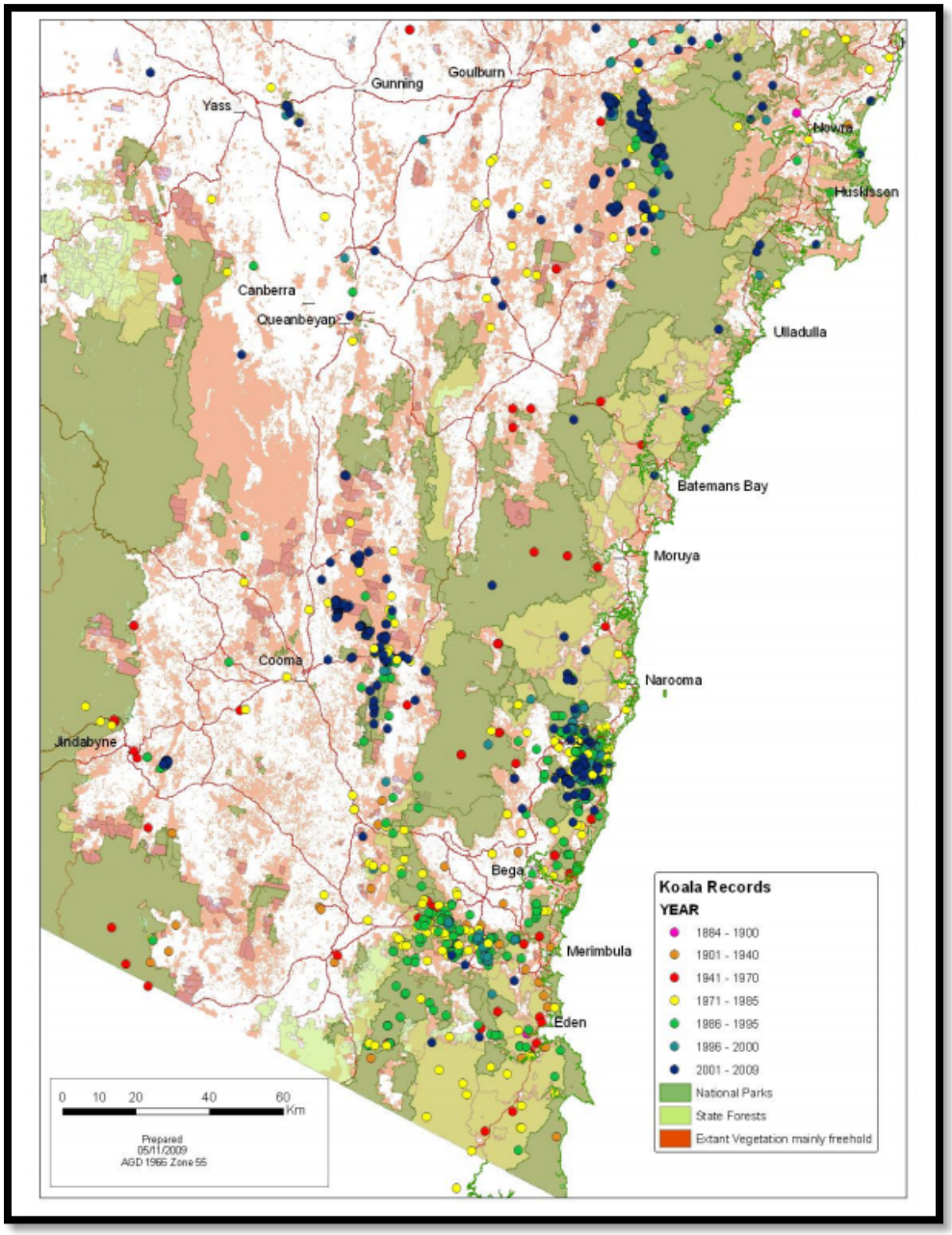


Vegetated surrounds of East Lynne



East Lynne's Regional Neighbours

East Lynne, with Jervis Bay to the north, Montague Island to the south, the high country to the south-east, and central NSW to the west

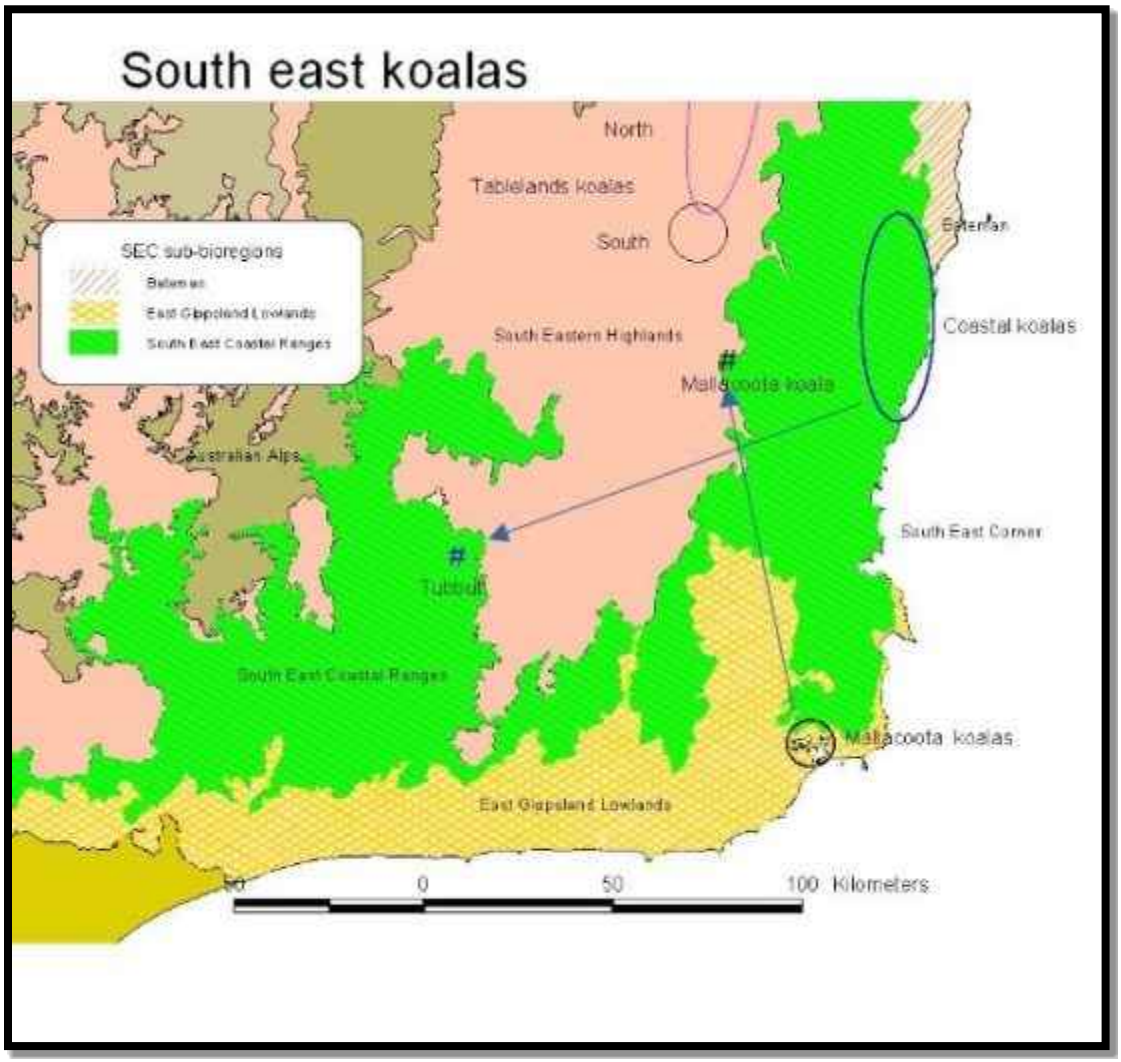


Koala Records to 2009 (South East NSW)

Extract from Robert Bertram Blog

"Now more than a year after the fires there is little information on the outcomes for koalas in the south east. Koalas on the tablelands were found emaciated and dehydrated before the fires. Based on our community research the few coastal koalas in unburnt areas had to survive between the trees with reduced leaf water content on ridges and slopes and bell-miner colonies or viney scrub in gullies.

It seems likely only the coastal koalas are endemic and they are identical to a koala found at Tubbut 30 years ago. A koala identical to those at Mallacoota was found last decade at Tantawanglo, where Victorian koalas were planned to be translocated."



Robert Bertram's Map

Occupancy Rates/Carrying Capacity Research

Extract from Draft National Koala Recovery Strategy, on Movement Patterns

"Studies of home range sizes for the Koala show they are highly variable depending on the location, generally being substantially larger inland in the semi-arid woodlands than in mesic coastal forests, reflecting variation in local patch context and quality. For example, some individuals in Central Mackay Coast bioregion have small home ranges of less than 2 ha (Ellis et al. 2015), whereas in the Mulga Lands bioregion home ranges are up to 169.5 ha (Davies et al. 2013). Home range size can also vary substantially within the same region (Ellis, Hale & Carrick 2002; Kavanagh, Stanton & Brassil 2007) and may shift spatially across years (Ellis, Melzer & Bercovitch 2009). High variability has been found on some islands (6.0-132.4 ha, North Stradbroke Island, Cristescu et al. 2011), while not on others (4.6 to 8.8 ha St. Bees Island, Ellis, Melzer & Bercovitch 2009) and the latter study found individuals in overlapping home ranges rarely used the same trees, indicating resource partitioning on fine scales. Juveniles tend to have relatively smaller home ranges than adults (Thompson 2006). Koalas use both natural and built features as home ranges or boundaries (Close, Ward & Phalen 2017) and for dispersal (e.g., tracks, Lassau et al. 2008).

Both sexes disperse from their natal home-range between about 18 and 36 months of age (Dique et al. 2003b; Mitchell & Martin 1990) where daughters are reported to occupy home ranges embedded within their maternal home range (Ellis, Melzer & Bercovitch 2009; Tucker, Melzer & Ellis 2007) or adjacent areas (Close, Ward & Phalen 2017). Typical of mammal behaviour, the species exhibit male bias dispersal (Dique et al. 2003b; Mitchell & Martin 1990) although this is not perhaps such a dichotomous characteristic in the Koala (Thompson 2006). During natal dispersal, juveniles are susceptible to vehicle strike, especially males (Canfield 1991; Dexter et al. 2018; Dique et al. 2003a). Dispersing individuals are recorded to move up to 20 km from their natal areas (Close, Ward & Phalen 2017; White 1999), with average distances reported at 3.5 km in south east Queensland (Dique et al. 2003b). While studies indicate a predominance of short-range movements (e.g., Dique et al. 2003b), genetic modelling in slightly fragmented landscapes of north-eastern NSW suggests longer movements may be in fact relatively common (15-20 % of movements at 16.8 to 20.3 km, Norman et al. 2019)."

Jurskis, Vic, The Great Koala Scam, 2020 (pp82-86)

Vic makes some mention of Carrying Capacity and "Sustainable Density" as part of his argument that managed forests with regular burning regimes are healthiest, and that low density koala populations are normal.

He cites failed translocation efforts in Victoria, where mortality rates of 25% to 100% occurred at rates of 0.3 and 0.4 koalas per hectare, which he says is unsustainable.

He references assumptions that 0.1 koalas per hectare are "moderate", "sustainable" or "low" and contends these rates are actually unnaturally high.

Chris Allen, pers comm

In informal discussion around 2012, Chris said 350 hectares (as a rule of thumb) is a south coast home range area. We have used this as our upper figure, but some of Chris' research below shows koalas at even thinner occupancy rates.

Note the figure of 169 hectares (Jurskis & Potter) below, but this was in 1997. Since then, Lunney et al have estimated the Eden population has declined at the rate of 70% per decade.

Extract From the Eurobodalla Koala Project pilot study (Pp. 46ff)

Densities and Home Range Sizes

"Home range size:

The mapped results for radio collared koalas reported by Jurskis and Potter, led them to the following conclusion on this aspect: "The average home range size (HM) was 169 ha equivalent to an average density of .006 koalas per ha of Forest." (p.40)

In reporting her 2011 undergraduate project, Merinda Williams [128, op cit] includes figures (and her sources cited below, Williams Pp. 33-37) to summarise known home range size. Williams' own study reports a spotlight survey which detected 25 koalas (including four of these with young) within the campus grounds, indicating a population density of 0.625 individuals per hectare. Williams remarks "This value is within the expected range for koala abundance within fragmented habitat in the Northern Rivers region of New South Wales, and is consistent with a previous study conducted within the Lismore area {Gall, 1980 cit – one animal per hectare}."

Other material cited by Williams gives an idea of the great variety of findings but also suggests the Bega Valley and Southern Tablelands density figures found by Allen [below] might be a reasonable rule of thumb for the Eurobodalla:

• McAlpine et al, 2006; Rhodes et al, 2006 – "The average home range is dependent on the number of trees per unit area. This usually extends to an area anywhere within the span of 1–200 ha."

• Mitchell, 1990 and Melzer et al, 2000 – "larger home ranges (and therefore lower koala densities) occurred in areas where preferred tree species were more sparsely distributed."

• Ellis et al, 2002 (Central Queensland) – "the home range was estimated as being between 101-135 ha."

• Hindell and Lee, 1987 (Brisbane Ranges/French Island); Martin & Handasyde, 1999 – "the home range for males was greater than that of females, at 3.1 ha and 2.1 ha respectively" and "supported by a range of studies that home ranges for male individuals is up to double that of females" and "a measure of abundance is provided by the calculation of koala population densities."

• Hindell and Lee, 1987 (Central-West Victoria) – "a density that fluctuated between 0.7 – 1.6 animals per hectare was reported, and abundance levels more than eight animals per hectare in north-eastern Victoria."

• Mitchell, in Martin and Handasyde, 1999 – "densities of 6-9 animals per hectare have been documented on French Island, Victoria."

• Mitchell and Martin, 1990 in Dique et al, 2004 – “densities as low as 0.005 koalas per hectare have been suggested.”
• McAlpine et al, 2008 – “koalas select individual tree species and forest stands with preferred tree species of a high proportion within their home range.”
• Dique et al, 2003; McAlpine et al, 2006 – “even though the koala is a solitary species, the home ranges of males and females will generally tend to overlap when home ranges are extensive.”

Chris Allen’s Bermagui/Murrah surveys (2007-2009 [27, op cit]) produced the following observation: 47 “An occupancy rate of 11.21% in a study area of 21,000 ha suggests that approximately 2354 ha of the area is occupied by koalas. With home range areas of 50–100 ha, a population of 23–47 koalas is suggested. This is only a tentative estimate, with some factors suggesting a higher estimate is warranted (for example, koalas will have overlapping home ranges and there may be unidentified activity cells) and others that it should be smaller (for example, the area derived using the occupancy rate data overall may be larger than home range areas).”

Allen’s 2011 Kooraban/Gulaga survey report [4, op cit] remarks: “These results suggest that only 5-15 koalas are surviving in the approximately 7000 hectares of forests assessed in this survey” and “The low activity levels at the active sites also suggest that the individual home ranges are large. As is the case with the Bermagui-Mumbulla population, each resident koala is probably occupying between 50 and 100 hectares with minimal overlap.” (p.13)

Allen’s earlier submission to the Threatened Species Scientific Committee (2010 [24, op cit]) contained the following: “Jurskis and Potter (1997, cit) provide data on home range areas used by radio-tracked koalas in the region. The harmonic mean areas of four mature koalas that appeared to be resident animals averaged 82ha. Supporting this, in assessing the data gathered in the preliminary phase of the 2007-9 survey in the Coastal Forests to the north east of Bega, Biolink (2007, cit) concluded that the koala home range areas within the study area were 50 - 100 ha. In the 2007-9 survey, 17670 trees at 589 sites covering a study area of approximately 22000 ha were assessed. Koala pellets were located at 66 (11.21%) of these sites. From these data we can extrapolate an overall “occupancy rate” (Phillips et al 2007, cit; Biolink 2007, cit) of approximately 10%, with this rate increasing to approximately 20% in Mumbulla State Forest, to the south of the study area, an area of approximately 6,000 ha. {Note that data from Campelltown (Ward and Close, 2004 cit) and from Kempsey (Phillips, pers. comm.) for low density populations of koalas utilising gum/stringybark eucalypt communities indicates koalas utilising smaller home range areas (10 – 20 ha and 30 ha respectively). It is possible that the home range size estimates above are conservative and in fact are somewhat smaller.}” (p.16)

In their 2000 document arguing the advantages of the RGBSAT survey technique [26, op cit] Phillips and Callaghan make the following observations about range size: “Studies of free-ranging Koalas have established that those in a stable breeding aggregation arrange themselves in a matrix of overlapping home range areas (Lee and Martin 1988; Faulks 1990; Mitchell 1990). Home range areas vary in size depending upon the quality of the habitat (measurable in terms of the density of preferentially utilised food tree species) and the sex of the animal (males tend

to have larger home range areas than females). Longterm (ie several years) fidelity to the home range area is generally maintained by adult Koalas in a stable population (Mitchell 1990; Phillips unpub. data).” (p.3) …and: “Ideally, activity levels derived from SAT sites should only be interpreted in the context of location-specific habitat utilisation data (Lunney et al. 1998; 48 Phillips et al. 2000; Phillips and Callaghan 2000). Low activity levels recorded in what might otherwise be considered important Koala habitat may be a result of historical disturbances including logging, mining, fire frequency, agricultural activities and/or urban development. Such considerations should not necessarily detract from the potential importance of such habitat for longer-term Koala conservation, particularly if Koala food trees are present and Koalas are known to occur in the general area. Low activity levels can also be associated with low-density Koala populations. Stable, low-density Koala populations are a natural phenomenon in some areas (Melzer and Lamb 1994; Jurskis and Potter 1997; Phillips and Callaghan 2000). Koala density in such areas generally reflects the absence of “primary” food tree species and reliance by the population on “secondary” food tree species only (Phillips and Callaghan 2000). While secondary food tree species will return significantly higher levels of utilisation when compared to other Eucalyptus spp. in the area, their level of use (as determined by field survey) will tend to be both size-class and/or density dependent when compared to a primary food tree species. (Phillips et al 2000; Phillips and Callaghan 2000). Application of a ‘Koala Habitat Atlas’ type methodology over the larger area in conjunction with historical research (eg Knott et al 1998) would be useful to clarify such issues.” (p.7) The authors include a table showing: “Mean activity levels and related measures of central tendency (expressed as percentage equivalents) associated with habitat utilisation by Koalas from six areas in eastern Australia. Data has been pooled to reflect three major categories of Koala activity which correspond to low and med-high density Koala populations of the tablelands and areas east of the Great Dividing Range, and those of more western areas respectively. Koala densities for the low density category are arbitrarily defined at ≤ 0.1 Koalas/ha.” (Data sources cited.) (p.13)

Gow-Carey’s (2012) study of the Tanja/Bermagui/Mumbulla/Kooraban/Gulaga low density habitat [54, op cit] included class analysis revealing proportions of each mapped habitat class (p.66) as well as mean patch size (p.67) and patch size variability {smallest and largest patches for each suitable category} (p.68). For example:

• 14,001 hectares of “highly suitable” habitat represented 33.6% of the total and 17,938 ha of “suitable” habitat represented 43% of the total;

• the mean patch size for “highly suitable” habitat was 138.6 ha, for “suitable” 118.8 ha, for “marginal” 96.2 ha and for “not suitable” 33.0 ha; and

• there were large variations between smallest and largest patches for each suitable category, eg the smallest “highly suitable” patch was 76 m2 and the largest patch was 27,340,933 m2.”

You Yangs

The Koala Clancy Foundation estimates 1 koala per 7,640 eucalypt trees in the You Yangs, Victoria.

Rus, Adrian: Movement patterns and spatio-temporal use of patches by a specialist herbivore, the koala, in a fragmented agricultural landscape:
https://ses.library.usyd.edu.au/bitstream/handle/2123/23657/rus_ai_thesis.pdf?sequence=1&isAllowed=y

Extract From Abstract

"My specific objectives were to investigate: 1) the effects of habitat fragmentation on koala movement and space use 2) the effects of patch quality and fragmentation on temporal foraging patterns 3) the internal and external factors driving periodic use of patches and routine movement.

For Aim 1), I GPS-tracked individuals every 4-hours for four months and calculated their total distance moved, tortuosity and the number of core areas. I used four metrics (proximity, functional connectivity, clumpiness, perimeter-to-area fractal dimension) to quantify landscape fragmentation within koala home-ranges and determine its effects on movement and space use. Functional connectivity had the greatest effect on individual movement and space use. Decreasing connectivity led to longer and more direct movements by koalas and more core areas within an individual home-range, all indicating higher movement costs. I therefore conclude that, for species occupying fragmented landscapes, promoting greater functional connectivity by restoring or protecting resource patches will reduce costs associated with the isolation of resource patches.

For Aim 2), I examined the external, environmental factors associated with tree foliage chemistry, shelter, and habitat fragmentation driving the temporal use of trees by koalas. I used movement patterns to determine the re-use of patches during both day and night, by measuring the number of revisits, average time spent in trees (i.e. Residence Time), and average Time-to-Return. I found that leaf nitrogen is a strong driver for koalas to revisit foraging patches, but habitat fragmentation also plays a role in their foraging decisions. During the night, there was a threefold increase in the number of revisits to trees with low tree connectivity (i.e. higher habitat fragmentation) with high leaf nitrogen content. In contrast, when trees were highly connected, high leaf nitrogen was less of an incentive to revisit. I suggest that from an individual koala's perspective, trees that are more isolated (less connected) and also high in nitrogen could be highly valued. Although nutritional quality of patches attracts herbivores to revisit patches during the night, I found that shelter and tree size (i.e. diameter at breast height) have a strong effect during the day. These results suggest that koalas place a higher value on trees that provide more shelter (i.e. tree canopy cover) because koala revisit to such trees was greater.

For Aim 3), I then investigated whether individual koalas showed periodic re-use of resource patches and routine movement; and if so, whether there were any internal (i.e. sex, age, body condition) and environmental drivers explaining these patterns. I used Fourier and wavelet analysis to detect periodicity, and then I used conditional entropy to examine routine movement. I found several significant temporal scales of periodicity by individual koalas, with some differences between males and females; and koalas showed stronger periodic use of

patches during decreased rainfall and lower plant productivity. Koalas also showed a low level of spatial routine.

Together, my results provide evidence that internal and external factors drive animal movement patterns and that habitat fragmentation is a strong drive of animal movement and space use. These insights help advance our understanding of animal movement ecology and how animals cope with the effects of habitat fragmentation, with implications for management and conservation of species occupying fragmented landscapes."

Extract From Results

"We collected 40,185 GPS locations from 36 koalas (19 females, 17 males), which included 19 during non-breeding season and 17 during breeding season. The koalas travelled an average of 24.3 km (SE = ±2.0) over 4 months, with males travelling 29.8 km (SE = ±3.3) and females travelling 19.5 km (SE= ±1.8). Average tortuosity for males was 0.010 (SE = ±0.006) and for females 0.013 (SE = ±0.009). Average number of core patches for males was 11 (SE = ±2) and for females 8 (SE = ±2). Connectivity ranged from 0.8 to 22.5 percent, with male average of 4.1 (SE = ±0.6) and female average of 6.7 (SE = ±1.1).

Distance travelled:

All the models within the 95% confidence set included the connectivity variable ($wi < 0.95$) and six models included both connectivity and sex (S1). Distance travelled by koalas was strongly associated with habitat fragmentation, sex, and year. The connectivity metric had the highest relative importance among all the variables, followed by sex. Distance travelled increased with decreasing patch connectivity, and in the most fragmented habitat, koalas travelled over 30 km, or three times more than the least fragmented habitat. Male koalas moved further than females."

Fire Impact

The 2019-2020 wildfire was considered the most intense ever. Climate scientists predict increasing intensity and frequency of wildfire. Future wildfire will impact on carrying capacity.

The *NSW Fire and the Environment Summary for 2019-20* describes the fire impact, which needs to be applied as a weighting to our carrying capacity and habitat potential estimates. In the immediate short term, that's a 39% reduction. The "persistence of ecosystems" indicator seems to imply a long-term 4% reduction for our purposes.

- 39% reduction in ecological carrying capacity in the fire ground
- 39% reduction in ecological condition in the fire ground
- 4% reduction in ecosystem persistence in the fire ground

The **ecological carrying capacity** indicator shows the effectiveness of habitat at each location to support native species and ecosystems, considering its ecological condition and the effect of surrounding habitat loss and fragmentation on biological movement such as foraging, dispersal and migration. In 2013, 33% of the original ecological carrying capacity was estimated as remaining in New South Wales. In 2020, this decreased to 31%. Within the RFS fire ground, ecological carrying capacity decreased from 62% in 2013 to 38% in 2020, representing a 39% reduction. This assessment reflects the immediate effects post-fire on ecological carrying capacity. The effects of regeneration and regrowth will be captured in future assessments.

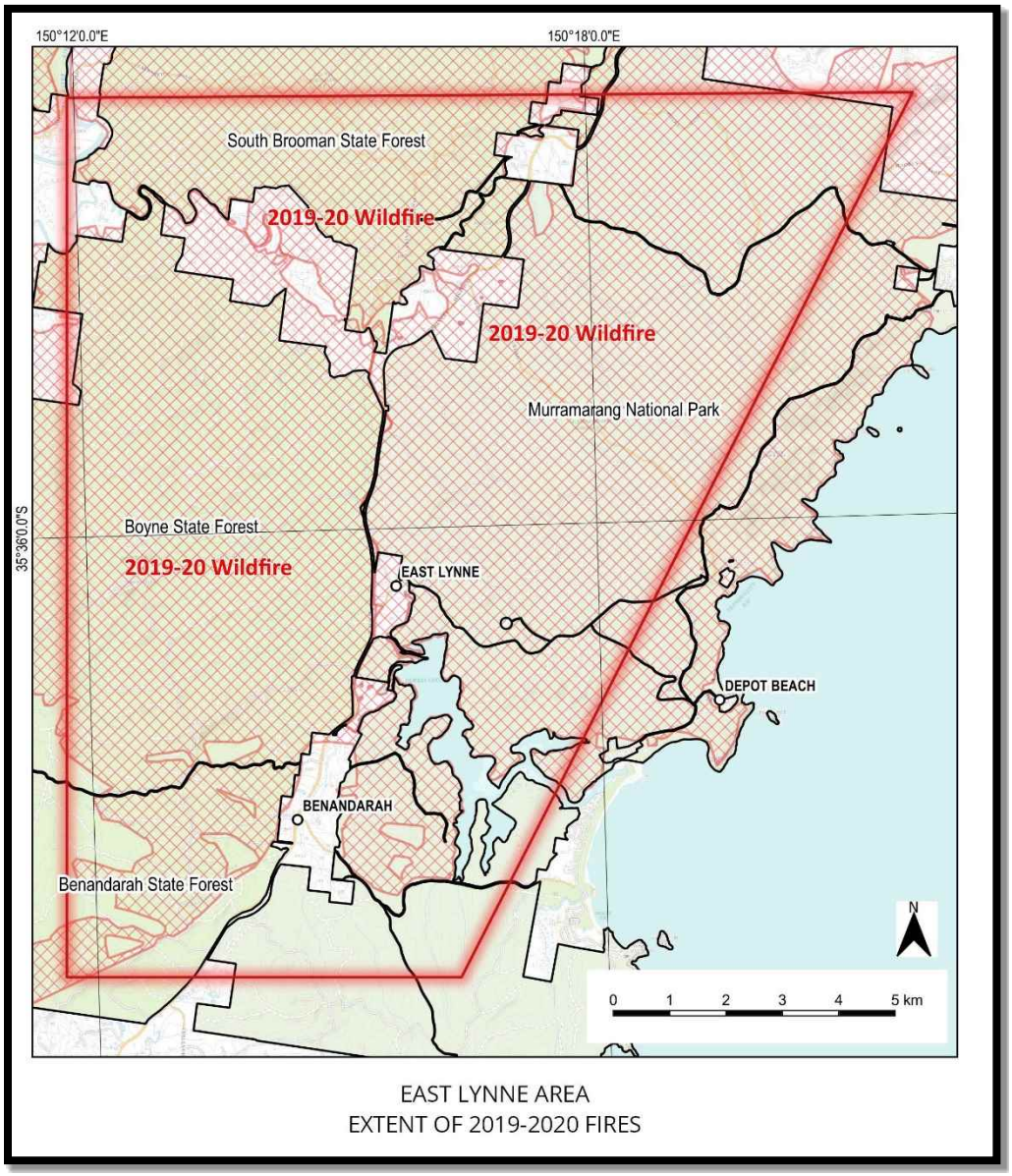
The **ecological condition** indicator shows the quality of terrestrial habitat at each location, estimating its intactness and naturalness without considering the indirect effects of surrounding habitat loss and fragmentation. In 2013, 44% of the original ecological condition in New South Wales was estimated as remaining. In 2020, this decreased to 42%. Within the RFS fire ground, ecological condition has decreased from 72% in 2013 to 44% in 2020, representing a 39% reduction. This assessment reflects the immediate effects post-fire on vegetation condition. The effects of regeneration and regrowth will be captured in future assessments.

The **persistence of ecosystems** indicator reflects the expected persistence of species diversity based on the proportion of habitat remaining in ecosystems, using a classification representing known and undiscovered species. This indicator is a metric for diversity across ecosystems, species and genetics. Plant species are used as a surrogate for all biodiversity. In 2013, 84% of the original diversity of NSW plants were estimated as likely to persist. In 2020, this decreased to 82%. In areas within the fire ground, the diversity of NSW plants likely to persist was reduced by 4%. This decline represents a loss of unique diversity. This is not equivalent to extinction of

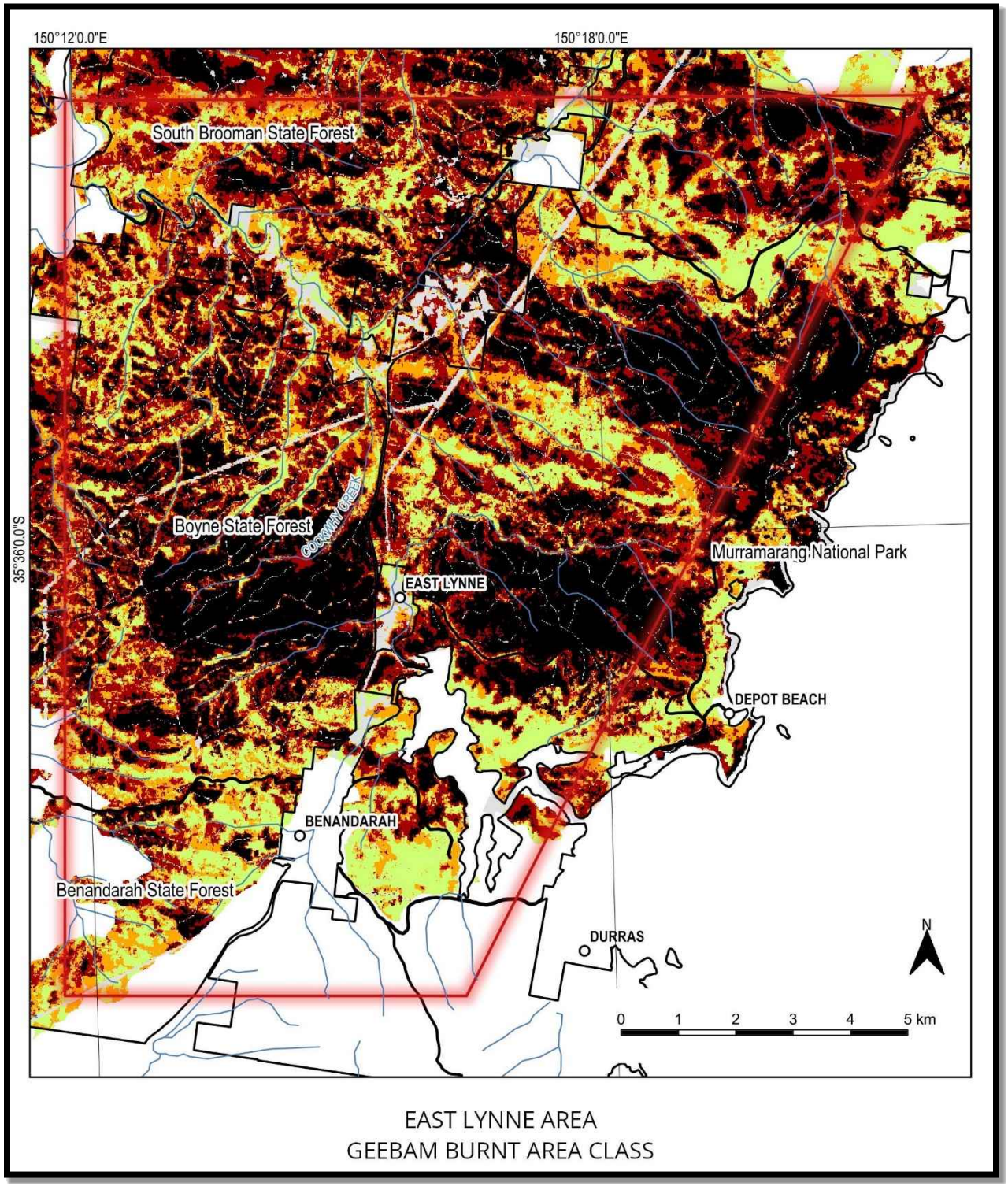
individual plant species. Field studies have demonstrated that floristic diversity can increase in a post-fire environment.

NSW Natural Resources Commission Report

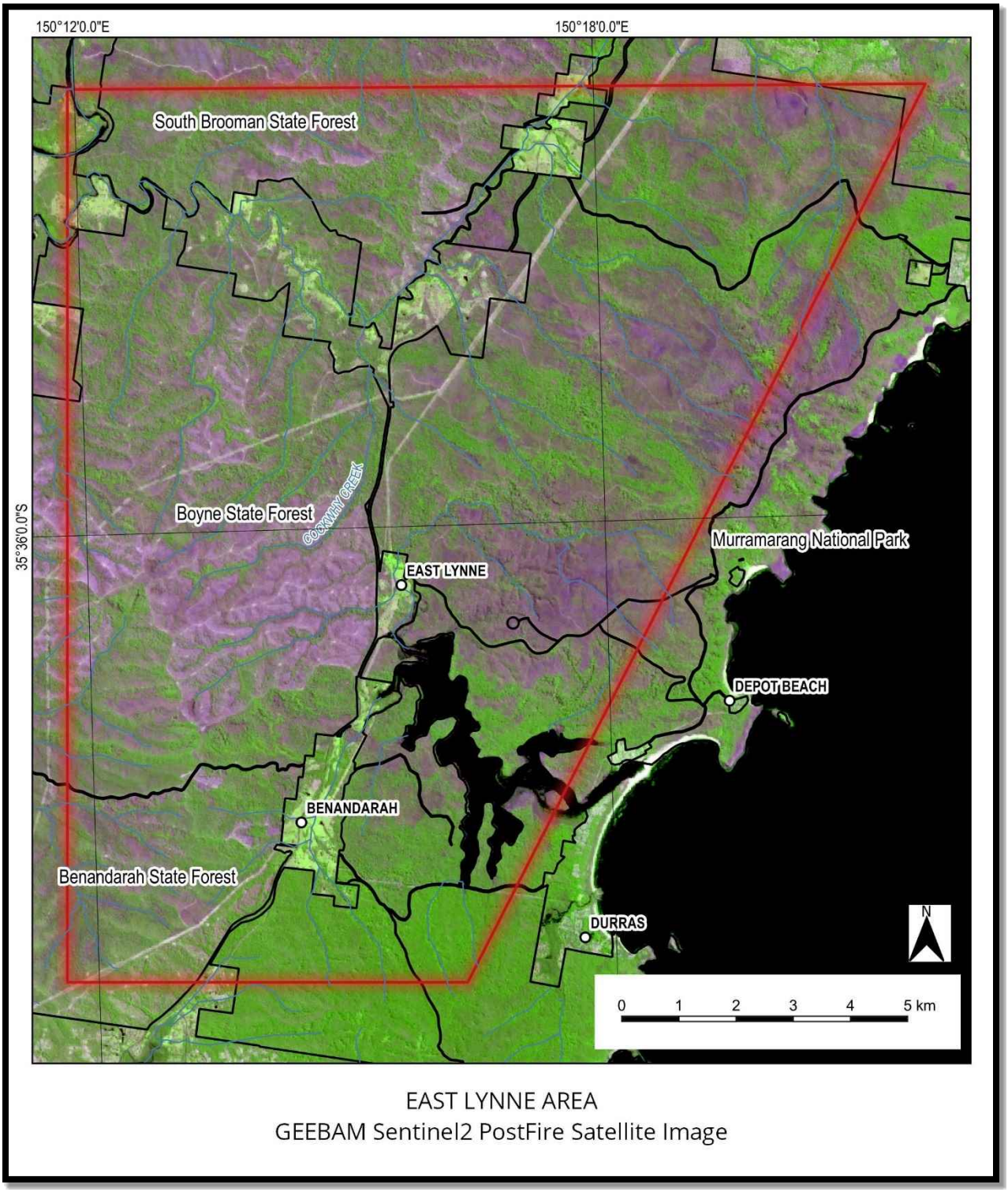
The Cabinet-in-Confidence ***Final report – Coastal IFOA Operations post 2019/20 wildfires – June 2021***, leaked to the media on 25th November 2021, nominated the Batemans Bay management zone as "High Risk" and recommended, pending gateway 2 and 3 assessments, harvesting should be allowed under standard Coastal IFOA prescriptions with additional measures, including temporary refuge based on fixed retention requirement of 75 per cent in local landscape areas.



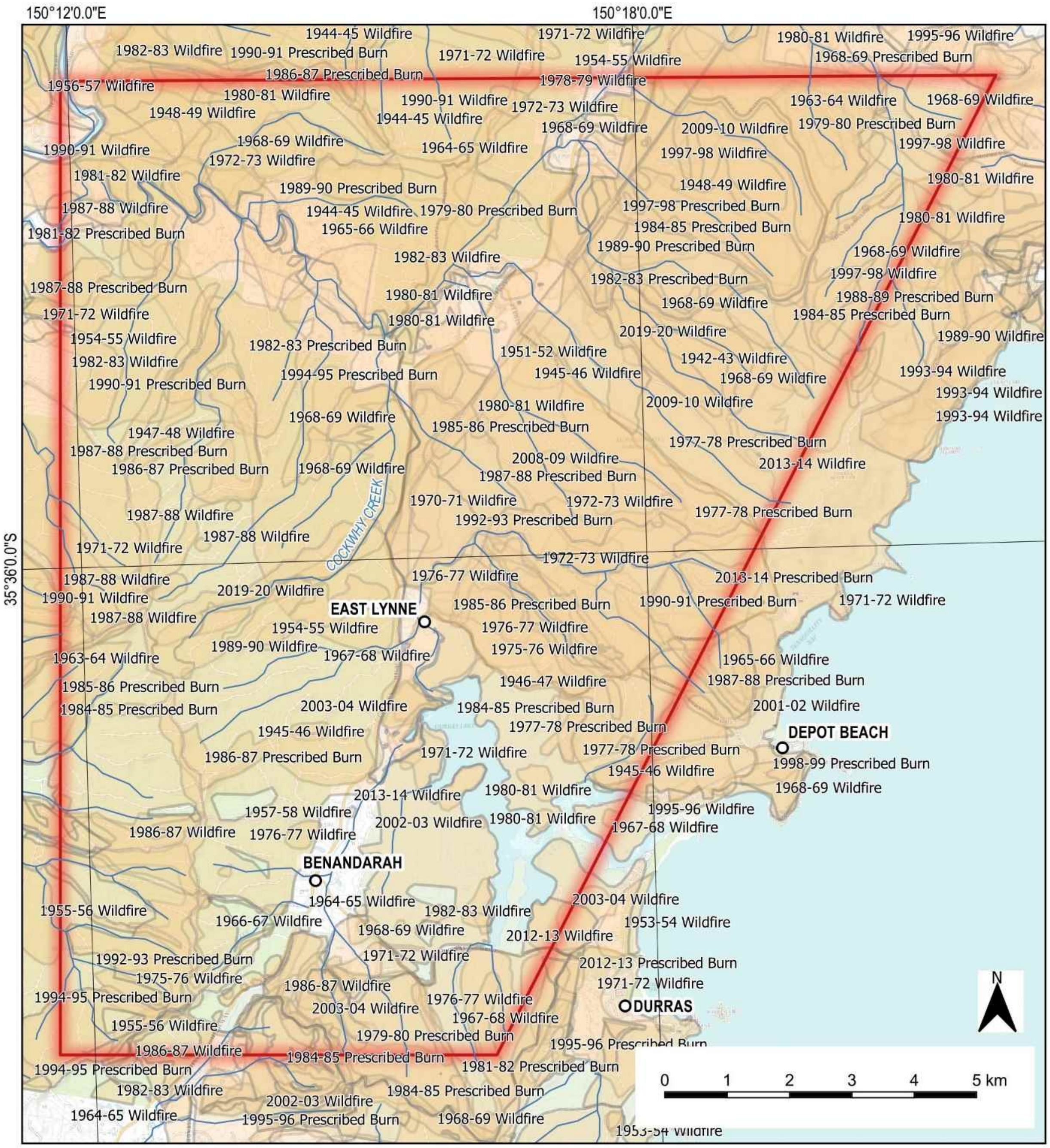
EAST LYNNE AREA
EXTENT OF 2019-2020 FIRES



EAST LYNNE AREA
GEEBAM BURNT AREA CLASS



EAST LYNNE AREA
GEEBAM Sentinel2 PostFire Satellite Image



EAST LYNNE AREA
EXTENT OF HISTORICAL FIRES

Conclusion

As usual with Southern Shoalhaven/Eurobodalla koala research, insufficient hard data are available, so there is nothing convincingly biometric about this study. Our conclusions are necessarily a best estimate based on what we could find. Although we have included small data-based exercises, we acknowledge the method is weighted more towards the discursive than the empirical.

Realistically, the East Lynne area can accommodate only an extremely low-density koala population currently. At best, one small resident group might be surviving.

From a future koala revival perspective, we have taken into account

- the pattern of local koala records
- the BioNet GIS mapping
- the FCNSW GIS mapping
- the FCNSW Harvest Plans analysis
- the volunteer plot survey results
- the Murramarang National Park material
- koala home range area, density and dispersal research
- the NSW Fire and Environment summary
- continuing clearing, development and logging, and
- the scarcity and diverse findings of available research

This all suggests a best-case estimate for a revived koala population is three or four resident groups in the longer term, after post-2019/20 wildfire ecological recovery plus deliberate interventions by public and private land managers.

There would be no more than one breeding association per 350 hectares of “best habitat”, overall. This is still a very low-density population. In this area, best habitat doesn’t fill the majority space. The population would be dependent for long-term survival on breeding connectivity with other populations beyond the East Lynne area.

The resident groups/breeding associations (say one breeding female, one dominant male and a few others each) would tend to favour the more nutritious spaces (eg river flats and patches of high/significant koala feed tree species other than pure Spotted Gum stands), but there would be seasonal variability in browse choice.

With deliberate intervention by private landholders, Shoalhaven, Eurobodalla and adjacent Councils, FCNSW and NPWS, the best-case recovery scenario could be one group each in the

Cockwhy and Central/South West/Southern precincts, and one or two groups in Murramarang National Park.

Kialoa has the potential to support an additional revived group when connectivity from Bawley Point to Murramarang National Park is taken into account, but the intensity of existing and future urban/acreage development might diminish the chances.