KOALAS LOST TO BULLDOZERS IN QUEENSLAND 2010-16

Key findings

- The annual death rate of koalas from bulldozing of habitats in Queensland, more than doubled after legal safeguards were weakened in 2012-13 by the former Newman LNP government - from an estimated minimum of about 590 p.a. in 2010-2012 to about 1,300 p.a. (estimated minimum) in 2012-2016.
- Over 5,000 koalas were lost due to bulldozing of habitats in the four years following removal of safeguards. Of these, about 2,800 almost certainly would not have died if safeguards had been retained.
- Koalas occur widely throughout the state, and most koala losses happen in remote rural areas far from the public gaze. While koala deaths in Southeast Queensland rightly provoke public concern, these are a fraction of state-wide deaths.
- These estimates are very conservative estimates, which do not include additional deaths from the legacy effects of past clearing in breaking up habitat, particularly in Southeast Queensland, where koalas face ongoing higher than natural death rates from vehicles, predators, disease and privation in the fragmented forests that remain. The cumulative impacts have resulted in the collapse of koala populations around Brisbane in the past two decades.

Loss of safeguards leads to accelerating bushland destruction

From 2004 to 2012, introduction of new controls over tree-clearing in Queensland resulting in dramatic declines in areas of bushland bulldozed, from over 500,000 ha in 2002-3 to 68,000 in 2009-10 (Fig. 1).[1]

In March 2012, the Newman LNP government swept to power and weakened enforcement of the Act[2], replacing requirements for permits with self-assessable codes through new Area Management Plans. Then in mid-2013, in

[1] https://www.qld.gov.au/environment/land/vegetation/mapping/slats-reports
[2] The Newman Government provided no tree-clearing data to the public. It was not until late in 2015 after the government changed, that the 2012-14 SLATS report was issued by the new Palaszczuk government. This report revealed that enforcement activity was purposely reduced under the Newman government, who instead gave priority to helping landholders who wanted to bulldoze habitats.

their own words, they "took the axe" to the law, breaking a pre-election promise that "The LNP will retain the current level of statutory vegetation protection".[3]

The chief changes of concern were:

- Ending the end-2006 ban on broadscale clearing of remnant bushland by:
    - Allowing "High Value Agriculture" broadscale clearing of remnant bushland under a development permit;
    - Allowing broadscale clearing of remnant bushland under self-assessable codes, which allow conversion of forests to paddocks with a few trees at unlimited scales, without need for a permit.
- Ending the 2009 protections for high value regrowth on freehold properties (which in highly cleared landscapes is often the only suitable habitat left for koalas).

Since then, tree-clearing has resurged dramatically, with the rise starting even before the laws were axed, likely due to the lapse in enforcement and introduction of Area Management Plans (AMPs) (Fig 1). The latest SLATS report for 2015-16, like previous reports, reveals that nearly all bulldozing of bushland in Queensland (consistently over 90%) is to make pasture for livestock, principally beef cattle.

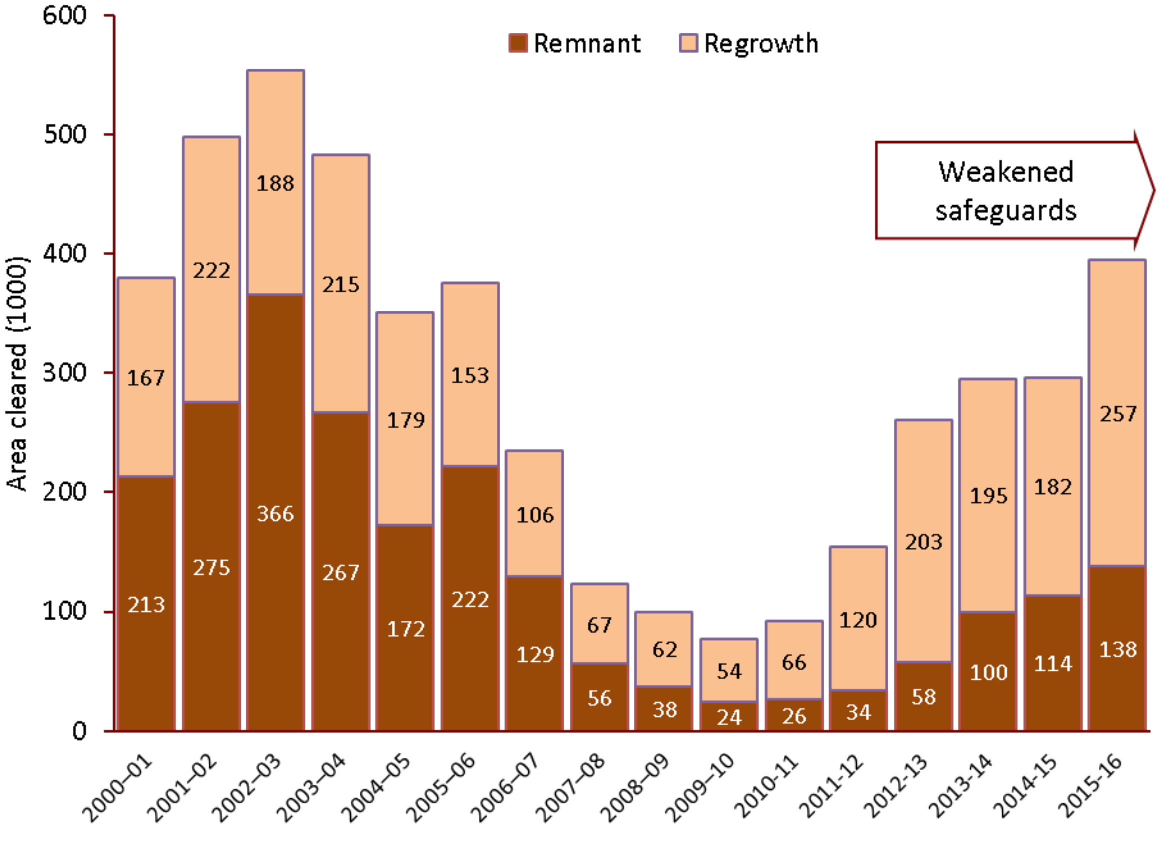

Figure 1. Areas of bushland bulldozed and cleared in Queensland 200-2016 according to Queensland Government SLATS reports for 2012-14, 2014-15 and 2015-16.

[3] *Bushland destruction rapidly increasing in Queensland* WWF briefing paper (2015) http://www.wwf.org.au/news/news/2015/queenslands-tree-clearing-map-of-shame#gs.dYgEK9I

Animal losses on the rise

Eminent zoologists in 2003 conservatively estimated about 100 million Australian mammals, birds and reptiles died annually in the late 1990s when bulldozing of bushland was at its peak, including 19,000 koalas.[4]

These authors recently updated this estimate of annual losses to 34 million p.a. for the period 2013-15, and 45 million for 2015-16.[5]

In this brief analysis, we attempt to update estimates for koalas, erring on the conservative side, and incorporating the latest information.

Koala losses on the rise

We previously reported at least 179 koalas lost to bulldozers in Southeast Queensland due to clearing in 2013-15 (top of bars 4 & 5 in Fig. 2)[6]. We now extend that estimate state-wide and to the six years 2010-2016.

New minimum estimates of koalas dying or killed due to bulldozing of their habitats rose from 503 in 2010-11 to 1,796 in 2015-16 (Fig. 2). There was a step change from 2010-12 to the later period 2012-2016, coinciding with weakening of controls (neglect of enforcement, AMPs and legal safeguards weakened), with average annual direct losses more than doubling from 592 p.a. to 1,296 p.a.

In the four years since safeguards were weakened, a minimum of 5,184 koalas is estimated to have died due to bulldozing of habitat. Of these, an estimated 2,818 died that would otherwise have survived under previous, stronger laws (Fig. 2).

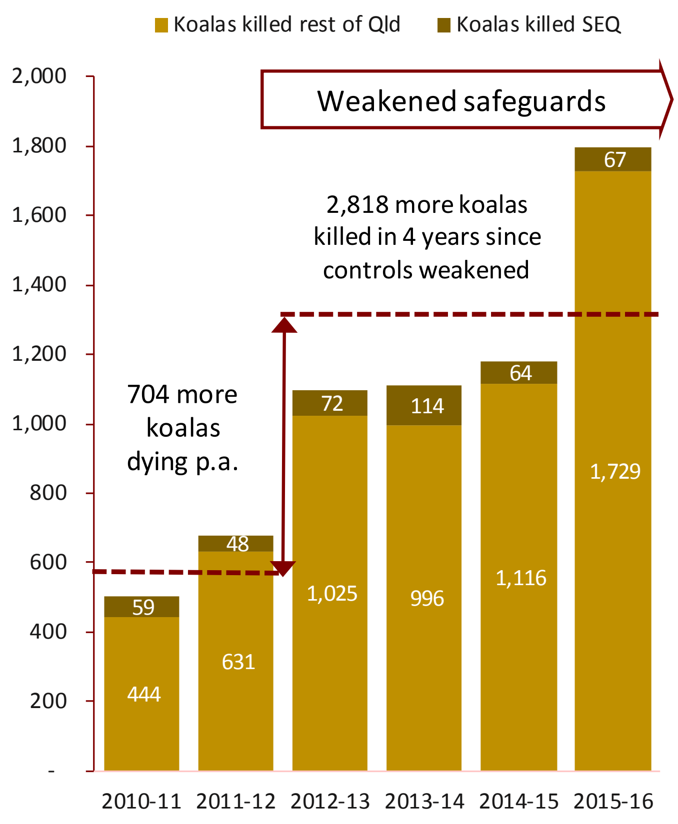

Figure 2. Estimates of koalas lost to bulldozing of their forest habitats from 2010 to 2016, for South East Queensland using the density modelling of Rhodes et al. (2017), and for the rest of the state using a uniform density of 2 koalas per km2. See Methods for details.

[4] http://www.wwf.org.au/ArticleDocuments/353/pub-impacts-landclearing-on-australian-wildlife-qld-1jan03.pdf.aspx?Embed=Y
[5] http://www.wwf.org.au/news/news/2017/tree-clearing-kills-68-million-animals-in-queensland-in-two-years
[6] http://www.wwf.org.au/news/news/2017/fears-179-koalas-lost-to-bulldozers minor difference in numbers is due to rounding error.

Important caveats

We assumed as in earlier studies, that when habitat is bulldozed, the animals living there mostly die, either from direct trauma, from starvation or from later misadventure having lost their homes, an assumption well-supported in ecological science.[7]

These figures are necessarily minimum estimates because:

- A restrictive map of habitat was used, based only on presence of a limited set of food trees. Significantly we ignored less preferred food species, shelter trees and other habitat requirements. By ignoring very sparse woodlands we excluded habitat for significant populations along the Great Dividing Range Southeast of Richmond in central Qld, and between Longreach and Charleville in southwest Qld (Fig 3). However, sparse habitats have both lower densities and lower susceptibility to clearing.
- A density estimate from the lower end of the range of reported estimates was used.
- These estimates do not include deaths due to ongoing higher death rates from vehicles, predator attacks, disease and privation experienced in fragmented, legacy-cleared habitats.[8]

This last point is of particular importance for Southeast Queensland. Despite seemingly small numbers losing habitat directly to bulldozing in Southeast Queensland over the period of concern (Fig. 2), the numbers lost due to legacy impacts of tree-clearing on death rates are sure to be much higher.

Most koala deaths in Southeast Queensland on the face of it may appear unrelated to tree-clearing, because deaths are mostly due to vehicle strikes, dog attacks and disease. However, these are all to varying extents consequences of past and ongoing habitat breakup.

As detailed in our recent report "Tree-clearing: the hidden crisis of animal welfare in Queensland" [9], over the six years from 2009 to 2014, more than 10,000 koalas (over 1,600 annually) were admitted to the four wildlife hospitals in Southeast Queensland out of an estimated population of only 15,000. As a result of the high ongoing rates of injury and death, Southeast Queensland populations have collapsed over the 18 years from 1996 to 2014 with an 80% decline in the Koala Coast (Brisbane, Logan and Redlands) population, and a 54% decline in the Pine Rivers population.[10]

Despite a bipartisan commitment in 2008 that there would be net gain of koala habitat in Southeast Queensland, there has in fact been ongoing loss, [11] and losses outside the region in the rest of the state are growing rapidly (Fig. 2).

[7] Cogger et al. 2003 and 2017 cited above.
[8] http://www.wwf.org.au/news/news/2017/tree-clearing-causing-queenslands-greatest-animal-welfare-crisis
[9] Ibid.
[10] Rhodes JH, Beyer H, Preece H and McAlpine C (2015) *South East Queensland Koala Population Modelling Study* Brisbane, Australia: UniQuest https://www.ehp.qld.gov.au/wildlife/koalas/pdf/seq-koala-population-modelling-study.pdf
[11] https://www.ehp.qld.gov.au/wildlife/koalas/pdf/koala-expert-panel-interim-report.pdf

Methods

Combined clearing layer

We obtained SLATS shapefiles for each of the years as shown in Fig 2 from http://qldspatial.information.qld.gov.au/.

We excluded polygons described as natural tree death, storm damage or timber plantations (harvest of), and masked out any polygons that were not woodland or forest at the commencement of the study period in 2010. That is, only if the Queensland Government's 2010 foliage projective cover was 11% or greater was a given mapped clearing area retained. Using the ArcGIS Union tool, we combined all these selected and masked shapefiles and assigned only the first year cleared to any polygon which was cleared more than once over the period. In this way, only active clearing of actual native forest or woodlands was counted. For ease of calculation we converted this shapefile to a 6 level raster at 30m pixel resolution in GDA94 Albers projection, snapped to the FPC source raster.

Southeast Queensland estimation method

Queensland was divided into two domains with different density and habitat mapping approaches.

The first domain was the Southeast Queensland (SE Qld) study area of the recent density modelling study by Rhodes et al. (2017).[12] In this domain we used the density map produced and kindly provided by the authors which they had also masked by a suitable habitat layer based on Broad Vegetation Groups (see Appendix B in that study). We converted densities to rounded integer values of density expressed as numbers of koalas per km^2 and converted to a raster snapped to FPC as described above. Combining these two layers we obtained a raster combining density with epoch cleared. By counting pixels in density and year categories we estimated the area of habitat cleared in SEQ and numbers of koalas that would have been living there in respective years cleared based on modelled densities (See Fig 2 for results).

Rest of state estimation method

The second domain comprised the rest of the state within which koalas are known to occur: including the bioregions of Brigalow Belt, Central Queensland Coast, Desert Uplands, Einasleigh Uplands, Mulga Lands, New England Tableland, Southeast Queensland, Wet Tropics, and the three eastern subregions of the Mitchell Grass Downs.[13]

In this domain, to estimate areas of habitat cleared, we did not use the habitat mask of Rhodes et al, which was based on Broad Vegetation Groups (v 10, BVGs). BVGs provide only a coarse indication of habitat. Also, the Rhodes et al. study provides no guidance on suitabilities of BVGs outside of SE Qld.

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[12] Rhodes JH, Beyer H, Preece H and McAlpine C (2015) *South East Queensland Koala Population Modelling Study* Brisbane, Australia: UniQuest https://www.ehp.qld.gov.au/wildlife/koalas/pdf/seq-koala-population-modelling-study.pdf

[13] As mapped by McAlpine et al. 2015. *Conserving koalas in the 21st Century*. ACEAS workshop report. http://aceas.org.au/index.php?option=com_content&view=article&id=86&Itemid=88

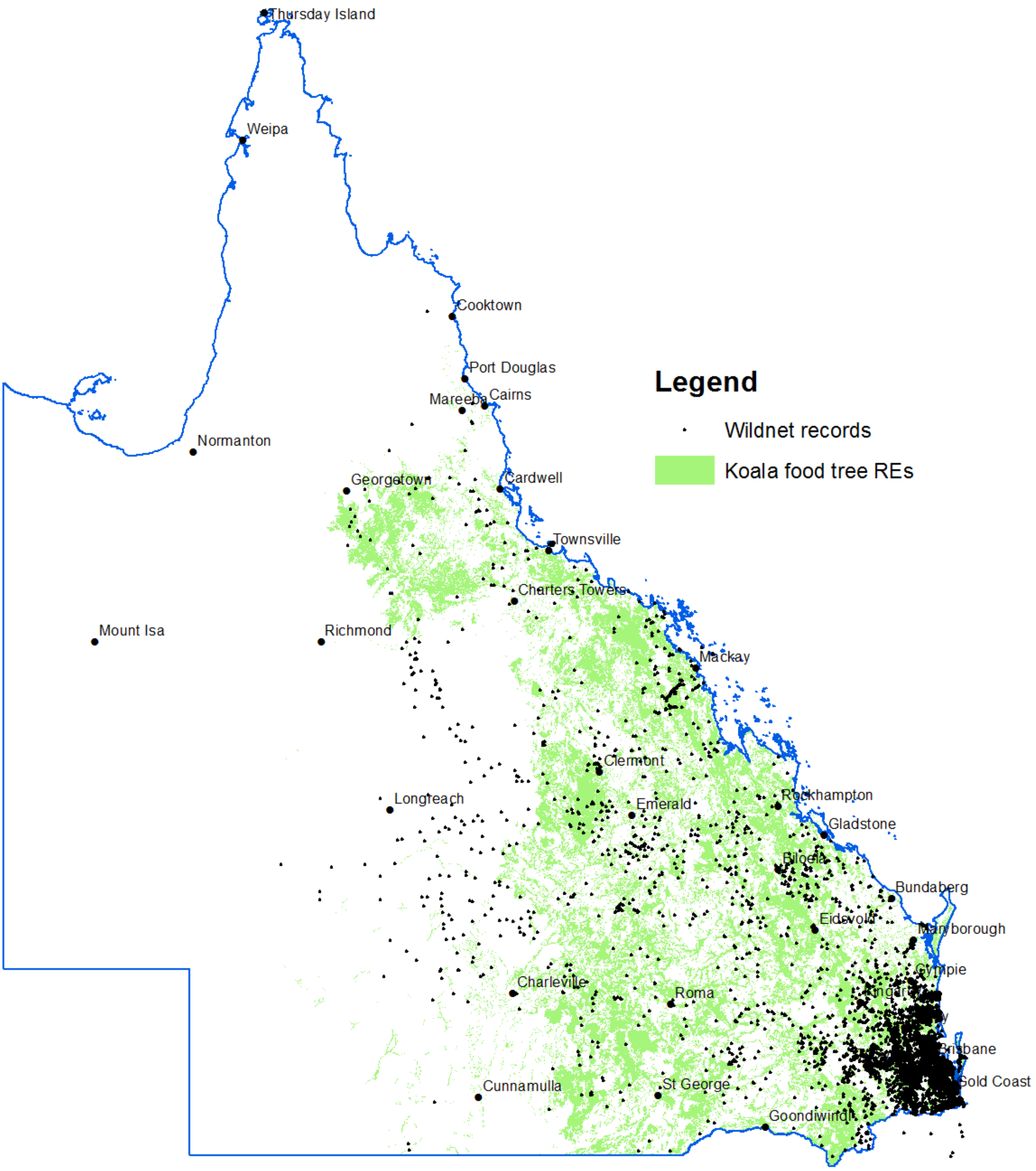

Figure 3. Map of regional ecosystems with a known koala food tree dominating the canopy, used as a proxy for koala habitat in this analysis, overlaid with point locations of koala sightings in the Queensland Government's Wildnet database.

Regional ecosystems provide a much finer scaled basis for mapping of habitat. To determine which regional ecosystems to include in the habitat layer we first compiled a list of favoured food trees based on predominant species identified in koala scats. Only species represented at 10% of more in scats were considered significant food trees as reported in two key studies of Melzer et al. (2014) and Sullivan et al. (2003).[14] These were all *Eucalyptus*:- *E. camaldulensis, E. coolabah, E. melanophloia, E. orgadophylla, E. tereticornis, E. crebra, E. populnea, E. drepanophylla, E. platyphylla, E. robusta, E. racemosa, E. pilularis,* and *E. thozetiana.*

We then selected from *Regional Ecosystems version 9* (Queensland Herbarium), those regional ecosystems with one of these species listed as dominant or co-dominant in the canopy. Very sparse regional ecosystems were excluded regardless if the right food tree species occurred. Also, regional ecosystems even if not flagged as very sparse were excluded if tree cover was described as very sparse in the description. The final selection of regional ecosystems is shown in Table 1 below. The map of these regional ecosystems is shown in Fig. 3 below. This map of habitat is both finer scaled but also more conservative than the approach in Rhodes et al. and leaves out many other REs in which koalas have been recorded (Fig. 3). In Southeast Queensland, the Rhodes et al. BVG based habitat mask covered over 600,000 ha, while the RE based layer derived here covered only 200,000ha.

Next we had to determine appropriate densities for the habitat outside of SE Qld. In the absence of density modelling as done for SE Qld by Rhodes et al, we used a uniform density of 2 koalas per km^2 as it is the median density of the Rhodes study for SE Qld and the lower end of the range of estimates for central Qld from Melzer et al. (1995)[15] and the second lowest non-zero value for the Mulga Lands as reported by Sullivan et al. (2003)[16]. It is much lower than other <u>minimum</u> density estimates such as $20/km^2$ in central Queensland reported by Ellis et al. (2014).[17] But our intent was deliberately to be conservative and prefer to under-estimate rather than over-estimate numbers.

We converted the habitat layer based on REs to a raster snapped to FPC and using raster arithmetic, intersected with the combined clearing raster described above. Pixel counts were used to estimate areas of forest and woodland habitat cleared in each respective year and koala number derived by multiplying areas by the nominal uniform density of 2 $koalas/km^2$. Results are shown in Fig. 2.

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[14] Table 3 in Melzer A, Cristescu R, Ellis W, FitzGibbon S, and Manno G, 2014. The habitat and diet of koalas (*Phascolarctos cinereus*) in Queensland. *Australian mammalogy*, 36(2), pp.189-199, and adding *E. thozetiana* from Table 6 in Sullivan, B.J., Norris, W.M. and Baxter, G.S., 2003. Low-density koala (*Phascolarctos cinereus*) populations in the mulgalands of south-west Queensland. II. Distribution and diet. *Wildlife Research,* 30(4), pp.331-338.

[15] Melzer, A. (1995). Aspects of the ecology of the koala, *Phascolarctos cinereus* (Goldfuss, 1817), in the sub-humid woodlands of Central Queensland. PhD thesis, University of Queensland, St Lucia, Brisbane.

[16] Sullivan, B.J., Baxter, G.S. and Lisle, A.T., 2003. Low-density koala (*Phascolarctos cinereus*) populations in the mulgalands of south-west Queensland. III. Broad-scale patterns of habitat use. *Wildlife Research*, 30(6), pp.583-591.

[17] Ellis, W., FitzGibbon, S., Melzer, A., Wilson, R., Johnston, S., Bercovitch, F., Dique, D. and Carrick, F., 2013. Koala habitat use and population density: using field data to test the assumptions of ecological models. *Australian Mammalogy*, 35(2), pp.160-165.

Table 1. Regional Ecosystems v9 with favoured koala food trees dominant or co-dominant.

RE	Description	Structure
11.10.11	Eucalyptus populnea, E. melanophloia +/- Callitris glaucophylla woodland on coarse-grained sedimentary rocks	Mid-dense
11.10.12	Eucalyptus populnea woodland on medium to coarse-grained sedimentary rocks	Sparse
11.10.7	Eucalyptus crebra woodland on coarse-grained sedimentary rocks	Sparse
11.11.1	Eucalyptus crebra +/- Acacia rhodoxylon woodland on old sedimentary rocks with varying degrees of metamorphism and folding	Mid-dense
11.11.10	Eucalyptus melanophloia woodland on deformed and metamorphosed sediments and interbedded volcanics	Sparse
11.11.15	Eucalyptus crebra woodland on deformed and metamorphosed sediments and interbedded volcanics	Sparse
11.11.19	Eucalyptus thozetiana, Acacia harpophylla woodland on old sedimentary rocks with varying degrees of metamorphism and folding	Sparse
11.11.20	Eucalyptus platyphylla woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands	Sparse
11.11.3	Corymbia citriodora, Eucalyptus crebra, E. acmenoides open forest on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	Mid-dense
11.11.4	Eucalyptus crebra woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	Sparse
11.11.9	Eucalyptus populnea or E. brownii woodland on deformed and metamorphosed sediments and interbedded volcanics	Sparse
11.12.1	Eucalyptus crebra woodland on igneous rocks	Sparse
11.12.13	Eucalyptus crebra, Corymbia spp., E. acmenoides woodland on igneous rocks. Coastal hills	Mid-dense
11.12.17	Eucalyptus populnea woodland on igneous rocks. Colluvial lower slopes	Sparse
11.12.2	Eucalyptus melanophloia woodland on igneous rocks	Sparse
11.12.3	Eucalyptus crebra, E. tereticornis, Angophora leiocarpa woodland on igneous rocks especially granite	Sparse
11.12.6	Corymbia citriodora open forest on igneous rocks (granite)	Mid-dense
11.12.7	Eucalyptus crebra woodland with patches of semi-evergreen vine thicket on igneous rocks (boulder-strewn hillsides)	Sparse
11.12.9	Eucalyptus platyphylla woodland on igneous rocks	Sparse
11.3.17	Eucalyptus populnea woodland with Acacia harpophylla and/or Casuarina cristata on alluvial plains	Sparse
11.3.18	Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii shrubby woodland on alluvium	Mid-dense
11.3.2	Eucalyptus populnea woodland on alluvial plains	Sparse
11.3.23	Eucalyptus conica, E. nobilis, E. tereticornis, Angophora floribunda woodland on alluvial plains. Basalt derived soils	Sparse
11.3.25	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	Mid-dense
11.3.29	Eucalyptus crebra, E. exserta, Melaleuca spp. woodland on alluvial plains	Sparse
11.3.3	Eucalyptus coolabah woodland on alluvial plains	Sparse
11.3.30	Eucalyptus crebra, Corymbia dallachiana woodland on alluvial plains	Sparse
11.3.35	Eucalyptus platyphylla, Corymbia clarksoniana woodland on alluvial plains	Sparse
11.3.36	Eucalyptus crebra and/or E. populnea and/or E. melanophloia on alluvial plains. Higher terraces	Sparse
11.3.37	Eucalyptus coolabah fringing woodland on alluvial plains	Sparse
11.3.38	Eucalyptus tereticornis, Melaleuca viridiflora, Corymbia tessellaris and Eucalyptus fibrosa subsp. fibrosa tall woodland with a grassy ground layer on alluvial plains and broad drainage lines derived from serpentinite	Mid-dense
11.3.39	Eucalyptus melanophloia +/- E. chloroclada open woodland on undulating plains and valleys with sandy soils	Sparse
11.3.4	Eucalyptus tereticornis and/or Eucalyptus spp. woodland on alluvial plains	Sparse
11.3.6	Eucalyptus melanophloia woodland on alluvial plains	Sparse
11.3.9	Eucalyptus platyphylla, Corymbia spp. woodland on alluvial plains	Sparse
11.4.10	Eucalyptus populnea or E. woollsiana, Acacia harpophylla, Casuarina cristata open forest to woodland on margins of Cainozoic clay plains	Sparse
11.4.12	Eucalyptus populnea woodland on Cainozoic clay plains	Mid-dense
11.4.2	Eucalyptus spp. and/or Corymbia spp. grassy or shrubby woodland on Cainozoic clay plains	Sparse
11.4.7	Eucalyptus populnea with Acacia harpophylla and/or Casuarina cristata open forest to woodland on Cainozoic clay plains	Mid-dense
11.5.1	Eucalyptus crebra and/or E. populnea, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii woodland on Cainozoic sand plains and/or remnant surfaces	Mid-dense
11.5.13	Eucalyptus populnea +/- Acacia aneura +/- E. melanophloia woodland on Cainozoic sand plains and/or remnant surfaces	Sparse
11.5.17	Eucalyptus tereticornis woodland in depressions on Cainozoic sand plains and remnant surfaces	Sparse
11.5.2	Eucalyptus crebra, Corymbia spp., with E. moluccana woodland on lower slopes of Cainozoic sand plains and/or remnant surfaces	Sparse

RE	Description	Structure
11.5.3	Eucalyptus populnea +/- E. melanophloia +/- Corymbia clarksoniana woodland on Cainozoic sand plains and/or remnant surfaces	Sparse
11.5.5	Eucalyptus melanophloia, Callitris glaucophylla woodland on Cainozoic sand plains and/or remnant surfaces. Deep red sands	Sparse
11.5.9	Eucalyptus crebra and other Eucalyptus spp. and Corymbia spp. woodland on Cainozoic sand plains and/or remnant surfaces	Sparse
11.7.1	Acacia harpophylla and/or Casuarina cristata and Eucalyptus thozetiana or E. microcarpa woodland on lower scarp slopes on Cainozoic lateritic duricrust	Mid-dense
11.7.6	Corymbia citriodora or Eucalyptus crebra woodland on Cainozoic lateritic duricrust	Mid-dense
11.8.14	Eucalyptus crebra, Corymbia dallachiana woodland on Cainozoic igneous rocks	Sparse
11.8.2	Eucalyptus tereticornis, E. melliodora woodland on Cainozoic igneous rocks	Sparse
11.8.4	Eucalyptus melanophloia open woodland on Cainozoic igneous rocks.	Sparse
11.9.10	Eucalyptus populnea open forest with a secondary tree layer of Acacia harpophylla and sometimes Casuarina cristata on fine-grained sedimentary rocks	Mid-dense
11.9.2	Eucalyptus melanophloia +/- E. orgadophila woodland on fine-grained sedimentary rocks	Sparse
11.9.7	Eucalyptus populnea, Eremophila mitchellii shrubby woodland on fine-grained sedimentary rocks	Sparse
11.9.9	Eucalyptus crebra woodland on fine-grained sedimentary rocks	Sparse
12.11.14	Eucalyptus crebra, E. tereticornis, Corymbia intermedia woodland on metamorphics +/- interbedded volcanics	Sparse
12.11.22	Angophora leiocarpa, Eucalyptus crebra woodland on metamorphics +/- interbedded volcanics	Sparse
12.11.23	Eucalyptus pilularis open forest on coastal metamorphics and interbedded volcanics	Mid-dense
12.11.27	Eucalyptus racemosa subsp. racemosa and/or E. seeana and Corymbia intermedia woodland on metamorphics +/- interbedded volcanics	Sparse
12.11.7	Eucalyptus crebra woodland on metamorphics +/- interbedded volcanics	Sparse
12.11.8	Eucalyptus melanophloia, E. crebra woodland on metamorphics +/- interbedded volcanics	Sparse
12.11.9	Eucalyptus tereticornis subsp. tereticornis or E. tereticornis subsp. basaltica open forest on metamorphics +/- interbedded volcanics. Usually higher altitudes	Mid-dense
12.12.12	Eucalyptus tereticornis, Corymbia intermedia, E. crebra +/- Lophostemon suaveolens woodland on Mesozoic to Proterozoic igneous rocks	Sparse
12.12.14	Eucalyptus racemosa subsp. racemosa +/- Lophostemon confertus, Syncarpia glomulifera, Eucalyptus acmenoides woodland usually on rocky near coastal areas on Mesozoic to Proterozoic igneous rocks	Sparse
12.12.2	Eucalyptus pilularis tall open forest on Mesozoic to Proterozoic igneous rocks especially granite	Mid-dense
12.12.23	Eucalyptus tereticornis subsp. tereticornis or E. tereticornis subsp. basaltica +/- E. eugenioides woodland on crests, upper slopes and elevated valleys and plains on Mesozoic to Proterozoic igneous rocks	Mid-dense
12.12.24	Angophora leiocarpa, Eucalyptus crebra woodland on Mesozoic to Proterozoic igneous rocks	Sparse
12.12.27	Corymbia trachyphloia, Eucalyptus crebra and Callitris endlicheri woodland on Mesozoic to Proterozoic igneous rocks	Mid-dense
12.12.7	Eucalyptus crebra woodland on Mesozoic to Proterozoic igneous rocks	Sparse
12.12.8	Eucalyptus melanophloia woodland on Mesozoic to Proterozoic igneous rocks	Sparse
12.2.6	Eucalyptus racemosa subsp. racemosa open forest on dunes and sand plains. Usually deeply leached soils	Mid-dense
12.2.8	Eucalyptus pilularis open forest on parabolic high dunes	Mid-dense
12.3.10	Eucalyptus populnea woodland on alluvial plains	Sparse
12.3.11	Eucalyptus tereticornis +/- Eucalyptus siderophloia, Corymbia intermedia open forest on alluvial plains usually near coast	Mid-dense
12.3.19	Eucalyptus moluccana and/or Eucalyptus tereticornis and E. crebra open forest to woodland, with a sparse to mid-dense understorey of Melaleuca irbyana on alluvial plains	Mid-dense
12.3.3	Eucalyptus tereticornis woodland on Quaternary alluvium	Sparse
12.3.4	Melaleuca quinquenervia, Eucalyptus robusta woodland on coastal alluvium	Mid-dense
12.3.7	Eucalyptus tereticornis, Casuarina cunninghamiana subsp. cunninghamiana +/- Melaleuca spp. fringing woodland	Sparse
12.5.12	Eucalyptus racemosa subsp. racemosa, E. latisinensis +/- Corymbia gummifera, C. intermedia, E. bancroftii woodland with heathy understorey on remnant Tertiary surfaces	Sparse
12.5.2	Corymbia intermedia, Eucalyptus tereticornis open forest on remnant Tertiary surfaces, usually near coast. Usually deep red soils	Mid-dense
12.5.3	Eucalyptus racemosa subsp. racemosa woodland on remnant Tertiary surfaces	Mid-dense
12.8.16	Eucalyptus crebra +/- E. melliodora, E. tereticornis woodland on Cainozoic igneous rocks	Sparse
12.8.17	Eucalyptus melanophloia +/- E. crebra, E. tereticornis, Corymbia tessellaris woodland on Cainozoic igneous rocks	Sparse
12.8.24	Corymbia citriodora subsp. variegata open forest on Cainozoic igneous rocks especially trachyte	Mid-dense
12.9-10.14	Eucalyptus pilularis tall open forest on sedimentary rocks	Mid-dense
12.9-10.4	Eucalyptus racemosa subsp. racemosa woodland on sedimentary rocks	Sparse

RE	Description	Structure
12.9-10.7	Eucalyptus crebra +/- E. tereticornis, Corymbia tessellaris, Angophora spp., E. melanophloia woodland on sedimentary rocks	Sparse
12.9-10.8	Eucalyptus melanophloia, E. crebra woodland on sedimentary rocks	Sparse
13.11.3	Eucalyptus crebra woodland on metamorphics	Sparse
13.11.4	Eucalyptus melanophloia woodland on metamorphics	Sparse
13.11.6	Corymbia citriodora subsp. variegata open forest on metamorphics	Mid-dense
13.12.10	Eucalyptus crebra, E. tereticornis, Angophora leiocarpa woodland on igneous rocks	Sparse
13.12.4	Eucalyptus caliginosa, E. tereticornis open forest on igneous rocks	Mid-dense
13.3.5	Eucalyptus camaldulensis fringing open forest	Mid-dense
13.3.7	Eucalyptus tereticornis, Angophora floribunda open forest on alluvial plains	Sparse
4.3.1	Eucalyptus camaldulensis +/- Melaleuca spp. woodland on drainage lines	Sparse
4.3.11	Eucalyptus coolabah +/- E. camaldulensis open woodland on alluvium, billabongs and permanent waterholes	Sparse
4.3.2	Eucalyptus camaldulensis +/- E. coolabah woodland on drainage lines	Sparse
4.3.6	Atalaya hemiglauca +/- Acacia georginae +/- Acacia cyperophylla var. cyperophylla woodland on alluvium	Sparse
6.3.1	Eucalyptus camaldulensis woodland on alluvium within Acacia aneura associations	Sparse
6.3.18	Eucalyptus populnea +/- Eremophila mitchellii +/- Acacia aneura +/- E. melanophloia woodland on flat alluvial plains	Sparse
6.3.2	Eucalyptus camaldulensis +/- E. coolabah +/- Acacia cambagei woodland on major drainage lines or rivers	Sparse
6.3.3	Eucalyptus camaldulensis +/- E. coolabah +/- E. populnea, Acacia stenophylla woodland on alluvium	Sparse
6.4.3	Eucalyptus populnea, Casuarina cristata or Acacia harpophylla +/- Geijera parviflora woodland on clay plains	Sparse
6.5.17	Eucalyptus populnea +/- E. melanophloia +/- Callitris glaucophylla +/- Acacia aneura woodland on sand plains	Sparse
6.5.2	Eucalyptus populnea, Acacia aneura and/or E. melanophloia woodland on Quaternary sediments	Sparse
6.5.3	Eucalyptus populnea, Acacia aneura +/- Eremophila mitchellii woodland within A. aneura communities	Sparse
6.7.5	Eucalyptus thozetiana or E. cambageana, Acacia harpophylla woodland on scarps	Sparse
7.11.37	Eucalyptus drepanophylla and Corymbia clarksoniana or C. erythrophloia woodland to open forest on dry uplands on metamorphics between Tolga and Mount Molloy	Sparse
7.11.42	Eucalyptus tereticornis, Pandanus sp., Lophostemon suaveolens, Melaleuca dealbata and E. pellita woodland to open forest of perched drainage areas on metamorphics	Sparse
7.11.44	Eucalyptus tereticornis open forest to woodland on coastal metamorphic foothills	Mid-dense
7.11.50	Eucalyptus platyphylla +/- E. drepanophylla +/- Corymbia spp. open woodland to open forest on metamorphics	Sparse
7.12.23	Corymbia intermedia and/or C. tessellaris +/- Eucalyptus tereticornis, open forest to tall open forest to woodland (or vine forest with these species as emergents) on coastal granite and rhyolite headlands and near-coastal foothills	Mid-dense
7.12.24	Eucalyptus portuensis and Corymbia intermedia open forest to woodland (or vine forest with E. portuensis and C. intermedia emergents) on foothills and uplands on granite and rhyolite	Mid-dense
7.12.28	Eucalyptus platyphylla +/- E. drepanophylla +/- Corymbia spp. open woodland to open forest on granite and rhyolite	Sparse
7.12.61	Eucalyptus tereticornis +/- E. granitica woodland to open forest of foothills and uplands on granite and rhyolite	Sparse
7.12.69	Eucalyptus drepanophylla and/or E. granitica +/- Corymbia clarksoniana +/- C. erythrophloia woodland on uplands on granite and rhyolite	Sparse
7.3.12	Mixed eucalypt open forest to woodland, dominated by Eucalyptus tereticornis and Corymbia tessellaris +/- Melaleuca dealbata, (or vine forest with these species as emergents). Lowland alluvial plains	Mid-dense
7.3.16	Eucalyptus platyphylla woodland to open forest on alluvial plains	Mid-dense
7.3.39	Eucalyptus tereticornis +/- E. platyphylla +/- Corymbia intermedia +/- Lophostemon suaveolens open woodland to open forest, and associated sedgelands and grasslands on broad drainage depressions of uplands	Mid-dense
7.3.40	Eucalyptus tereticornis open forest on well-drained alluvial plains of lowlands	Mid-dense
7.3.43	Eucalyptus tereticornis open forest to woodland on uplands on well-drained alluvium	Mid-dense
7.5.1	Eucalyptus tereticornis, Corymbia intermedia and E. reducta woodland to open forest of uplands on weathered soils of a remnant surface	Sparse
7.8.10	Eucalyptus tereticornis, E. drepanophylla (or E. granitica), E. portuensis, Corymbia intermedia woodland to open forest, or E. moluccana woodland to open forest, of uplands and highlands on basalt	Sparse
7.8.7	Eucalyptus tereticornis open forest to tall open forest and associated grasslands, predominantly on basalt uplands	Mid-dense
7.8.8	Eucalyptus tereticornis, E. reducta +/- Angophora floribunda open forest to woodland on basalt	Sparse
8.11.1	Eucalyptus drepanophylla +/- E. platyphylla woodland on hills formed from metamorphosed sediments	Sparse
8.11.12	Eucalyptus crebra and/or E. drepanophylla and/or E. exserta and/or Corymbia clarksoniana and/or C. xanthope and/or Lophostemon confertus low woodland on metamorphics on islands and headlands	Sparse

8.11.4	Eucalyptus platyphylla and/or Corymbia clarksoniana and/or C. intermedia and/or C. tessellaris woodland on low undulating areas on metamorphosed sediments	Sparse
8.12.12	Eucalyptus tereticornis and/or Corymbia spp. and/or E. platyphylla and/or Lophostemon suaveolens woodland to open forest on hill slopes on Mesozoic to Proterozoic igneous rocks	Mid-dense
8.12.14	Eucalyptus drepanophylla and/or E. crebra and/or E. exserta and/or Acacia spirorbis subsp. solandri and/or Lophostemon confertus low woodland on islands and headlands, on Mesozoic to Proterozoic igneous rocks, and Tertiary acid to intermediate volcanics	Mid-dense
8.12.20	Eucalyptus drepanophylla and/or E. platyphylla +/- Corymbia spp. +/- E. crebra woodland on low gently undulating landscapes on Mesozoic to Proterozoic igneous rocks	Sparse
8.12.22	Eucalyptus drepanophylla and/or Corymbia clarksoniana +/- C. erythrophloia +/- E. platyphylla +/- E. exserta +/- C. trachyphloia woodland on hills and ranges at low to moderate altitudes, in drier areas	Sparse
8.12.25	Eucalyptus tereticornis +/- E. tereticornis x E. platyphylla woodland on hill slopes of islands on Mesozoic to Proterozoic igneous rocks	Sparse
8.12.6	Eucalyptus drepanophylla +/- E. platyphylla +/- Corymbia clarksoniana woodland on low to medium hills, on Mesozoic to Proterozoic igneous rocks	Sparse
8.12.9	Eucalyptus tereticornis +/- Corymbia intermedia +/- Lophostemon suaveolens woodland on undulating uplands, on Mesozoic to Proterozoic igneous rocks	Mid-dense
8.3.5	Eucalyptus platyphylla and/or Lophostemon suaveolens and/or Corymbia clarksoniana woodland on alluvial plains	Sparse
8.3.6	Eucalyptus tereticornis and/or Corymbia intermedia (or C. clarksoniana) and/or C. tessellaris +/- Lophostemon suaveolens open forest on alluvial levees and lower terraces	Mid-dense
8.5.3	Eucalyptus drepanophylla +/- Corymbia clarksoniana, +/- E. platyphylla +/- C. dallachiana +/- Melaleuca viridiflora woodland on broad low rises and gently sloping Tertiary sand plains	Sparse
9.11.14	Eucalyptus crebra and Corymbia citriodora subsp. citriodora +/- Corymbia spp. woodland on metamorphic hills and mountains in far south-west of bioregion	Sparse
9.11.15	Eucalyptus crebra and/or E. cullenii and/or E. whitei +/- Corymbia pocillum or C. erythrophloia woodland on metamorphic hills	Sparse
9.11.16	Eucalyptus crebra +/- Corymbia erythrophloia or C. pocillum woodland on steep to rolling hills	Sparse
9.11.2	Eucalyptus crebra (or several other ironbark species) +/- Corymbia spp. woodland on shallow texture contrast soils on low metamorphic hills and lowlands	Sparse
9.11.22	Eucalyptus melanophloia +/- Corymbia erythrophloia +/- Terminalia platyptera low woodland on metamorphic hills	Sparse
9.11.29	Eucalyptus crebra, Corymbia leichhardtii and C. lamprophylla woodland on steep to rugged metamorphic hills	Mid-dense
9.11.4	Eucalyptus crebra, Corymbia clarksoniana, C. citriodora subsp. citriodora +/- E. portuensis open forest on shallow soils on metamorphic hills and ranges	Mid-dense
9.12.11	Eucalyptus crebra and/or E. whitei +/- Corymbia erythrophloia open woodland on steep to rolling hills on igneous rocks	Sparse
9.12.12	Eucalyptus crebra and Corymbia erythrophloia +/- E. microneura open woodland on igneous rocks	Sparse
9.12.16	Eucalyptus crebra and Corymbia dallachiana +/- C. erythrophloia open woodland on pre-Cainozoic basalt loams and flats to undulating plains	Sparse
9.12.18	Eucalyptus crebra or E. exilipes +/- Corymbia citriodora subsp. citriodora +/- C. peltata open woodland on granites with thin sand sheet	Sparse
9.12.19	Eucalyptus crebra or E. granitica +/- Corymbia citriodora subsp. citriodora +/- E. portuensis mixed woodland on igneous hills	Sparse
9.12.21	Eucalyptus crebra or E. drepanophylla and Corymbia spp. open woodland on flat to undulating country on igneous rocks	Sparse
9.12.23	Eucalyptus drepanophylla or E. crebra, Corymbia leichhardtii and C. lamprophylla low open woodland on igneous rocks	Sparse
9.12.28	Eucalyptus melanophloia low open woodland, often with E. crebra, on low hills on igneous rocks	Sparse
9.3.1	Eucalyptus camaldulensis and/or E. tereticornis +/- Melaleuca spp. +/- Casuarina cunninghamiana fringing woodland on channels and levees	Sparse
9.3.11	Wetlands (sometimes ephemeral) with aquatic species and fringed with Eucalyptus spp. communities within basalt plains and flows	Sparse
9.3.16	Eucalyptus tereticornis and/or E. platyphylla and/or Corymbia clarksoniana woodland on alluvial flats, levees and plains	Sparse
9.3.19	Eucalyptus coolabah and/or E. leptophleba woodland on alluvial plains	Sparse
9.3.6	Eucalyptus platyphylla +/- Eucalyptus spp. +/- Corymbia spp. woodland on alluvial plains	Sparse
9.5.3	Eucalyptus crebra or E. drepanophylla and Corymbia clarksoniana woodland on sand plains	Sparse
9.5.7	Eucalyptus crebra and Corymbia erythrophloia +/- C. polycarpa woodland on kandosols	Sparse
9.7.3	Eucalyptus crebra or E. portuensis +/- Corymbia clarksoniana woodland on lateritised surfaces and edges of Tertiary surfaces	Sparse
9.8.1	Eucalyptus crebra +/- Corymbia dallachiana +/- E. leptophleba open woodland on plains and rocky rises of basalt geologies	Sparse
9.8.10	Eucalyptus tereticornis and Lophostemon suaveolens woodland +/- a shrubby understorey on rocky basalt flows	Sparse
9.8.4	Eucalyptus crebra and/or E. tereticornis open woodland on basalt plains	Sparse