

NSW Threatened Species Scientific Committee

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Notice and reasons for the Final Determination

The NSW Threatened Species Scientific Committee, established under the *Biodiversity Conservation Act 2016* (the Act), has made a Final Determination to list *Phascolarctos cinereus* (Koala) Goldfuss 1817 as an ENDANGERED SPECIES in Part 2 Division 1 of Schedule 1 of the Act; and as a consequence, to omit the listing of:

1. *Phascolarctos cinereus* (Koala) Goldfuss 1817 in Part 3 Division 1 of Schedule 1 (Vulnerable species) of the Act. Listing of Endangered species is provided for by Part 4 of the Act; and
2. The following 3 *Phascolarctos cinereus* (Koala) Goldfuss 1817 populations in Part 2 Division 4, of Schedule 1 Endangered species) of the Act, as provided for in clause 4.1(5)(a) of the *Biodiversity Conservation Regulation 2017*:
 - a. The “population between the Tweed River and Brunswick River east of the Pacific Highway”,
 - b. The “Hawks Nest and Tea Gardens population”, and
 - c. The population “in the Pittwater Local Government Area”.

The NSW Threatened Species Scientific Committee is satisfied that *Phascolarctos cinereus* (Koala) Goldfuss 1817 (combined populations of Queensland, New South Wales (NSW) and the Australian Capital Territory (ACT)) has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method (DAWE 2022) and is eligible to be listed in accordance with section 4.4(4) of the Act on the basis of the risk of extinction in NSW. The acceptance of the Common Assessment Method is provided for in section 4.14 of the Act.

Summary of Conservation Assessment

The Threatened Species Scientific Committee accepts the assessment undertaken by the Commonwealth Threatened Species Scientific Committee in its *Conservation Advice for Phascolarctos cinereus (Koala) combined populations of Queensland, NSW and the Australian Capital Territory (2022)*.

The koala was found to be Endangered in accordance with section 4.14 of the Act and clauses 4.2(1)(b) and (2)(c) of the *Biodiversity Conservation Regulation 2017*. The main reason for the species' eligibility is that the species has undergone a large reduction in population size due to a decline in its geographic distribution and habitat quality.

The NSW Threatened Species Scientific Committee has found that:

1. The koala (*Phascolarctos cinereus*, Goldfuss 1817) (family Phascolarctidae) is a medium-sized marsupial with a stocky body, large, rounded ears, sharp claws and variable but predominantly grey-coloured fur. Males are typically larger than females. Its morphological appearance changes gradually from south to north

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across its range, with larger individuals in the south and smaller individuals in the north. The average weight of males is 12 kg in Victoria compared with 6.5 kg in Queensland. In the south, the koala is characterised by longer, thicker, brown-grey fur, whereas in the north it has shorter, silver-grey fur (Martin and Handasyde 1999).

2. The koala is a wide-ranging marsupial endemic to Australia, occurring in Queensland, NSW, the ACT, Victoria and South Australia (Martin *et al.* 2008). The distribution of the koala as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (the EPBC Act) encompasses coastal and inland regions south from the Herberton area in the north of Qld, through NSW and the ACT and extending westward into semi-arid regions (DAWE 2022). The koala does not occur continuously across this range, with its distribution fragmented by cleared land or unsuitable habitat (Martin and Handasyde 1999; NSW DECC 2008). In NSW, koalas are known from the Mulga Lands, Darling Riverine Plains, Brigalow Belt South, Nandewar, New England Tablelands, South East Queensland (NSW Section) Sydney Basin and South East Corner, South Western Slopes, Cobar Peneplain, Riverina, and Murray Darling Depression bioregions (DAWE 2022).
3. The koala forms an integral part of Australian identity and it has become a national icon that is recognised internationally as a symbol of Australia (Markwell 2020a, b). Koalas are culturally significant for many Indigenous peoples in Australia. They hold specific and diverse roles for different Indigenous language groups, are depicted in rock art and are prevalent in creation stories (DAWE 2022).
4. Koala habitats across the broad distribution of the species are typically characterised by eucalypt forests and woodlands. These include a diverse range of vegetation associations determined by local climate, topography and landscape characteristics. Habitat suitability models indicate that koalas are best suited to locations where the mean maximum summer temperatures are 23-26°C and mean annual rainfall ranges from 700 -1500 mm (Adams-Hosking *et al.* 2011). Koalas can also be found in more extreme environments at the limits of their natural range (McAlpine *et al.* 2015). A koala's home range across the species' distribution is highly variable, with home ranges in Queensland and New South Wales reported to vary between 3 and 500 ha (Wilmott 2020).
5. Koalas are tree-dwelling, obligate folivores (leaf eaters) with a highly specialised diet. Their diet is defined by the availability and palatability of a limited variety of *Eucalyptus*, *Corymbia* and *Angophora* species. Koalas are nocturnal and move across the ground between food and shelter trees. Movement increases in the breeding season (typically September to February) (Melzer and Tucker 2011). Koalas are reported to utilise more than 400 tree species for their food and habitat requirements, with preferred tree species varying between habitat type and location across their range (Moore and Foley 2005; Moore *et al.* 2010).
6. Generation length (IUCN 2022) of the koala is estimated to be six to eight years. In the wild, longevity for koalas is more than 15 years for females and more than 12 years for males (Martin and Handasyde 1999). Female koalas reach sexual

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maturity between two and three years of age (McLean and Handasyde 2007) and may then produce one offspring per year. Females have a 12-month lactation period and young koalas are weaned after this period. Koalas may not breed every year if conditions are unfavourable, and breeding can be unsuccessful due to poor body condition or disease (e.g. *Chlamydia*) (McLean and Handasyde 2007).

7. The koala (DAWE 2022) occupies an extent of occurrence (EOO) estimated to be 1,665,850 km², based on a minimum convex polygon enclosing all known mapped occurrences of the species; the method of assessment recommended by IUCN (2022). The area of occupancy (AOO) is estimated at 19,428 km², based on 2 x 2 km grid cells method; the scale recommended for assessing area of occupancy by IUCN (2022). These calculations are based on the mapping of point records from a 20-year period (2000–20) (DAWE 2022).
8. The koala's distribution and population size has undergone a decline (Melzer *et al.* 2000; Sherwin *et al.* 2000; DAWE 2022). Much of the koala's national distribution now overlaps with human-modified landscapes. Vegetation clearance from activities including urbanisation, grazing, agriculture and mining have significantly reduced the distribution of koalas (McAlpine *et al.* 2015). Climate change drivers (e.g. drought and rising temperatures) have also resulted in a reduction of climatically suitable habitat (Adams-Hosking *et al.* 2011). The only bioregion in NSW to have convincing evidence of a stable population was the New England Tablelands, however this bioregion has since had 13 percent burnt in the 2019/20 fires (DAWE 2022). The koala (DAWE 2022) is estimated to have undergone a large reduction in population size of 50% over the last 20 years (3x generation length). This is likely to be an underestimate as the impact of both the 2019/20 bushfires and the preceding drought have not been accounted for in that figure (DAWE 2022). It was estimated that populations had declined by 10 per cent by one year after the 2019/20 fires and would continue to decline thereafter without returning to their pre-fire population size (Legge *et al.* 2021). The Commonwealth has concluded that the estimated population reduction is within the Endangered range (DAWE 2022).
9. Human activities including deforestation and land clearance for grazing, agriculture, urbanisation, timber harvesting, mining and other activities have resulted in loss, fragmentation and degradation of koala habitats. Large areas of forest and woodland within the koala's range were cleared between 2000 and 2017 (Ward *et al.* 2019) with clearing for grazing accounting for most of this loss of koala habitat (McAlpine *et al.* 2015; Evans 2016). Extinction risk of the koala is predicted to be greater in the western distribution of its range in NSW than in the east due to these land use changes and future scenarios of climate change (Santika *et al.* 2014). Urban expansion is concentrated along the eastern seaboard fringe of Australia (Clark and Johnston 2016), which is also a stronghold of the koala. Low density and peri-urban development are also expanding into forested and agricultural landscapes in these areas. The expanding coal and coal seam gas developments of the past two decades and recent clearing for renewable energy projects represent additional but localised impacts to koalas (McAlpine *et al.* 2015). Land clearing continues to impact habitat across the koala's range (DES 2018).

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'Clearing of native vegetation' is listed as a Key Threatening Process under the Act.

10. Areas with a suitable climate for koalas are contracting (Adams-Hosking *et al.* 2011). Climate change predictions indicate drier, warmer conditions across the range of the koala, and a progressive eastward and southwards contraction in the suitable climate envelope and habitat for koalas is projected (Adams-Hosking *et al.* 2011). Modelled climatic suitability from 2010 to 2030 indicates a 38-52% reduction in available habitat for the koala and a 62% reduction in koala habitat by 2070 has been forecast (Adams-Hosking *et al.* 2011). The effects of climate change may result in an increase in koala mortality from heatwave events and droughts, decline in reproduction rates associated with changes in food quality and availability, changed movement patterns, exposure to diseases and other factors in addition to the influence of climate change on fire regimes. 'Anthropogenic Climate Change' is listed as a Key Threatening Process under the Act.
11. Southeast Australia has experienced two of its worst droughts in the historical record over the last 21 years: the Millennium Drought (2000-2009) and the Big Dry (2017-2019). These periods of abnormally low rainfall have been associated with reductions in numbers (Seabrook *et al.* 2011; DPIE 2020). Average winter and spring rainfall are predicted to continue to decline across the koala's range (BoM 2021). Projections based on current trends suggest that by 2100, koala habitats will, on average, be in drought for 50% of the time, with severe drought occurring every five years. This is an increase from the current frequency of drought occurring every five years and severe drought every 30 years.
12. During the 2019/20 bushfire season an estimated 9% (>36,800 km²) of the entire koala distribution was impacted by fire, with a total of 34,666 km² burnt in NSW (DAWE 2021). The bioregions most heavily impacted by fire containing koalas included the South East Corner (52 percent burnt), the Sydney Basin (30 percent burnt) and NSW North Coast (30 percent burnt) (DAWE 2022). Koalas have displayed nuanced responses to fire with reductions in numbers following high-severity fire but little change in occupancy or density following low-severity fire (NSW Government 2021a). Koala monitoring records from north-east New South Wales following the 2019/20 bushfires, indicate that sites characterised by high-severity fire (e.g. with canopy scorch) had zero koala occupancy (i.e. zero return/recovery) immediately post fire. At sites where koalas have been detected following fire, refuge areas were present in the surrounding landscape, or fire severity was lower (NSW Government 2021b). While koalas have returned to bushfire impacted locations it is likely to take many years before populations are fully re-established. It is predicted that Australia will experience increases in intensity and frequency of fires into the future (BoM 2019, 2021). 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' is listed as a Key Threatening Process under the Act.
13. Vehicle related mortality occurs regularly on roads close to occupied koala habitat (Gonzalez-Astudillo 2018; Queensland-Government 2021). Dog attacks are a significant cause of death and injury especially in areas within and adjacent to peri-

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urban and residential areas (DPIE 2020). Koalas are unable to adapt to these threats and as human activities continue to expand into koala habitat, trauma from these threats will increase.

Wild populations of koalas carry disease pathogens including koala retrovirus (KoRV) and Chlamydia (*Chlamydia percorum*). Inadvertent spread of disease has also occurred historically following koala translocations. Disease can be a major contributor to population reduction and diminishes population viability. Chlamydia causes infertility, blindness and death (Polkinghorne *et al.* 2013). The prevalence of disease (chlamydiosis) has been found to increase following extreme stress from hot weather, drought, habitat loss and fragmentation (Lunney *et al.* 2012; Davies *et al.* 2013).

14. *Phascolarctos cinereus* (Koala) Goldfuss 1817 is not eligible to be listed as a critically endangered species.
15. *Phascolarctos cinereus* (Koala) Goldfuss 1817 is eligible to be listed as an endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a very high risk of extinction in the near future as determined in accordance with the criteria prescribed by the Act and the *Biodiversity Conservation Regulation 2017*.

Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: Endangered under clauses 4.2(1)(b) and (2)(c).

Clause 4.2 – Reduction in population size of species (Equivalent to IUCN criterion A)

**Assessment outcome: Endangered under clauses 4.2(1)(b) and (2)(c),
Biodiversity Conservation Regulation 2017.**

| (1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon: | | | |
|--|-----|---|---|
| | (a) | for critically endangered species | a very large reduction in population size, or |
| | (b) | for endangered species | a large reduction in population size, or |
| | (c) | for vulnerable species | a moderate reduction in population size. |
| (2) - The determination of that criteria is to be based on any of the following: | | | |
| | (a) | direct observation, | |
| | (b) | an index of abundance appropriate to the taxon, | |
| | (c) | a decline in the geographic distribution or habitat quality, | |
| | (d) | the actual or potential levels of exploitation of the species, | |
| | (e) | the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites. | |

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Clause 4.3 - Restricted geographic distribution of species and other conditions (Equivalent to IUCN criterion B)

Assessment Outcome: Not met

| The geographic distribution of the species is: | | | |
|--|-----|---|---|
| | (a) | for critically endangered species | very highly restricted, or |
| | (b) | for endangered species | highly restricted, or |
| | (c) | for vulnerable species | moderately restricted, |
| and at least 2 of the following 3 conditions apply: | | | |
| | (d) | the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations, | |
| | (e) | there is a projected or continuing decline in any of the following: | |
| | | (i) | an index of abundance appropriate to the taxon, |
| | | (ii) | the geographic distribution of the species, |
| | | (iii) | habitat area, extent or quality, |
| | | (iv) | the number of locations in which the species occurs or of populations of the species, |
| | (f) | extreme fluctuations occur in any of the following: | |
| | | (i) | an index of abundance appropriate to the taxon, |
| | | (ii) | the geographic distribution of the species, |
| | | (iii) | the number of locations in which the species occur or of populations of the species. |

Clause 4.4 - Low numbers of mature individuals of species and other conditions

(Equivalent to IUCN criterion Clause C)

Assessment Outcome: Not met

| The estimated total number of mature individuals of the species is: | | | | |
|--|-----|---|---|----------------|
| | (a) | for critically endangered species | very low | |
| | (b) | for endangered species | low, or | |
| | (c) | for vulnerable species | moderately low. | |
| and either of the following 2 conditions apply: | | | | |
| | (d) | a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species): | | |
| | | (i) | for critically endangered species | very large, or |
| | | (ii) | for endangered species | large, or |
| | | (iii) | for vulnerable species | moderate |
| | (e) | both of the following apply: | | |
| | | (i) | a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and | |
| | | (ii) | at least one of the following applies: | |

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| | | | |
|--|--|-------|--|
| | | (A) | the number of individuals in each population of the species is: |
| | | (i) | for critically endangered species |
| | | (ii) | for endangered species |
| | | (iii) | for vulnerable species |
| | | (B) | all or nearly all mature individuals of the species occur within one population, |
| | | (C) | extreme fluctuations occur in an index of abundance appropriate to the species. |

Clause 4.5 - Low total numbers of mature individuals of species

(Equivalent to IUCN criterion D)

Assessment Outcome: Not met

| The total number of mature individuals of the species is: | | |
|---|-----------------------------------|-------------------|
| (a) | for critically endangered species | extremely low, or |
| (b) | for endangered species | very low, or |
| (c) | for vulnerable species | low. |

Clause 4.6 - Quantitative analysis of extinction probability

(Equivalent to IUCN criterion E)

Assessment Outcome: Data Deficient

| The probability of extinction of the species is estimated to be: | | |
|--|-----------------------------------|--------------------|
| (a) | for critically endangered species | extremely high, or |
| (b) | for endangered species | very high, or |
| (c) | for vulnerable species | high |

Clause 4.7 - Very highly restricted geographic distribution of species–vulnerable species

(Equivalent to IUCN criterion D2)

Assessment Outcome: Not met

| | |
|-------------------------|--|
| For vulnerable species, | the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period. |
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Dr Anne Kerle

Chairperson

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References:

- Adams-Hosking C, Grantham HS, Rhodes JR, McAlpine C, Moss PT (2011) Modelling climate-change-induced shifts in the distribution of the koala. *Wildlife Research* 38,122–130.
- BoM (2019) Special Climate Statement 68—widespread heatwaves during December 2018 and January 2019.
<http://www.bom.gov.au/climate/current/statements/scs68.pdf>
(accessed 11 March 2022).
- BoM (2021) Climate Change in Australia. Projections for Australia's NRM regions. Bureau of Meteorology.
<https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/super-clusters/?current=ESC&tooltip=true&popup=true>
(accessed: 15 February 2021).
- Clark G, Johnston E (2016) Coasts: Population growth and urban development: Coastal development and land use.', in Australia State of the Environment 2016, Australian Government Department of the Environment and Energy (former), Canberra.
- Davies NA, Gramotnev G, McAlpine C, Seabrook L, Baxter G, Lunney D, Rhodes JR, Bradley A (2013) Physiological Stress in Koala Populations near the Arid Edge of Their Distribution. *PLOS ONE* 8,e79136.
- DAWE (2021) Bushfire Recovery Environmental Analysis Decision Support (BREADS) tool. V21_18_IBRA. Department of Agriculture, Water and Environment.
- DAWE (2022) Conservation Advice *Phascolarctos cinereus* (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory. Canberra: Department of Agriculture, Water and the Environment. Available from:
<http://www.environment.gov.au/biodiversity/threatened/species/pubs/85104-conservation-advice-12022022.pdf>
- DECC (2008) Recovery Plan for the Koala (*Phascolarctos cinereus*) (Approved) (Approved recovery Plan for the Koala) (p. 124) Sydney: Department of Environment and Climate Change.
<http://www.environment.nsw.gov.au/resources/threatenedspecies/08450krp.pdf>

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- DES (2018) Land cover change in Queensland: a Statewide Landcover and Trees Study Summary Report: 2016–17 and 2017–18, Queensland Department of Environment and Science, Brisbane, available from https://www.qld.gov.au/data/assets/pdf_file/0031/91876/landcover-change-in-queensland-2016-17-and-2017-18.pdf.
- DPIE (2020) Saving our species. Framework for the spatial prioritisation of koala conservation actions in NSW. Iconic Koala Project. State of NSW and Department of Planning, Industry and Environment. <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/framework-spatial-prioritisation-koala-conservation-190045.pdf>.
- Evans MC (2016) Deforestation in Australia: drivers, trends and policy responses. *Pacific Conservation Biology* **22**,130–150.
- Gonzalez-Astudillo V (2018) Analysis of morbidity and mortality of wild koalas in south-east Queensland using passive surveillance data. PhD Thesis. The University of Queensland.
- IUCN (2022) IUCN Standards and Petitions Committee. 2022. Guidelines for Using the IUCN Red List Categories and Criteria. Version 15. Prepared by the Standards and Petitions Committee. Downloadable from <http://www.iucnredlist.org/documents/RedListGuidelines.pdf>.
- Legge S, Woinarski JCZ, Garnett ST, Geyle H, Lintermans M, Nimmo DG, Rumpff L, Scheele BC, Southwell DG, Ward M, Whiterod NS, Ahyong S, Blackmore C, Bower D, Brizuela Torres D, Burbidge AH, Burns P, Butler G, Catullo R, Dickman CR, Doyle K, Ensby, M., , Ehmke G, Ferris J, Fisher D, Gallagher R, Gillespie G, Greenlees MJ, Hayward-Brown B, Hohnen R, Hoskin C, Hunter D, Jolly C, Kennard M, King A, Kuchinke D, Law B, Lawler I, Loyn R, Lunney D, Lyon J, MacHunter J, Mahony M, Mahony S, McCormack R, Melville J, Menkhorst P, Michael D, Mitchell N, Mulder E, Newell D, Pearce L, Raadik T, Rowley J, Sitters H, Spencer R, Lawler S, Valavi R, Ward M, West M, Wilkinson D & Zukowski S (2021). Estimates of the impacts of the 2019-2020 fires on populations of native animal species. NESP Threatened Species Recovery Hub project 8.3.2 report. (Brisbane, Australia.).
- Lunney D, Crowther MS, Wallis I, Foley WJ, Lemon J, Wheeler R, Madani G, Orscheg C, Griffith JE, Krockenberger M (2012) Koalas and climate change: a case study on the Liverpool Plains, north-west New South Wales. In 'Wildlife and Climate Change: towards robust conservation strategies for Australian Fauna'. (Eds D Lunney, P Hutchings) pp,150-168. (Royal Zoological Society of New South Wales, Mosman, NSW, Australia)
- Markwell K (2020a) Getting close to a national icon: an examination of the involvement of the koala (*Phascolarctos cinereus*) in Australian tourism. *Tourism Recreation Research*, **46**, 473–486.

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- Markwell K (2020b). Koalas are the face of Australian tourism. What now after the fires? <https://theconversation.com/koalas-are-the-face-of-australian-tourism-what-now-after-the-fires-129347>.
- Martin R, Handasyde KA (1999) 'The koala: natural history, conservation and management.' (UNSW press: Kensington)
- Martin RW, Handasyde KA, Krokenberger A (2008) Koala *Phascolarctos cinereus* In 'The Mammals of Australia'.(Eds S Van Dyck, R Strahan.) pp,198-201. (Reed New Holland: Australia)
- McAlpine C, Lunney D, Melzer A, Menkhorst P, Phillips S, Phalen D, Ellis W, Foley W, Baxter G, de Villiers D, Kavanagh R, Adams-Hosking C, Todd C, Whisson D, Molsher R, Walter M, Lawler I, Close R (2015) Conserving koalas: A review of the contrasting regional trends, outlooks and policy challenges. *Biological Conservation* **192**, 226–236.
- McLean N, Handasyde KA (2007) Sexual maturity, factors affecting the breeding season and breeding in consecutive seasons in populations of overabundant Victorian koalas (*Phascolarctos cinereus*) *Australian Journal of Zoology* **54**, 385–392.
- Melzer A, Carrick F, Menkhorst P, Lunney D, John BS (2000) Overview, critical assessment, and conservation implications of koala distribution and abundance. *Conservation Biology* **14**, 619–628.
- Melzer A, Tucker G (2011) Koalas of the St Lawrence region of Central Queensland. Report 1: Defining the population. Queensland Department of Transport and Main Roads.
- Moore BD, Foley WJ (2005) Tree use by koalas in a chemically complex landscape. *Nature* **435**, 488–490.
- Moore BD, Lawler IR, Wallis IR, Beale CM, Foley WJ (2010) Palatability mapping: a koala's eye view of spatial variation in habitat quality. *Ecology* **91**, 3165-3176.
- NSW Government (2021a) Koala research in NSW forests. NSW Government, Department of Primary Industries.
<https://www.dpi.nsw.gov.au/forestry/science/koala-research>.
- NSW Government (2021b) Monitoring Koalas in Hinterland Forests of Northeast NSW and the effect of 2019 fires on the meta-population. Department of Primary Industries. <https://www.dpi.nsw.gov.au/forestry/science/koala-research>.
- NSW TSSC (2020) Guidelines for interpreting listing criteria for species, populations and ecological communities under the NSW Biodiversity Conservation Act 2016. Version 2.1.

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- Polkinghorne A, Hanger J, Timms P (2013) Recent advances in understanding the biology, epidemiology and control of chlamydial infections in koalas. *Veterinary Microbiology* **165**, 214–223.
- Queensland-Government (2021) Koala hospital data extracted from the Department of Environment and Science koala hospital database (KoalaBase) between July 1996 - December 2019.
<https://www.data.qld.gov.au/dataset/koala-hospital-data/resource/7c6f7da8-ef7a-48e4-bf4e-c449a885e46d> (accessed 10/03/22).
- Santika T, McAlpine CA, Lunney D, Wilson KA, Rhodes JR (2014) Modelling species distributional shifts across broad spatial extents by linking dynamic occupancy models with public-based surveys. *Diversity and Distributions* **20**,786–796.
- Seabrook L, McAlpine C, Baxter G, Rhodes J, Bradley A, Lunney D (2011) Drought-driven change in wildlife distribution and numbers: a case study of koalas in south west Queensland. *Wildlife Research* **38**, 509–524.
- Sherwin WB, Timms P, Wilcken J, Houlden B (2000) Analysis and Conservation Implications of Koala Genetics. *Conservation Biology* **14**, 639–649.
- Ward MS, Simmonds JS, Reside AE, Watson JEM, Rhodes JR, Possingham HP, Trezise J, Fletcher R, File L, Taylor M (2019) Lots of loss with little scrutiny: The attrition of habitat critical for threatened species in Australia. *Conservation Science and Practice* **1**,e117.
- Wilmott L (2020) Koala home range size and chlamydia disease expression correlated with soil fertility. Ecological Society of Australia Conference 2020. <https://www.esa2020.org.au/full-scientific-program/>.