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# 2024 update of National Koala Population estimates

## Supporting documentation for the 2024 update of the NKMP National koala population approach

15 April 2024

## Citation

CSIRO (2024). *2024 update of National Koala Population estimates*. Progress Report. CSIRO

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# 1 Introduction

This report provides the background to the National Koala Monitoring Program's second annual reporting of the estimated national population of koalas. Contained in this report are contemporary estimates for both the listed (Queensland, New South Wales and the Australian Capital Territory) and the unlisted (Victoria and South Australia) populations, alongside mapping of the current estimated distributions for these areas. We detail the modelling and data assumptions used to derive this estimate, and give background to the approach and inputs used. The results of this study are being prepared into a peer reviewed scientific paper which will be made available online once published.

## 1.1 Background

In February 2022, the koala (combined populations of Queensland, New South Wales, and the Australian Capital Territory) was up-listed to 'Endangered' under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Previous estimates have relied on more qualitative approaches such as expert elicitation to try and fill this gap.

The National Koala Monitoring Program (NKMP) provides a robust, data-driven approach to deriving koala population estimates across both the koala's listed (Qld, NSW, ACT) and unlisted (Vic and SA) ranges. The program is achieving this by designing and implementing an inclusive monitoring and modelling approach which enables the integration of multiple different sources of data and knowledge into processes which are established to ensure a long-lasting and robust monitoring program. Since the March 2023 release of the preliminary baseline estimate the NKMP has:

- Published a novel statistical methodology which has been used to create the National monitoring design (Foster et al 2023a)
- Conducted 214 koala surveys within regional QLD, which follow the national design, surveying a combined distance of 1,057 km.
- Collected information on the location and abundance of 67 non-koala species, including 51 sightings of the Endangered greater glider.
- Koala Spotter (one of our data collection applications) has gained 430 unique users and has been used to spot 270 koalas.
- The NKMP has connected with >1,500 individuals across 348 activities right across koala conservation, science and policy spaces.
- Published the analytical approach and software package being used to develop the NKMP National koala model (Foster et al 2023b)

In March 2023, the National Koala Monitoring Program (NKMP) provided a "preliminary national baseline population estimate for koalas". Details of this 2023 estimate are reported here. This estimate was in two parts, namely a distribution map and a population estimate for each of the north, the south, and the combined/national populations. Whilst preliminary, this 2023 estimate

was unlike previous estimates in that it was based solely on data, and not expert opinion about distribution and abundance.

The challenges in providing a solely data-driven estimate remain the same as for the 2023 estimate: namely that the data are limited, fragmented and contain bias as well as signal. The preliminary 2023 estimate was enabled by two distinct advances. The first of these was a concerted effort to collate koala presence, absence, and abundance data from a wide range of sources (individuals, research organisations, community groups, local governments, and state governments). This effort had been neglected up until this point. The second advance was an analytical framework to combine all these disparate sources and types of data. This methodology was, and still is, right at the forefront of statistical ecology.

This report presents a snapshot of the on-going efforts to refine the preliminary estimates. There are multiple avenues being progressed to make these improvements: 1) new data collected by the NKMP and its partners, 2) refined data handling procedures, 3) furthering intuitive understanding of the likely sources of non-koala variation (ie patterns induced by piecemeal data collection), 4) improvements and refactoring of the statistical model and the associated analysis code, and 5) establishment of a broader community of koala modellers. All these advances lead to a better understanding of the data and the patterns that they describe.

## 1.2 Advances in this update

The baseline assumptions of the model remain the same as the previous update and can be found here. This update is the result of many improvements to the analysis process. Some of the changes are small and have not been explicitly mentioned. However, the more noteworthy improvements/developments that have contributed to this estimate include:

1. Inclusion of new survey data. Notably those collected throughout Queensland as part of the NKMP backbone survey design.
2. Compiled, extended, curated, and refined our database of koala data.
    a. Established a network of custodians of koala data.
    b. Established a set of robust and updatable rules for cleaning publicly available koala presence-only data.
    c. Performed a close inspection of all data, with particular focus on more variable data sources and have removed noisy and spurious data.
    d. Harmonised metadata to encode more consistent description of sampling practises between datasets.
3. Identified and sourced a best-available set of environmental variables which can explain koala distribution
    a. Refined our national model for koala feed trees.
    b. Elicited drivers of koala distribution and linked them to environmental variables.
4. Assessed, refined and encoded the spatial patterns of human search effort for wildlife.
5. Identified, implemented, refined and tested a statistical framework for bringing together disparate sources of data which is now peer reviewed and published (Foster et al 2023b)
6. Established a network of koala and ecological modellers to help refine and review the NKMP's modelling efforts.

# 2 Results

The NKMP modelling approach is developed to enable the integration of all available data sources to provide the best possible, national scale, estimates of koala population and distribution. The results presented here highlight this approach using datasets collected over the past 10 years. As the national program is deployed we will be able to update these estimates of the current state of the population with increasing confidence. It is also expected that the impact of any significant events in recent years will become clearer as more contemporary data is collected and modelled.

## 2.1 Population estimates

The national baseline estimate presented in this report is delivered with wide confidence bounds, representing the relative uncertainty of generating a large-scale estimate from currently available data sources. This is not surprising as the datasets used to derive this estimate are varied and do not represent a high-quality sample of all the possible places that koalas can be found across their range. The NKMP monitoring design has been developed to counter this challenge and, as such, our confidence in subsequent estimates will increase as the technical monitoring backbone of the program is fully deployed.

Our current best available estimate for koala population size at national and population scales are given in Table 1. These estimates are broadly in line with previous estimates but are slightly smaller. Other estimates of koala populations at large scales, across a similar timeframe, tended to have wide confidence margins and are highly varied between different studies (Table 2).

**Table 1. Updated NKMP estimates of koala populations (2024)**

| Region | Population Estimate |
|---|---|
| Aus | 224k – 524k |
| Sth | 129k – 286k |
| Nth | 95k – 238k |

**Table 2. Previous published estimates of koala populations size**

| Year | 2001 | 2012 | 2012 | 2014 | 2018 | 2020 | 2020 | 2021 | 2021 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Source | SA Gov[1] | SA Gov[1] | Adams–Hosking *et al*. (2016)[2] | IUCN[3] | AKF[4] | Heard & Ramsey (2020)[5] | NSW Gov[6] | AKF[4] | Federal CA[7] based on Adams–Hosking *et al*. (2016) | NKMP (initial estimate) |
| Aus | | | 331,000 (144k–605k) | 300,000 (100k–500k) | 45,000–82,000 | | | 32,000–58,000 | | 287,830 – 628,010 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sth | | | | | | | | | | 170,780 – 383,570 |
| Nth | | | | | | | | | 92,184 | 117,050 – 244,440 |
| Qld | | | 79,000 (33k–153k) | | 10,090–19,150 | | | 6,455–12,085 | | |
| NSW | | | 36,000 (14k–73k) | | 11,010–15,520 | | 20,000 (15k–30k) | 6,040–9,605 | | |
| Vic | | | 183,000 (77k–327k) | | 14,280–27,640 | Native: 413,000<br>Plantation: 47,000 | | 11,950–23,080 | | |
| SA | Kangaroo Island: 27,000 | Adelaide Hills & Mt Lofty Ranges: 114,000 | 33,000 (19k–51k) | | Excl. KI: 10,355–19,840 | | | Excl. KI: 7,615–13,150 | | |

Sources of previous regional and national koala estimates

[1]SA Gov:The South Australian Koala Conservation and Management Strategyhttps://cdn.environment.sa.gov.au/environment/docs/koala-conservation-and-management-strategy-gen.pdf
[2]Adams-Hosking et al. (2016)https://onlinelibrary.wiley.com/doi/epdf/10.1111/ddi.12400
[3]IUCN:https://www.iucnredlist.org/species/16892/166496779
[4]AKF:Koala Population Estimates. https://www.savethekoala.com/wp-content/uploads/2021/09/KoalaEstimates2021.pdf
[5]Heard & Ramsey: Modelling Koala abundance across Victoria. https://www.wildlife.vic.gov.au/__data/assets/pdf_file/0022/512752/Heard-and-Ramsey_Koala_Popn_Assessment_FINAL.pdf
[6]NSW Gov:https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/koala-strategy-2022-220075.pdf
[7]Federal Conservation advice:http://www.environment.gov.au/biodiversity/threatened/species/pubs/85104-conservation-advice-12022022.pdf*Note: Population estimates are based on Adams-Hosking et al. (2016) with a percent decline based on expert-elicitation values for bioregional population declines.*

## 2.2 Distribution

The results shown in Figure 1 and Figure 2 represent our current best estimate of the realised distribution of koalas, given the environmental and search effort within each spatial location. This distribution includes the climatic and landscape drivers of koala distribution as well as spatially smooth random variation that is a common feature of wildlife distribution. Maps represent the 'probability that at-least one koala is present within a cell' so can be interpreted as green tones meaning a likely presence of koalas, to peach tones meaning a low probability that koalas are present in this location. Importantly, in contrast to many of the more commonly presented distributional approaches we can deliver these estimates with associated upper and lower boundaries of confidence. Like our population estimates, the wide range of these confidence bounds highlights the difficulties in creating estimates from fragmented and limited data sources.

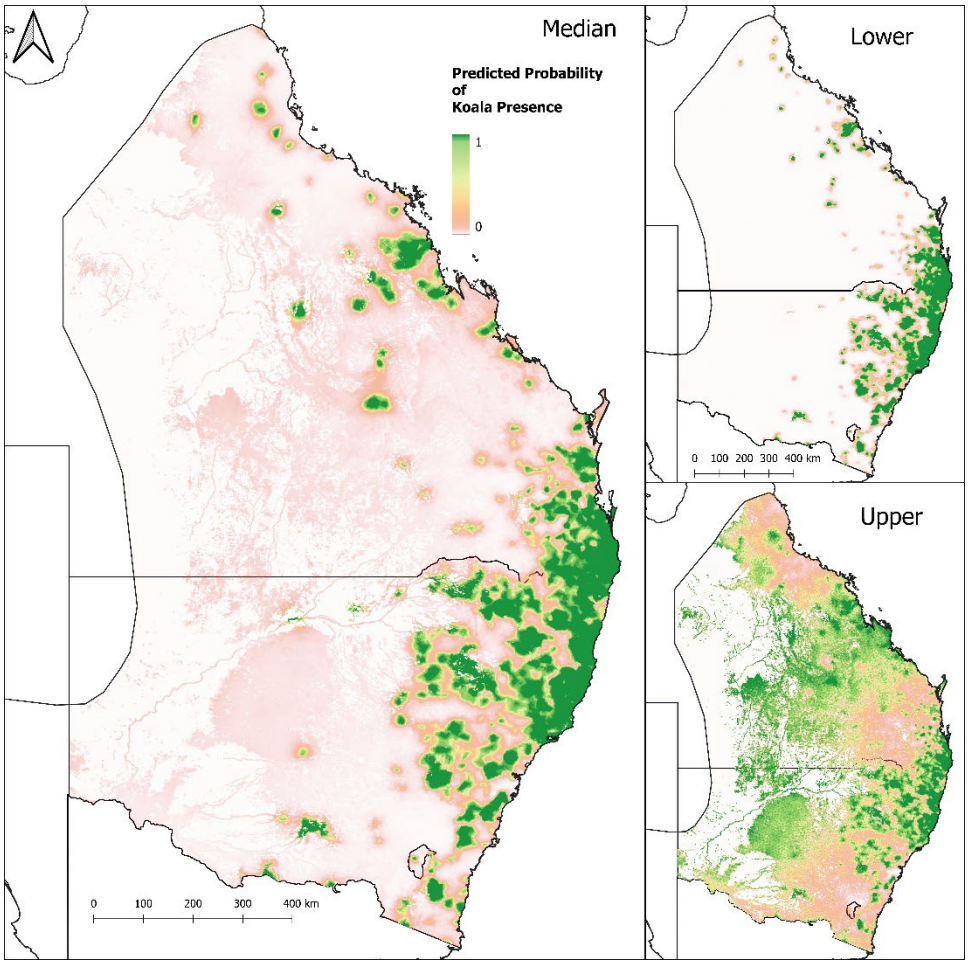


**Figure 1. The predicted distribution of koalas across their listed range – QLD, NSW, ACT. Large panel on the left shows the median predictions whereas smaller panels show the upper and lower confidence estimates for the distribution. Grid cell size ≈ 2 km.**

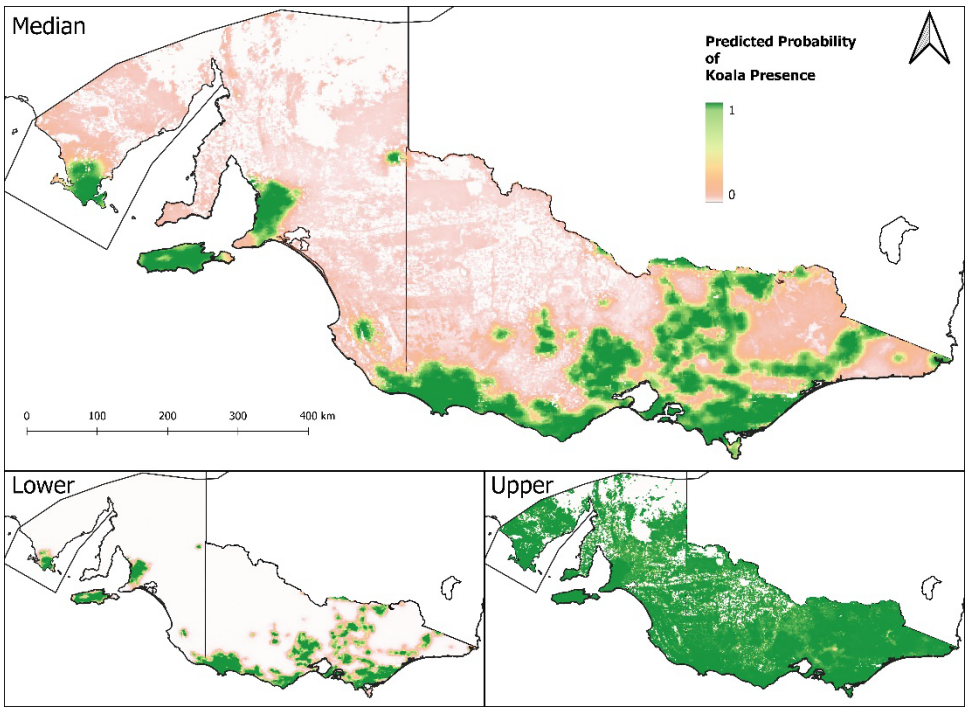


**Figure 2. The predicted distribution of koalas across their unlisted range – VIC and SA. Large panel on the above shows the median predictions whereas smaller panels below show the upper and lower confidence estimates for the distribution. Grid cell size ≈ 2 km.**

# 3 Limitations and next steps

The NKMP team have worked to address many of the data and model design challenges for this update, overall producing a much more robust and defined model. However we acknowledge that the current model has some limitations/uncertainties. In particular the current model is:

- reliant on historic koala survey data with insufficient amounts of contemporary survey data in all areas. There has been significant data collection efforts within regional QLD that have been included in this update, however, other contemporary efforts in other regions are still being processed before being made available to the model
- likely achieving a poor characterisation of overabundant populations within the Southern part of the species range. If true this would have the effect of reducing population predictions relative to the true population within those areas.

The NKMP modelling team, and koala modelling working group, are actively working to address these uncertainties and plan to produce a revised update in September 2024. This update will aim to further refine the model and address these limitations by:

1) Obtaining new data, especially nationally consistent data. The distribution pattern in the northern part of Queensland has been refined substantially. In the time before the next update, we expect to have a substantial amount of contemporary data from the NKMP and from its collaborating partners within other regions.
2) Utilise the established network of koala modellers to help refine and to validate the NKMP's modelling efforts.
3) Perform a sensitivity analysis to investigate how sensitive the estimates are to changes in the model's assumptions.
4) Extend the model (or investigate the impact of these assumptions)

Additional future developments will include:

1) Preparing a framework for assessing the effect of adding new, national, data
2) Encoding space-time processes into the model to enable the koala distribution to vary through time and improve our ability to detect temporal changes in populations
3) Preferential sampling, to allow for the possibility that surveys have been historically performed where koalas are thought to occur.

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