

**Supplementary Material**

**An analysis of the long-term trends in the records of Friends of the Koala in north-east New South Wales: I. Cause and fate of koalas admitted for rehabilitation (1989–2020)**

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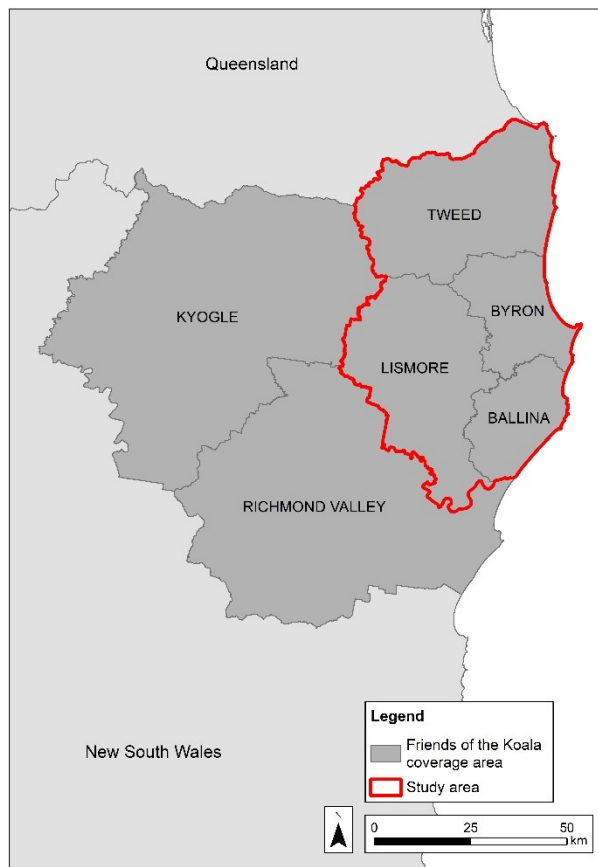
<sup>C</sup>Australian Museum, 1 William Street, Sydney, NSW 2010, Australia.

<sup>D</sup>Faculty of Science, Sydney School of Veterinary Science, University of Sydney, Sydney, NSW 2006, Australia.

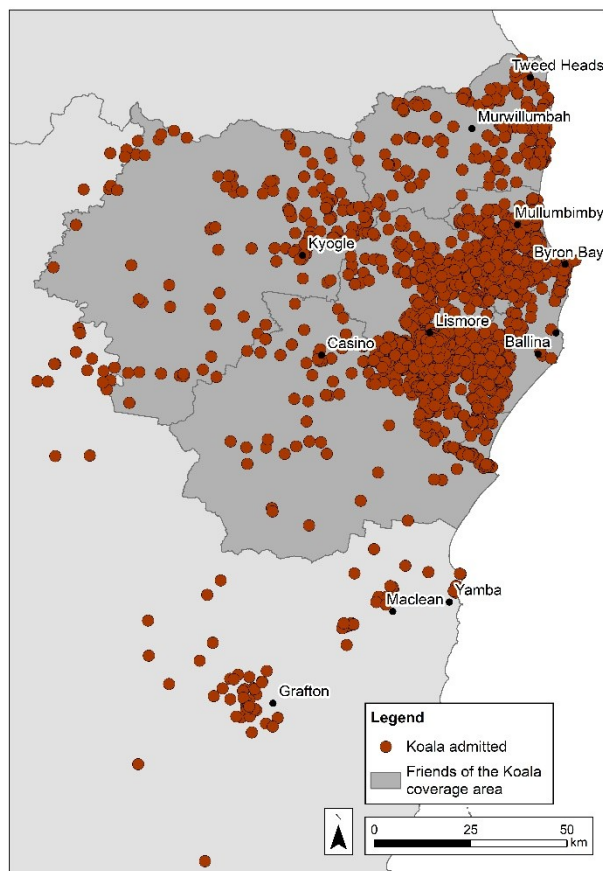
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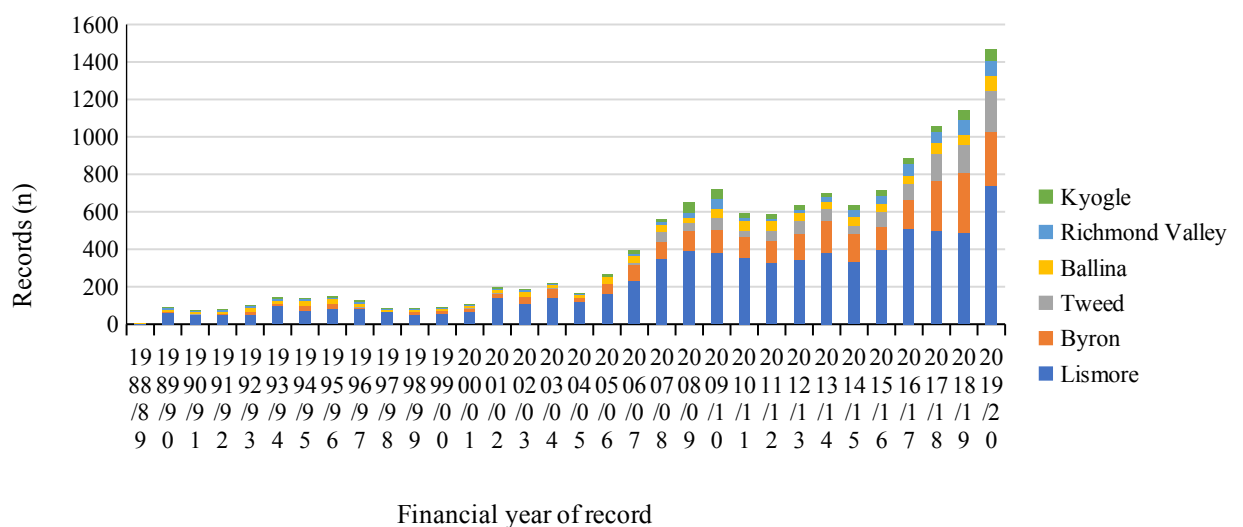
**Supplementary Figure 1:** Outline of the area covered by Friends of the Koala in north-east NSW (shaded in dark grey) and the focal study area of Lismore, Ballina, Byron and Tweed LGAs (red outline) with two adjacent LGAs Kyogle and Richmond Valley.



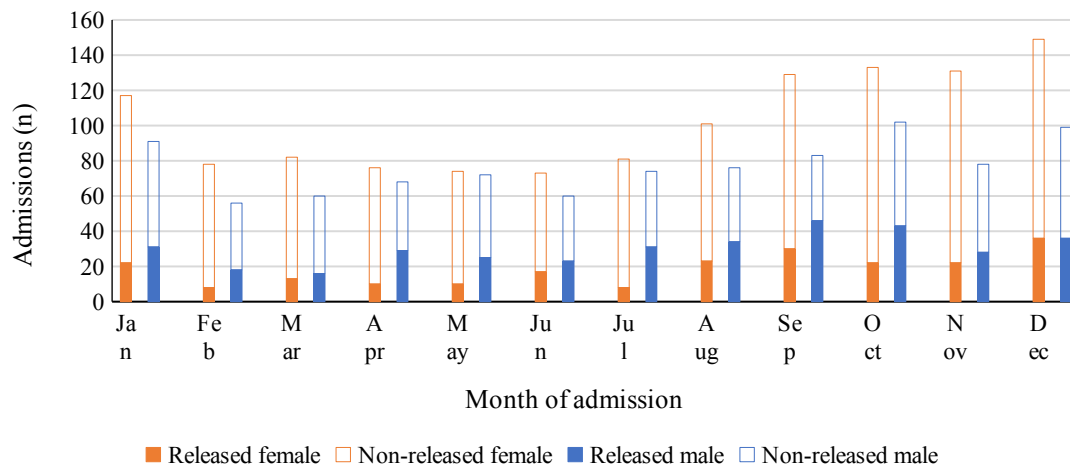
**Supplementary Figure 2.** Rescue locations in north-east NSW, principally Lismore, Ballina, Byron and Tweed LGAs, for all the koalas admitted to Friends of the Koala for rehabilitation over 31 years.



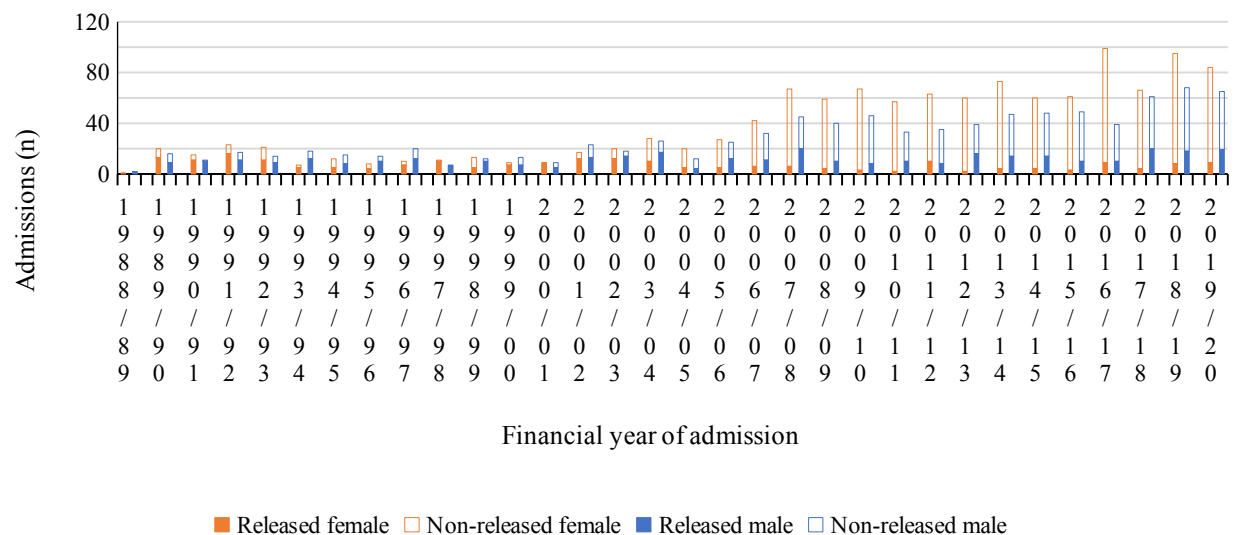
**Supplementary Figure 3.** All koala records (includes sightings as well as admissions; total  $n = 13,312$ ) of Friends of the Koala over 31 years across the six most prominent LGAs (as presented on the figure).



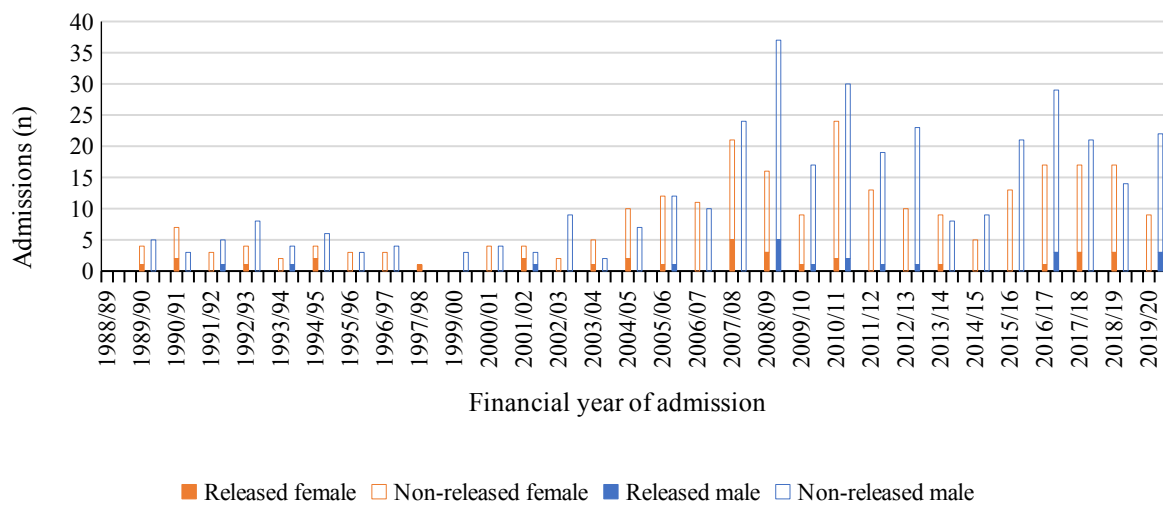
**Supplementary Figure 4.** Number of female and male admissions to Friends of the Koala due to chlamydiosis over 31 years by month of admission (total n value is presented above columns), with released and non-released koalas presented by the coloured and outlined columns, respectively.



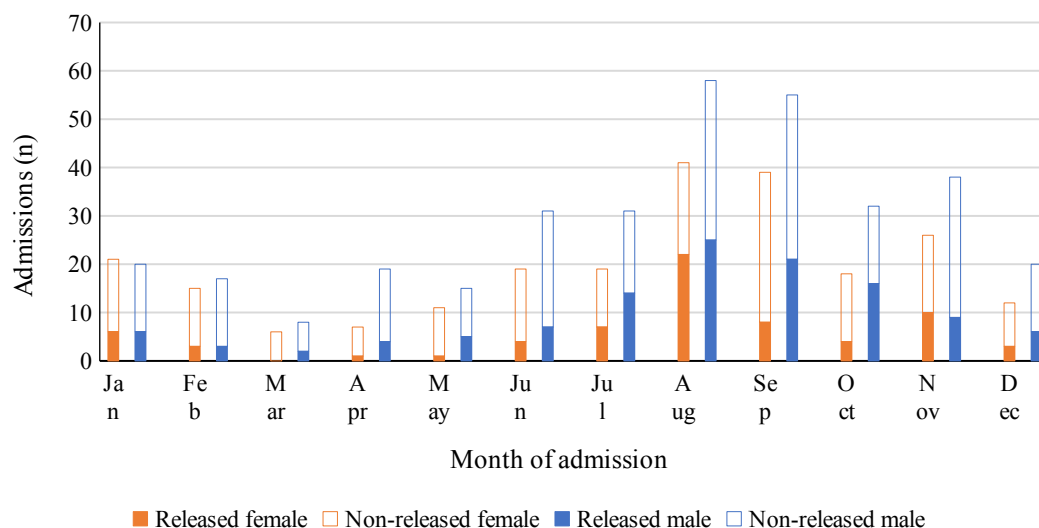
**Supplementary Figure 5.** Comparison of number of female and male admissions and releases due to chlamydiosis over 31 financial years showing that while the admission rates are rising, the release rates as a proportion are falling.



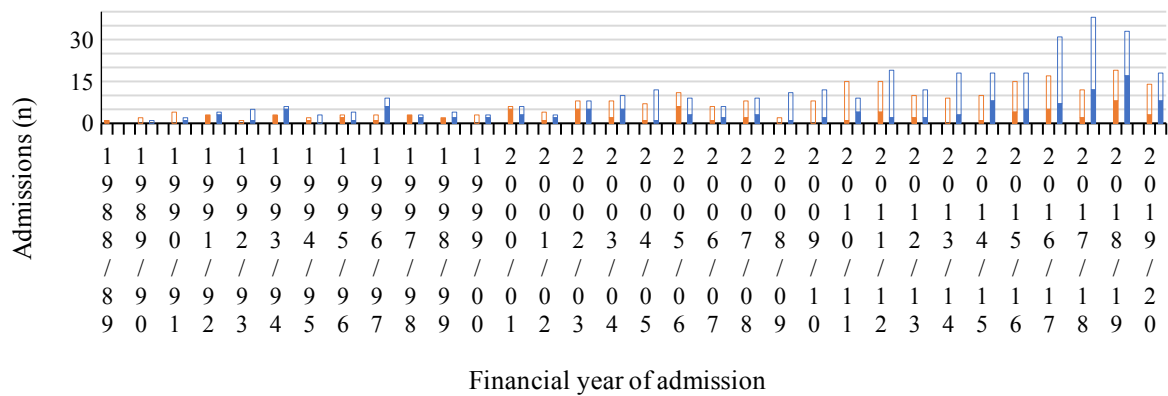
**Supplementary Figure 6.** Number of female and male admissions to Friends of the Koala due to diseases other than chlamydiosis over 31 financial years with released and non-released koalas presented by the coloured and outlined columns, respectively.



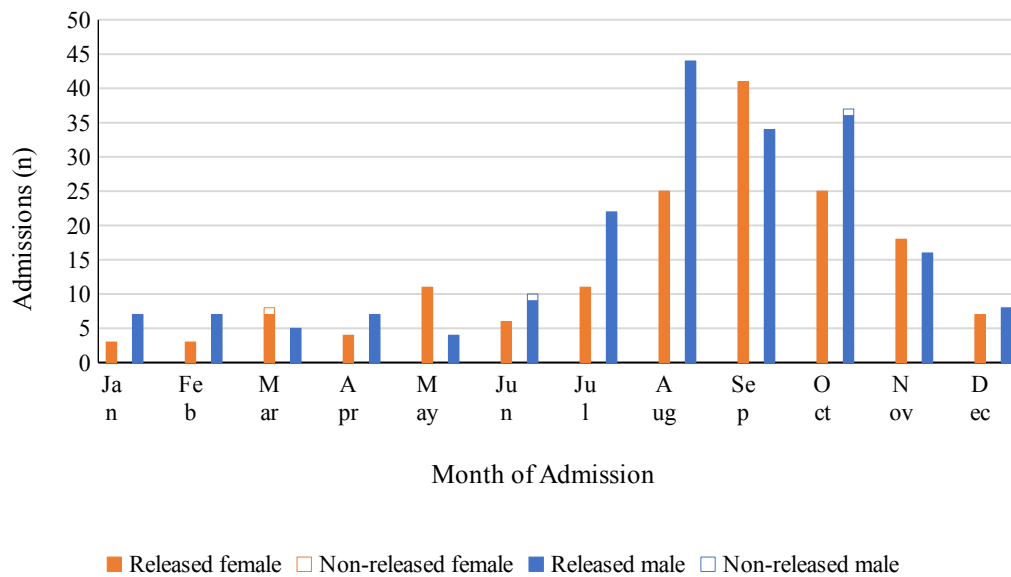
**Supplementary Figure 7.** Number of female and male admissions to Friends of Koala due to motor vehicle collision over 31 years by month of admission (total n value is presented above columns), with released and non-released koalas presented by the coloured and outlined columns, respectively.



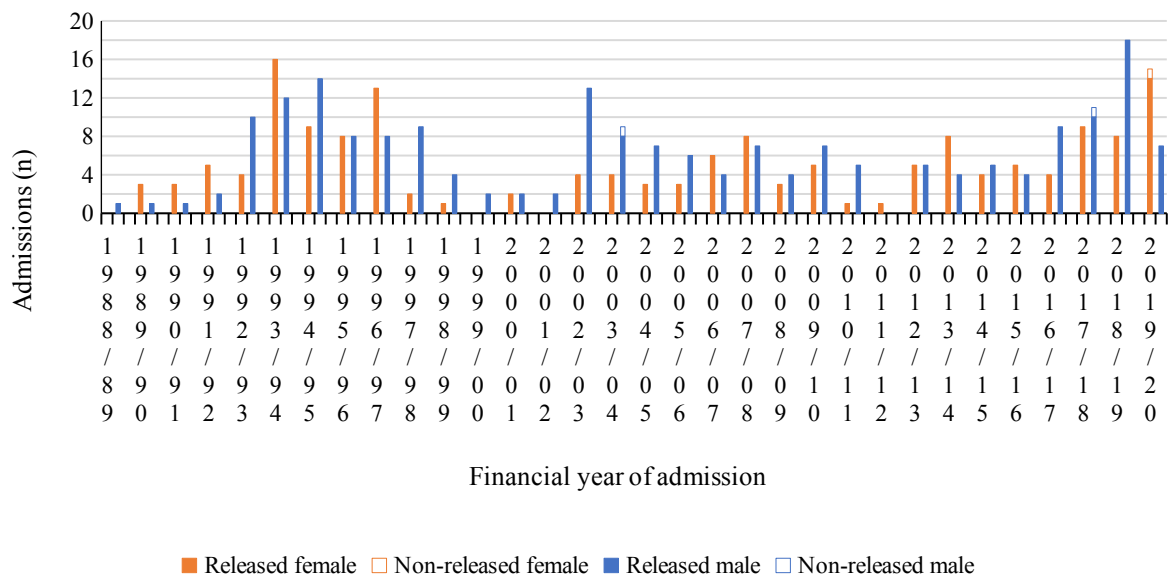
**Supplementary Figure 8.** Number of female and male admissions to Friends of the Koala due to motor vehicle collision over 31 financial years with released and non-released koalas presented by the coloured and outlined columns, respectively.



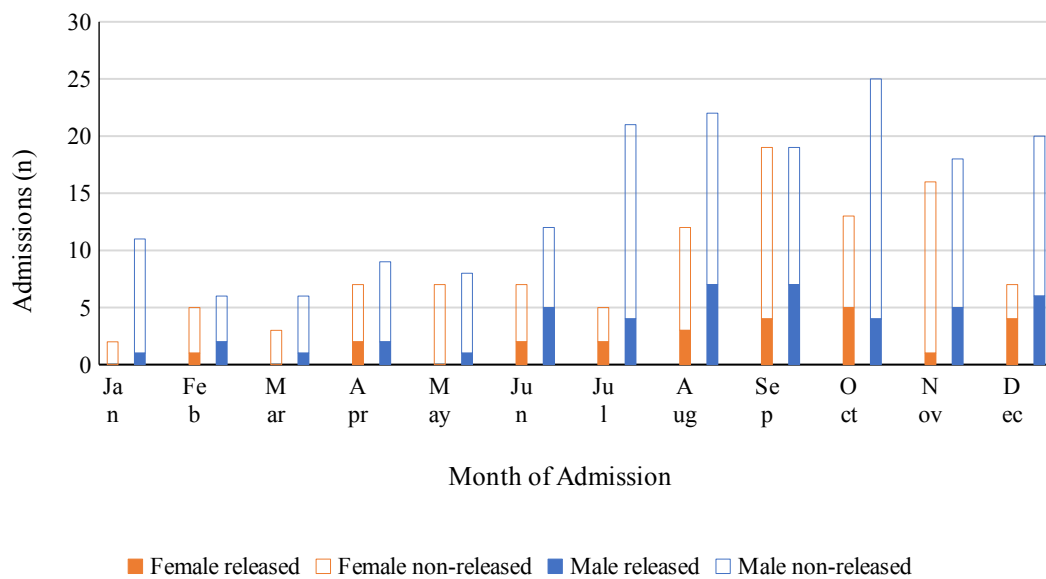
**Supplementary Figure 9.** Number of female and male admissions to Friends of the Koala due to being in an unsuitable environment over 31 years by month of admission (total n value is presented above columns), with released and non-released koalas presented by the coloured and outlined columns, respectively. The numbers non-released were so low that they are not clearly visible.



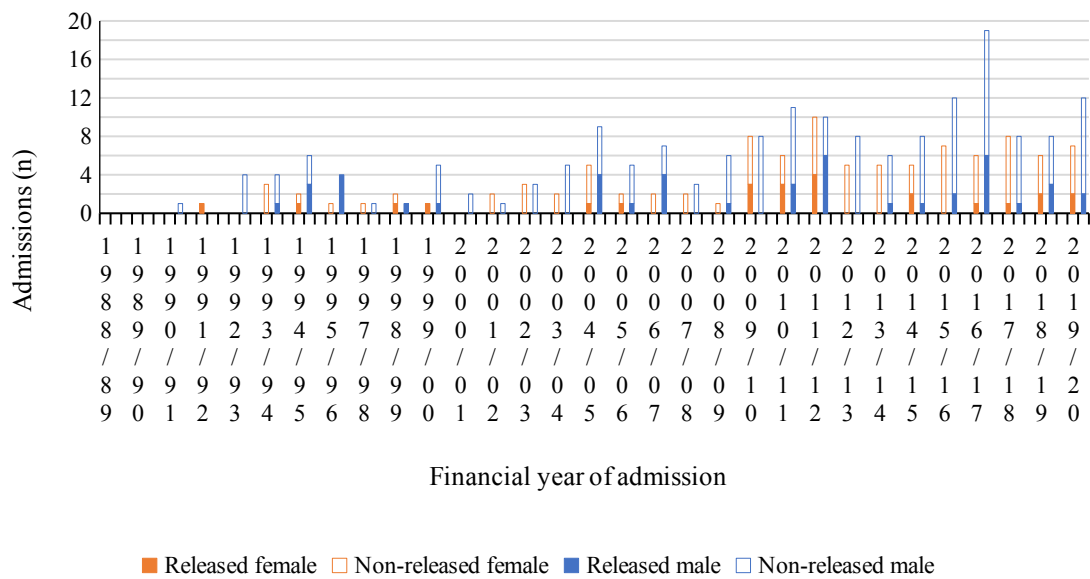
**Supplementary Figure 10.** Number of female and male admissions to Friends of the Koala due to being in an unsuitable environment over 31 financial years with released and non-released koalas presented by the coloured and outlined columns, respectively.



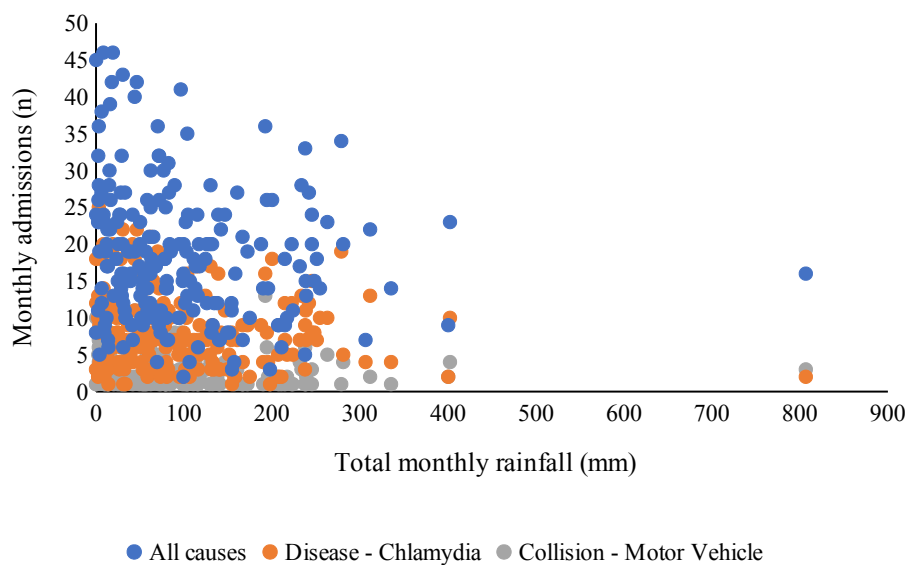
**Supplementary Figure 11.** Number of female and male admissions to Friends of the Koala due to a dog attack over 31 years by month of admission (total n value is presented above columns), with released and non-released koalas presented by the coloured and outlined columns, respectively.



**Supplementary Figure 12.** Number of female and male admissions to Friends of the Koala due to a dog attack over 31 financial years with released and non-released koalas presented by the coloured and outlined columns, respectively.



**Supplementary Figure 13.** The total monthly rainfall at Lismore Airport (mm; x axis) against the number of monthly admissions to Friends of the Koala (y axis) for all causes of admission, chlamydiosis and motor vehicle collisions from February 2002 to May 2020.



## Methods

A Spearman's rank correlation was used to assess the relationship between total monthly rainfall (mm) at Lismore Airport weather station from 2002 to 2020 (Bureau of Meteorology 2021) and the total numbers of admissions due to all causes, as well as chlamydiosis and motor vehicle collision.

## Results

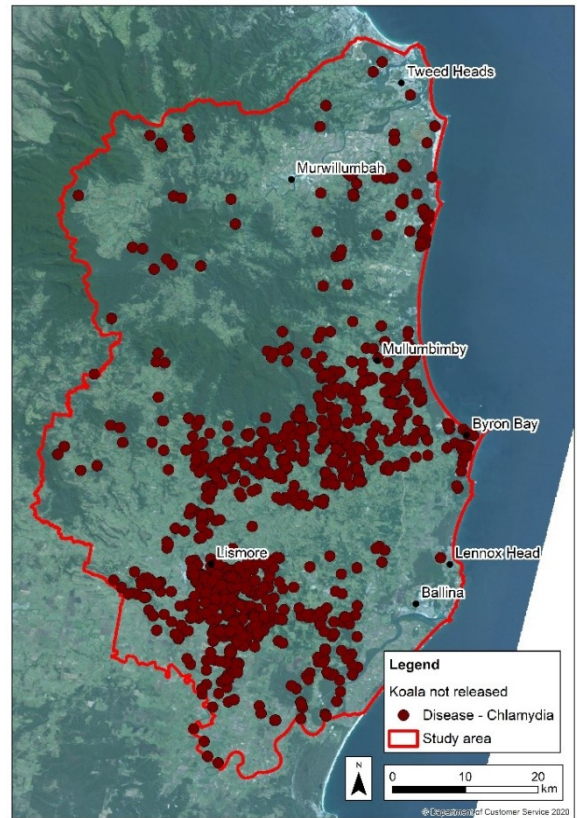
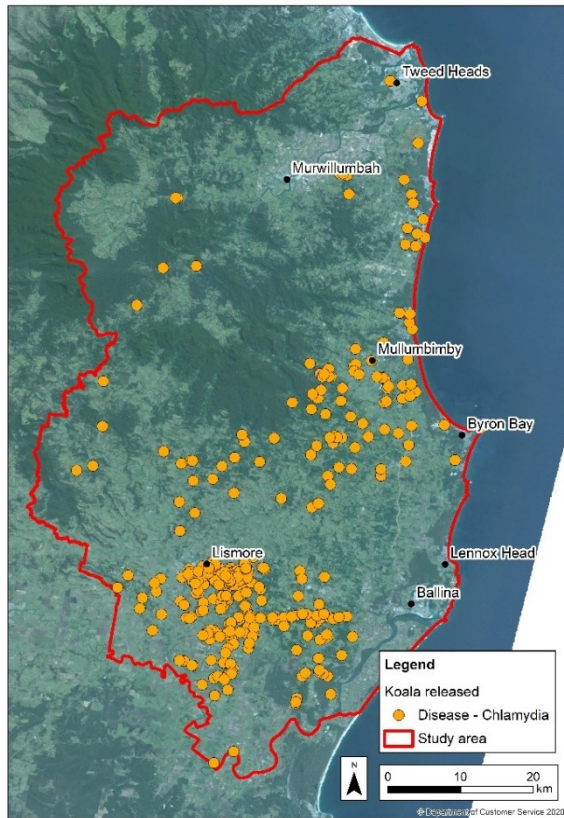


There was a weak negative relationship between total monthly rainfall (mm) and the number of admissions per month when looking at all admissions (Spearman's rank correlation = -0.180,  $t = -2.334$ , d.f. = 163,  $p = 0.021$ ) or motor vehicle collisions only (Spearman's rank correlation = -0.196,  $t = -2.547$ , d.f. = 163,  $p = 0.012$ ) where increasing rainfall results in decreasing admissions (Figure 23). There was no significant relationship between total monthly rainfall and admissions due to chlamydiosis (Spearman's rank correlation = -0.150,  $t = -1.942$ , d.f. = 163,  $p = 0.054$ ).

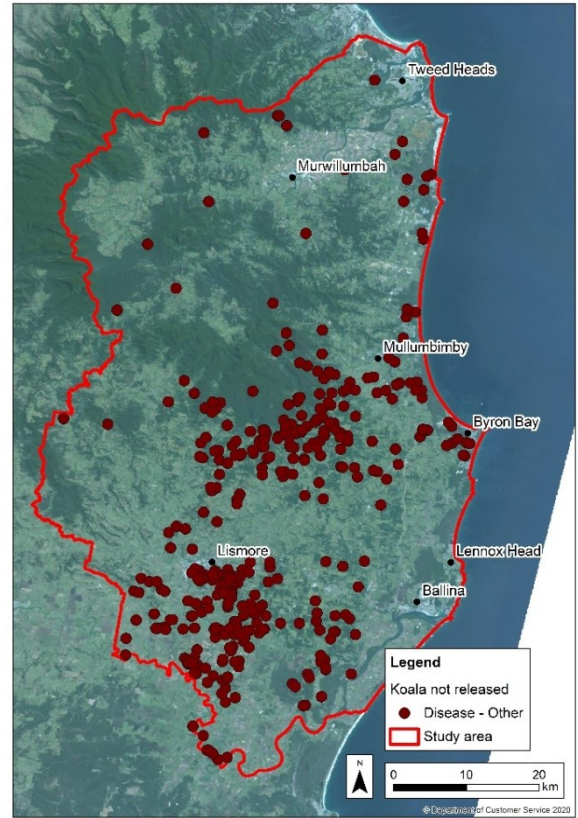
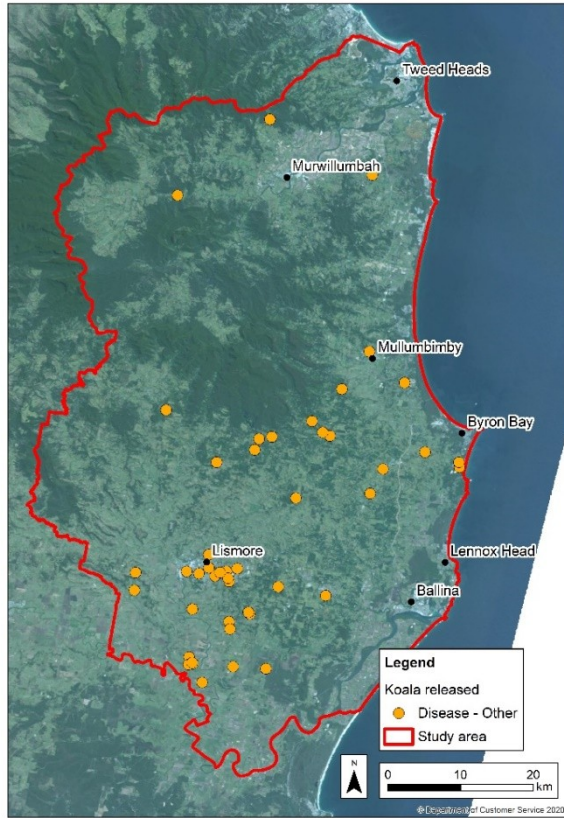
### *Discussion*

Since drought has a known adverse effect on koala populations in NSW and beyond (Lunney *et al.* 2012; Lunney *et al.* 2014; Lunney *et al.* 2017; Lunney *et al.* 2020; McAlpine *et al.* 2015; Seabrook *et al.* 2011) we sought a numerical relationship between rainfall and admissions over an 18-year period in Lismore, which corresponds to when the most koalas were admitted. In the Lismore area there was only a weak indication that decreasing rainfall increases admissions. This includes the millennium drought of the first years of the 21<sup>st</sup> century and the intense drought in the two years preceding the 2019/20 bushfires. It thus represents a contrast to elsewhere, especially in the north-west part of the state where there was a powerful effect of drought (Lunney *et al.* 2012d; Lunney *et al.* 2017; Lunney *et al.* 2020). However, we do not know what was happening to the wild population, and whether there was a higher death rate or a reduced reproductive rate in the dry years. One interpretation is that the causes of admission are largely independent of rainfall and thus rehabilitation records are not a measure of the impact of drought, and thus potentially not a good measure of climate change. Alternately, recent drought in NSW and the reduction in food availability could have resulted in increased movement of koalas and predisposed them to misadventure, contributing to the increase in admissions for motor vehicle collision, unsuitable environment and dog attack from 2016/17 to 2019/20. Further, an increased death rate in the wild, and particularly, a reduced reproductive rate because of drought, would not be reflected in admissions to rehabilitation.

**Supplementary Figure 14.** Rescue locations in north-east NSW for koalas admitted to Friends of the Koala for rehabilitation due to chlamydiosis over 31 years that were a) released, and b) not released.

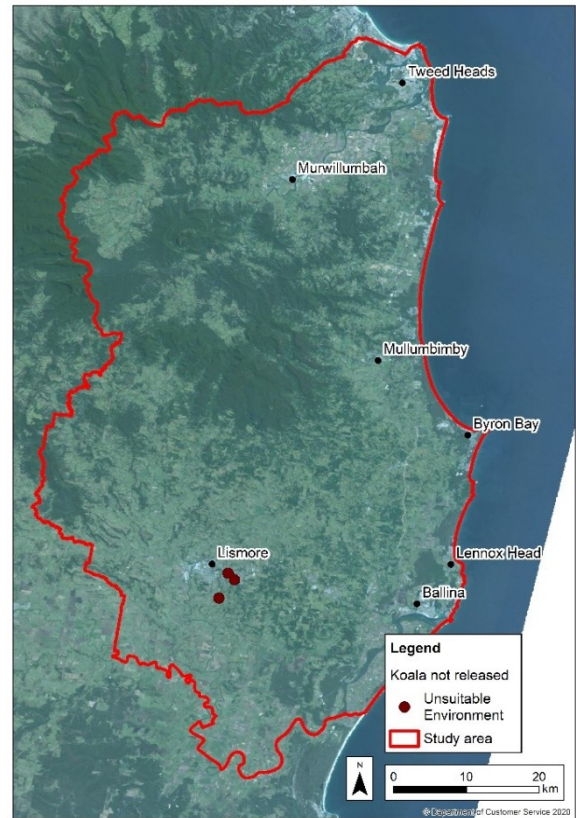
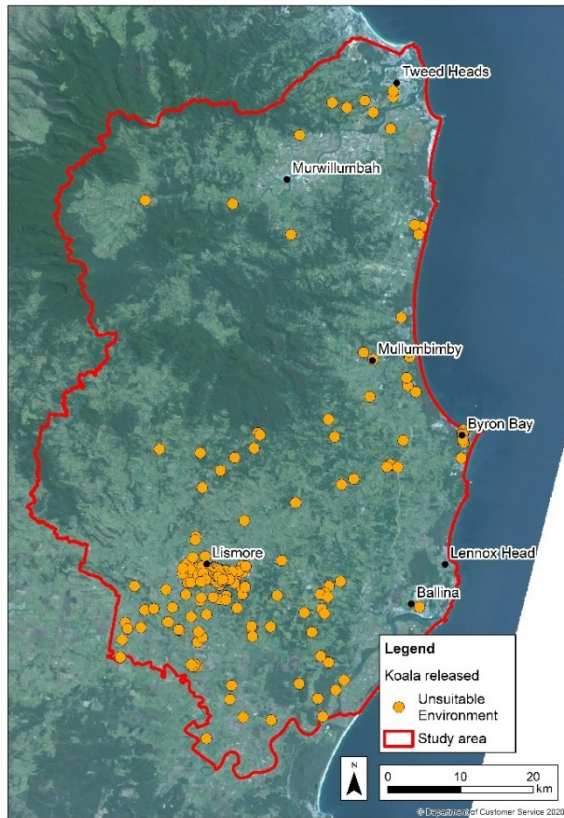


**Supplementary Figure 15.** Rescue locations in north-east NSW for koalas admitted to Friends of the Koala for rehabilitation due to diseases other than chlamydiosis over 31 years that were a) released, and b) not released.

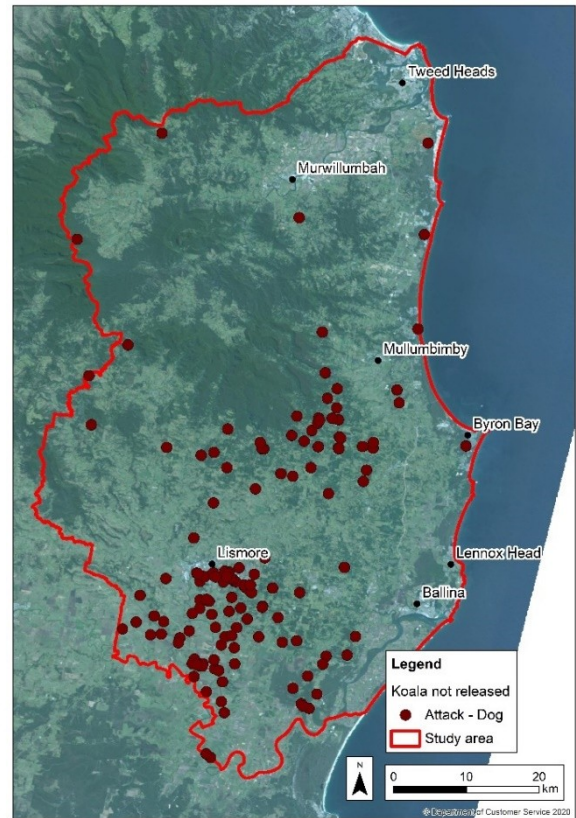
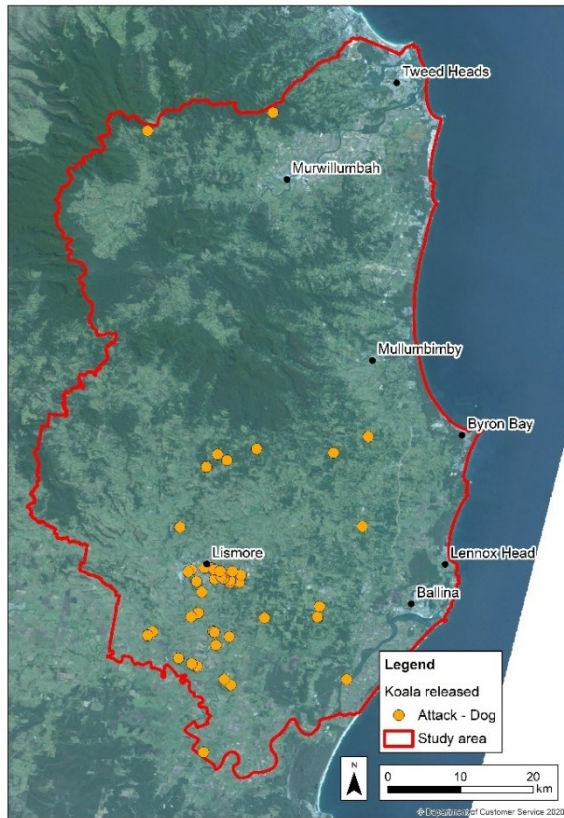




**Supplementary Figure 16.** Rescue locations in north-east NSW for koalas admitted to Friends of the Koala for rehabilitation due to an unsuitable environment over 31 years that were a) released, and b) not released.

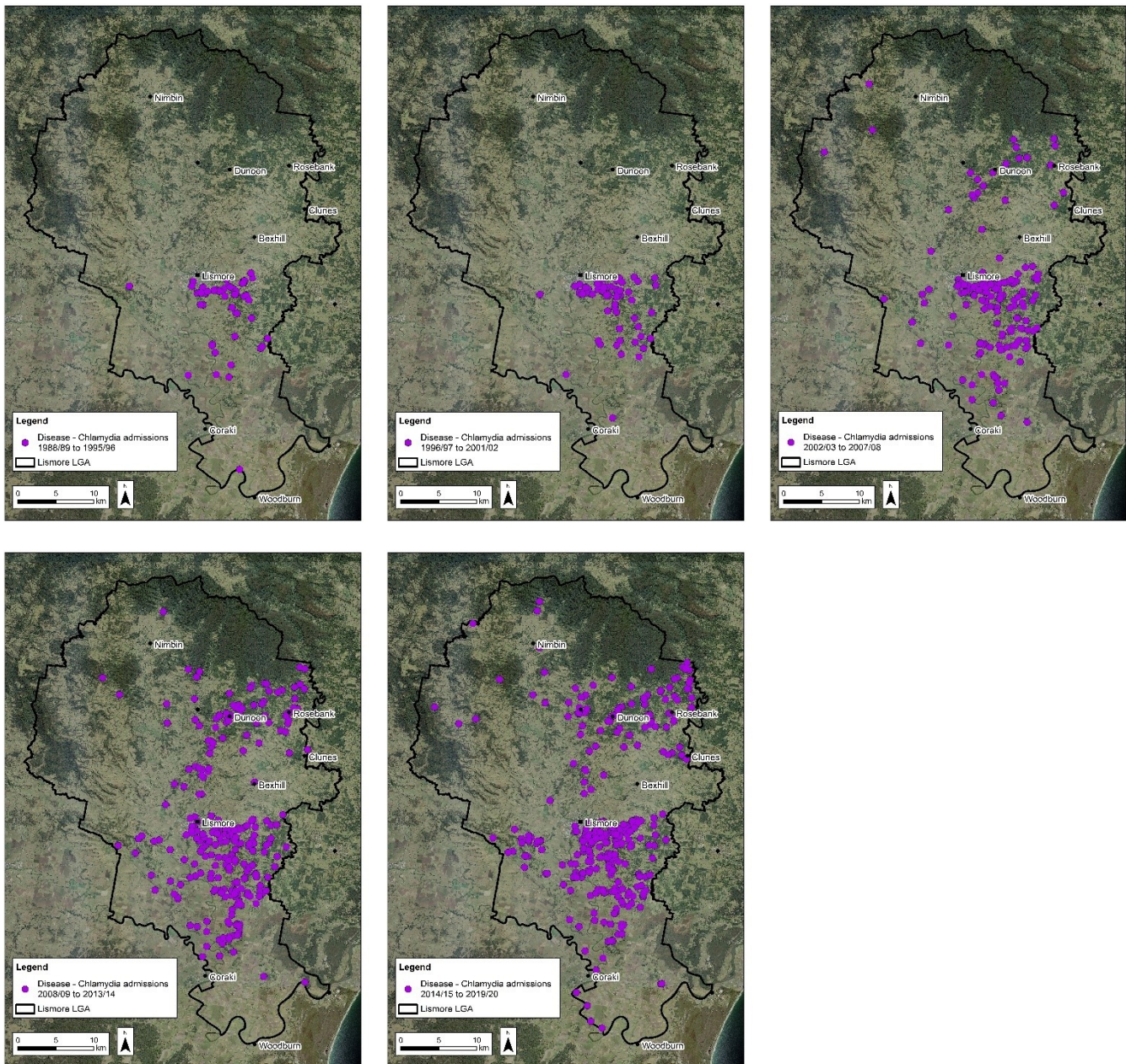


**Supplementary Figure 17.** Rescue locations in north-east NSW for koalas admitted to Friends of the Koala for rehabilitation due to a dog attack over 31 years that were a) released, and b) not released.





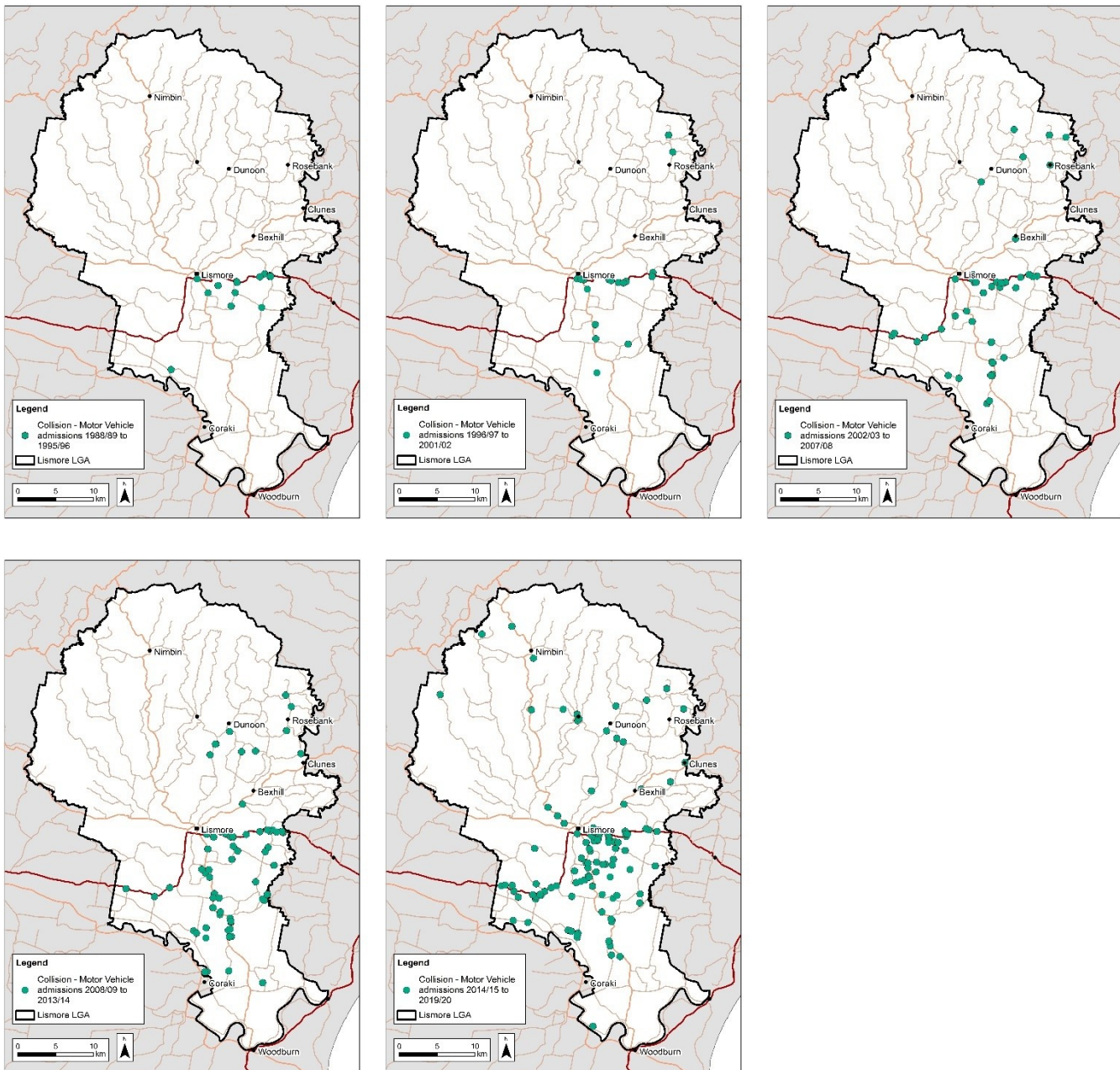
**Supplementary Figure 18.** Map of rescue locations in Lismore LGA, north-east NSW for koalas admitted to Friends of the Koala for rehabilitation due to chlamydiosis during the years a) 1988/89 – 1995/96, b) 1996/97 – 2001/02, c) 2002/03 – 2007/08, d) 2008/09 – 2013/14, and e) 2014/15 – 2019/20.



The first generation of admissions for chlamydiosis shows a small number of locations, mainly just to the south of Lismore CBD, then forming a slight arc to the east and back. The second generation shows a slight increase in locations, mainly through consolidation within the compass of the first generation. In the third generation, the number of locations shows a

marked increase, comprising more locations to the south of the Lismore CBD but, most conspicuously, west from Rosebank through Dunoon in the middle section of the LGA. This change possibly reflects dispersal from the Nightcap Range (west of Mullumbimby and north of Lismore) utilising planted macadamia orchard windbreaks (Lorraine Vass, pers. comm. August 2021.) The fourth generation reveals another increase in locations, especially across the middle section of the LGA, with this stretch joining the Lismore cluster. The area south of Lismore also shows an increase in locations. The fifth generation shows the same pattern as the fourth generation.

**Supplementary Figure 19.** Map of rescue locations in Lismore LGA, north-east NSW for koalas admitted to Friends of the Koala for rehabilitation due to motor vehicle collision during the years a) 1988/89 – 1995/96, b) 1996/97 – 2001/02, c) 2002/03 – 2007/08, d) 2008/09 – 2013/14, and e) 2014/15 – 2019/20.

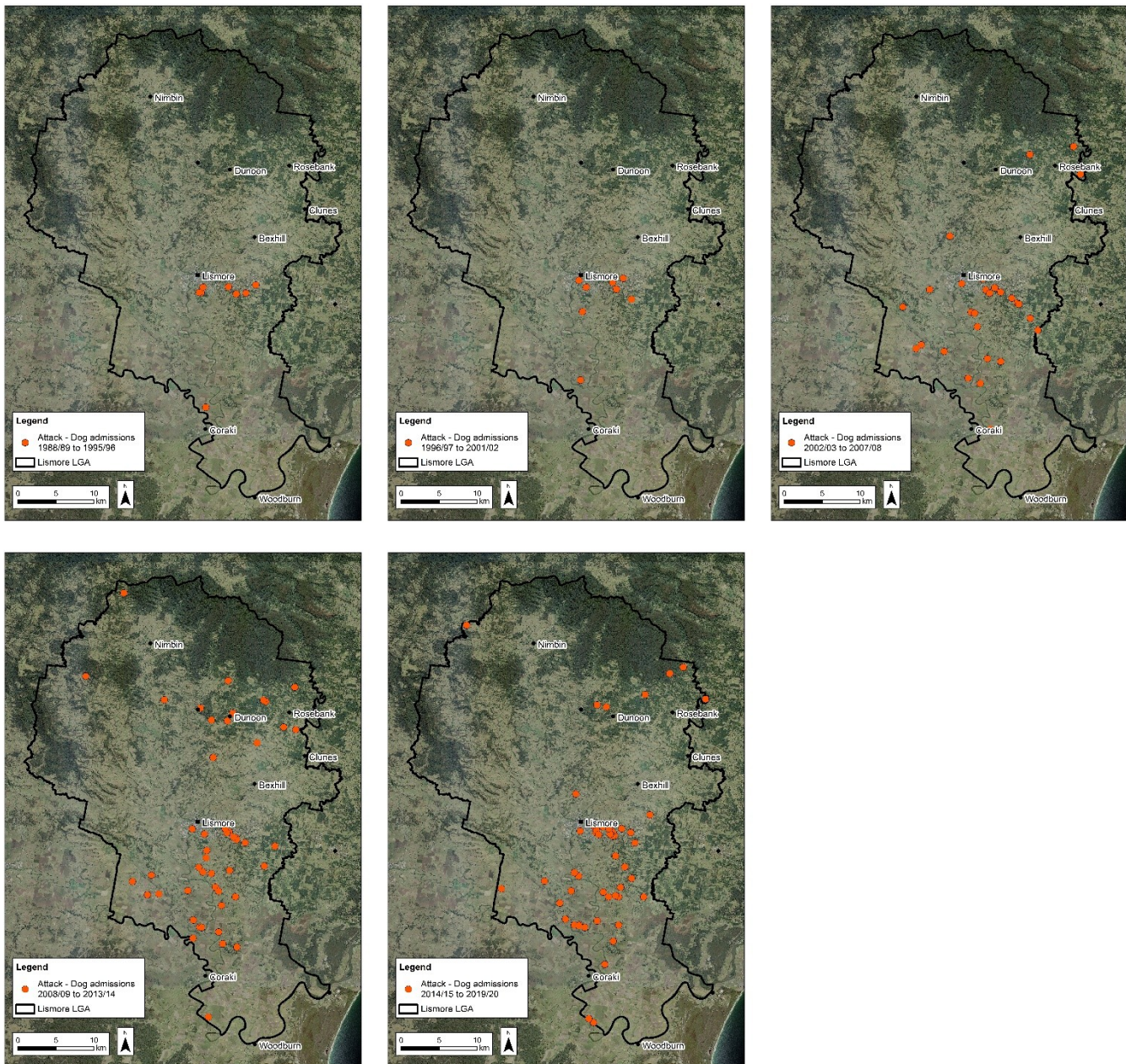


For admissions from motor vehicle collisions, there was only a small number of locations, basically just east of Lismore, on both primary and arterial roads. By the fourth generation, the scatter of locations was broader, but clumped both south and east of Lismore, and west from Rosebank through Dunoon. Noticeably, all levels of road have injured koalas admitted to



rehabilitation, with a concentration on primary roads, especially the Bruxner Highway (running east-west through Lismore), whereas most records are on local roads.

**Supplementary Figure 20.** Map of rescue locations in Lismore LGA, north-east NSW for koalas admitted to Friends of the Koala for rehabilitation due to dog attacks during the years a) 1988/89 – 1995/96, b) 1996/97 – 2001/02, c) 2002/03 – 2007/08, d) 2008/09 – 2013/14, and e) 2014/15 – 2019/20.



The dog attacks resulting in admission to care have a focus south of Lismore and stretching from Rosebank to Dunoon. Also noticeable is that almost all the admissions are in the eastern half of the Lismore LGA.