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Koala admissions to a wildlife hospital in coastal New South Wales, Australia, over a nine-year period, 2014–2022

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ABSTRACT

The koala (*Phascolarctos cinereus*) population in Australia has been subjected to numerous threats leading to a significant decline in their numbers. The Port Macquarie region serves as a vital habitat for these iconic marsupials. Analysing records of 1227 koalas admitted to the Port Macquarie Koala Hospital (2014–2022), this study aimed to understand admission causes, temporal trends, and risk factors. Anthropogenic activities accounted for almost half (49.7%) of all admissions with 'dangerous area' and 'motor vehicle accident' (MVA) being common aetiologies. Young koalas were more susceptible to 'dangerous area', 'MVA', and 'dog attack' than other age groups. Koalas admitted for suspected chlamydia were also a significant contributing factor for admissions, and was most common in young koalas. Overall, the majority of koalas were candidates for rehabilitation or release (54.3%), but mature and aged koalas had the highest odds for mortality. This study highlights the ongoing impact of anthropogenic activities on koalas, emphasises the need for public education and reporting to mitigate risks, and underscores the importance of addressing diseases like chlamydia. These results contribute to our understanding of the factors influencing koala hospital admissions and can inform conservation and management strategies for this iconic Australian species.

Keywords: anthropogenic activity, chlamydia, conservation, hospital admission, koala, mortality, New South Wales, *Phascolarctos cinereus*.

Introduction

Koalas (*Phascolarctos cinereus*) are an iconic Australian marsupial, intrinsically linked to Australia's identity. Currently, this species is facing a conservation crisis in Queensland (Qld), New South Wales (NSW) and the Australian Capital Territory (ACT), having been officially listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Department of Agriculture Water and the Environment 2022). This designation is indicative of observed decreases in population levels among crucial populations across these states, with an estimated average decline of 24% over the past three generations and the subsequent three generations (Adams-Hosking *et al.* 2016). The estimated percentage of loss in Queensland and New South Wales stood at 53% and 26%, respectively, in 2012 (Adams-Hosking *et al.* 2016). There have been no published updates since, but Adams-Hosking *et al.* (2016) provide rates of loss to enable updated estimates as required.

Key threats to koala population decline include land use change and climate change (Australian Government 2022). Additionally, disease, dog attacks and vehicle collisions are important threats (Australian Government 2022). These threats synergistically contribute to habitat loss, fragmentation, and degradation, exacerbating disease impacts, disrupting population processes, hindering safe movement, and causing a loss of genetic diversity (McAlpine *et al.* 2015; Australian Government 2022).

Significant growth in human population, particularly in urban areas, poses a pronounced challenge to koala populations, with heightened concerns specifically in NSW and Qld along the eastern seaboard (McAlpine *et al.* 2015). While major cities have been focal points for population expansion, there is a shifting trend as coastal towns and cities

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undergo rapid expansion (McAlpine *et al*. 2015). In these regions, the intricate interplay of various threatening processes, alongside the influence of high land values, compounds the complexities of successful koala conservation efforts (McAlpine *et al*. 2015). To develop effective strategies for the conservation and management of koalas in these regions, it is important to gain a comprehensive understanding of the causes of koala morbidity and mortality. Wildlife hospitals serve as a rich and largely untapped resource of valuable information that can provide insights into the factors influencing koala health and survival.

The Port Macquarie region, situated along the NSW coastline, supports a significant population of koalas. The Port Macquarie Koala Hospital (PMKH), dedicated to the rescue, rehabilitation, and release of injured and sick koalas, has been at the forefront of koala conservation efforts in the area since 1973. A previous retrospective study conducted over a 30-year period (1975–2004) examined the admission trends of 3781 koalas admitted to the PMKH, reporting that trauma (attributed to motor vehicle collision and dog attack, 41%) and chlamydia (20.4%) caused the largest number of hospital admissions (Griffith *et al*. 2013). Further, this study highlighted important factors influencing admissions, including age, season, and sex. However, given the dynamic nature of ecological systems and the potential changes in koala populations and their environment, it is essential to assess the current status of koala admissions in the region to continue to facilitate best practice conservation strategies.

Here I present the results of a nine-year analysis of data collected from the PMKH. The objectives of this study were to identify the primary causes, outcomes, and temporal trends of hospital admissions for koalas in the Port Macquarie region to determine and quantify some of the current threats to their survival in this region.

Methods

Study site and data collection

The koala hospital admission records used in this study were obtained from the Port Macquarie Koala Hospital (PMKH; 31°26′34.87″S, 152°55′9.71″E); the provided data spanned the years 2014–2022. Established in 1973, PMKH is a licensed wildlife rehabilitation facility that attracts thousands of national and international visitors annually. Port Macquarie is situated 390 km north of Sydney and encompasses a catchment area of approximately 8300 km^2 on the mid-north coast of NSW; the current population size of Port Macquarie is about 86,749 (Australian Bureau of Statistics 2021).

Hospital admission records of 1519 koala patients admitted to PMKH between 3 January 2014 and 24 December 2022 were compiled in an electronic database (Microsoft Excel, ver. 16.73) for organisation and analysis. In the first instance a thorough data cleaning process was undertaken. This included identifying and removing any duplicate rows in the dataset, ensuring correct data types for each variable and simultaneously cleaning data text to address inconsistencies and errors, such as typos or variations in case. To assess the accuracy of PMKH records, the age classification assigned to koalas documented as admitted as orphaned young was investigated. Of 167 orphaned young, 162 (97%) were classified as juveniles, three (2%) were categorised inaccurately as young koalas, and two (1%) had no age recorded.

Information contained in the records included: patient identification number, admission date, age category, weight, cause of admission (COA), and outcome; weight and sex were included in the hospital records, but data were not recorded consistently and were therefore not included in the analysis. Of the 1519 cases, 293 were excluded for the following reasons: no cause of admission reported ($n = 276$), captured for research ($n = 12$), and self-admitted (koalas found on the hospital public walkway; $n = 5$). This resulted in 1227 cases remaining for assessment. Of these, 193 (15%) were koalas with more than one admission over the nine-year study period.

These data were analysed for admission and outcome trends. Where trends were assessed per season, seasons were referred to as: summer (December, January, February), autumn (March, April, May), winter (June, July, August), spring (September, October, November). COA was used as a nominal outcome variable with 11 categories: ‘dangerous area’ (koalas found in unsuitable locations compromising their welfare, e.g. up telegraph poles, on bridges, in urban neighbourhoods, on highways), ‘motor vehicle accident’ (MVA), ‘suspected chlamydiosis’ (koalas presenting with one or more clinical signs of chlamydiosis), ‘sitting at tree base’ (koala observed sitting at tree base with minimal effort to move upon approach), ‘dog attack’, ‘bushfire’, ‘tree fall’, ‘low in tree’, ‘joey’ (orphaned young), and ‘other’ (causes of admission with fewer than 20 entries). Animal outcomes following admission were grouped into either ‘candidates for rehabilitation or release’ or ‘mortality’ (dead on arrive, natural death, or euthanasia on welfare grounds). Age categories were as follows: juvenile (<2 years), young adult (2–5 years), mature adult (5–10 years), and aged adult (>10 years).

Statistical analysis

Statistical analysis was performed using Prism, ver. 9.5.1. Descriptive statistics were used to determine the frequency of cases for each season, diagnosis, and outcome during the study period. Linear regression was used to explore temporal trends, including total number of admissions, diagnoses and age. One-way ANOVA was performed to compare the average number of cases by season, utilising Tukey’s *post hoc* analysis to explore pair-wise comparisons and investigate significant relationships. To assess risk factors for presentation to the hospital, univariable logistic regression

analyses were performed for the explanatory variables (age, season, year) to examine their unadjusted association with the outcome of admission (candidates for rehabilitation or release or mortality). Variables significant in the univariable analyses ($P < 0.05$) were used to build a multivariable logistic regression model using a manual forward stepwise approach to quantify risk factors for admission after adjusting for each other. Finally, logistic regression was used to analyse relationships between age, season, year, and COA on the outcome of the case to produce odds ratios with 95% confidence interval.

Results

Causes of admission and temporal trends

Causes of admission are summarised in Table 1. Overall, the most common COA was 'dangerous area', accounting for 305 admissions (24.9%), followed by 'suspected chlamydiosis' (n = 268; 21.8%), 'MVA' (n = 214; 17.4%), 'sitting at tree base' (n = 171; 14%), and 'dog attack' (n = 90; 7.4%). These five causes together constituted 85.4% of all hospital admissions (1048/1227). Admission due to bushfire was sporadic, with admissions in 2017 (n = 10), 2018 (n = 1), 2019 (n = 54), and 2020 (n = 1); during 2019, admissions due to bushfire occurred in November (n = 45) and December (n = 8). The leading cause of admission for juvenile and young koalas was 'dangerous area' (n = 52, 31.1%; n = 155; 29.8%), followed by 'MVA' (n = 26, 15.7%) and 'suspected chlamydiosis' (n = 116, 22.3%), respectively. The leading cause of admission for mature and aged koalas was 'suspected chlamydiosis' (n = 79, 25.2%; n = 66, 29.5%), followed by 'MVA' (n = 69, 22%) and 'sitting at tree base' (n = 55; 24.7%), respectively.

Overall, the highest number of hospital admissions occurred in spring (n = 458, 37.3%), followed by summer (n = 308, 25.1%), winter (n = 284, 23.1%), and autumn (n = 177, 14.4%) (Fig. 1). The overall number of admissions in spring was statistically different from the number of admissions in autumn ($P \leq 0.001$) and winter ($P = 0.034$). The leading COA in both spring and winter was 'dangerous area' (n = 134, 29.3%; n = 83, 29.2%; respectively), followed by 'suspected chlamydiosis' (n = 82, 17.9%), and 'MVA' (n = 57, 20%). The leading COA in summer was 'suspected chlamydiosis' (n = 88, 28.9%) followed by dangerous area (n = 59, 19.2%). The leading COA in autumn was 'suspected chlamydiosis' (n = 49, 27.7%), followed by 'sitting at tree base' (n = 38, 21.5%), respectively. There was no significant change in the total number of koalas admitted to the hospital per year from 2014 to 2022 ($F_{1,7} = 0.5127$, $P = 0.49$) (Fig. 2). However, koala admission numbers fluctuated between 2014 and 2019 around a general upward trajectory, in line with increasing human population size. Following a peak in admissions in 2019 (n = 242), there was a continual decline in admissions through to 2022. There was no significant change in the number of admissions for any COA over the study period (MVA, $P = 0.187$; 'sitting at tree base', $P = 0.648$; 'suspected chlamydiosis', $P = 0.528$; 'dog', $P = 0.534$; 'joey', $P = 0.367$; 'dangerous area', $P = 0.163$; 'fall', $P = 0.833$; 'low in tree', $P = 0.487$; 'bushfire', $P = 0.763$; and 'other', $P \geq 0.431$). Finally, there was no significant change in the number of admissions for any age category over the study period ($P = 0.28$).

Risk factors for admission

The variable age was significant at the univariable level ($P \leq 0.001$) whereas season and year were insignificant (season: $P = 0.213$; year: $P = 0.313$).

Outcomes of admission

Of the koalas admitted to hospital, the majority were candidates for rehabilitation or release (54.3%), but the remaining koalas (45.7%) succumbed to mortality or were euthanised (Table 2, Fig. 3). 'Dangerous area' had the highest rate of candidates for rehabilitation or release (81%; OR: 35.15, CI = 20.83–61.45), followed by 'low in tree' (76.7%; OR: 12.16, CI = 5.043–32.83), 'joey' (73.7%; OR: 6.822, CI = 2.295–23.31), 'fall from tree' (51.9%; OR: 3.985, CI = 1.712–9.376), and 'bushfire' (50%; OR: 3.265). The rate of candidates for rehabilitation or release for the remaining COA categories (excluding the category 'other') were below 50% (range: 25.1–48.8%). The season 'spring' (60.1%) and the age categories 'juvenile' (64.2%) and 'young' (59.1%) had the highest rates of candidates for rehabilitation or release, with odds ratios of 1.197 (CI = 0.8473–1.693), 2.294 (CI = 1.368–3.866), and 2.120 (CI = 0.453–3.110), respectively.

MVA had the highest mean mortality rate at 74.8%, followed by 'sitting at tree base', (65.7%), 'suspected chlamydiosis' (53.1%), and 'dog attack' (51.5%) (Table 2). The mortality of the remaining COA categories (excluding the category 'other') was below 50% (range: 20–48.7%). MVA had the highest odds ratio for mortality at 5.55 (CI = 3.357–9.299) followed by 'sitting at tree base' at 0.535 (CI = 3.344–0.8517). The season 'autumn' (50.9%) and the age categories 'aged' (58.3%) and 'mature' (50.3%), had the highest rates of mortality with odds ratios of 1.244 (CI = 0.8468–1.830), 0.6125 (CI = 0.4078–0.9163), and 0.4827 (CI = 0.3303–0.7019), respectively.

Discussion

During the study period, the most prevalent cause of admission for koalas at PMKH was 'dangerous area', constituting a quarter of all admissions. This finding differs from a previous study conducted in the same location using

Table 1. Summary of admissions to the Port Macquarie Koala Hospital from 2014 to 2022.

Explanatory variable	Dangerous area	Motor vehicle accident	Suspected chlamydiosis	Sitting at tree base	Dog attack	Bushfire	Fall from tree	Low in tree	Other	Joey	Total admissions	% Candidates for rehabilitation or release	% Mortality	Top 3 leading COA
Season														
Spring	134	81	82	46	30	47	9	11	12	6	458	60.7	39.2	DA, Suspected chlamydiosis, MVA
Summer	59	46	88	42	21	17	7	10	11	7	308	51.7	48.3	Suspected chlamydiosis, DA, MVA
Autumn	29	30	49	38	13	1	3	3	6	5	177	49.1	50.9	Suspected chlamydiosis, Sitting at tree base, MVA
Winter	83	57	49	45	26	1	9	6	6	2	284	51.5	48.5	DA, MVA, Suspected chlamydiosis
Age														
Juvenile	52	26	7	23	20	11	6	1	1	20	167	64.1	35.9	DA, MVA, Sitting at tree base
Young	155	100	116	49	41	30	6	11	14	0	521	59.3	40.7	DA, Suspected chlamydiosis, MVA
Mature	57	69	79	44	20	18	6	8	13	0	314	49.8	50.2	Suspected chlamydiosis, MVA, DA
Aged	41	19	66	55	9	7	10	10	7	0	224	41.8	58.2	Suspected chlamydiosis, Sitting at tree base, DA
Overall	305	214	268	171	90	66	28	30	35	20	1227	54.2	45.8	DA, Suspected chlamydiosis, MVA

COA, cause of admission; DA, dangerous area; MVA, motor vehicle accident.

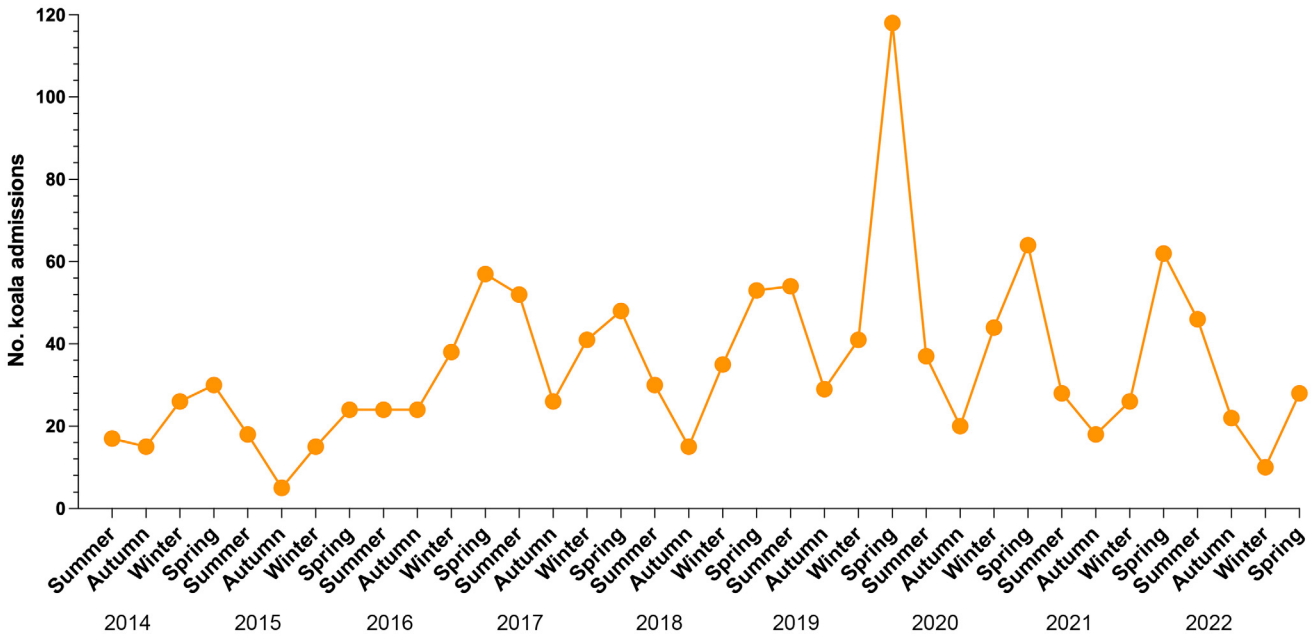

Fig. 1. Number of koala admissions per season per year.

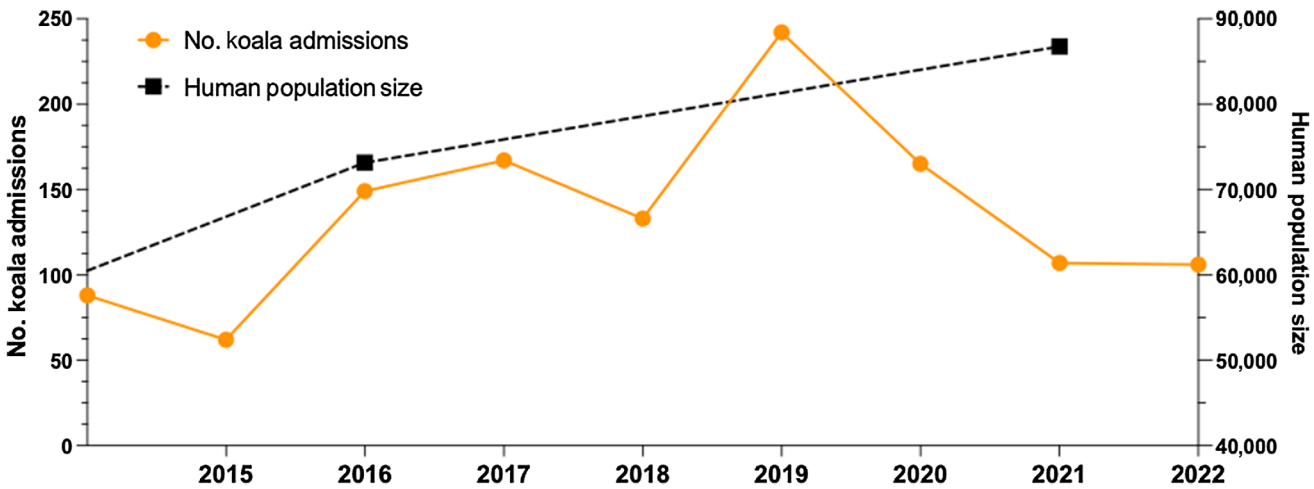

Fig. 2. Total koala admissions per year plotted against Port Macquarie population size according to cencus data obtained from the Bureau of statistics.

data from over 18 years ago (Griffith *et al.* 2013), which highlighted trauma as the primary reason for hospital admissions. Nevertheless, both findings underscore the clear and ongoing link between anthropogenic activities and its impact on koalas in the region. Other significant causes of admission included 'suspected chlamydiosis', 'MVA', 'sitting at tree base', and 'dog attack'. Together, these factors accounted for the majority of admissions, aligning with previous studies conducted in New South Wales (Charalambous and Narayan 2020; Lunney *et al.* 2023*a*, 2023*b*) and other regions of Australia: Kerlin *et al.* (2022) in south-east Queensland; Schlagloth *et al.* (2022) in Victoria; Gonzalez-Astudillo *et al.* (2017) in south-east Queensland; Taylor-Brown *et al.* (2019) in Beerwah, south-east Queensland, finding trauma and disease to be the leading causes of admission.

Causes of admission associated with human activities accounted for nearly half (49.7%) of all koala admissions in this study. This high rate of anthropogenic activity-induced admissions aligns with previous studies by Griffith *et al.* (2013) in Port Macquarie and Taylor-Brown *et al.* (2019) in Beerwah (south-east Queensland), in which car strikes, dog attacks, and abnormal urban location (e.g. telegraph poles, bridges, building infrastructure) were responsible for admitting 41% and 42% of koalas, respectively. In Victoria, car strikes and dog attacks contributed to 60% and 21% of koala hospital admissions, respectively (Schlagloth *et al.* 2022).

Table 2. Outcomes and odds of mortality for each cause of admission presented to the Port Macquarie Koala Hospital.

Cause of admission	% Positive outcome	% Mortality	Odds of mortality/Odds ratio (CI)
Dangerous area	81	19	0.03410 (0.02000–0.05626)
Motor vehicle accident	25.1	74.8	5.558 (3.357–9.299)
Suspected chlamydiosis	46.9	53.1	0.3706 (0.2359–0.5758)
Sitting at tree base	34.3	65.7	0.5348 (0.3344–0.8517)
Dog attack	48.8	51.5	0.3474 (0.2022–0.5936)
Fall from tree	51.9	48.1	0.2517 (0.1071–0.5855)
Low in tree	76.7	23.3	0.08299 (0.03075–0.1999)
Bushfire	50	50	0.3750 (0.1071–0.5855)
Joey	73.7	26.3	0.1445 (0.04231–0.4288)
Other	58.8	41.2	0.2111 (0.09633–0.4506)

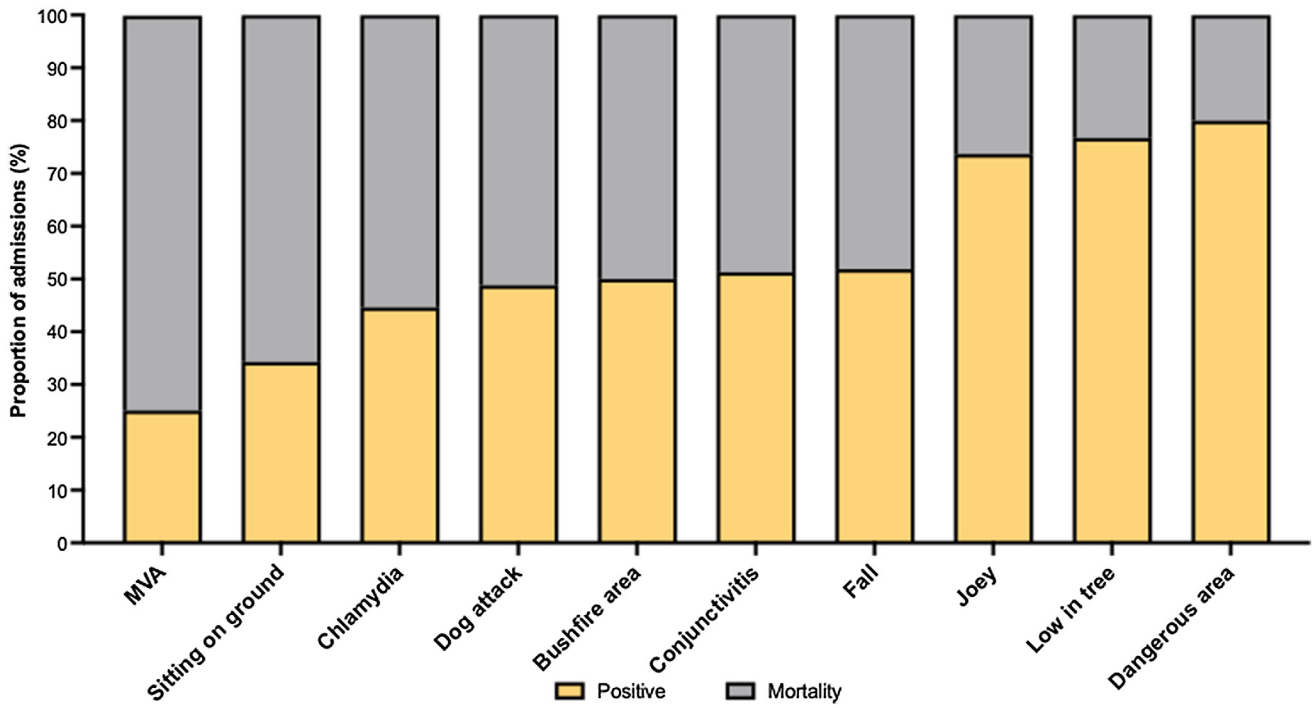

Fig. 3. The proportion of each cause of admission resulting in a positive outcome (release or forwarded to a carer) versus mortality.

These findings contrast with those from NSW where only 25% (Lunney *et al.* 2023*b*) and 23% (Charalambous and Narayan 2020) of admissions were attributed to anthropogenic factors. Instead, chlamydia and disease were the leading cause of admission, accounting for 43% (Lunney *et al.* 2023*b*) and 31% of all admissions (Charalambous and Narayan 2020), respectively. Further, in Queensland, a state-wide analysis found disease was the primary cause of koala admissions, accounting for 48% of all admissions (Kerlin *et al.* 2022).

The reason for the difference in causes of admission across populations is unclear without further investigation. However, different koala populations have been shown to exhibit varying responses to chlamydial infections, leading to differences in disease prevalence and severity (Quigley and Timms 2020; Robbins *et al.* 2020). Such disparity may be influenced by factors such as variations in chlamydial strains, infection loads, and genetic predispositions among koalas (Robbins *et al.* 2020). Alternatively, disparities in human behaviour across regions may contribute to these variations. This could stem from differences in awareness and knowledge of chlamydia, leading to variations in reporting behaviour. Moreover, distinctions in driving habits, dog-keeping practices, as well as differences in human population density and the degree of habitat fragmentation (Brearley *et al.* 2013) across locations, may also play a role. If the latter, by increasing awareness and understanding of

chlamydia among communities, promoting responsible pet ownership practices, and advocating for habitat conservation efforts, we may mitigate some of the disparities observed across regions.

Young and mature koalas were the most at-risk cohorts for 'dangerous area' and 'MVA', which was also more likely to occur in spring and summer. Increased daylength at this time of year may play a pertinent role in koala morbidity through human behaviour change (i.e. longer hours of activity than in winter: Evans 2019). However, this susceptibility is largely attributed to koala behavioural ecology, where these age groups either undergo relocation (in the case of dispersing young individuals) or, although the current study lacks specific data on sex, young and mature male koalas are more likely to be mobile during the koala breeding season (September–February: Dique *et al.* 2003; Taylor and Goldingay 2012; Griffith *et al.* 2013; Kerlin *et al.* 2023). This increased mobility predisposes these subpopulations to encounters with hazardous areas such as roads and backyards, increasing their vulnerability to motor vehicle collisions and dog attacks. The implications of elevated mortality among young koalas extend beyond immediate demographic losses. Firstly, these age groups represent the future reproductive potential of the koala population. Consequently, their premature mortality jeopardises the population's capacity to sustain itself and uphold genetic diversity over successive generations (Fowler *et al.* 2000). Secondly, the loss of young individuals disrupts the natural demographic structure of koala populations, potentially leading to imbalances among age cohorts. Such disruptions can engender profound ramifications for population stability and resilience, posing long-term threats to the viability of koala populations (Fowler *et al.* 2000).

Similar to previous studies (Griffith *et al.* 2013; Gonzalez-Astudillo *et al.* 2017; Taylor-Brown *et al.* 2019; Charalambous and Narayan 2020; Kerlin *et al.* 2022; Lunney *et al.* 2023*a*, 2023*b*), disease emerged as a significant contributing factor for koala admissions. Various causes of admission, such as 'suspected chlamydiosis', 'sitting at tree base', and 'low in tree' can all be associated with diseased koalas; collectively, these accounted for 38.1% of all admissions in the present study. Consistent with the work of Griffiths *et al.* (2013), the continued observation of clinical signs of chlamydiosis in this case series suggests the ongoing persistence of chlamydiosis in the Port Macquarie koala population. Similar to Griffiths *et al.* (2013) and Lunney *et al.* (2023*b*) this study found that signs of chlamydiosis occur more frequently during spring and summer. However, unlike the findings of Griffiths *et al.* (2013) and Lunney *et al.* (2023*b*), which reported that aged koalas were primarily admitted for chlamydia symptoms, the present study found a higher prevalence of chlamydiosis signs among young koalas. The reason for this disparity between studies is unclear. In the context of Port Macquarie, it is possible there have been shifts in environmental conditions or population dynamics that have altered the susceptibility of different age groups to chlamydiosis. Changes in habitat, food availability, or the prevalence of chlamydia within the koala population could also be influential factors. Further investigation into these factors, would be necessary to provide a comprehensive understanding of the observed discrepancies.

Griffith *et al.* (2013) reported an increase in hospital admissions resulting from 'MVA', while Taylor-Brown *et al.* (2019) documented a general rise in hospital admissions coinciding with an expanding human population. However, the present study yielded contrasting results. Despite a 95.5% increase in the Port Macquarie human population size from 2016 to 2021, there was no significant change in the total number of admissions or admissions related to specific causes throughout the study period. While it is possible that the Port Macquarie koala population may not be impacted by the growing human population, it is also possible that the impact of the COVID-19 pandemic and associated lockdown measures (resulting in reduced human mobility) may have influenced the outcomes observed in the present study. The other possible explanation is that the Port Macquarie koala population has declined over time, so that even with a larger human population, there are simply fewer koalas present and therefore fewer hospital admissions. However, without longitudinal estimations of koala population numbers, the interaction between human and koala population sizes remains uncertain.

One potential cause of reduced koala population is bushfire – specifically, for this population, the 2019/2020 fire season. Lunney *et al.* (2022) and Lunney *et al.* (2023*a*) emphasise the relatively minor role of fire in long-term koala rescue and rehabilitation efforts in NSW, with 0.6% (1989–2019) and 2.5% (1973–2020) of koala admissions attributed to bushfires, respectively. Similarly, prior to 2019 (2014–2018), PMKH saw only 11 (2%) koalas admitted due to bushfire. However, when bushfires do occur, the consequences can be catastrophic. The NSW Department of Planning, Industry and Environment (DPIE 2021) reports that 7% (5.5 million ha) of the state, including over 2.7 million ha of national park land, was affected by the 2019–2020 fire season, and estimations suggest between 5000 and 8000 koalas were impacted by these fires (van Eeden *et al.* 2020). Using data from Friends of the Koala (who rescue and rehabilitate koalas across the Ballina, Byron, Kyogle, Lismore, Richmond Valley, and Tweed Local Government Areas), Lunney *et al.* (2022) report that only 12% of koala hospital admissions during September–December 2019 were attributed to bushfires. In contrast, the present analysis of PMKH data found that over a third (35%) of hospital admissions during the same period were due to bushfires. While other causes of admission accounted for more admissions during this period, it is likely that the number of koalas rescued and admitted represents only a fraction of those affected by the fires; however, there are no estimations of these numbers (Lunney *et al.* 2022).

Notably, following a peak in PMKH admission numbers in 2019, there has been a steady decline in admissions each subsequent year through 2022. This trend suggests a potential population decline in the Port Macquarie region; however, this is purely speculative without Port Macquarie koala population estimations. Regardless, consistent with Lunney *et al*. (2022), the present study found that 50% of koalas that were admitted to the hospital for bushfire related injuries ultimately recovered, underscoring the vital efforts of those involved in the rescue and rehabilitation of fire-affected koalas.

In conclusion, this study provides crucial insights into some of the primary threats faced by koalas in the Port Macquarie region over the past nine years, including dangerous areas, vehicular collisions, and dog attacks. The findings of this study have significant implications for targeted mitigation strategies aimed at protecting koalas. Measures such as the establishment of wildlife corridors, implementation of speed limits in koala habitat areas, responsible pet ownership campaigns, and land-use planning prioritising koala conservation can be informed by this information. Continuing long-term monitoring and evaluation is recommended to establish a foundation for ongoing assessment of koala populations in this region. By tracking changes over time, it will be possible to evaluate the effectiveness of conservation measures, rehabilitation efforts, and policy interventions. It is hoped that the results presented herein will stimulate further research, foster collaborative efforts, and ultimately contribute to the long-term survival and well-being of koala populations in the Port Macquarie region and beyond.

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