

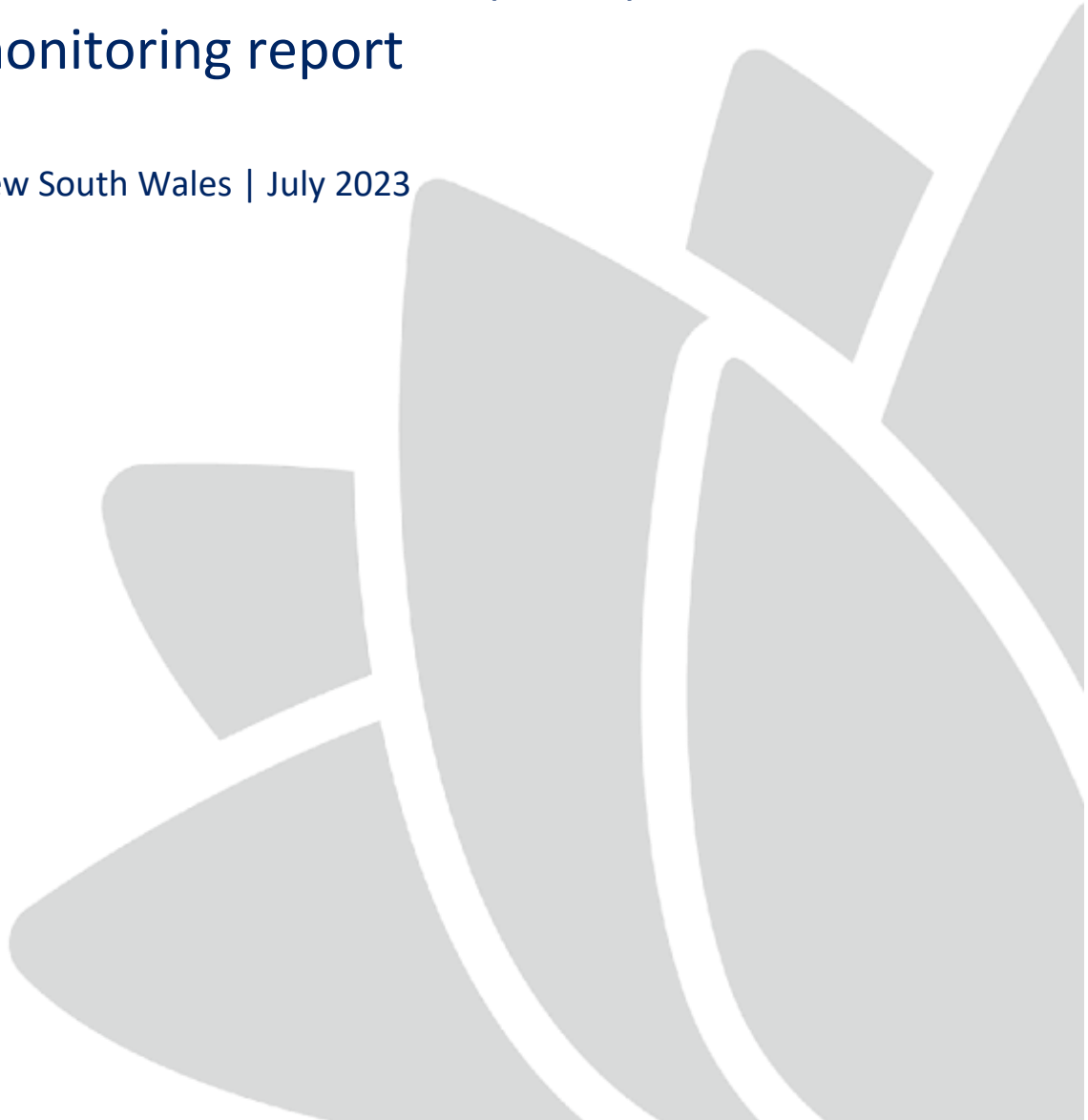


**Transport for
New South
Wales**

Warrell Creek to Nambucca Heads

**Operational Phase – Year five (2023) autumn interim
road-kill monitoring report**

Transport for New South Wales | July 2023



Pacific Highway upgrade: Warrell Creek to Nambucca Heads

Road-kill monitoring – autumn
interim report year five (2023)

SANDPIPER
ECOLOGICAL
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1. Introduction

In 2015, Roads and Maritime Services (RMS) NSW, in conjunction with Acciona Ferrovial Joint Venture (AFJV), commenced the Upgrade of the Pacific Highway between Warrell Creek and Nambucca Heads (WC2NH). The WC2NH project was opened to traffic in two stages: stage 2a - 13.5km section from Lower Warrell Creek Bridge to Nambucca Heads opened on 18 December 2017; and stage 2b 6.25km section from the southern end of the project to the Lower Warrell Creek bridge opened in late June 2018. The Upgrade included several road-kill mitigation measures to minimise vehicle collisions with native wildlife. The types of structures constructed to mitigate road-kill included:

- Fauna fencing to exclude fauna from the road corridor and to guide fauna towards connectivity structures.
- Fauna Drop Down Structures (escape ramps) along the fauna fencing.
- Fauna connectivity structures, including culverts, bridges, rope bridges and glide poles.

Several fauna fence designs were installed to target threatened species including:

- **Type 1** - Chainmesh fence 1.8 m tall with floppy top feature, which is designed to exclude a range of native mammal species such as macropods, possums, spotted-tail Quoll (*Dasyurus maculatus*) and koala (*Phascolarctos cinereus*). 18.03 km of this fence type occurs at the site.
- **Type 3** - Small gauge mesh fence with sheet metal return angled away from the highway (combined with fauna floppy top fence), which is designed to exclude green-thighed frog (*Litoria brevipalmata*) from the road corridor. 1.32 km of type 3 fauna fence occurs at the site, overlapping with the type 1 fencing.
- **Type 4** - Chainmesh fence 4 m tall through the Macksville Flying-fox camp Paperbark Swamp Forest community designed to discourage grey-headed flying-fox (*Pteropus poliocephalus*) from flying within range of passing traffic when exiting or entering the roost. 1km of type 4 fence occurs at the site.

Sandpiper Ecological Surveys (SES) has been engaged by Transport for NSW (TfNSW) to deliver the WC2NH operational ecological and water quality monitoring program, which includes seasonal road-kill surveys over the entire upgrade length. Monitoring of road-kill is a requirement of the approved WC2NH koala, spotted-tailed quoll and grey-headed flying-fox management plans and the Ecological Monitoring Program (RMS 2018a). Priority species for road-kill surveys are grey-headed flying-fox, koala, spotted-tailed quoll, and giant barred frog (*Mixophyes iteratus*). Monitoring is required for the first five years of operation and includes weekly surveys for the first 12 weeks of operation and four surveys (at weekly intervals) each season thereafter. Seasonal surveys are scheduled for January (summer), April (autumn), July (winter) and October (spring). Due to the staged opening of the project, monitoring of stage 2a commenced in December 2017 with monitoring of stage 2b commencing in July 2018. The 12-week monitoring period for stage 2b ended on 30 September 2018 and Sandpiper Ecological commenced monitoring in October 2018.

The aim of road-kill monitoring is to:

- report on any vertebrate road-kill following opening to traffic.
- assess the effectiveness of fauna fencing to prevent fauna from being killed by vehicles while attempting to cross the WC2NH Upgrade.

The following report details the findings of the April 2023 sample and discusses the results in light of the monitoring aims and previous reports.

2. Methods

2.1 Study area

The WC2NH project covers a total length of 19.75km and extends from Warrell Creek in the south to Nambucca Heads in the North (Figure 1).

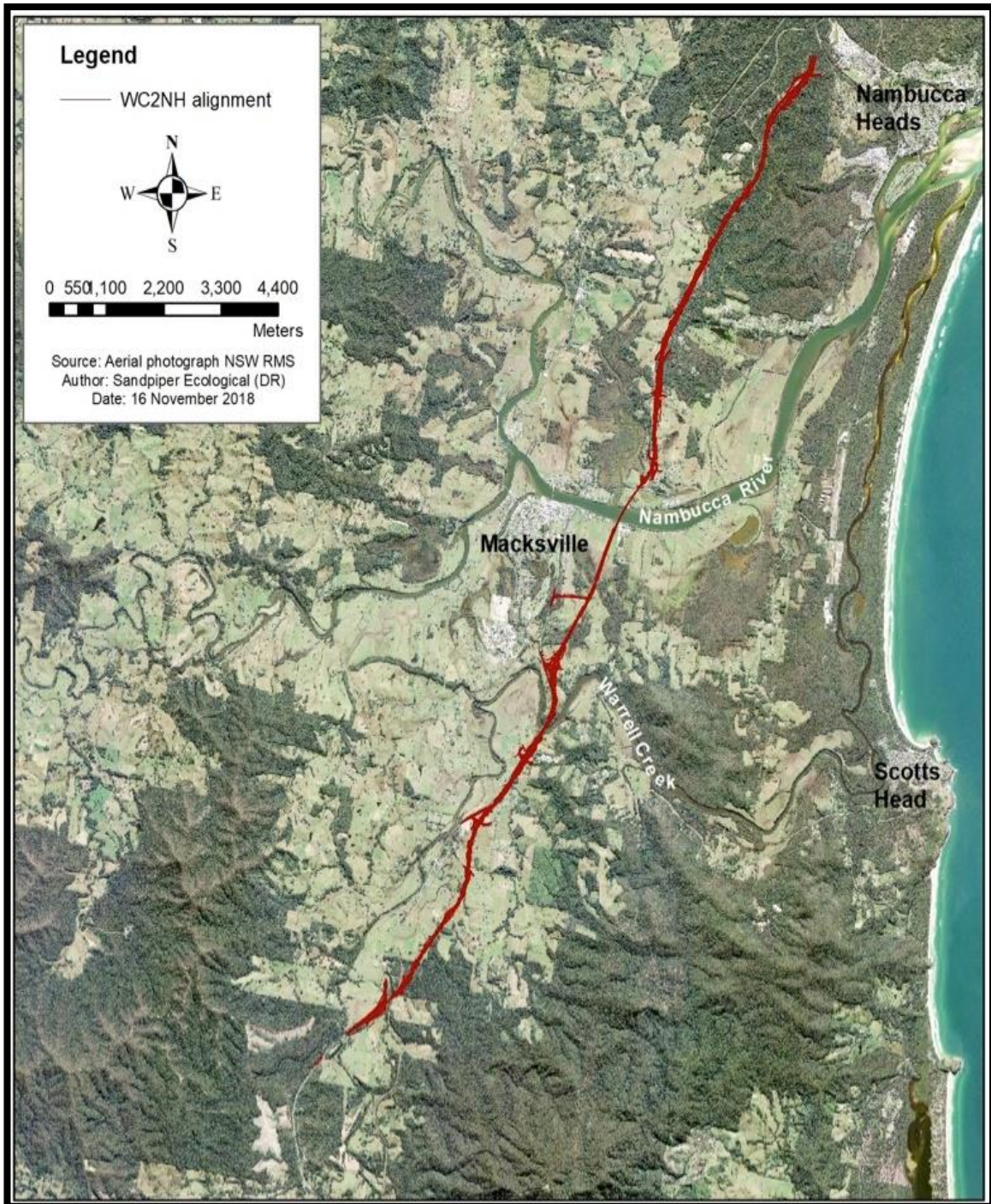


Figure 1: Location of the WC2NH alignment.

2.2 Road-kill surveys

Prior to the autumn 2021 monitoring event the road mortality survey method was revised to ensure compliance with the updated TfNSW Traffic Control at Worksites Manual. The updated guidelines require vehicles to be parked 3 m from (& behind) the wire rope, 11 m from the fog line if there is no wire rope, and pedestrians to walk 3 m behind the wire rope. These distance restrictions could not be achieved using the former method which required a vehicle to pull off the highway each time a fauna mortality was observed.

Surveys were conducted by a team consisting of a driver and an ecologist passenger who had experience identifying road-killed fauna. The surveys were conducted from a moving vehicle driven at a speed of 80-90km/hr in the left lane. The vehicle was equipped with an amber light (flashing) and a warning sign (Plate 1) to alert other drivers.

Surveys were conducted weekly during each monitoring month and began within three to four hours after sunrise. During each survey, the ecologist scanned the road surface and road shoulder for any road-killed fauna. If any fauna was detected, the species or fauna group was recorded using the internal GPS of a smart device, and the waypoint was recorded in Australia topo maps android application.

In cases where the fauna records were likely to be a potential target species, such as spotted-tailed quoll, koala, grey-headed flying-fox, or giant barred frog, the team inspected them more closely from a safe location. At the end of each survey, the data were uploaded as a CSV file from the Australia Topo maps application and recorded into Microsoft Excel on a desktop computer for further analysis.



Plate 1: Work vehicle with signage, flashing amber light and indicators.

Data collected on each road-kill included:

- Geographic coordinate
- Presence/absence of fauna exclusion fence adjacent the record (recorded from GIS)
- Species/fauna group
- Date of survey
- Road-kill location – north or southbound carriageway

Data collected for threatened species listed on the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* and/or the *Biodiversity Conservation (BC) Act 2016*, included, where possible: sex and age (juvenile/adult); the presence of pouch young if applicable; the presence of flightless young (flying-foxes); distance to a fauna connectivity structure; distance to a drop-down structure if applicable; damage to fauna fencing; weather conditions; if the animal was a flying-fox – distance to the nearest camp, distance to nearest canopy vegetation, and presence of flowering food trees in median or road-side vegetation.

Broad size classes used to group fauna recorded at WC2NH included:

- Small mammal – rodent, juvenile bandicoot
- Medium mammal – bandicoot, brushtail possum, ringtail possum, cat
- Large mammal – wallabies and kangaroos
- Small bird – noisy miner, honeyeaters
- Medium bird – magpies, pigeons, frogmouth, swamp hen, ducks, kookaburra
- Large bird – Ibis, large forest owl, egret

2.3 Data summary and analysis

To identify potential duplicates in the road-kill data, the mapping software QGIS was employed. Initially, all road-kill data was uploaded into QGIS and cross-referenced with data from the previous week and/or season (specifically summer 2023). This process aimed to identify duplicate records and improve data accuracy.

In order to determine the location of each road-kill relative to the exclusion fence, road-kill records were overlaid onto a plan showcasing the extent of the exclusion fence using QGIS. If the exclusion fence was present on only one side, the corresponding record was classified as having "No fence." For road-kill incidents on bridges, they were considered unfenced unless the exclusion fence extended at least 100 meters beyond both ends of the bridge.

Additionally, road-kill were categorised into two groups. The first group consisted of species or groups whose natural movement would typically not be hindered by the presence of an exclusion fence, including birds, small reptiles, frogs, small mammals, and flying-foxes (not excluded species). The second group comprised species or groups likely to be excluded by the fence (excluded species – Table 1). Freshwater turtles were included in this group due to the expectation that an exclusion fence with a ground return would effectively obstruct their movement onto the carriageway (Table 1). Although small lace monitors have the ability to traverse an exclusion fence, they were still included as it is rare to observe individuals of that size in open habitats (Table 1).

For the purpose of temporal (years, seasons, and weeks) and spatial (fenced vs. unfenced) comparisons of road-kill during operational monitoring (2019-2023), road-kill totals were pooled across years and taxonomic groups (e.g., bandicoots, macropods). These totals were then converted to a rate of road-kill per kilometer per week, enabling meaningful comparisons with other highway projects that may have varying alignment lengths. Notably, the 2018 survey data was excluded from the pooled comparison due to the staged opening of the project occurring between 2017 and 2018.

Table 1: Fauna groups included in comparison of fenced and unfenced sections of alignment.

Group	Species included
Macropods	Red-necked wallaby, swamp wallaby & eastern grey kangaroo
Bandicoots	Long-nosed & northern brown bandicoots
Possum	Brushtail & ringtail possums
Canid	Fox & dog
Feline	Cat
Leporidae	Hare & rabbits
Freshwater turtles	Long-necked, saw-shelled and Macleay river turtles
Goanna	Lace monitor

2.4 Statistical analysis

Statistical analysis is to be undertaken as part of the year five annual report and was not performed on the autumn 2023 dataset.

3. Results

3.1 Autumn 2023 sample

3.1.1 Weather condition

Weather conditions during the road-kill surveys were generally good, with no rain during each survey and low to moderate cloud cover (Table 2). The relative humidity varied from low – high, ranging from 48% to 74%, and the temperature ranged from 18.5°C to 21.7°C (Table 2). During the surveys, no rainfall was recorded. However, it should be noted that rain was recorded in the 24 hours leading up to the surveys including light rain on 2/4/23, when 2 mm of rainfall was recorded and 9 mm on 25/4/23. Visibility was good during all surveys and favorable for detecting road-kill.

Table 2: Weather conditions were recorded at 9 am on each sample day in April 2023. Relative humidity and temperature data were obtained from the Bureau of Meteorology Coffs Harbour Airport (station 059151) with rainfall data from the Bellwood station (059150).

Date	Rain present	Rainfall to 9am (mm)	Relative humidity (%)	Temperature (°C)	Cloud cover (Oktas)	Visibility
2/4/23	Nil	2.0	73	20.2	8	Good
10/4/23	Nil	0	52	18.5	0	Good
17/4/23	Nil	0	48	21.7	0	Good
25/4/23	Nil	9.0	74	19.7	4	Good

3.1.2 Road-kill survey

A total of 29 road-killed fauna were recorded during the Autumn 2023 sample at an overall rate of 0.37 rk/km/week (number of road-killed individuals per kilometer per week) (Table 3). Mammals were the most diverse group, with two species and four groups recorded, birds with three species and three groups, and reptile species with two species and two groups (Table 3). Mammals were also the most frequently detected fauna group, with 14 individuals, followed by birds (10 individuals) and reptiles (4 individuals) (Table 3). Bandicoot spp. Unidentifiable bird species had the highest frequency of road-kill with five records, followed by rodent species (4) and medium mammal species (3) (Table 3). One introduced species (dog) was recorded along the fence at Cocksburn lane overpass. No frogs or raptor species were recorded during the autumn 2023 surveys. A single threatened species, the grey headed flying fox was recorded east of Macksville along Gumma floodplain. The full summary of fauna recorded to date is included in Appendix A, Table A2.

Table 3: Species of vertebrate fauna recorded during year five (2023) summer (January) and autumn (April) road-kill surveys along the WC2NH alignment. For a full road-kill summary of all surveys to date, see Appendix A, Table A2. RK=Road-kill. Pr. = probable

Species	Sum 23	Aut 23	Win 23	Spr 23	Total
Birds					
Little pied cormorant	1				
Tawny frogmouth	2	1			
Tytonidae spp.		1			
Laughing kookaburra					
Heron		1			
Magpie lark		1			
<i>Corvus</i> spp.	1				
Raptor spp. (pr. Whistling kite)	1				
Small bird spp.	2	1			
Unidentifiable bird spp.	4	5			
Total birds	11	10	0	0	0
Mammals					
Short-beaked echidna	1				
Red-necked wallaby	1				
Northern brown bandicoot	1				
Long-nosed bandicoot	1				
Bandicoot spp.	8	5			
Grey Headed Flying fox		1			
Microbat spp.	1				
Rodent spp.	3	4			
Small mammal spp.	1	1			
Medium mammal spp.	1	3			
Total mammals	18	14	0	0	0
Reptiles					
Eastern blue-tongued lizard	1				
Chelidae spp.		1			
Lace monitor		1			
Small eyed snake		1			
Unidentified reptile spp.	1	1			
Lizard spp.	1				
Total reptiles	3	4	0	0	0
Introduced species					
Dog	0	1	0	0	0
Total introduced	0	1	0	0	0
Grand total	32	29	0	0	0
Rk/week/km	0.41	0.37	0.00	0.00	0.00

3.1.3 Distribution of road-kill

In autumn of 2023, road-killed fauna was recorded in various sections of the WC2NH alignment (Figures 2 and 3). The highest incidence of road-kill was recorded in the northern section of the alignment to the west of Nambucca Heads (7 records), and between the unfenced section south of the Mattick Road Overpass to Nambucca Bridge (4 records), (Figures 2 and 3). Five road-kills, including one grey headed flying fox, were recorded in the fenced section along Gumma Floodplain. The one introduced species (dog) was recorded at Cockburns Lane Overpass. Other records were distributed between the Bald Hill Road Overpass and the project's southern extent at Upper Warrell Creek Bridge (Figure 3).

More road-kill was recorded in the fenced section of the alignment (16 records) compared to the unfenced (13 records) sections (Figures 2, 3, and Table 4). Six of the fifteen records in fenced areas were individuals that the fauna fence should block under normal circumstances, including two bandicoots, one lace monitor, one dog, one medium mammal and a freshwater turtle (Table 4). The remaining eleven individuals were fauna that readily move through (rodent spp.) or over (birds and flying foxes) exclusion fencing (Table 4).

Bandicoots tended to be recorded along the unfenced section of the alignment between the Rosewood Road Overpass and south of Upper Warrell Creek Bridge (Figure 3, 3 records), with two other records in the fenced section north of Mattick Road Overpass (Figure 2). Birds were recorded north of Alberts Drive Overpass and south of Nambucca Bridge (Figure 3, 5 records) and in the northern extent of the highway through Nambucca State Forest (Figure 2). One lace monitor was recorded in the fenced section at Lower Warrell Creek Bridge (Figure 3). No macropods were recorded during the autumn 2023 surveys.

Table 4: The number of road-killed fauna recorded in fenced and unfenced sections of the WC2NH alignment during the April (autumn) 2023 sample period. Includes sub-totals for fauna that the fauna fence should block under normal circumstances (excluded) and fauna that would not be stopped by the fauna fence (not excluded).

Species and fauna groups	Excluded vs not excluded	Fenced	Unfenced
Bandicoot spp.	Excluded	2	3
Lace monitor	Excluded	1	
Chelidae spp.	Excluded	1	
Medium mammal spp.	Excluded	1	2
Dog	Excluded	1	
Sub-total (excluded)		6	5
Bird spp.	Not excluded	3	2
Reptile spp.	Not excluded	1	
Rodent spp.	Not excluded	1	3
Small bird spp.	Not excluded		1
Small mammal spp.	Not excluded	1	
Grey Headed Flying fox	Not excluded	1	
Tawny frog mouth	Not excluded	1	
White -faced heron	Not excluded	1	
Magpie lark	Not excluded	1	
Tytonidae spp.	Not excluded		1
Small-eyed snake	Not excluded		1
Sub-total (not excluded)		11	8
Grand Total		16	13

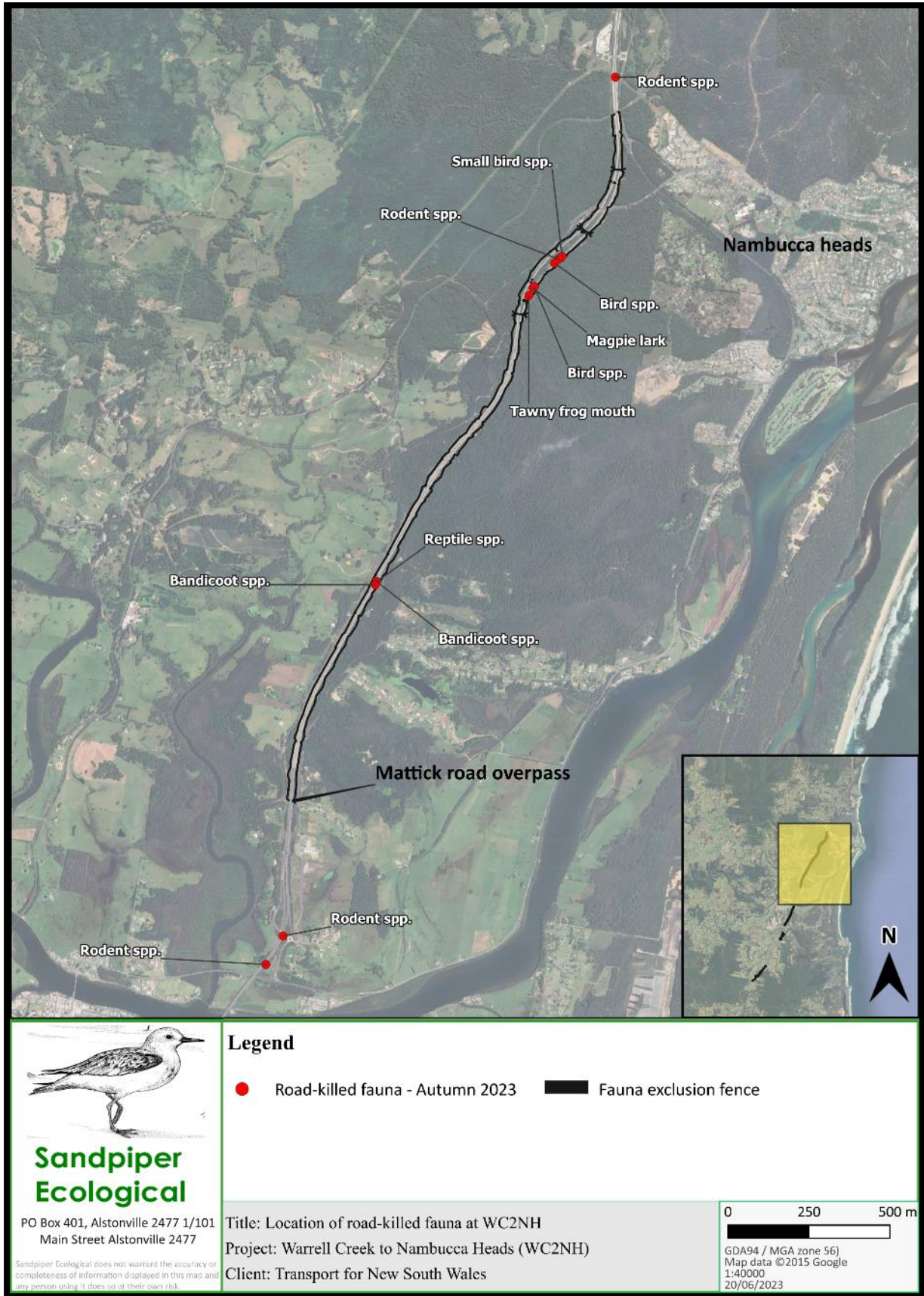


Figure 2: Location of road-killed fauna recorded in autumn 2023 along the WC2NH alignment (northern extent).

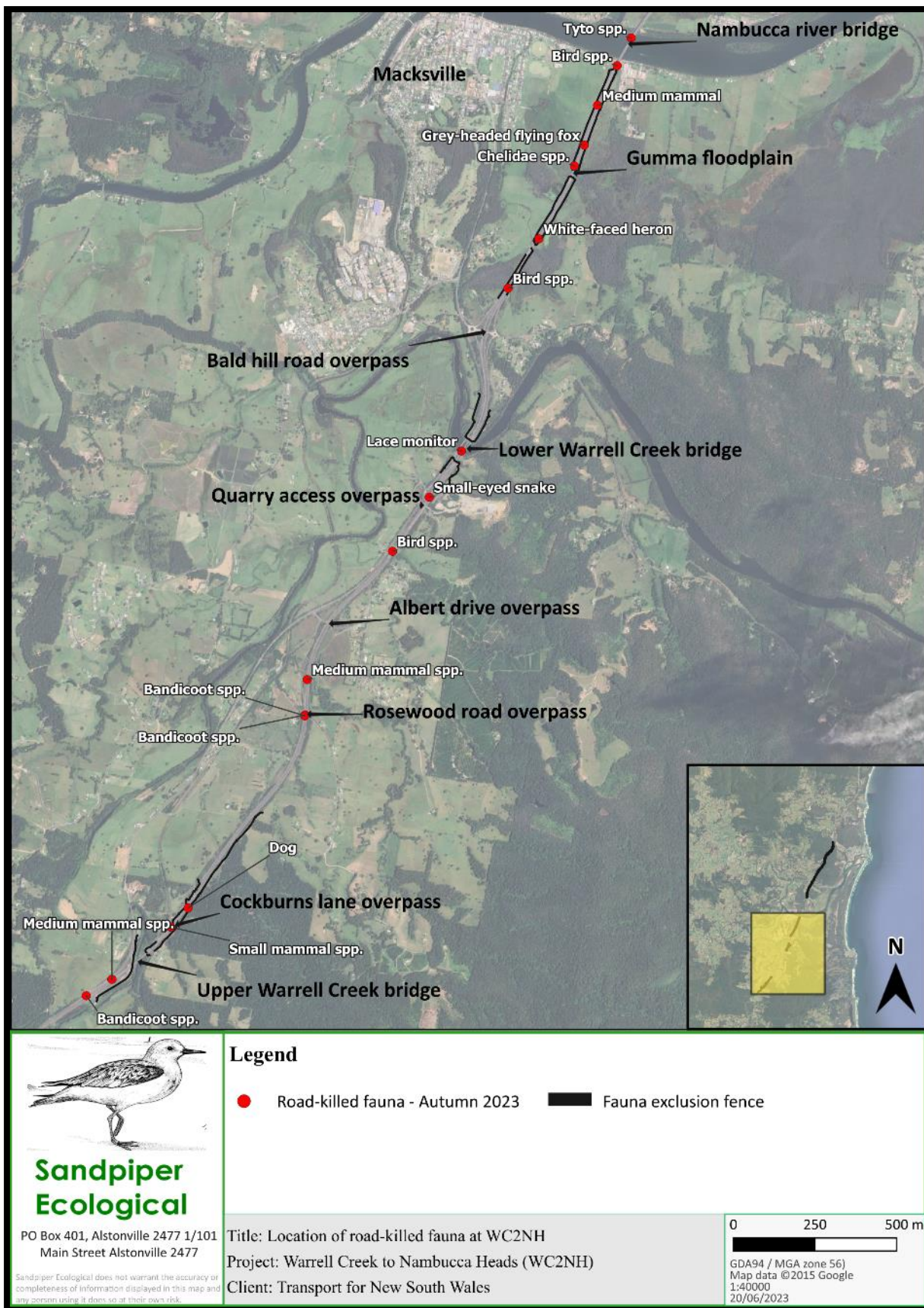


Figure 3: Location of road-killed fauna recorded in autumn 2023 along the WC2NH alignment (southern extent).

4. Discussion

4.1 Autumn 2023

In April 2023, road-kill monitoring conducted along the entire WC2NH alignment indicated that fauna continued to be struck by vehicles more than four years after the highway upgrade opened. The autumn sample recorded 29 individuals, resulting in a road-kill rate of 0.37 individuals/km/week, which is slightly below the average rate at WC2NH of 0.44 road-killed individuals/km/week (see Appendix A, Table A1). Autumn 2023 records were equal to the autumn 2022 roadkill records and 9.8% less than the summer 2023 records when 0.41 individuals/km/week was recorded. Importantly, previous annual reports (Sandpiper 2019, 2020, 2021, 2022) have consistently identified temporal variation as a feature of road-kill monitoring, potentially due to seasonal changes in breeding cycles and foraging demands and environmental conditions, as well as survey conditions, with some survey periods favoring increased carcass retention and detection such as during the dry recent autumn 2023 survey. Interestingly, the observed autumn road-kill rate exceeded the rate of 0.3 rk/km/week reported by Taylor and Goldingay (2004) for three major, unfenced roads in north-eastern New South Wales.

Across all surveys mammals and birds have consistently accounted for the majority of road-kill incidents. It is worth noting that the survey method employed has a bias towards larger and more long-lasting carcasses, which are commonly observed among birds and mammals (Ogletree and Mead 2020). Additionally, this method limits the ability to confidently identify all carcasses, resulting in some individuals being categorised based on their size and general fauna group. The absence of amphibians in April 2023 is consistent with previous surveys and further emphasises the difficulty of identifying road-killed amphibians during vehicle-based surveys (Sandpiper Ecological 2022).

Despite the presence of exclusion fence, some fauna species that would normally be prevented from entering the carriageway continue to be recorded as road-kill within fenced sections of the alignment similar to findings in 2021 and 2022 (Sandpiper Ecological 2021, 2022). Even though fenced areas reported a higher road-kill incidence in 2021 and 2022, our results do not quantify the number of individuals deterred from entering the carriageway by the exclusion fence. At WC2NH, the exclusion fences align with vegetated regions where a greater fauna abundance is anticipated. Without these fences, road-kill in these areas would likely be significantly higher, as indicated by de Carvalho et al. (2014). Notably, bandicoots make up the majority of road-kill records within fenced areas, especially north of Mattick road, likely due to their behaviour and ability to navigate through small gaps near open drains. It is unlikely that any exclusion fence can be completely effective at all times, and some level of road mortality for these species may be unavoidable. Nevertheless, it is crucial to prioritise the prevention of obvious fence breaches that allow access for priority species like spotted-tailed quoll, koala, and giant barred frog. This survey was the first to record a lace monitor road-kill within the WC2NH alignment, with one individual recorded at the lower Warrell Creek Bridge. Fauna fence is designed to exclude large reptiles like lace monitors and the subject record was found in an unfenced section between two small fenced sections of highway. During winter, a thorough assessment will be carried out to inspect and verify the integrity of the exclusion fence stretching from Warrell Creek to Nambucca Heads.

There was no macropod road-kill recorded during autumn 2023 monitoring which is the first time this has occurred since monitoring commenced (See appendix Table A1). With the data available it is difficult to confirm if the decrease is due to a decline in local abundance caused by high road-kills in 2020 (27 individuals), or a combination of seasonal changes in behaviour and environmental conditions (Bond and Jones 2013). A more comprehensive analysis in the annual year five report is likely to assist in determining the reason for the decline in macropod road-kills.

Data suggest that species likely to be blocked by exclusion fence are killed regardless of whether a drop-down occurs nearby. Whilst the influence of drop-downs on road-kill rate requires further analysis this observation is consistent with drop-down monitoring which showed negligible use by native fauna (Sandpiper Ecological 2019b).

4.2 Threatened fauna

Since WC2NH became operational four threatened species have been recorded as road-kill (grey-headed flying-fox, masked owl, black bittern and eastern grass owl), with no additional threatened species recorded in autumn 2023. One grey-headed flying fox was recorded on the Gumma Floodplain, within an area of Type 4 exclusion fence, which was designed to reduce flying-fox mortality. The presence of a single flying-fox mortality in the type 4 fenced area is not evidence that the fence has failed. Importantly, priority threatened species including koala, spotted-tailed quoll or giant barred frog have not been recorded in road-kill surveys to date.

5. Conclusion and recommendations

Overall, the road-kill rate in autumn 2023 was less than the previous summer survey and below the overall operational monitoring average of 0.44 road-killed individuals/km/week. However, in order to confirm any temporal trends and accurately assess road-kill rates in known hot spots, continued monitoring is necessary (Table 5).

Table 5: Recommendations based on findings of the autumn year five operational phase road-kill monitoring program.

Number	Recommendation	Transport for NSW Response
1.	Continue to undertake road-kill monitoring in accordance with the Ecological Monitoring Program and the operational phase methods	Agreed.

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Appendix A – Field data

Table A1: Road-kill summary of all fauna recorded to date during operational phase monitoring at WC2NH (2018-2023). * denotes threatened species; ** = stage 2a only; Sum = summer; Aut = autumn; Win = winter; Spr = spring.

Species	Sum 17/18**	Aut 18 **	Win 18 **	Spr 18	Sum 19	Aut 19	Win 19	Spr 19	Sum 20	Aut 20	Win 20	Spr 20	Sum 21	Aut 21	Win 21	Spr 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 23	Aut 23	Total
Birds																							
Australian magpie	6	1	0	1	0	0	0	2	2	1	0	0	1	0	0	2	0	0	0	0	0	0	16
Grey butcherbird	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pied butcherbird	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Magpie-lark	2	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1	1	3	0	0	0	1	15
Australian white ibis	0	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	4
Cattle egret	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Little pied cormorant	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	3
Buff-banded rail	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Purple swamphen	3	0	2	2	0	1	0	2	3	0	1	1	0	3	1	1	0	0	0	0	0	0	20
Wonga pigeon	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
White-headed pigeon	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Crested pigeon	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3
Galah	7	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Rainbow lorikeet	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Eastern grass owl*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Australian boobook	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4
Masked owl*	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4
Eastern barn owl	0	0	11	3	0	1	5	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	24
Tawny frogmouth	1	3	1	2	0	6	0	4	0	1	0	1	1	1	1	0	0	0	1	0	1	1	25

Species	Sum 17/18**	Aut 18 **	Win 18 **	Spr 18	Sum 19	Aut 19	Win 19	Spr 19	Sum 20	Aut 20	Win 20	Spr 20	Sum 21	Aut 21	Win 21	Spr 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 23	Aut 23	Total
Australian owl-nightjar	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Laughing kookaburra	3	0	2	1	0	2	0	3	1	1	2	1	0	0	0	2	2	0	0	0	1	0	21
Forest kingfisher	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Australian wood duck	20	0	0	2	2	0	1	2	0	0	0	2	1	0	0	0	0	0	0	0	0	0	30
Pacific black duck	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Whistling kite	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Black-shouldered kite	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Torresian crow	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Pied currawong	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3
Black-faced cuckoo-shrike	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Noisy miner	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	4
Dollarbird	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Green catbird	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Australasian figbird	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Black bittern*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Eastern yellow robin	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pheasant coucal	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	4
Masked lapwing	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Welcome swallow	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Red-browed finch	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Raptor spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Duck spp.	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Corvus spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Tyto spp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2
Heron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Small bird	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	1	2	2	0	2	1	12

Species	Sum 17/18**	Aut 18 **	Win 18 **	Spr 18	Sum 19	Aut 19	Win 19	Spr 19	Sum 20	Aut 20	Win 20	Spr 20	Sum 21	Aut 21	Win 21	Spr 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 23	Aut 23	Total
Medium bird	0	0	0	1	2	2	2	2	6	1	1	0	0	2	0	2	0	0	0	0	0	0	21
Unidentifiable bird	5	4	1	0	3	0	0	0	0	0	2	2	1	0	2	2	2	7	0	2	4	5	42
Total birds	53	8	22	17	18	16	13	25	16	11	8	9	10	12	8	11	6	14	4	2	11	10	304
Mammals																							
Short-beaked echidna	0	0	0	3	0	0	0	2	0	1	2	1	0	0	0	0	0	1	0	1	1	0	12
Black flying-fox	2	1	0	0	7	1	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	15
Grey-headed flying-fox*	0	0	0	0	8	0	0	5	2	0	0	0	0	2	0	0	0	0	0	0	0	1	18
<i>Pteropus</i> spp.	0	0	0	0	3	8	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	15
Short-eared brushtail possum	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Common brushtail possum	0	0	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4
<i>Trichosurus</i> spp.	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	3
Common ringtail possum	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Eastern grey kangaroo	0	0	0	3	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5
Red-necked wallaby	0	0	6	0	8	2	8	3	7	1	8	3	1	1	4	2	1	0	3	3	1	0	62
Swamp wallaby	2	1	0	1	0	1	1	0	0	1	1	2	1	0	2	1	1	0	4	0	0	0	19
Wallaby spp.	0	0	0	0	0	2	0	0	3	0	0	2	0	1	0	1	2	1	0	2	0	0	14
Macropod spp.	3	0	2	1	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	10
Northern brown bandicoot	1	0	1	0	1	1	1	2	2	3	3	0	1	2	2	1	0	0	2	1	1	0	25
Long-nosed bandicoot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Bandicoot spp.	0	0	0	0	0	1	0	4	0	0	0	1	0	2	4	2	4	3	4	9	8	5	47
<i>Chalinolobus</i> spp. (microbat)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Microbat spp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	3
Swamp rat	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Rodent spp.	0	0	0	0	0	2	0	0	0	0	0	1	0	0	1	1	1	1	2	0	3	4	16
Small mammal	0	0	0	0	2	0	0	0	0	0	1	0	1	3	0	0	0	1	0	0	1	1	10
Medium mammal	0	0	0	2	4	2	4	5	2	2	2	0	0	2	4	2	2	3	1	0	1	3	41

Species	Sum 17/18**	Aut 18 **	Win 18 **	Spr 18	Sum 19	Aut 19	Win 19	Spr 19	Sum 20	Aut 20	Win 20	Spr 20	Sum 21	Aut 21	Win 21	Spr 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 23	Aut 23	Total
Large mammal	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4
Unidentified Mammal	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Total mammals	9	2	10	17	37	20	17	23	18	13	20	10	5	16	18	10	12	11	17	16	18	14	333
Reptiles																							
Common blue-tongued skink	1	0	0	2	1	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	1	0	8
Carpet python	1	0	0	2	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7
Common tree snake	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Eastern long-neck turtle	1	0	0	6	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	10
Macquarie river turtle	5	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Unidentified <i>Chelidae</i> spp.	6	0	0	0	0	0	0	1	0	0	0	1	2	4	1	0	0	1	1	2	0	1	20
Red-bellied black snake	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
Eastern water dragon	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Eastern bearded dragon	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2
Blackish blind snake	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Yellow-faced whipsnake	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Unidentified reptile	0	0	0	0	0	0	0	2	0	1	0	0	0	2	0	0	2	3	0	0	1	1	12
Lace monitor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Lizard spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2
Small eyed snake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Total reptiles	17	3	0	12	2	2	1	5	2	2	0	4	4	7	1	0	2	4	1	4	3	4	80
Frogs																							
Green tree frog	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Striped marsh frog	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Medium frog	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Large frog	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Species	Sum 17/18**	Aut 18 **	Win 18 **	Spr 18	Sum 19	Aut 19	Win 19	Spr 19	Sum 20	Aut 20	Win 20	Spr 20	Sum 21	Aut 21	Win 21	Spr 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 23	Aut 23	Total	
Total frogs	5	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	
Introduced species																								
Cat	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	3	
Dog	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2
European fox	3	1	1	2	1	1	2	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	14
European hare	2	0	0	1	0	0	0	0	0	1	0	1	0	1	0	0	1	0	1	0	0	0	0	8
Rabbit	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Black rat	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4
House mouse	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Rock pigeon	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Domestic goose	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Total introduced species	8	1	2	5	2	2	2	0	0	1	0	2	1	2	2	1	4	0	1	0	0	1	37	
Grand total	92	14	34	55	59	40	33	53	36	27	28	25	20	37	29	22	24	29	23	22	32	29	763	
Grand total	1.16	0.18	0.43	0.70	0.75	0.51	0.42	0.67	0.46	0.34	0.35	0.32	0.25	0.47	0.37	0.28	0.30	0.37	0.29	0.28	0.41	0.37	0.44	