Transport for
New South Wales

Warrell Creek to Nambucca Heads

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

Transport for New South Wales | February 2023

Pacific Highway upgrade: Warrell Creek to Nambucca Heads (WC2NH)

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

Sandpiper Ecological Surveys

Final Report
15 March 2023

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Project Team:

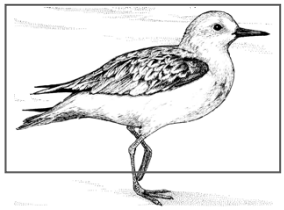
Dr D. Rohweder (Project management, reporting)

Mr L. Andrews (Reporting and fieldwork)

Ms A. English (Fieldwork)

Report prepared for:

Transport for New South Wales



ABN: 82 084 096 828

837 Rogerson Road, McKees Hill

P 0401 195 480 | E david@sandpipereco.com.au

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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 January 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).

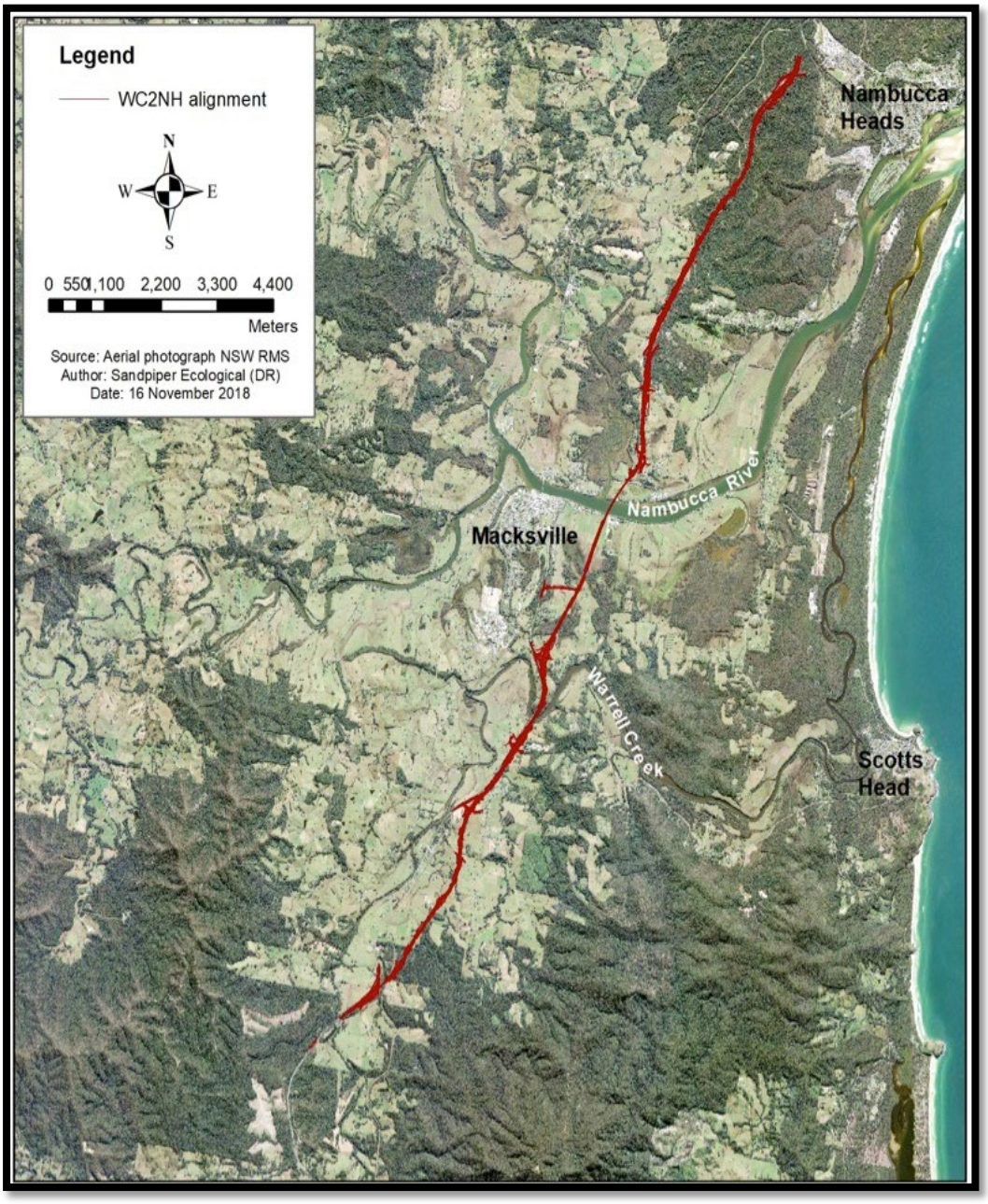

Figure 1: Location of the WC2NH alignment.

2.2 Road-kill surveys

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 was revised during the autumn 2021 monitoring event.

Road-kill 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.

In cases where the fauna records were likely to be a potential target species, such as spotted-tailed quoll, koala, grey-headed flying-fox, and 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 Australia Topo maps 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

QGIS was used to identify possible duplicates in the road-kill data. This was achieved by uploading all road-kill data to QGIS and cross-referencing it with the data from the previous week and/or season (i.e., spring 2022). The consistent use of at least one team member, GPS coordinates, and carcass descriptions helped in identifying duplicates.

For temporal (i.e., years, seasons and weeks) and spatial (i.e., fenced vs unfenced) comparisons of road-kill during operational monitoring (2019-2023), road-kill totals were pooled across years and taxonomic groups (i.e., bandicoots, macropods) and converted to a rate of road-kill/km/week to enable comparisons to other highway projects of varying alignment lengths. The 2018 survey data was excluded from the pooled comparison due to the staged opening of the project occurring between 2017-2018.

2.4 Statistical analysis

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

3. Results

3.1 Summer 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 was moderate to high, ranging from 60% to 79%, and the temperature ranged from 24.1°C to 25.8°C (Table 2). Rainfall to 9 am varied across the surveys, with no rainfall on most survey days, except on 23/1/23, when 7 mm of rainfall was recorded. Visibility was good during all surveys and favorable for detecting road-kill.

Table 1: Weather conditions were recorded at 9 am on each sample day in October 2022. 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 (^{0}C)	Cloud cover (Oktas)	Visibility
9/1/23	Nil	0	60	22.2	0	Good
15/1/23	Nil	0	61	24.4	0	Good
23/1/23	Nil	7	68	24.1	2	Good
30/1/23	Nil	0	79	25.8	0	Good

3.1.2 Road-kill survey

A total of 32 road-killed fauna were recorded during the January 2023 sample at an overall rate of 0.41 rk/km/week (number of road-killed individuals per kilometer per week) (Table 3). Mammals were the most diverse group, with four species and five groups recorded, birds with two species and four groups, and reptile species with two groups (Table 3). Mammals were also the most frequently detected fauna group, with 18 individuals, followed by birds (11 individuals) and reptiles (3 individuals) (Table 3). Bandicoot spp. had the highest frequency of road-kill with eight records, followed by unidentifiable bird spp. (4) rodent species (3), tawny frogmouth (2), and small bird secies (2) (Table 3). The remaining road-kill records were of single individual species or groups (Table 3). No frogs or threatened species were recorded during the summer 2023 surveys. A single raptor species was recorded on the Nambucca Bridge and was identified as a probable whistling kite. The full summary of fauna recorded to date is included in Appendix A, Table A2.

Table 2: Species of vertebrate fauna recorded during year five (2023) summer (January) road-kill surveys along the WC2NH alignment. For a full road-kill summary of all surveys to date, see Appendix A, Table A2. RK=Roadkill. Pr. = probable

Species	Sum 23	Aut 23	Win 23	Spr 23	Total
Birds					
Little pied cormorant	1				
Tawny frogmouth	2				
Laughing kookaburra					
Corvus spp.	1				
Raptor spp. (pr. Whistling kite)	1				
Small bird spp.	2				
Unidentifiable bird spp.	4				
Total birds	11	0	0	0	0
Mammals					
Short-beaked echidna	1				
Red-necked wallaby	1				
Northern brown bandicoot	1				
Long-nosed bandicoot	1				
Bandicoot spp.	8				
Microbat spp.	1				
Rodent spp.	3				
Small mammal spp.	1				
Medium mammal spp.	1				
Total mammals	18	0	0	0	0
Reptiles					
Eastern blue-tongued lizard	1				
Unidentified reptile spp.	1				
Lizard spp.	1				
Total reptiles	3	0	0	0	0
Grand total	**32**	**0**	**0**	**0**	**0**
Rk/week/km	**0.41**	**0.00**	**0.00**	**0.00**	**0.00**

3.1.3 Distribution of road-kill

In summer of 2023, road-killed fauna was recorded in various sections of the WC2NH alignment (Figures 2 and 3). Road-kill records during summer year five monitoring tended to be more frequent in the northern section of the alignment to the west of Nambucca Heads (7 records), between the unfenced section south of the Mattick Road overpass to Old Coast Road (6 records), and along the Gumma floodplain including Nambucca Bridge (4 records) (Figures 2 and 3). Other records were distributed between the Bald Hill Road overpass and the project's southern extent at Upper Warrell Creek Bridge (Figure 3).

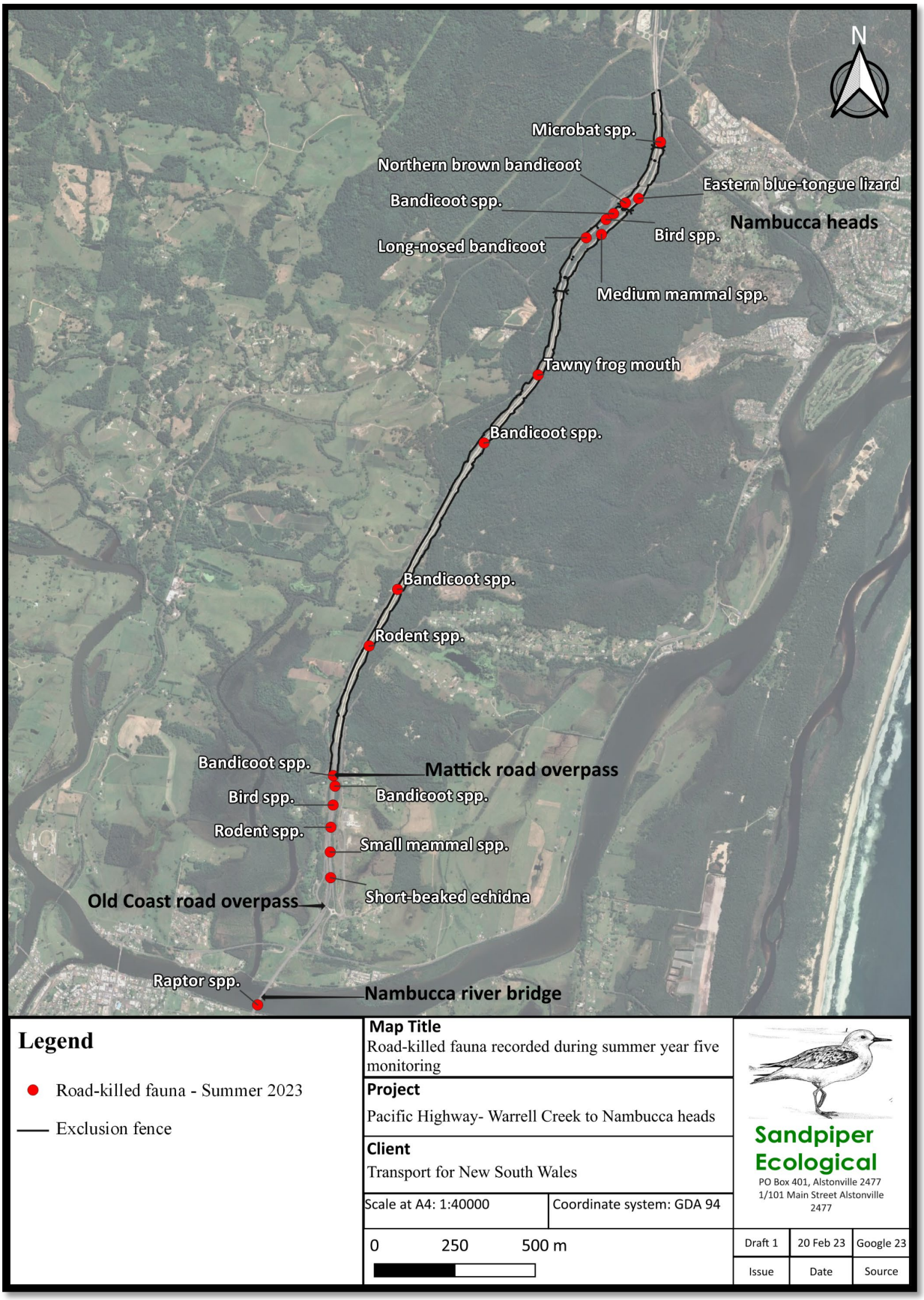

Figure 2: Location of road-killed fauna recorded in summer 2023 along the WC2NH alignment (northern extent).

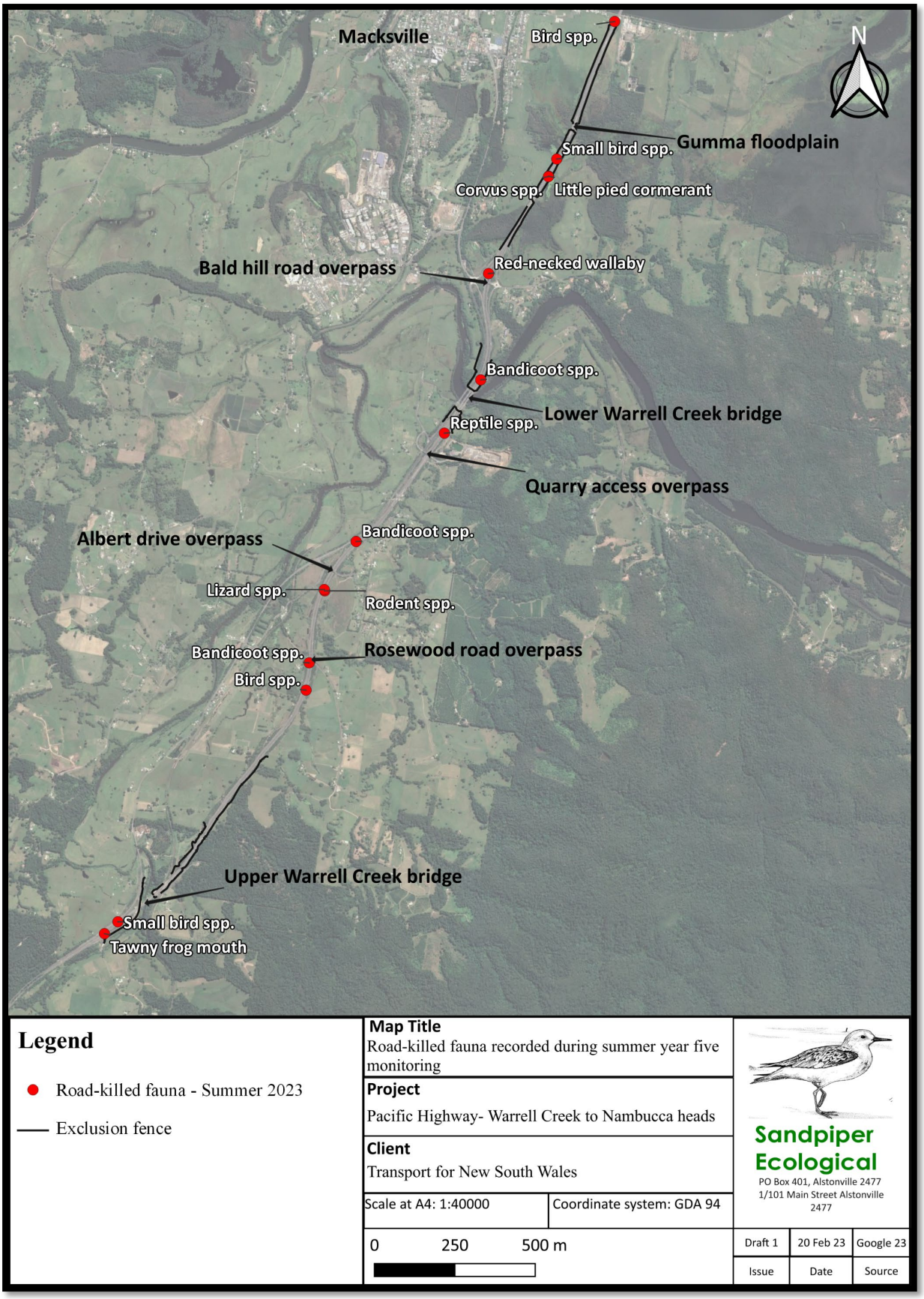

Figure 3: Location of road-killed fauna recorded in summer 2023 along the WC2NH alignment (southern extent).

More road-kill was recorded in the unfenced section of the alignment (17 records) compared to the fenced (15 records) sections (Figures 2, 3, and Table 4). Seven of the fifteen records in fenced areas were individuals that the fauna fence should block under normal circumstances, including six bandicoots and one medium mammal (Table 4). The remaining six individuals were fauna that readily move through (eastern blue-tongue lizard, rodent spp.) or over (birds and microbats) exclusion fencing (Table 4).

Bandicoots tended to be recorded along the fenced section of the alignment to the north of the Mattick Road overpass (Figure 2, 5 records), with one other record in a short fenced section to the north of Lower Warrell Creek Bridge (Figure 3). Birds were recorded on and to the south of the Nambucca River bridge, with one record of a tawny frogmouth in the northern extent of the project west of Nambucca Heads (Figure 2). One red-necked wallaby was recorded in an unfenced section of alignment near the Bald Hill Road Overpass. This was the only macropod recorded during the summer 2023 surveys (Figure 3).

Table 3: The number of road-killed fauna recorded in fenced and unfenced sections of the WC2NH alignment during the January (summer) 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
Long-nosed bandicoot	Excluded	1	
Northern brown bandicoot	Excluded	1	
Bandicoot spp.	Excluded	4	4
Medium mammal spp.	Excluded	1	
Red-necked wallaby	Excluded		1
Short-beaked echidna	Excluded		1
Sub-total (excluded)		**7**	**6**
Bird spp.	Not excluded	1	3
Lizard spp.	Not excluded		1
Reptile spp.	Not excluded		1
Rodent spp.	Not excluded	1	2
Small bird spp.	Not excluded	1	1
Small mammal spp.	Not excluded		1
Microbat spp.	Not excluded	1	
Tawny frog mouth	Not excluded	1	1
Little pied cormorant	Not excluded	1	
Raptor spp.	Not excluded		1
Corvus spp.	Not excluded	1	
Eastern blue-tongue lizard	Not excluded	1	
Sub-total (not excluded)		**8**	**11**
Grand Total		**15**	**17**

4. Discussion

4.1 Summer 2023

In January 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 summer sample recorded 32 individuals, resulting in a road-kill rate of 0.41 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). Notably it is the highest recorded summer rate since 2020 and the highest rate since autumn 2021, representing a 35% increase from the most recent spring 2022 survey (0.3 rk/km/week). 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, as well as survey conditions, with some survey periods favoring increased carcass retention and detection such as during the dry recent summer 2023 survey. Interestingly, the observed summer road-kill rate was higher than the rate (0.3 rk/km/week) reported by Talor and Goldingay (2004) on three major roads located which were unfenced in north-eastern New South Wales.

Mammals and birds continue to comprise the majority of road kills in all surveys to date. Notably, the survey method is biased towards larger and long-lasting carcasses, which tend to be birds and mammals (Ogletree and Mead 2020). The method also reduces the ability to identify all carcasses confidently, resulting in some individuals being assigned to a size class and fauna group. The absence of amphibians in January 2023 is consistent with previous surveys and further emphasises the difficulty of identifying road-killed amphibians during vehicle-based surveys (Sandpiper 2022).

Despite exclusion fences, fauna that would normally be prevented from entering the carriageway continue to be recorded within fenced sections of the alignment similar to results in 2021 and 2022. Bandicoots, in particular, make up the majority of road-kill records within fenced areas, especially north of Mattick road, likely due to their behavior 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.

Only one macropod road-kill was recorded during summer 2023 monitoring which is equivalent to autumn 2022 and the lowest on record (See appendix Table A1). The record was around the known hot-spot at the Bald Hill Road overpass and continues the trend of increased risk of macropod vehicle strikes around unfenced sections of the alignment and at interchanges (Sandpiper 2022). With the data available it is difficult to confirm whether the decrease in macropods is due to a decline in local abundance caused by high road-kills in 2020 (27 individuals), particularly for red-necked wallaby (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 summer

2023. 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

Despite a slight increase in the road-kill rate during the summer of 2023 compared to previous seasons, the rate remained 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 summer 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	Noted.

6. References

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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 (2018-2022). * 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	Spri 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 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	16
Grey butcherbird	0	0	1	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	1
Magpie-lark	2	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1	1	3	0	0	0	14
Australian white ibis	0	0	1	0	0	0	0	0	1	0	0	0	0	1	1	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	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	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	1
Purple swamphen	3	0	2	2	0	1	0	2	3	0	1	1	0	3	1	1	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	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	1
Crested pigeon	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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	11
Rainbow lorikeet	0	0	0	0	0	0	0	1	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	1
Australian boobook	0	0	1	1	0	0	1	0	0	0	1	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	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	24
Tawny frogmouth	1	3	1	2	0	6	0	4	0	1	0	1	1	1	1	0	0	0	1	0	1	24

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	Spri 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 23	Total
Australian owlet-nightjar	0	0	0	0	1	0	0	0	0	1	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	21
Forest kingfisher	1	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	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	3
Whistling kite	0	0	0	1	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	2
Torresian crow	0	0	0	0	1	0	0	0	0	0	0	0	1	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	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	1
Noisy miner	0	0	0	0	0	0	0	0	0	0	0	0	3	1	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	2
Green catbird	0	0	0	0	1	0	0	0	0	0	0	0	1	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	1
Black bittern*	0	0	0	0	0	1	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	1
Pheasant coucal	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	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	1
Welcome swallow	0	0	0	0	0	0	0	1	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	1
Raptor spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Duck spp.	0	0	0	0	0	1	0	0	0	1	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	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
Small bird	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	1	2	2	0	2	11

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	Spri 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 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	21
Unidentifiable bird	5	4	1	0	3	0	0	0	0	0	2	2	1	0	2	2	2	7	0	2	4	37
Total birds	53	8	22	17	18	16	13	25	16	11	8	9	10	12	8	11	6	14	4	2	11	294
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	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	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	17
Pteropus spp.	0	0	0	0	3	8	1	0	1	1	0	0	0	1	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	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	4
Trichosurus spp.	0	0	0	0	0	0	0	0	1	1	1	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	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	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	62
Swamp wallaby	2	1	0	1	0	1	1	0	0	1	1	2	1	0	2	1	1	0	4	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	14
Macropod spp.	3	0	2	1	1	0	0	0	0	2	1	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	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	1
Bandicoot spp.	0	0	0	0	0	1	0	4	0	0	0	1	0	2	4	2	4	3	4	9	8	42
Chalinolobus spp. (microbat)	0	0	0	1	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	3
Swamp rat	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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	12
Small mammal	0	0	0	0	2	0	0	0	0	0	1	0	1	3	0	0	0	1	0	0	1	9

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	Spri 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 23	Total
Medium mammal	0	0	0	2	4	2	4	5	2	2	2	0	0	2	4	2	2	3	1	0	1	38
Large mammal	0	0	0	1	1	0	0	1	0	0	1	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	4
Total mammals	9	2	10	17	37	20	17	23	18	13	20	10	5	16	18	10	12	11	17	16	18	319
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	8
Carpet python	1	0	0	2	1	1	0	1	0	0	0	0	1	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	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	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	7
Unidentified *Chelidae* spp.	6	0	0	0	0	0	0	1	0	0	0	1	2	4	1	0	0	1	1	2	0	19
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	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	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	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	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	1
Unidentified reptile	0	0	0	0	0	0	0	2	0	1	0	0	0	2	0	0	2	3	0	0	1	11
Lizard spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
Total reptiles	17	3	0	12	2	2	1	5	2	2	0	4	4	7	1	0	2	4	1	4	3	76
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	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	3
Medium frog	0	0	0	3	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	1
Total frogs	5	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9

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	Spri 21	Sum 22	Aut 22	Win 22	Spr 22	Sum 23	Total
Introduced species																						
Cat	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	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	1
European fox	3	1	1	2	1	1	2	0	0	0	0	0	0	1	2	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	8
Rabbit	1	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	4
House mouse	0	0	0	0	1	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	2
Domestic goose	0	0	0	1	0	0	0	0	0	0	0	1	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	36
Grand total	**92**	**14**	**34**	**55**	**59**	**40**	**33**	**53**	**36**	**27**	**28**	**25**	**20**	**37**	**29**	**22**	**24**	**29**	**23**	**22**	**32**	**734**
Rk/week/km	**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**	**0.44**