Pacific Highway Upgrade Warrell Creek to Nambucca Heads

Operational phase road-kill monitoring – winter 2021.

Sandpiper Ecological

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Alstonville

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Table of contents

List of tables

List of plates

List of figures

1. Introduction

1.1 Background

In 2015, Transport for NSW (formerly NSW Roads and Maritime Service), 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 a number of 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 underpasses, 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*). A total of 18.03km 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*) and giant barred frog (*Mixophyes iteratus*) from the road corridor. A total of 1.32km 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. A total of 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-killed fauna 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. 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. 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 seasonal monitoring in October 2018. Geolink (2018a, b, c, d) conducted previous road-kill monitoring.

The aim of road-kill monitoring is to:

- Report on any vertebrate road-kill following opening to traffic; and
- Assess the effectiveness of fauna fence in preventing fauna being killed by vehicles while attempting to cross the WC2NH upgrade.

The results of monitoring in 2018, 2019, 2020 and summer and autumn 2021 have been previously reported on (Sandpiper Ecological 2018, 2019, 2020, 2021a, b). The following report covers the winter 2021 monitoring event and includes the entire WC2NH alignment.

1.2 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).

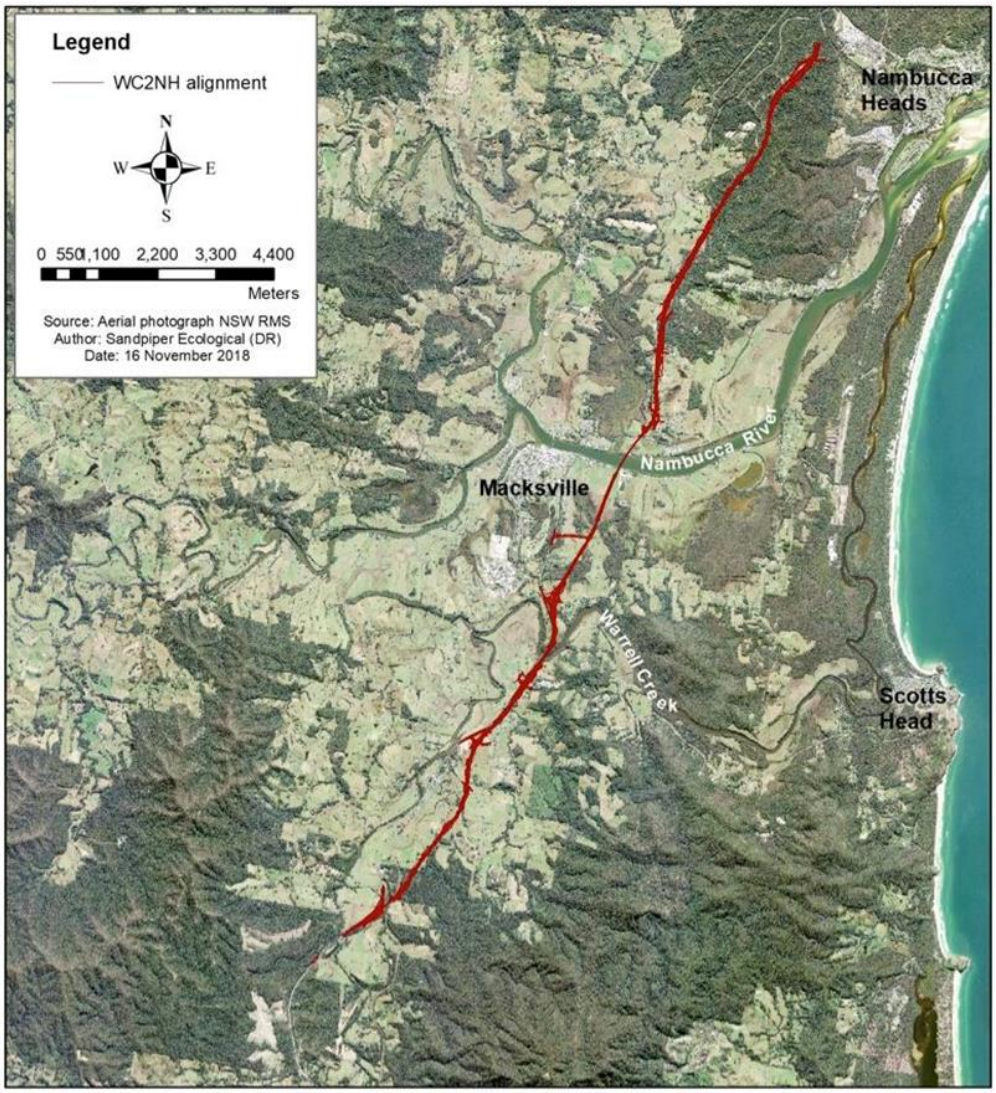

Figure 1: Location of the WC2NH alignment.

2. Methods

2.1 Safety

To ensure compliance with the updated TfNSW Traffic Control at Worksites Manual (TfNSW 2020) the road mortality survey method was revised. The updated guidelines require vehicles to be parked 3m from (& behind) wire rope, 11m from the fog line if there is no wire rope, and pedestrians to walk 3m behind wire rope. These distance restrictions could not be achieved using the former method and the method was revised prior to the autumn 2021 survey.

2.2 Road mortality surveys

Surveys were conducted by a two-person team from a constantly moving vehicle driven at 80-90km/hr in the left lane. The vehicle was equipped with an amber (flashing) light and warning sign (Plate 1). The team consisted of a driver and an ecologist passenger with experience identifying road-killed fauna. Surveys were undertaken weekly and commenced within three hours of sunrise. During each survey, the ecologist scanned the road surface and road shoulder for fauna. When road-killed fauna were detected the species or fauna group was recorded into an audio recorder with the record number, and a "drop pin" showing the site location was placed on an iPad running Motion-X. Fauna records considered likely to be an unidentified target species (i.e. spotted-tailed quoll, koala, grey-headed flying-fox, giant barred frog) were inspected more closely from a safe location. At the completion of each survey, the audio recordings were played back and data were uploaded to Microsoft Excel on a desktop computer, with GPS coordinates downloaded from the iPad.

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); presence of pouch young if applicable; 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 nearest camp, distance to nearest canopy vegetation, and presence of flowering food trees in median or roadside vegetation.

Broad size classes used to group fauna included:

- Small mammal – rodent, phascogale, sugar glider
- Medium mammal – bandicoot, potoroo, brushtail possum
- Large mammal – wallabies and kangaroos
- Small bird – noisy miner, honeyeaters
- Medium bird – magpies, pigeons, frogmouth, swamp hen, ducks
- Large bird – Ibis, large forest owl, egret

All road-kills were cross-referenced with the previous survey data to identify possible duplicates. The consistent use of at least one team member across all surveys, GPS coordinates of each specimen, detailed carcass descriptions, and detailed location descriptions assisted with identifying duplicates. Distance to connectivity structure, and distance to escape structure was determined via GIS. All other data were uploaded to an iPad in the field.

2.2 Data summary and analysis

Data from the winter 2021 survey were uploaded to Microsoft Excel. The winter data were compared with results from autumn 2021 to further assist in identifying duplicate records. Data were then plotted to show the total number of road-kills in winter 2021 and the number of road-kills in different fauna groups each week of the survey. The location of winter 2021 road-kills was overlaid on the WC2NH alignment to show distribution, and the data compared to road-kills recorded in summer, autumn, winter and spring 2018, 2019, 2020 and summer and autumn 2021 (Sandpiper Ecological 2018, 2019, 2020, 2021a, b).

3. Results

3.1 Weather conditions

Light rain occurred in the 24-hour period prior to the first sample, and light rain occurred during sample four (Table 1). Weather conditions were fine and visibility good during other sample events (Table 1).

Table 1: Weather conditions during each sample event. *preceding 24 hours. All data was obtained from the Bureau of Meteorology Coffs Harbour weather station except for rainfall data, which was obtained from Bellwood station.

Date	Average Relative Humidity (%)	Rainfall (mm)*	Max Temperature (^{0}C)	Max Wind Speed (km/h)	Visibility during survey	Rain during survey
2/7/21	75	6	21.9	33	Good	Nil
9/7/21	95	0	19.3	37	Good	Nil
16/7/21	73	0	23.4	59	Good	Nil
23/7/21	61	0	19.3	54	Good	Light

3.2 Species richness and abundance

A total of 29 road-killed fauna were recorded during the winter 2021 sample period. Fauna included nine native species and one introduced species (European fox), as well as six fauna groups (Table 2). Birds and mammals were the most diverse native species groups, represented by five species and two groups, and four species and three groups respectively. Reptiles featured one fauna group.

Red-necked wallaby, bandicoot spp. and medium mammal were the most frequently detected species/group with four records each, followed by swamp wallaby, northern brown bandicoot, bird spp. and European fox with two records each (Table 2). The change in survey method, coupled with degradation of carcasses made identification to species level difficult, resulting in 24% of records being assigned to a group (i.e. bird spp., medium mammal and small bird; Table 2). No frogs were recorded during the winter year 3 surveys.

Of the 29 road-kill records, 20 (69%) were species expected to be blocked by exclusion fence (i.e. turtles and medium and large mammals). Although not all of these were recorded in fenced sections of the alignment. The remaining nine records were species that readily move through or over exclusion fencing.

Table 2: Species of vertebrate fauna recorded during seasonal road-kill surveys throughout the operational phase of the WC2NH upgrade. * 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	Total
Birds																
Australian magpie	6	1		1				2	2	1			1			14
Grey butcherbird			1													1
Magpie-lark	2		1		1		1		1		1	1		1		9
Australian white ibis			1						1					1	1	4
Cattle egret				1						1						2
Little pied cormorant					1											1
Buff-banded rail					1											1
Purple swamphen	3		2	2		1		2	3		1	1		3	1	19
Wonga pigeon														1		1
White-headed pigeon										1						1
Crested pigeon	2															2
Galah	7				1			3								11
Rainbow lorikeet								1								1
Eastern grass owl*				1												1
Australian boobook			1	1			1				1					4
Masked owl*	1				1		1					1				4
Eastern barn owl			11	3		1	5	2	1							23
Tawny frogmouth	1	3	1	2		6		4		1		1	1	1	1	22
Australian owlet-nightjar					1					1						2
Laughing kookaburra	3		2	1		2		3	1	1	2	1				16
Forest kingfisher	1															1
Australian wood duck	20			2	2		1	2				2	1			30
Pacific black duck	2		1													3
Whistling kite				1												1
Black-shouldered kite					1	1										2
Torresian crow					1								1			2

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	Total
Pied currawong				1									1		1	3
Black-faced cuckoo-shrike								1								1
Noisy miner													3	1		4
Dollarbird					2											1
Green catbird					1								1			2
Australasian figbird										1						1
Black bittern*						1										1
Eastern yellow robin						1										1
Pheasant coucal							1		1					1	1	4
Masked lapwing							1									1
Welcome swallow								1								1
Red-browed finch										1						1
Duck spp.						1				1						2
Tyto spp.										1						1
Small bird								2						1	1	4
Medium bird				1	2	2	2	2	6	1	1			2		18
Unidentifiable bird	5	4	1		3						2	2	1		2	20
Total birds	53	8	22	17	18	16	13	25	16	11	8	9	10	12	8	254
Mammals																
Short-beaked echidna				3				2		1	2	1				9
Black flying-fox	2	1			7	1	1							1		12
Grey-headed flying-fox*					8			5	2					2		17
Pteropus spp.					3	8	1		1	1				1		15
Short-eared brushtail possum													1			1
Common brushtail possum			1	2						1						4
Trichosurus spp.									1	1	1					3
Common ringtail possum					1			1								2
Eastern grey kangaroo				3			1								1	4

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	Total
Red-necked wallaby			6		8	2	8	3	7	1	8	3	1	1	4	52
Swamp wallaby	2	1		1		1	1			1	1	2	1		2	13
Wallaby spp.						2			3			2		1		8
Macropod spp.	3		2	1	1					2	1					10
Northern brown bandicoot	1		1		1	1	1	2	2	3	3		1	2	2	20
Bandicoot spp.						1		4				1		2	4	12
Chalinolobus spp. (microbat)				1												1
Microbat spp.					1											1
Swamp rat														1		1
Rodent spp.						2						1			1	4
Small mammal					2						1		1	3		7
Medium mammal				2	4	2	4	5	2	2	2			2	4	29
Large mammal				1	1			1			1					4
Unidentified Mammal	1			3												4
Total mammals	10	2	10	17	36	20	17	23	18	13	20	10	5	16	18	253
Reptiles																
Common blue-tongued skink	1			2	1				2				1			7
Carpet python	1			2	1	1		1					1			7
Common tree snake	1	2						1								4
Eastern long-neck turtle	1			6						1		2				10
Macquarie river turtle	5	1					1									7
Unidentified *Chelidae* spp.	6							1				1	2	4	1	15
Red-bellied black snake	1															1
Eastern water dragon	1			1												2
Eastern bearded dragon												1		1		3
Blackish blind snake						1										1
Yellow-faced whipsnake				1												1
Unidentified reptile								2		1				2		5

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	Total
Total reptiles	17	3	0	12	2	2	1	5	2	2	0	4	4	7	1	64
Frogs																
Green tree frog	2															2
Striped marsh frog	3															3
Medium frog				3												3
Large frog				1												1
Total frogs	5	0	0	4	0	0	0	0	0	0	0	0	0	0	0	9
Introduced species																
Cat	1															1
Dog													1			1
European fox	3	1	1	2	1	1	2							1	2	14
European hare	2			1						1		1		1		6
Rabbit	1															1
Black rat	1					1										2
House mouse					1											1
Rock pigeon			1	1												2
Domestic goose				1								1				2
Total introduced species	8	1	2	5	2	2	2	0	0	1	0	2	1	2	2	30
Total	93	14	34	55	57	40	33	53	36	27	28	25	20	37	29	610

Over the winter 2021 sample period the number of road-kill recorded each week decreased from 15 in week one to six in week two, five in week three and three in week four (Figure 2).

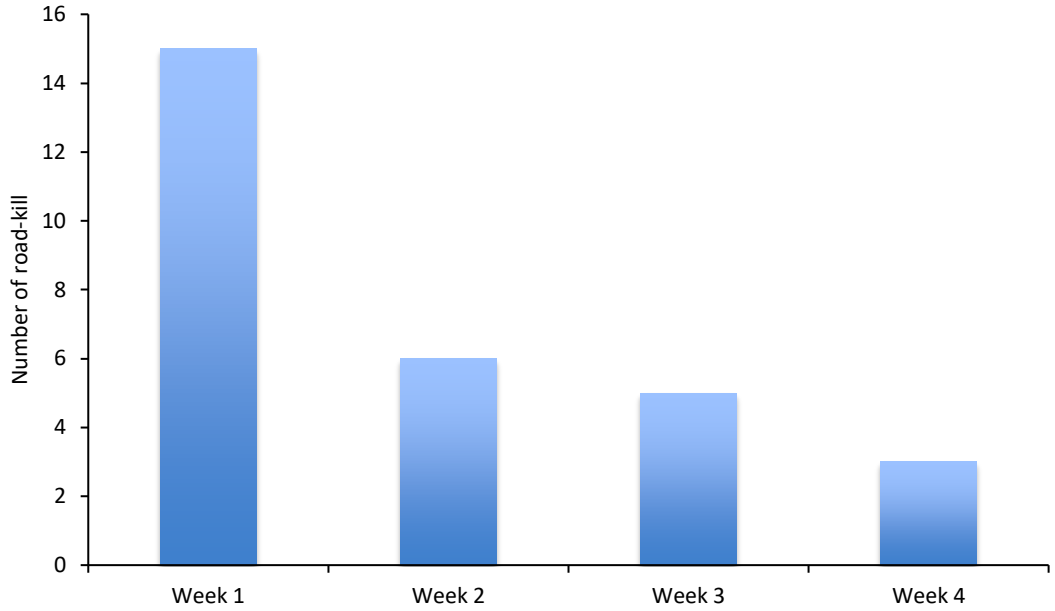

Figure 2: Number of road-kills recorded in each sample week during the winter 2021 sample period.

The number of road-killed flying-foxes has varied over the monitoring period (Figure 3). Black flying-fox, grey-headed flying-fox and total number of flying-foxes peaked in summer 2019 with seven, eight and 18 road-kills, respectively. Numbers have fluctuated and largely declined since then, with no flying-foxes recorded in winter and spring 2020, summer 2021 and winter 2021 (Figure 3). Four road-killed flying-foxes were recorded in autumn 2021, including two grey-headed flying-fox.

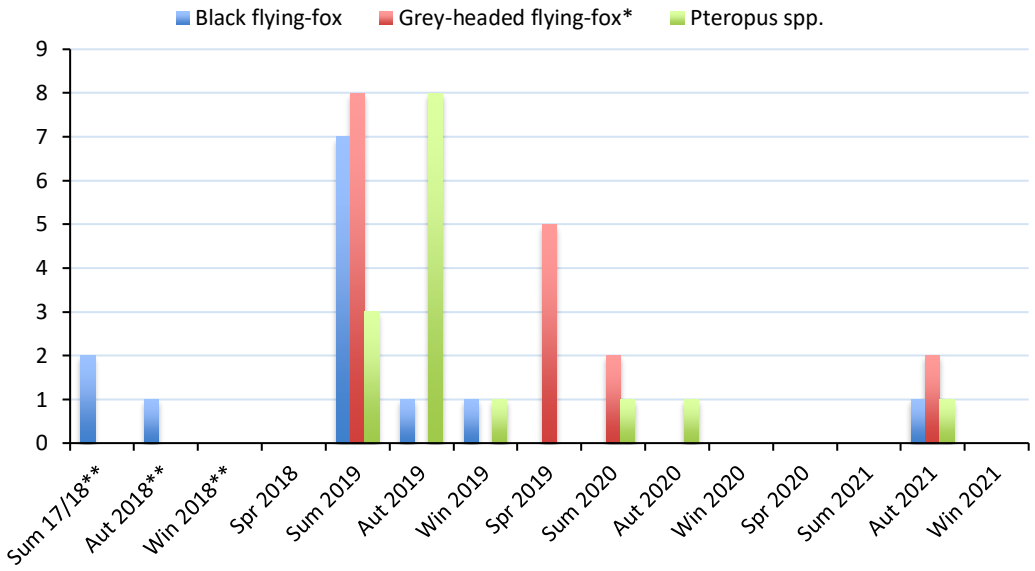

Figure 3: Number of road-killed flying-foxes from all sample periods. *denotes threatened species. **Stage 2a only.

3.3 Opportunistic road-kill information

No opportunistic road-kill was recorded during winter 2021.

3.4 Distribution of road-kill

Fauna road-kills were recorded across the entire WC2NH alignment during winter 2021 (Figures 4-8). More than half of the records (59%) occurred between Warrell Creek to just north of the Nambucca River (12 records) and from Rosewood Road to just south of Albert Drive (five records). During the winter 2021 period, 11 road-kills were recorded in areas with exclusion fence, 17 in areas without exclusion fence and one in an area with exclusion fence on one side of the carriageway (Figures 4-8). Seven of the fenced section records (24% of all records) were species that should be blocked by the fence (i.e. freshwater turtle and medium and large mammals). Thirteen records (45% of all records) in sections without fence or with an exclusion fence on one side, were of species expected to be blocked by an exclusion fence.

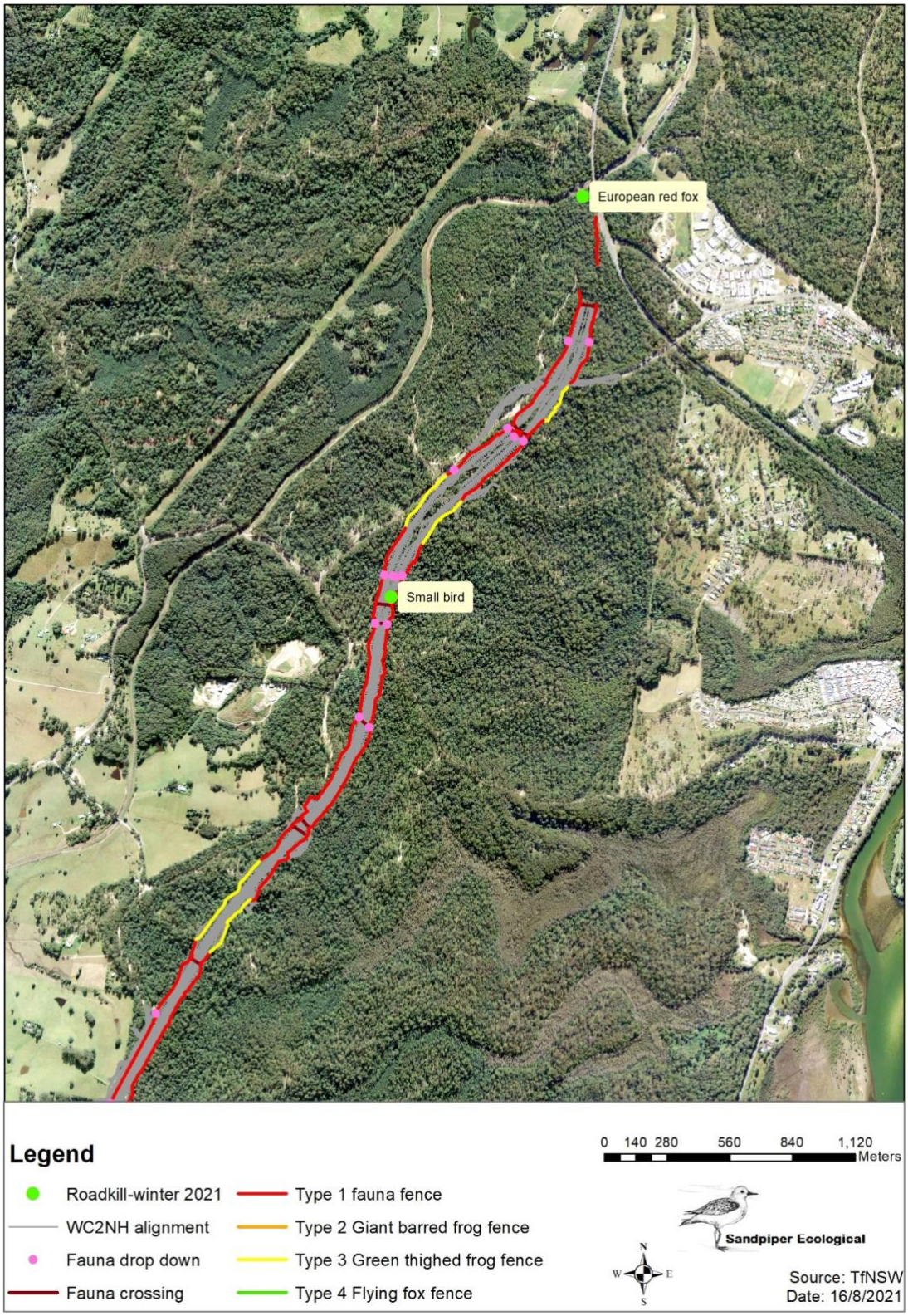

Figure 4: Location of road-killed fauna recorded in winter 2021.

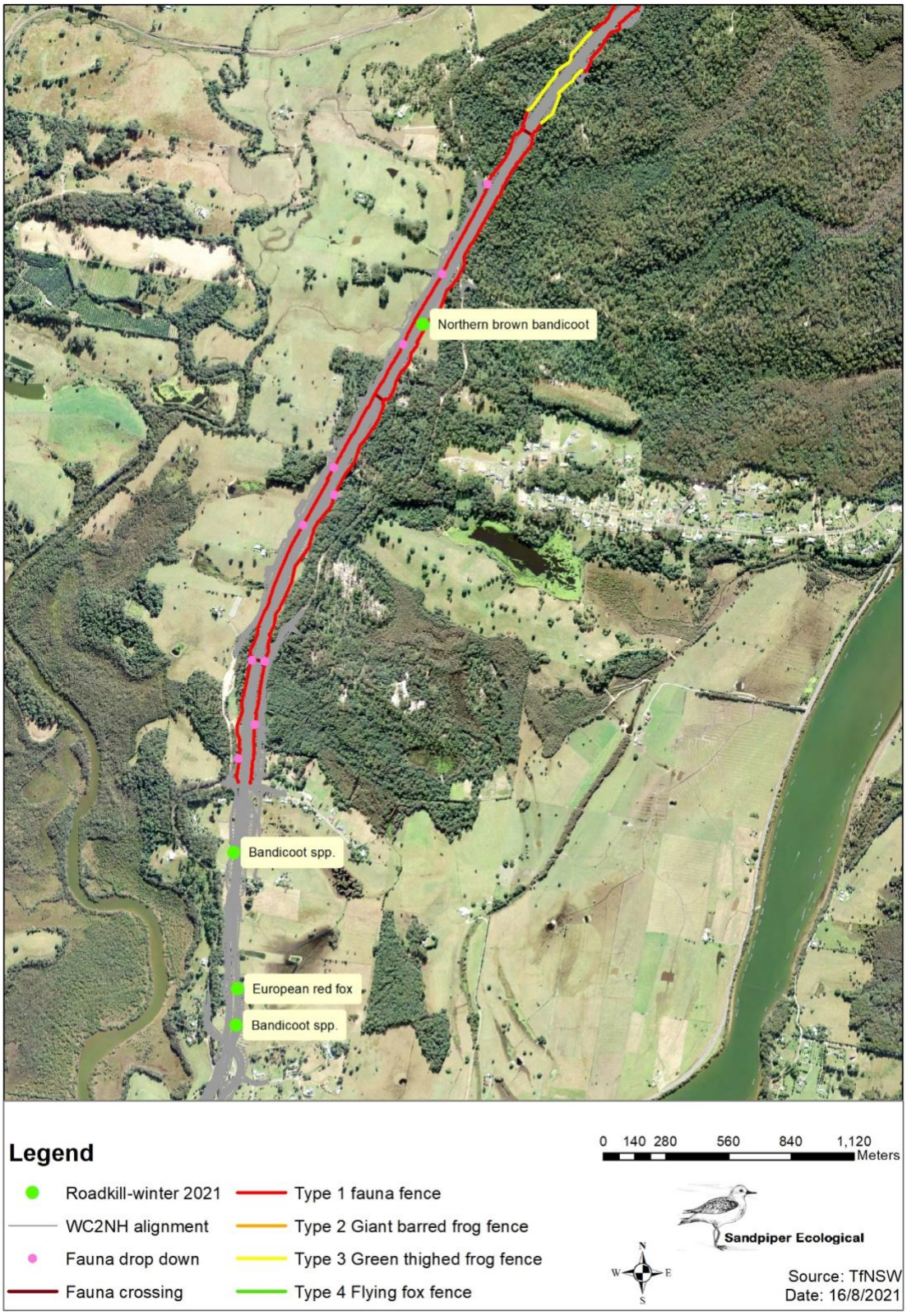

Figure 5: Location of road-killed fauna recorded in winter 2021.

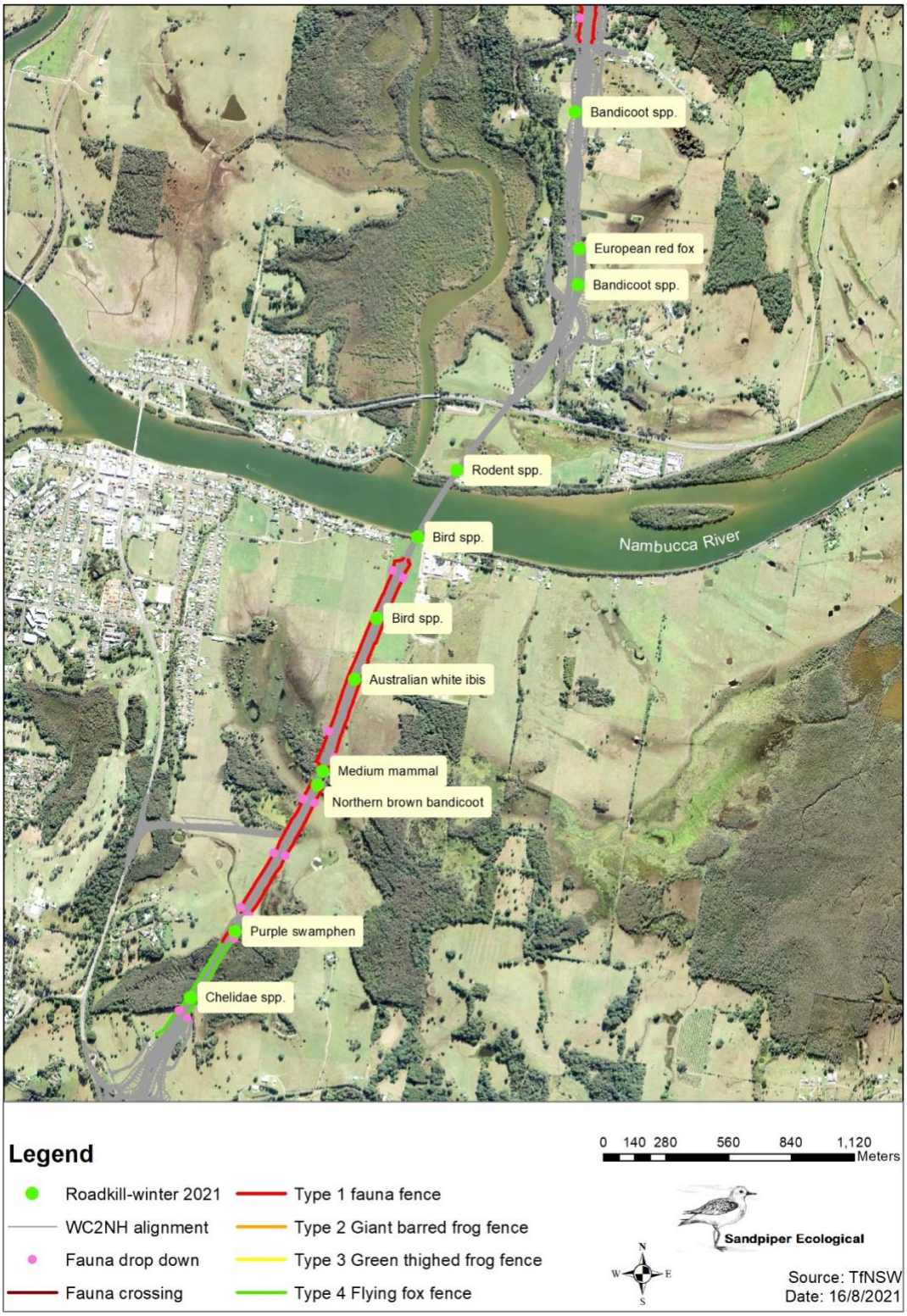

Figure 6: Location of road-killed fauna recorded in winter 2021.

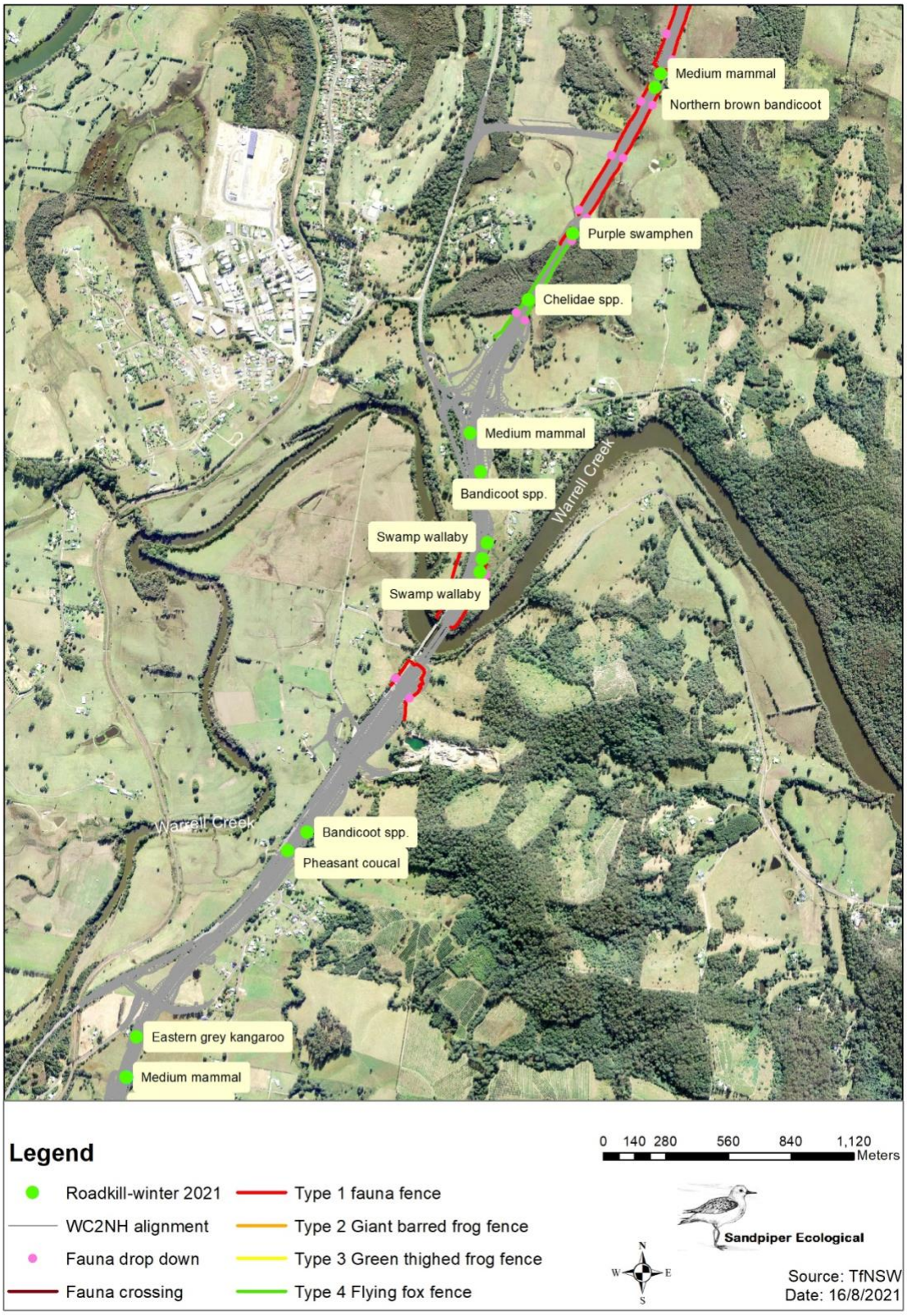

Figure 7: Location of road-killed fauna recorded in winter 2021.

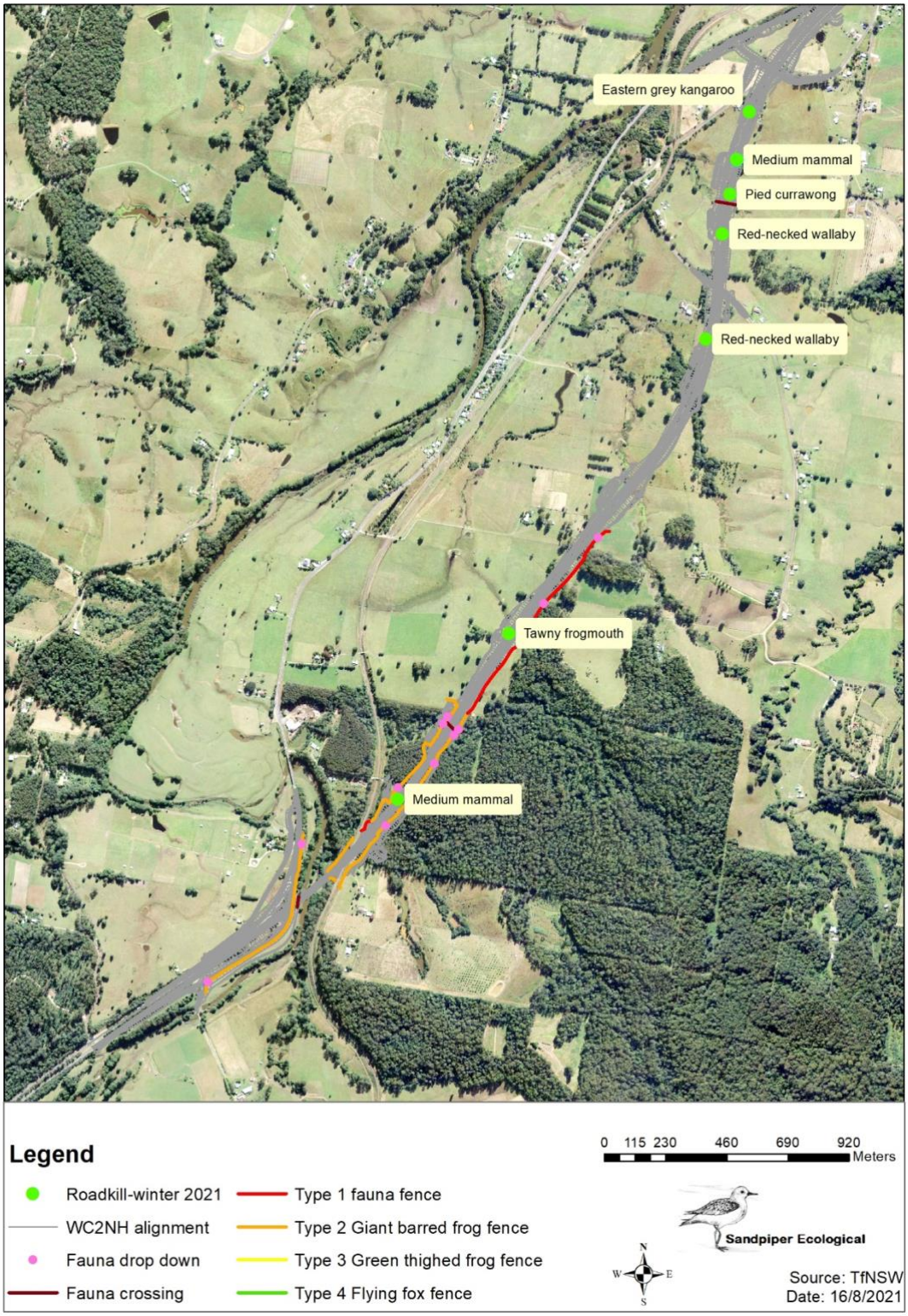

Figure 8: Location of road-killed fauna recorded in winter 2021.

4. Discussion

4.1 Winter 2021

Road-kill monitoring of the WC2NH alignment in winter 2021 indicates that fauna continue to be killed by vehicles three years after the entire alignment was open to traffic. The number of road-kills recorded in winter 2021 (29 individuals) was similar to the equivalent sample in 2020 (28 individuals) and eight individuals less than the preceding autumn 2021 sample. Importantly, no threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999*, or the *Biodiversity Conservation Act 2016* were recorded during the winter 2021 survey.

The higher number of road-kills recorded in the first week of sampling reflects the period over which kills can accumulate. This has been a trend in the majority of sample periods, and means that the number of road-kills recorded during a month overestimates the actual number of animals killed in that month.

Concern has previously been raised about the effect of road-kill on the local red-necked wallaby population (Sandpiper Ecological 2020b). In 2021 the number of road-killed wallaby's increased from one in both summer and autumn to four in winter. Whilst this is substantially less than recorded in previous years the results are consistent with a trend of higher rates of road-kill in summer and winter (see Table 2), with summer 2021 being an exception. A summer and winter peak in macropod road-kill is likely associated with breeding, juvenile independence, food availability and quality. Red-necked wallaby's do not have a defined breeding season, although partial seasonality has been documented (see Higginbottom and Johnson 2000). Reduced grass quality in winter means individuals may move larger distances in search of new growth, which may occur along road-sides, or cause individuals to cross roads.

Road-kill hotspots identified in winter 2021 are consistent with previous surveys. The area from Warrell Creek to Nambucca River contained 41% of all road-kills. This area includes the Nambucca River and Gumma Floodplain, which have consistently recorded a high incidence of road-kill (Sandpiper Ecological 2018; 2019; 2020; 2021a, b). The unfenced area from Rosewood Road to just south of Albert Drive was also identified as a hot spot during winter 2021. Birds and mammals have comprised the majority of road-kills in all surveys to date.

4.2 Flying-fox impacts

Alike the equivalent sample in 2020, there were no road-killed flying-foxes recorded in winter 2021. This is consistent with results from spring 2020 and summer 2021, and the number of road-killed flying-foxes decreased from the preceding autumn 2021 survey (four individuals). Improved foraging conditions during 2020/21 and thereby less reliance on roadside vegetation, and winter dispersal likely contributes to these results (Churchill 2008).

4.3 Effectiveness of fauna fencing

The spatial pattern of road-kill occurrence is broadly consistent with that of the majority of previous samples. The proportion of individuals expected to be blocked by the fence was lower in areas with exclusion fence (24%) than areas without exclusion fence (45%). Importantly, no mortality of target threatened species (expected to be blocked by the fence) were recorded in winter 2021. Monitoring shows that where present, exclusion fencing is effective in mitigating road-strike for target species.

5. Recommendations

Recommendations relating to the winter 2021 operational phase road-kill monitoring are summarised in Table 3.

Table 3: Recommendations following the winter 2021 operational phase road-kill monitoring and Transport for NSW response.

Number	Recommendation	Transport for NSW Response
1.	Continue seasonal road-kill surveys using the revised method applied in the autumn and winter year 3 (2021) surveys	Agreed and adopted

6. References

Geolink (2018a). *Roadkill monitoring report: WC2NH Stage 2A*. Report prepared for NSW Roads and Maritime Services.

Geolink (2018b). *Roadkill monitoring summary report: autumn (April) 2018*. Letter report prepared for NSW Roads and Maritime Services.

Geolink (2018c). *Roadkill monitoring summary report: winter (July) 2018*. Letter report prepared for NSW Roads and Maritime Services.

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Higginbottom, K. & Johnson, C. (2000). Partial seasonality of breeding in red-necked wallabies (Macropus rufogriseus banksianus). *Journal of Zoology:* **251,** 71-77.

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Sandpiper Ecological (2021a). Pacific Highway Upgrade, Warrell Creek to Nambucca Heads: Operational phase road-kill monitoring- summer 2021. Report prepared for Transport for NSW.

Sandpiper Ecological (2021b). Pacific Highway Upgrade, Warrell Creek to Nambucca Heads: Operational phase road-kill monitoring- autumn 2021. Report prepared for Transport for NSW.

Appendix A – Field Survey Data

Table A1: Winter 2021 roadkill results. Obs = Observers; LA = Luke Andrews, AE = Amber English; xing = crossing.

Carriageway	Species	Sex & age class	Presence of pouch or back young	RK general location	Easting	Northing	Cleared off Rd (Y/N)	Fauna fence P/A & proximity	Proximity to xing structure	Proximity to drop-down
SB	Small bird	Uk	nil	50 from end of VM	496601	6609305	No	Yes	NA	NA
SB	Bandicoot spp.	Uk	nil	100 m north of Macksville exit	494425	6603686	No	No	1084	NA
SB	Northern brown bandicoot	Uk	nil	on Gumma floodplain bridge 1	493260	6601451	No	Yes	20	78
SB	Purple swamphen	Uk	nil	100 m north of end of flying fox fence	492893	6600798	No	Yes	NA	NA
SB	Bandicoot spp.	Uk	nil	400m S bald hill road	492481	6599733	No	No	756	NA
SB	Red-necked wallaby	Uk	nil	350 N lower WC bridge	492489	6599344	No	No	345	70
SB	Red-necked wallaby	Uk	nil	380 N lower WC bridge	492510	6599415	No	No	420	145
SB	Swamp wallaby	Uk	nil	300 N lower WC bridge	492479	6599285	No	Yes	283	24
SB	Medium mammal	Uk	nil	300 S Albert drive	490894	6597026	No	No	165	NA
SB	Pied currawong	Uk	nil	400ms Albert drive	490869	6596896	No	No	NA	NA
NB	Tawny frogmouth	Uk	nil	1.5km N Upper WC bridge	490038	6595247	No	Half fenced	NA	NA
NB	Pheasant coucal	Uk	nil	On crouches creek bridge	491618	6598039	No	No	NA	NA
NB	*Chelidae* spp.	Uk	nil	100m N of Macksville on ramp	492693	6600503	No	Yes	378	92
NB	Bird spp.	Uk	nil	200m S NB bridge	493525	6602196	No	yes	NA	NA
NB	Rodent spp.	Uk	nil	100m N NB bridge	493884	6602858	No	No	NA	NA
SB	Northern brown bandicoot	Uk	nil	300 N of site 3 culvert	495259	6606819	No	Yes	373	123
SB	Red-necked wallaby	Uk	nil	250 S Albert drive	490777	6596352	No	No	242	NA
SB	Bandicoot spp.	Uk	nil	100m N Williamsons Creek	491705	6598122	No	No	394	NA
NB	Bandicoot spp.	Uk	nil	700m S Site 3 culvert	494413	6604458	No	No	307	NA
NB	Medium mammal	Uk	nil	100m S Macksville exit	492433	6599906	No	No	897	NA
SB	Medium mammal	Uk	nil	on Gumma floodplain bridge 1	493285	6601514	No	Yes	10	81
SB	Bird spp.	Uk	nil	On NB bridge	493708	6602559	No	No	NA	NA
SB	Swamp wallaby	Joey	nil	400m N Lower WC bridge	492489	6599343	No	No	344	70
SB	Red-necked wallaby	Uk	nil	200m Rosewood Road	490840	6596747	No	No	108	NA
NB	Medium mammal	Uk	nil	30m N Cockburns lane	489620	6594623	No	Yes	341	45
NB	European fox	Uk	nil	40 s NB railway	497457	6611094	No	Yes	**30**	**658**
SB	European fox	Uk	nil	on old coast road off ramp	494431	6603848	No	No	**1245**	**NA**
SB	Australian white ibis	Uk	nil	300 S of NB bridge	493427	6601923	No	Yes	NA	NA
NB	Eastern grey kangaroo	Uk	nil	200 S Albert drive	490942	6597206	No	No	**351**	**NA**