

Oxley Highway to Kempsey

2022/2023 Annual Ecological Monitoring Report

Transport for NSW | October 2023

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Purpose

This report provides an update on the ecological monitoring associated with the Oxley Highway to Kempsey Pacific Highway upgrade.

This report covers the period from **22 July 2022 to 21 July 2023** and has been prepared in accordance with the Oxley Highway to Kempsey Ecological Monitoring Program (Version 3 and 4 2019 and Version 5 2022), for submission to the Department of Planning and Environment and Environment Protection Authority (EPA).

This report includes monitoring outcomes for the following monitoring undertaken in the 2022/2023 reporting period:

- Koala
- Spotted-tailed Quoll
- Giant-barred Frog
- Yellow-bellied Glider
- Brush-tailed Phascogale
- Squirrel Glider
- Fauna Fence and Road-kill
- Fauna Underpass
- Aerial Crossings
- Widened Median
- Nest Boxes

In some instances, monitoring of a particular species or mitigation measure requires several monitoring events throughout the year. In these instances, it is considered more informative to wait until all monitoring events have been conducted for that year, before reporting on the results. This allows for between seasons and further statistical analysis to be conducted than if individual monitoring events are reported on.

Table 1 identifies the species / mitigation measures monitored for the OH2K project in accordance with the Ecological Monitoring Program (Version 3 and 4 2019 and Version 5 2022), and also highlights the specific species / mitigation monitoring included in this 2022/2023 report (**Appendices A – K**).

Table 1 Ecological monitoring requirements and reporting outcomes

Species / mitigation monitored	Timing	Done/ yet to be done	Reporting
Koala	Spring/Summer	<p>Year 3 monitoring (2017) completed.</p> <p>Year 4 monitoring (2018) completed.</p> <p>Year 5 monitoring undertaken in spring 2019 and summer 2019/20.</p> <p>Year 6 monitoring undertaken spring 2020 and summer 2020/21.</p> <p>Year 8 monitoring undertaken in spring 2022 and summer 2022/2023.</p>	<p>Year 8 monitoring included in this report. Appendix A.</p> <p>This is the final monitoring event and report as required by the Ecological Monitoring Program.</p>
Spotted-tail Quoll	Autumn/winter	<p>Year 4 monitoring (2018) completed.</p> <p>Year 6 monitoring undertaken in autumn/winter 2020.</p> <p>Year 8 monitoring scheduled for autumn/winter 2022.</p>	<p>Year 8 monitoring included in this report. Appendix B.</p> <p>This is the final monitoring event and report as required by the Ecological Monitoring Program.</p>
Giant Barred Frog	Spring, Summer and Autumn	<p>Year 3 monitoring (2017/18) completed.</p> <p>Year 4 monitoring (2018/19) completed.</p> <p>Year 5 monitoring undertaken in spring 2019, summer 2019/20 and autumn 2020.</p> <p>Year 6 monitoring undertaken spring 2020, summer 2020/21 and autumn 2021.</p> <p>Year 7 monitoring scheduled for spring 2021, summer 2021/22 and autumn 2022.</p> <p>Year 8 monitoring undertaken in spring 2022, summer 2022/2023 and autumn 2023.</p>	<p>Year 8 monitoring included in this report. Appendix C.</p> <p>This is the final monitoring event and report as required by the Ecological Monitoring Program.</p>

Green-thighed Frog	Summer (although ultimately rainfall dependent) on four occasions during operational phase (year 4-7)	<p>Year 4 (2017/2018) monitoring completed.</p> <p>Year 5 2018/19 monitoring not undertaken due to lack of rain as per EMP. Recent approved updates to the EMP permits flexibility for future monitoring to permit alternative rainfall events deemed suitable by the project ecologist.</p> <p>Year 6 2019/20 undertaken summer 2019/2020</p> <p>Year 7 2020/21 undertaken in summer 2022 in accordance with required trigger rainfall events.</p> <p>Year 8 2021/22 scheduled dependent if suitable rainfall event occurs (to account for missed Year 5). The required trigger rainfall events did not occur during the required seasonal period for monitoring. This final monitoring will be undertaken during spring/summer 2023 and summer (January-February) 2024 pending required trigger rainfall events.</p>	Year 8 monitoring report to be provided following spring/summer 2023 and summer 2024 (January-February) monitoring.
Yellow-bellied Glider	August-December year 4, 6 and 8.	<p>Year 4 monitoring (2018) completed</p> <p>Year 6 monitoring Undertaken in August-December 2020.</p> <p>Year 8 monitoring undertaken in August-December 2022.</p>	<p>Year 8 monitoring included in this report. Appendix D.</p> <p>This is the final monitoring event and report as required by the Ecological Monitoring Program.</p>
Brush-tailed phascogale	Winter and summer year 4, 6 and 8.	<p>Year 4 monitoring (2018) completed.</p> <p>Year 6 monitoring undertaken winter 2020 and summer 2020.</p> <p>Year 8 monitoring scheduled for winter 2022 and summer 2022/2023.</p>	<p>Year 8 monitoring included in this report. Appendix E.</p> <p>This is the final monitoring event and report as required by the Ecological Monitoring Program.</p>

Squirrel Glider	April-August year 4, 6 and 8.	Year 4 monitoring (2018) completed. Year 6 monitoring undertaken April-August 2020. Year 8 monitoring undertaken in April-August 2022.	Year 8 monitoring included in this report. Appendix F. This is the final monitoring event and report as required by the Ecological Monitoring Program.
Fauna Fence and Road Kill Report	Weekly during October (spring), January (summer) and April (autumn) in Year 4, 5, 6 and 8	Construction / post opening – July 2017 – June 2018 completed. Year 4 monitoring (2018/19) completed. Year 5 monitoring October 2019, January 2020 and April 2020 completed Year 6 monitoring undertaken Roadkill - October 2020, January 2021, and April 2021. Fauna Fence - Autumn 2020 and spring/summer 2020/2021 Year 6 monitoring undertaken Roadkill – Autumn (April) 2022, Spring (October) 2022, and Summer (January) 2023. Fauna Fence - Autumn 2022 and Spring/Summer 2022/2023.	Year 8 monitoring included in this report. Appendix G. This is the final monitoring event and report as required by the Ecological Monitoring Program.
Fauna underpass Monitoring Report	Autumn and spring/summer year 4, 6 and 8	Year 4 monitoring (2018/19) completed. Year 6 monitoring undertaken late autumn 2020, late spring /early summer 2020. Year 8 monitoring undertaken in late autumn 2022, late spring /early summer 2022.	Year 8 monitoring included in this report. Appendix H. This is the final monitoring event and report as required by the Ecological Monitoring Program.
Aerial Crossings	Autumn and spring/summer year 4, 6 and 8.	Year 4 monitoring (2018) completed. Year 6 monitoring undertaken autumn and spring/summer 2020. Year 8 monitoring undertaken in autumn and spring/summer 2022.	Year 8 monitoring included in this report. Appendix I. This is the final monitoring event and report as required by the Ecological Monitoring Program.

Widened Median	June-September year 4, 6 and 8.	Year 4 monitoring (2018) completed. Year 6 monitoring Undertaken June-September 2020 Year 8 monitoring undertaken in June-September 2022	Year 8 monitoring included in this report. Appendix J. This is the final monitoring event and report as required by the Ecological Monitoring Program.
Nest Box	Summer and winter year 4, 6 and 8.	Year 4 summer 2018 and winter 2018 complete Year 6 monitoring undertaken summer 2020 and winter 2020 Year 8 monitoring undertaken in 2022 and winter 2022.	Year 8 monitoring included in this report. Appendix K. This is the final monitoring event and report as required by the Ecological Monitoring Program.
Bat box	Summer and winter year 4, 6 and 8.	Year 4 summer 2018 and winter 2018 complete Year 4 outcomes recommended discontinuing monitoring due to lack of uptake. Additional roost structure analyses determined uptake of new underpass structures by target species. Ongoing monitoring/reporting not required.	No further monitoring / Reporting
Revegetation and landscaping	Monthly through construction and 1 year after operation	Year 4 monitoring (2018/19) completed. Year 5 monitoring (2019/20) completed	No further Reporting

Statutory and planning framework

Approval for the Oxley Highway to Kempsey Pacific Highway upgrade was granted by the then Department of Planning & Infrastructure on 8 February 2012. Transport for NSW has constructed and opened the project in stages. The three main stages of the project are:

- Stage 1 - The Sancrox Traffic Arrangement works located about two kilometres north of the Oxley Highway / Pacific Highway intersection. This section of the project opened to traffic on 30 November 2015
- Stage 2 - Kundabung to Kempsey Stage consisting of about 14 kilometres of dual carriageway, commencing north of Barry's Creek near Kundabung (chainage 24,000) and connecting to the Kempsey Bypass at Stumpy Creek (Chainage 37,800). This stage of the project opened to traffic on 31 October 2017.
- Stage 3 - Oxley Highway to Kundabung Stage consisting of about 24 kilometres of dual carriageway, commencing just north of the Oxley Highway / Pacific Highway intersection (chainage 700) and connecting with the Kundabung to Kempsey stage just north of Barry's Creek (chainage 24,000). This stage of the project opened to traffic in two parts initially on 17 November 2017 and finally in its entirety on 29 March 2018.

The Oxley Highway to Kempsey Pacific Highway upgrade approval included the requirement to develop an ecological monitoring program:

The Proponent shall develop an Ecological Monitoring Program to monitor the effectiveness of the biodiversity mitigation measures implemented as part of the project. The program shall be developed by a suitably qualified and experienced ecologist in consultation with the OEH and DPI (Fishing and Aquaculture) and shall include but not necessarily be limited to:

- a) an adaptive monitoring program to assess the effectiveness of the mitigation measures identified in conditions B1, B4, B7 and B31(b) and allow amendment to the measures if necessary. The monitoring program shall nominate performance parameters and criteria against which effectiveness will be measured and include operational road kill surveys to assess the effectiveness of fauna crossings and exclusion fencing implemented as part of the project;*
- b) mechanisms for developing additional monitoring protocols to assess the effectiveness of any additional mitigation measures implemented to address additional impacts in the case of design amendments or unexpected threatened species finds during construction (where these additional impacts are generally consistent with the biodiversity impacts identified for the project in the documents listed under condition A1);*
- c) monitoring shall be undertaken during construction (for construction-related impacts) and from opening of the project to traffic (for operation/ ongoing impacts) until such time as the effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods (i.e 6 years) after opening of the project to traffic, unless otherwise agreed by the Director General. The monitoring period may be reduced with the agreement of the Director General in consultation with the OEH and DPI (Fishing and Aquaculture), depending on the outcomes of the monitoring;*
- d) provision for the assessment of the data to identify changes to habitat usage and whether this can be directly attributed to the project;*
- e) details of contingency measures that would be implemented in the event of changes to habitat usage patterns directly attributable to the construction or operation of the project; and*
- f) provision for annual reporting of monitoring results to the Director General and the OEH and DPI (Fishing and Aquaculture), or as otherwise agreed by those agencies.*

The Program shall be submitted to the Director General for approval no later than 6 weeks prior to the commencement of construction that would result in the disturbance of native vegetation (unless otherwise agreed by the Director General).

The initial Oxley Highway to Kempsey Ecological Monitoring Program was approved by the Department of

Planning & Environment on 25 January 2014. This was updated in 2016 (Version 2) and approved by the Department on 6 December 2016.

The EMP was further updated (Version 3 and 4) in 2019 and approved by the Department on 20 August 2019.

The species and mitigation monitoring reports included in the appendices to this annual report have been assessed against the 2019 Version 3 and 4 EMP.

A fifth revision of the Ecological Monitoring Program was submitted to the Minister on 6 May 2022 and approved by the Minister on 30/05/2022. The amendments to the Ecological Monitoring Program were for updates to the Spotted-tail Quoll monitoring methodology.

Appendix A – Koala



Koala Monitoring 2022

Year 8 Surveys – Oxley Highway to Kempsey, Pacific Highway Upgrade

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Cover photograph: Koala recorded in Maria River State Forest during Spotted-tailed Quoll Monitoring in 2018 and Koala recorded in Underpass C32.35 during 2020 underpass monitoring.

Executive Summary

Context

This report documents findings from the spring-summer 2022 monitoring period for the Koala, as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project).

Aims

The aim of the Koala monitoring program is to determine whether the Project is having an impact on Koala populations within the study area.

Methods

Each monitoring location was surveyed in accordance with the monitoring method and design specified in the Oxley Highway to Kempsey Pacific Highway Upgrade Ecological Monitoring Program (EMP, TfNSW 2022). Monitoring involved Spot Assessment Technique (SAT) plots and spotlighting. Surveys were undertaken in November 2022, December 2022, January 2023 and February 2023.

Key Results

- A total of 85 plots across 30 clusters were surveyed in spring-summer 2022. Koalas were found to be present within 10 of the 30 clusters (33%). This is lower than baseline, 2015, 2016, 2017, 2018, 2019 and 2020 surveys (83%, 45%, 37%, 52%, 52%, 74% and 57% respectively).
- The mean SAT activity level for all plots, measured as the percentage of trees at each plot with scats present, was 1.1% and ranged from 0 to 16.7%. This is similar to the mean activity recorded for plots during 2015, 2016, 2017 and 2020 surveys (2.0%, 0.7%, 1.8% and 1.9% respectively), but lower than the mean activity during baseline surveys (4.9%) and 2019 surveys (3.3%).
- Koalas were recorded more frequently at impact clusters (40%) than at control clusters (27%), which is consistent with results observed in the previous monitoring events.
- Koalas have been recorded using four of the 14 culverts (located within the vicinity of the monitoring sites) being monitored as part of the Fauna Underpass Monitoring for the Project.
- There was no significant change in the difference between Koala presence at control and impact clusters between 2022 and baseline surveys.
- There was no significant change in the difference between Koala presence at clusters with and without mitigation between 2022 and baseline surveys.
- Average plot activity levels for each treatment type have not decreased from the baseline surveys beyond the recommended 10% tolerance level.
- There were no Koala road kill records during 2022/2023 monitoring.
- There has not been a notable alteration in Koala record distribution pre and post construction.
- Grids traversed by the Project corridor have the lowest Koala density, and grids adjacent to the Project corridor have the highest Koala density in both the pre-construction and post-construction periods. Average record density has increased for each group of grids post construction.

Conclusions

All performance measures have been met.

Management Implications

As no significant changes in Koala presence, distribution, density and activity levels from baseline surveys have been detected to date, and as Koalas have been detected using four dedicated fauna underpasses within the Project area, additional mitigation actions are not considered necessary.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the then Commonwealth Department of Environment (DoE) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project. The Koala was identified as requiring mitigation and monitoring during the Project's construction and operational periods.

1.1.1 Legal status

The Koala (*Phascolarctos cinereus*) is listed as endangered under both the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth EPBC Act. Monitoring of the species is required under the Project's approval.

1.1.2 Monitoring framework

The design, methods and performance indicators that define the Koala monitoring program are specified in the EMP. The monitoring program specifies that monitoring of all sites would occur in Years 1, 2 and 3 (construction phase) once substantial construction had commenced. Following the completion of the Project, monitoring was to continue in Years 4, 5, 6 and 8 (operation phase) or until the mitigation measures can be demonstrated to have been effective for the Koala.

To date, these monitoring events have been conducted and reported on as follows:

- Spring-summer 2015: *Koala Monitoring. Year 1 surveys - Oxley Highway to Kempsey Pacific Highway Upgrade* (Niche 2016)
- Spring-summer 2016: *Koala Monitoring 2016. Year 2 surveys - Oxley Highway to Kempsey Pacific Highway Upgrade* (Niche 2017)
- Spring-summer 2017: *Koala Monitoring 2017. Year 3 surveys - Oxley Highway to Kempsey Pacific Highway Upgrade* (Niche 2018a)
- Spring-summer 2018: *Koala Monitoring 2018. Year 4 surveys - Oxley Highway to Kempsey Pacific Highway Upgrade* (Niche 2019a)
- Spring-summer 2019: *Koala Monitoring 2019. Year 5 surveys - Oxley Highway to Kempsey Pacific Highway Upgrade* (Niche 2020a)
- Spring-summer 2020: *Koala Monitoring 2019. Year 6 surveys - Oxley Highway to Kempsey Pacific Highway Upgrade* (Niche 2021a)
- Spring-summer 2022: Current report.

Construction monitoring was completed in spring-summer 2017. This report represents the fourth (Year 8) and final of the required operational monitoring reports.

1.1.3 Baseline data

In accordance with the EMP, baseline surveys for the Koala were undertaken in 2014 to provide baseline data that could be used to identify changes in habitat use before and after construction of the Project, and determine whether any changes can be reasonably attributed to the Project. Baseline monitoring was conducted by Lewis Ecological prior to the commencement of construction (Lewis 2014). Remote cameras were also opportunistically deployed (targeting other threatened species) in August 2013, while spotlighting and Spot Assessment Technique (SAT) plot surveys were undertaken in spring 2013.

1.1.4 Purpose of this report

This report details the findings obtained from the 2022 monitoring period. As mentioned previously, it represents the third of four monitoring reports for the operational phase of the Project.

The aim of this report is to summarise the methods and results of the spring-summer 2022 monitoring, and to compare the results with the baseline surveys to determine whether performance measures are being met and comment on whether additional measures should be considered.

1.2 Performance Measures

The EMP specifies the following performance measures for the Koala:

- *Monitoring is undertaken during baseline surveys from Year 1 – Year 6 & Year 8, or until mitigation measures are demonstrated to be effective.*
- *Monitoring during Year 1 – Year 6 & Year 8 is undertaken at the Impact and Control sites where monitoring was undertaken during baseline surveys, subject to ongoing landowner agreement. Where landowner agreement cannot be obtained and the process in Section 3.1.2 of the EMP has been followed, this performance indicator will also be considered to have been met.*
- *Mitigation measures are demonstrated to be effective as defined in the EPBC approval when all monitoring events are considered at Year 8.*
- *Fauna fence is installed at a minimum in areas identified in Schedule 3 of the EPBC approval at Year 4.*
- *Density: Koala spotlighting records are compared to and discussed with reference to the baseline records, with the baseline detection frequency rate of 1 Koala per spotlight hour considered as the baseline density, as recommended in the baseline report. Compare the NSW BioNet wildlife Atlas density ranking of 5 km² grids, as per the baseline report, between pre and post-construction at Year 8.*
- *Movement: Reduction in Koala road kill compared to the baseline of 1 Koala road kill per 8 weeks for an average baseline plot activity level of 5%, whereby proportional changes in average plot activity level may be reflected in the acceptable level of Koala road kill.*
- *Distribution: Compare the number of records and clustering of records, as per the baseline report, between pre-construction and construction/post-construction at Year 8.*
- *Habitat Use: Koala SAT activity levels will be compared to the baseline activity levels data (below) with a 10% tolerance level, as recommended in the baseline report, to account for variability:*
 - *Broader study area set at 5% activity*
 - *The treatment classes of mitigation set at 8.05%, no mitigation set at 2.64% and control / reference set at 4.03%*
 - *Comparison of percent tree use with baseline tree use.*

1.3 Monitoring Timing

Spotlighting is to occur in spring and SAT plot monitoring is to occur during spring-summer.

1.4 Reporting

Annual reporting of monitoring results will include:

- A detailed description of the monitoring methodology
- Results of the monitoring surveys
- Discussion of the results, including how the results compare against performance measures and if contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA) and the Australian Department of Climate Change, Energy, the Environment and Water (DCCEEW).

2. Survey Methodology

2.1 Koala Spot Assessment Technique (SAT)

2.1.1 Monitoring design

In accordance with the baseline monitoring surveys, eight broad areas within a 20 kilometre (km) radius of the Project were surveyed. These eight areas include South Sancrox, North Sancrox, Cairncross State Forest (South), Cairncross State Forest (North), Cooperabung Hill, Mingaletta Road to Smiths Creek, Kundabung Road to North of Pipers Creek and Maria River State Forest. Within each of these areas, three types of monitoring treatments were established:

- **Type A:** Impact with mitigation. Mitigation plots are located within 500 metres (m) of sufficiently large culverts (>1.8 m, to allow Koalas to pass under the Highway) that are paired with floppy top fencing.
- **Type B:** Impact without mitigation. Plots where mitigation has not been proposed or only partial mitigation is proposed. Partial mitigation plots are where only floppy top fencing is present but with obvious openings at interchanges or entry/exit points.
- **Type C:** Control or reference. These are located in areas at least 3 km, and often 5-10 km from the Project.

Each treatment type (A, B or C) is represented by a cluster of three SAT plots within each of the eight areas, resulting in nine SAT plots per area giving a total of 72 baseline SAT plots, established by Lewis (2014) (with the exception of Cairncross State Forest (South), which had an additional type B cluster during baseline surveys and Mingaletta to Smiths Creek where no type B cluster was established during baseline surveys). Of these 72 plots, 24 were mitigation (type A), three part mitigation and 21 no mitigation (type B) and 24 were control sites (type C). To ensure a balanced monitoring design between impact plots (mitigated and not mitigated) and control plots, an additional 24 control plots (type C) were established during the first monitoring event in 2015 (Niche 2016). In accordance with the baseline monitoring design these additional 24 control plots were established at least 3 km from the Project and were grouped in clusters of three plots, one cluster for each of the eight broad areas.

In 2015, eight of the baseline plots had to be relocated to nearby locations because they had been established in the construction site itself or because they were located on private property and access was not possible. Three of the baseline monitoring plots that could not be accessed could not be relocated because there weren't any suitable sites nearby. These three plots were all part of the same cluster (impact, no mitigation) located in the North Sancrox area.

Details of the 96 monitoring plots are presented in Table 1 and the location of the 93 accessible monitoring plots are shown in Figure 1. During the 2022 monitoring, eight of the 93 monitoring plots were not monitored due to: six plots (KUNDABUNG 6, MIN-SMITHS CK3, COOPERABUNG 1, LAKE INNES1-3) being inaccessible due inability to contact landholder and two plots (SAT ST1 and SAT ST2) being inaccessible due to track damage.

Table 1: SAT monitoring plots

Area	Type	Sub-category	Data source	Plot name	Easting	Northing
South Sancrox	Impact	No Mitigation	Baseline	1 Sancrox East - Cassegrains	483348	6521736
	Impact	No Mitigation	Baseline	2 Sancrox East - Cassegrains	483455	6521789
	Impact	No Mitigation	Baseline	3 Sancrox East - Cassegrains	483412	6521882

Area	Type	Sub-category	Data source	Plot name	Easting	Northing
	Impact	Mitigation	Baseline_Niche relocation	1 Sancrox South	483299	6520671
	Impact	Mitigation	Baseline_Niche relocation	2 Sancrox South	483254	6520383
	Impact	Mitigation	Baseline_Niche relocation	3 Sancrox South	483196	6520217
	Control	Control	Baseline	1 Cowarra State Forest	480608	6519056
	Control	Control	Baseline	2 Cowarra State Forest	480658	6519496
	Control	Control	Baseline	3 Cowarra State Forest	481305	6519136
	Control	New Control	Niche	COWARRA NC1	479706	6518522
	Control	New Control	Niche	COWARRA NC2	479788	6517922
	Control	New Control	Niche	SAT COWARRA NC3	479795	6518227
North Sancrox	Impact*	No Mitigation	Baseline	1 Sancrox North - Expressway Spares	483042	6521731
	Impact*	No Mitigation	Baseline	2 Sancrox North - Expressway Spares	482869	6521683
	Impact*	No Mitigation	Baseline	3 Sancrox North - Expressway Spares	482999	6521818
	Impact	Mitigation	Baseline	1 Fernbank Creek	483101	6523362
	Impact	Mitigation	Baseline	2 Fernbank Creek	483032	6523223
	Impact	Mitigation	Baseline	3 Fernbank Creek	483056	6523123
	Control ⁺	Control	Baseline	1 Lake Innes	488124	6518469
	Control ⁺	Control	Baseline	2 Lake Innes	488047	6518398
	Control ⁺	Control	Baseline	3 Lake Innes	488228	6518390
	Control	New Control	Niche	COWARRA NC3 -SAT COW4	479674	6516436
	Control	New Control	Niche	SAT COW5	479704	6516174
	Control	New Control	Niche	SAT COW6	479667	6515913
Cairncross State Forest (South)	Impact	No Mitigation	Baseline	1 Cairncross State Forest (South)	482428	6526536
	Impact	No Mitigation	Baseline	2 Cairncross State Forest (South)	482385	6526644
	Impact	No Mitigation	Baseline	3 Cairncross State Forest (South)	482393	6526416
	Impact	No Mitigation	Baseline	16 Cairncross State Forest (south)	481655	6527256
	Impact	No Mitigation	Baseline	17 Cairncross State Forest (south)	481590	6527316
	Impact	No Mitigation	Baseline	18 Cairncross State Forest (south)	481637	6527175
	Impact	Mitigation	Baseline	4 Cairncross State Forest (South)	482249	6525930
	Impact	Mitigation	Baseline	5 Cairncross State Forest (South)	482125	6526077
	Impact	Mitigation	Baseline	6 Cairncross State Forest (South)	482488	6526226
	Control	Control	Baseline	1 Limeburners Creek ""The Hatch""	487011	6529909
	Control	Control	Baseline	2 Limeburners Creek ""The Hatch""	487014	6529455
	Control	Control	Baseline	3 Limeburners Creek ""The Hatch""	487035	6528694
	Control	New Control	Niche	SAT PEVI1	476817	6528422
	Control	New Control	Niche	SAT PEVI2	476730	6528225
	Control	New Control	Niche	Cairncross NC1	475996	6528211
	Cairncross State Forest (north)	Impact	No Mitigation	Baseline_Niche relocation	7 Cairncross State Forest (North)	481346
Impact		No Mitigation	Baseline	8 Cairncross State Forest (North)	481695	6530786
Impact		No Mitigation	Baseline	9 Cairncross State Forest (North)	481184	6530864
Impact		Mitigation	Baseline	10 Cairncross State Forest (north)	481238	6530264

Area	Type	Sub-category	Data source	Plot name	Easting	Northing
	Impact	Mitigation	Baseline	11 Cairncross State Forest (north)	481173	6530319
	Impact	Mitigation	Baseline	12 Cairncross State Forest (north)	481438	6530335
	Control	Control	Baseline	13 Cairncross State Forest (Pembrooke)	473751	6528881
	Control	Control	Baseline	14 Cairncross State Forest (Pembrooke)	473464	6528969
	Control	Control	Baseline	15 Cairncross State Forest (Pembrooke)	473424	6529115
	Control	New Control	Niche	SAT RR1	475284	6532709
	Control	New Control	Niche	SAT RR2	475113	6532603
	Control	New Control	Niche	SAT RR3	474816	6532732
Cooperabung Hill	Impact ⁺	No Mitigation	Baseline	1 Cooperabung	482793	6537012
	Impact	No Mitigation	Baseline	2 Cooperabung	482755	6537093
	Impact	No Mitigation	Baseline	3 Cooperabung	482876	6537115
	Impact	Mitigation	Baseline_Niche relocation	4 Cooperabung	482481	6539327
	Impact	Mitigation	Baseline_Niche relocation	5 Cooperabung	482364	6539761
	Impact	Mitigation	Baseline	6 Cooperabung	482364	6538610
	Control	Control	Baseline	1 Cooperabung Hill (Gum Scrub)	475489	6541854
	Control	Control	Baseline	2 Cooperabung Hill (Gum Scrub)	475570	6541903
	Control	Control	Baseline	3 Cooperabung Hill (Gum Scrub)	475838	6541962
	Control	New Control	Niche	SAT FL1	473693	6542127
	Control [#]	New Control	Niche	SAT ST1	473346	6543256
	Control [#]	New Control	Niche	SAT ST2	473682	6542890
Mingaletta to Smiths Creek	Impact	Mitigation	Baseline	1 Mingaletta-Smiths Creek	483304	6543632
	Impact	Mitigation	Baseline	2 Mingaletta-Smiths Creek	483444	6543585
	Impact ⁺	Mitigation	Baseline	3 Mingaletta-Smiths Creek	483100	6543670
	Control	Control	Baseline	1 Ballengara State Forest (Gregs Road)	477750	6543274
	Control	Control	Baseline	2 Ballengara State Forest (Gregs Road)	477644	6543623
	Control	Control	Baseline	3 Ballengara State Forest (Gregs Road)	477551	6543709
	Control	New Control	Niche	SAT BR1	477010	6544693
	Control	New Control	Niche	SAT BR2	476890	6544832
	Control	New Control	Niche	SAT BR3	476777	6544973
Kundabung Road to North of Pipers Creek	Impact	No Mitigation	Baseline	1 Kundabung	483095	6549036
	Impact	No Mitigation	Baseline	2 Kundabung	482873	6549112
	Impact	No Mitigation	Baseline	3 Kundabung	483285	6549374
	Impact	Mitigation	Baseline	4 Kundabung	483369	6550655
	Impact	Mitigation	Baseline	5 Kundabung	483331	6550938
	Impact ⁺	Mitigation	Baseline	6 Kundabung	483083	6550608
	Control	Control	Baseline	1 Kumbatine National Park	476044	6549609
	Control	Control	Baseline	2 Kumbatine National Park	476165	6549738
	Control	Control	Baseline	3 Kumbatine National Park	475889	6549468
	Control	New Control	Niche	SAT MAC1	476538	6552784
	Control	New Control	Niche	SAT MAC2	476558	6552361

Area	Type	Sub-category	Data source	Plot name	Easting	Northing
	Control	New Control	Niche	SAT MAC3	476481	6552612
Maria River State Forest	Impact	Part Mitigation	Baseline_Niche relocation	1 Maria River	483074	6554460
	Impact	Part Mitigation	Baseline	2 Maria River	482836	6554330
	Impact	Part Mitigation	Baseline_Niche relocation	3 Maria River	482993	6554024
	Impact	Mitigation	Baseline	4 Maria River	482886	6552623
	Impact	Mitigation	Baseline	5 Maria River	482754	6552462
	Impact	Mitigation	Baseline	6 Maria River	483135	6552449
	Control	Control	Baseline	1 Maria River National Park	486965	6554366
	Control	Control	Baseline	2 Maria River National Park	486971	6554479
	Control	Control	Baseline	3 Maria River National Park	487004	6554203
	Control	New Control	Niche	SAT CO1	486292	6552230
	Control	New Control	Niche	SAT CO3	486811	6552227
	Control	New Control	Niche	SAT MAR 1	486811	6552454

* not surveyed since baseline due to private landowner access restrictions; # not surveyed in 2022 due to track restrictions; + not surveyed in 2022 due to inability to contact landholder.

2.1.2 SAT Methodology

Surveys were undertaken following the SAT methodology (Phillips and Callaghan 2011) in accordance with the EMP monitoring procedure for Koala population monitoring. The SAT method involves a radial assessment of Koala activity within the immediate area surrounding a tree that is known to have been used by the species or is considered to be of importance to the species. The following describes the application of this technique:

1. Locate and mark a tree that is:
 - a) A tree of any species beneath which one or more Koala faecal pellets have been observed; and/or
 - b) A tree in which a Koala has been observed; and/or
 - c) Any other tree known or considered to be important for Koalas or of interest for other assessment purposes.
2. Identify and mark the 29 nearest trees to the tree marked initially.
3. Undertake a search for Koala faecal pellets beneath each of the 30 marked trees. Visually inspect the ground surface beneath trees to a distance of one metre from the trunk. If no pellets are observed, rake the leaf litter within the prescribed search area. Two person minutes per tree should be dedicated to the search for faecal pellets. The search should be ended once a single pellet is found or the search time has expired (whichever happens first). Faecal pellets should not be removed from the site unless verification is necessary.
4. Calculate the activity level of a site as the percentage of surveyed trees within the site (of 30 trees) that have a Koala faecal pellet recorded within its search area. The result is used to assess whether the site supports “Low”, “Medium (normal)” or “High” Koala activity.
5. Record the presence (or absence) of scats, along with a number of other attributes including the species of the tree under which the scat was located.

The selection criteria trees (SCTs) of each plot were marked (tagged) and have been used as the centre tree for the radial searches during each survey event.

2.1.3 Analysis

General SAT plot presence and activity results are presented for plot, cluster and area. More detailed analyses of impact vs. control sites and mitigation vs. no mitigation sites were undertaken using cluster presence/absence results. Plots within the same cluster are not independent from each other and therefore cannot be used for most statistical analyses. Between year activity levels were compared using mean plot activity results.

Based on the methods used to collect the data and the location of the plots, it was determined that a Chi-square test was the most suitable statistical test to assess differences in Koala presence between areas, treatments and years. This test compares the proportion of plots with and without Koala scats and so is suitable for presence/absence data. The Chi-square test also allows for analysis of data where sample sizes between categories may differ, as is the case here where there are an unequal number of impact and control sites.

2.2 Additional Surveys

Additional survey methods were adopted in 2019 as a result of the revision and adoption of an updated EMP (TfNSW 2022).

2.2.1 Spotlighting

Spotlighting surveys were undertaken as per baseline surveys at six sites across three locations: Cairncross State Forest, Ballengarra State Forest and Maria River National Park (Figure 1). Spotlighting locations have been set up in a paired Before After Control Impact (BACI) configuration comprising an impact site and a control site which exhibit similar vegetation/habitat type and landscape features. Field surveys involved a 10 minute listening period on arrival at site, followed by spotlighting performed by two observers using handheld variable beam ~100 watt spotlights whilst walking a 500 m transect over 30 minutes. These surveys are to be repeated on three separate occasions at least seven days apart.

2.2.2 NSW BioNet Wildlife Atlas

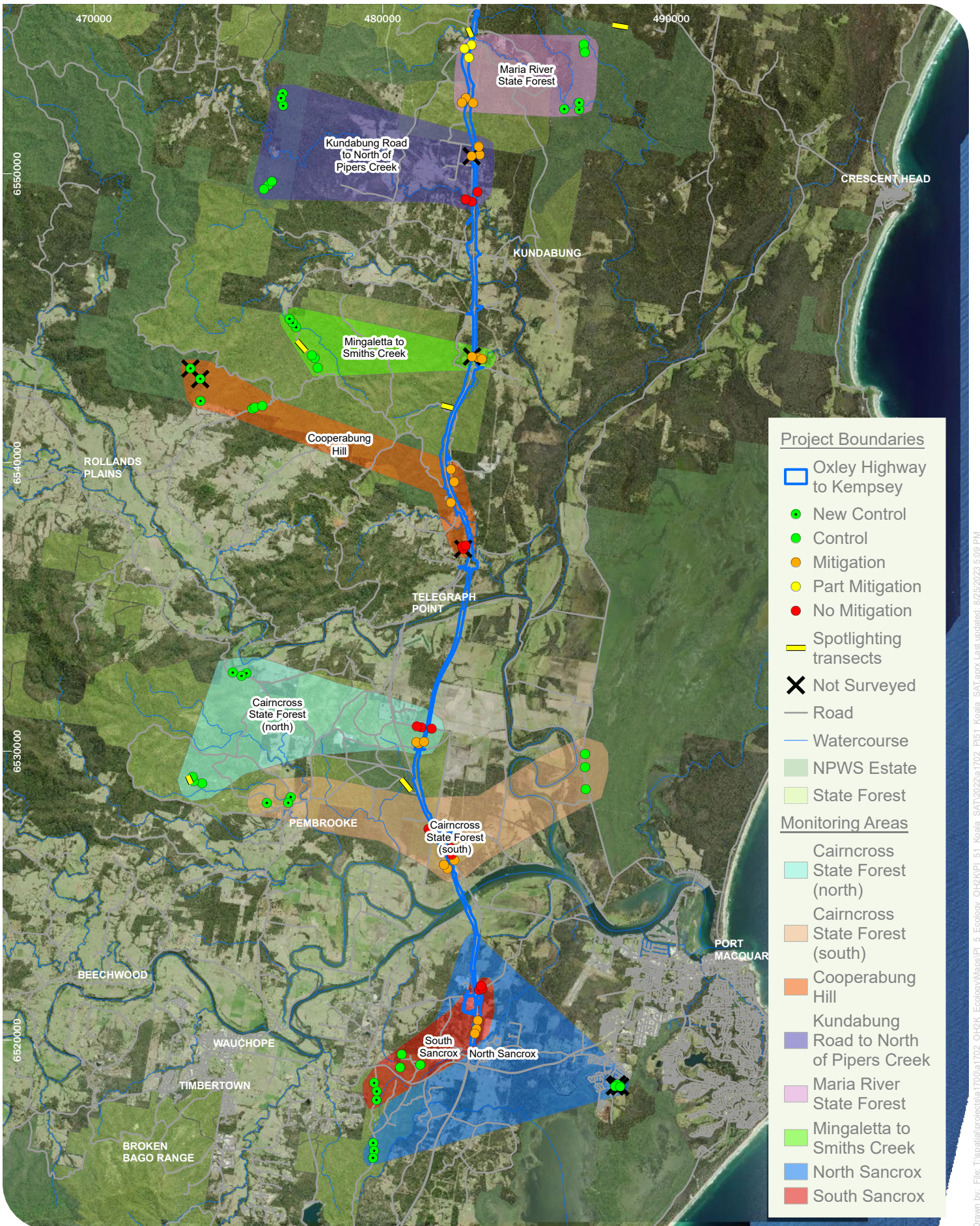
NSW BioNet wildlife Atlas records will be used to compare Koala distribution and density. A comparison of pre-construction records (i.e. 2004 - 2013 inclusive) to post-construction records at Year 8 (i.e. 2014 – 2022 inclusive) was undertaken, as per baseline methods.

Koala distribution: Koala distribution was measured using BioNet Wildlife Atlas records within 10 km of the study area so as to provide a comparison with the baseline monitoring distribution data. The Atlas data was divided into the following two chronological time scales:

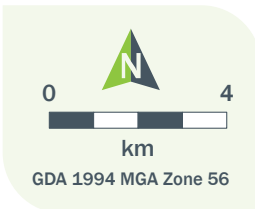
- Pre-construction: 2004-2013 inclusive
- Post-construction: 2014-2022 inclusive

Differences in Koala records between 2004-2013, and 2014-2022 were discussed with reference to obviously clustering of records as focal points for Koala populations.

Koala density: Koala density was measured using historic records from the BioNet Wildlife Atlas to describe reporting rates using a standardised 5 km² across the study area. The number of records within each grid was calculated for two time periods; pre-construction (2004-2013) as a baseline for comparison, and post-construction (2014-2022).



Drawn by: File: T:\spatial\projects\1700\1702_0\H2K_Ecology\Maps\PI_5_Ecology_OH2K\PI_51_Koala_SAT\2022\1702_P151_Koala_SAT.aprx Last updated: 8/25/2023 5:09 PM



SAT plot and spotlighting transect locations
 Koala Monitoring: Pacific Highway Upgrade - Oxley Highway to Kempsey

Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 P15.1
 Client: Roads and Maritime Services

Figure 1

3. Results

3.1 SAT Plots

Surveys were undertaken between 9 December 2022 and 28 February 2023. Field data for each SAT plot is presented in Annex 1. The DBH (diameter at breast height) is provided for the SCT.

A total of 85 accessible SAT plots were surveyed across the eight monitoring areas (Figure 1).

3.1.1 Presence/absence

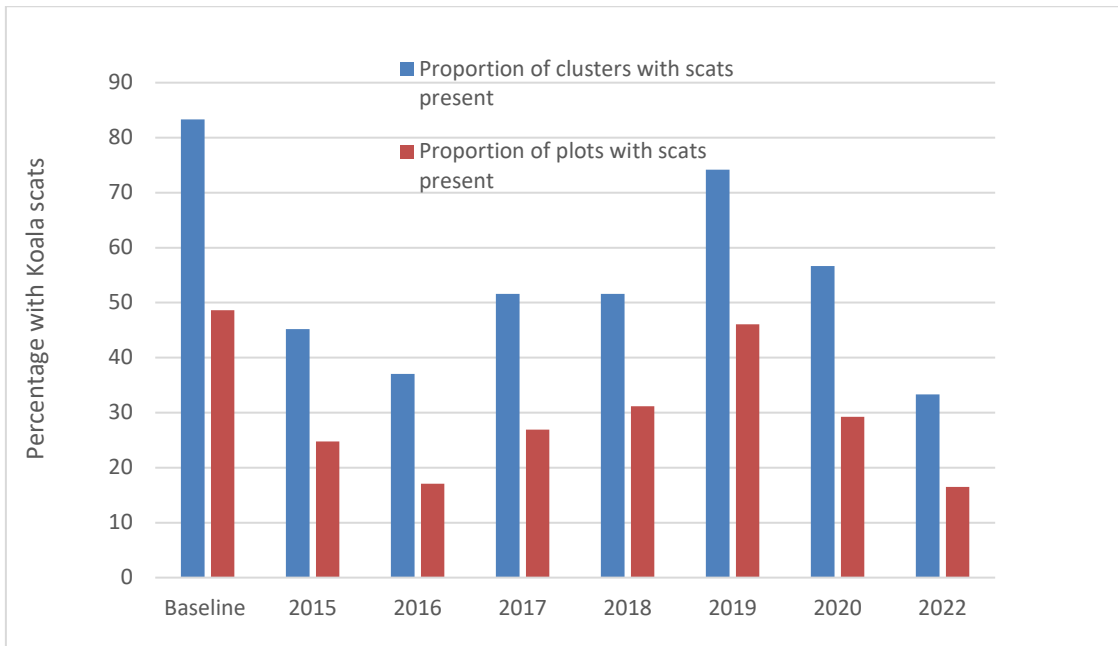
SAT plots

Table 2 provides a summary of presence/absence results for plots and clusters at each monitoring event. Graph 1 shows the percentage of plots and clusters with scats present for each monitoring period to date and Graph 2 shows the percentage of clusters within each area with scats present, for each monitoring period to date. Table 3 provides a detailed comparison of the activity level for each plot and presence/absence results of each cluster for each monitoring period to date and Figure 2 shows the SAT cluster presence/absence results for the 2022 monitoring (map reference ID for each cluster is listed in Table 3).

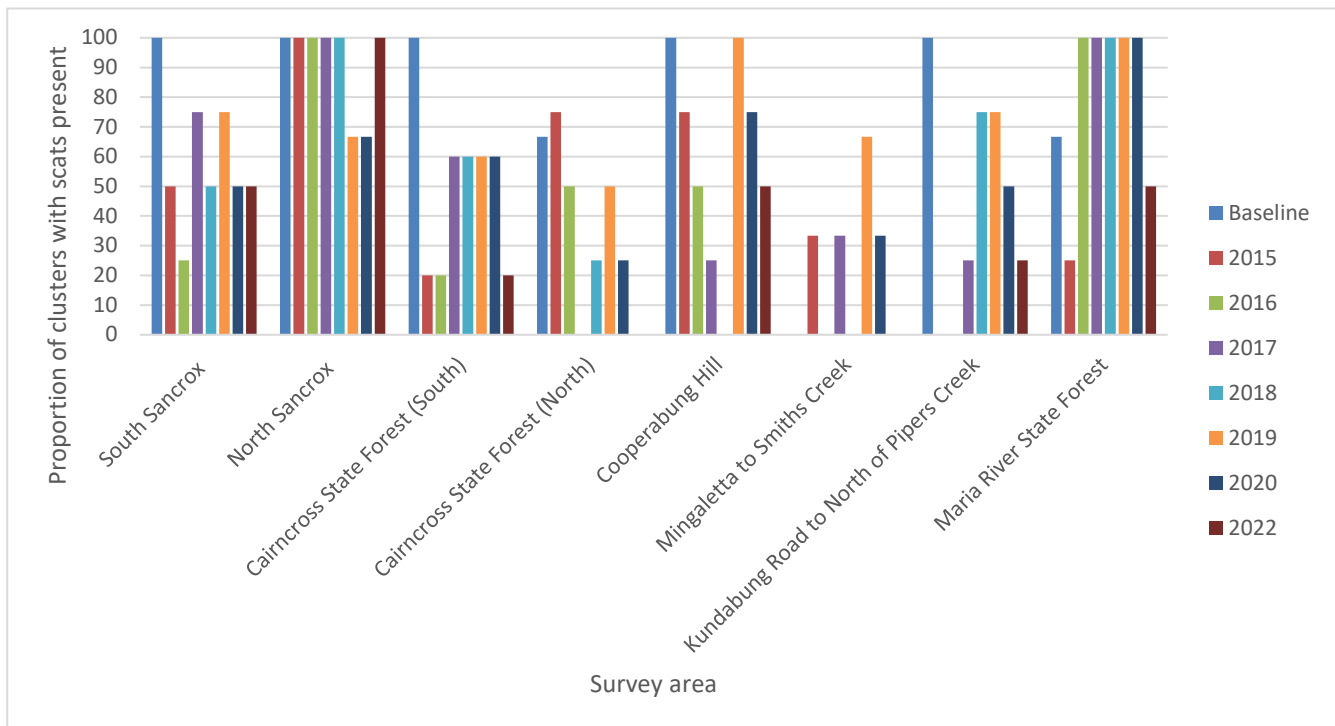
Of the 85 surveyed plots, Koala scats were recorded at 16.5% (14 of 85) of the individual plots. This is lower than previous surveys 2015, 2016, 2017, 2018, 2019 and 2020 surveys (25%, 17%, 27%, 31%, 46% and 29% respectively). This is also lower than the 49% recorded during baseline surveys. When grouped according to cluster, Koala scats were recorded at 33% of clusters (10 of 30). This is lower than baseline, 2015, 2016, 2017, 2018, 2019 and 2020 surveys (83%, 45%, 37%, 52%, 52%, 74% and 57% respectively).

Table 2: Presence/absence results

	Baseline	2015	2016	2017	2018	2019	2020	2022
Number of plots with scats present (n = plots surveyed)	35 (49%, n = 72)	23 (25%, n = 93)	14 (17%, n = 82)	25 (27%, n = 93)	29 (31%, n = 93)	41 (46%, n = 89)	26 (29%, n = 89)	14 (16.5%, n = 85)
Number of clusters with scats present (n = clusters surveyed)	20 (83%, n = 24)	14 (45%, n = 31)	10 (37%, n = 27)	16 (52%, n = 31)	16 (52%, n = 31)	23 (74%, n = 31)	17 (57%, n = 30)	10 (33%, n = 30)



Graph 1: Percentage of plots and clusters with scats present for each monitoring event to date



Graph 2: Koala presence in areas across all monitoring events

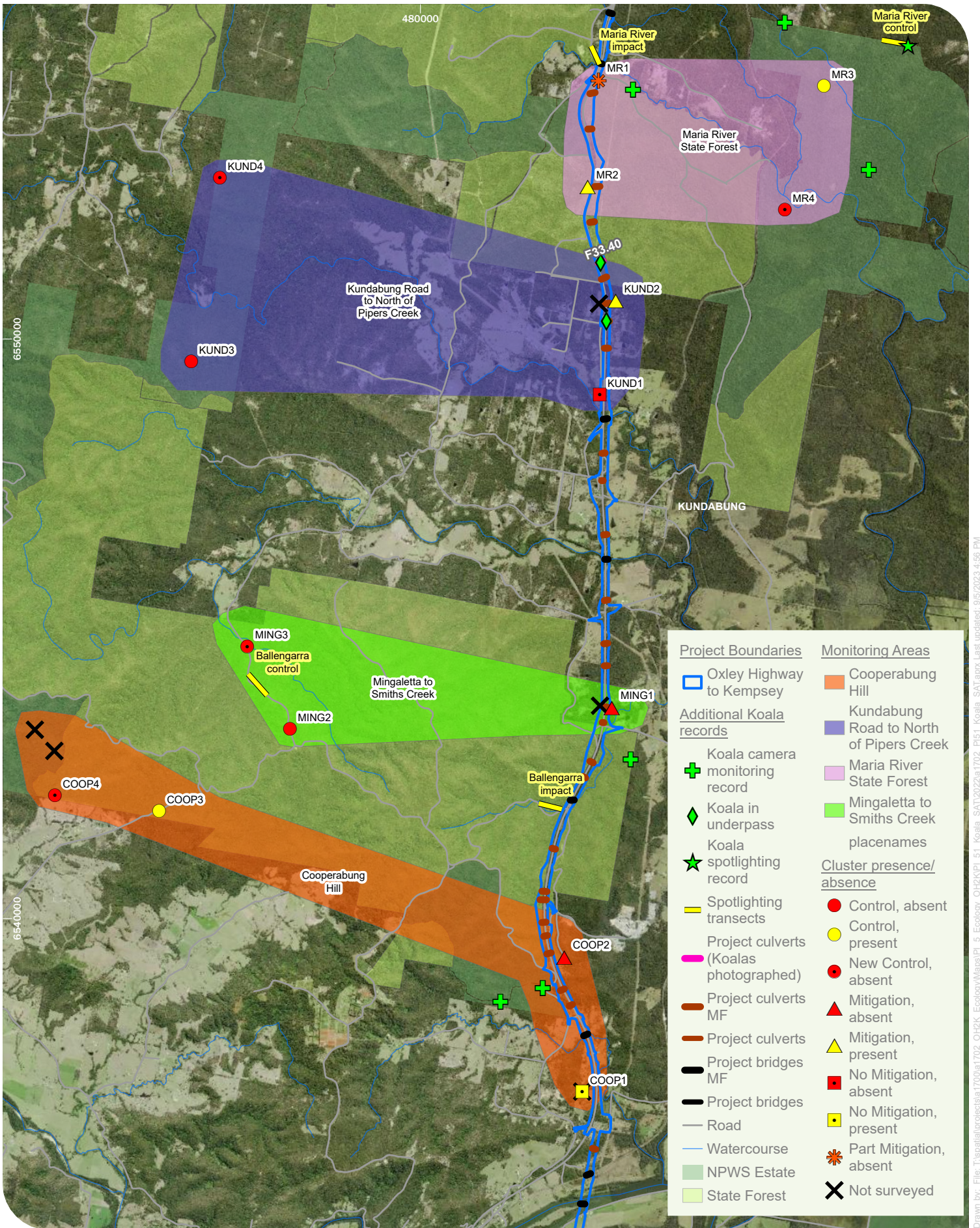
Table 3: SAT plot results baseline – 2022

Area	Type	Data source	Site ID	MapRef	Plot activity (%)								Scat presence (per cluster)								
					Base line	2015	2016	2017	2018	2019	2020	2022	Baseline	2015	2016	2017	2018	2019	2020	2022	
South Sancrox	No Mitigation	Baseline	SANCROX E1	SSAN1	10.0	3.3	0.0	23.3	6.7	3.3	3.3	0.0	present	present	absent	present	present	present	present	absent	
			SANCROX E2		0.0	0.0	0.0	0.0	0.0	fire	0.0	0.0									
			SANCROX E3		0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0									
	Mitigation	Baseline_Niche relocation	SANCROX S1	SSAN2	13.3	0.0	0.0	3.3	0.0	fire	3.3	0.0	present	absent	absent	present	present	present	present	present	present
			SANCROX S2		3.3	0.0	0.0	0.0	6.7	fire	0.0	10.0									
			SANCROX S3		10.0	0.0	0.0	0.0	3.3	3.3	0.0	0.0									
	Control	Baseline	COWARRA SF1	SSAN3	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	present	absent	present	absent	absent	present	absent	absent	absent
			COWARRA SF2		3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
			COWARRA SF3		10.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0									
New Control	Niche	SAT COWARRA NC1	SSAN4	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	Not monitored	present	absent	present	absent	absent	absent	absent	present
		SAT COWARRA NC2		-	3.3	0.0	6.7	0.0	0.0	0.0	0.0										
		SAT COWARRA NC3		-	0.0	0.0	3.3	0.0	0.0	0.0	0.0										
North Sancrox	No Mitigation	Baseline	SANCROX N1	-	3.3	-	-	-	-	-	-	-	present	No access	No access	No access	No access	No access	No access	No access	
			SANCROX N2		0.0	-	-	-	-	-	-	-									
			SANCROX N3		0.0	-	-	-	-	-	-	-									
	Mitigation	Baseline	FERNBANK CK1	NSAN1	33.3	0.0	3.3	16.7	3.3	0.0	10.0	10.0	present	present	present	present	present	absent	present	present	
			FERNBANK CK2		30.0	0.0	6.7	6.7	0.0	0.0	0.0	10.0									
			FERNBANK CK3		23.3	6.7	3.3	13.3	6.7	0.0	3.3	0.0									
	Control	Baseline	LAKE INNES1	NSAN2	26.7	13.3	0.0	3.3	6.7	3.3	3.3	-	present	present	present	present	present	present	present	present	No access
			LAKE INNES2		13.3	6.7	3.3	6.7	3.3	0.0	3.3	-									
			LAKE INNES3		3.3	6.7	0.0	0.0	3.3	10.0	10.0	-									
New Control	Niche	SAT COW4	NSAN3	-	10.0	0.0	3.3	3.3	0.0	0.0	0.0	Not monitored	present	present	present	present	present	absent	absent	present	
		SAT COW5		-	0.0	0.0	0.0	0.0	3.3	0.0	0.0										
		SAT COW6		-	0.0	3.3	0.0	10.0	0.0	0.0	3.3										
		Baseline	CAINCROSS SF1	CCS1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	present	present	absent	absent	absent	present	present	absent	

Area	Type	Data source	Site ID	MapRef	Plot activity (%)								Scat presence (per cluster)									
					Base line	2015	2016	2017	2018	2019	2020	2022	Baseline	2015	2016	2017	2018	2019	2020	2022		
Cairncross State Forest (South)	No Mitigation		CAINCROSS SF2		3.3	6.7	0.0	0.0	0.0	3.3	0.0	0.0										
			CAINCROSS SF3		0.0	3.3	0.0	0.0	0.0	0.0	0.0	3.3	0.0									
	No Mitigation	Baseline		CAINCROSS SF16	CCS2	0.0	0.0	3.3	3.3	0.0	0.0	0.0	0.0	present	absent	present	present	present	absent	absent	absent	
				CAINCROSS SF17		0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0									
				CAINCROSS SF18		13.3	0.0	0.0	6.7	3.3	0.0	0.0	0.0									
	Mitigation	Baseline		CAINCROSS SF4	CCS3	3.3	0.0	0.0	3.3	6.7	13.3	3.3	3.3	present	absent	absent	present	present	present	present	present	
				CAINCROSS SF5		3.3	0.0	0.0	0.0	0.0	13.3	0.0	0.0									
				CAINCROSS SF6		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
	Control	Baseline		LIMEBURNERS CK1	CCS4	0.0	0.0	0.0	3.3	0.0	0.0	-	0.0	present	absent	absent	present	absent	absent	absent	absent	
				LIMEBURNERS CK2		3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
			LIMEBURNERS CK3		0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0										
New Control	Niche		SAT PEVI1	CCS5	-	0.0	0.0	0.0	6.7	3.3	0.0	0.0	Not monitored	absent	absent	absent	present	present	present	absent		
			SAT PEVI2		-	0.0	0.0	0.0	3.3	0.0	3.3	0.0										
			SAT PEVI3		-	0.0	0.0	0.0	0.0	0.0	0.0	0.0										
Cairncross State Forest (north)	No Mitigation	Baseline_Niche relocation	CAINCROSS SF7	CCN1	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	absent	present	absent	absent	absent	present	absent	absent		
		Baseline	CAINCROSS SF8		0.0	20.0	0.0	0.0	0.0	3.3	0.0	0.0										
		Baseline	CAINCROSS SF9		0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0										
	Mitigation	Baseline		CAINCROSS SF10	CCN2	3.3	0.0	0.0	0.0	3.3	6.7	3.3	0.0	present	present	present	absent	present	present	present	absent	
				CAINCROSS SF11		3.3	0.0	3.3	0.0	0.0	0.0	0.0	0.0									
				CAINCROSS SF12		6.7	3.3	0.0	0.0	0.0	3.3	0.0	0.0									
	Control	Baseline		CAINCROSS SF13	CCN3	6.7	3.3	3.3	0.0	0.0	0.0	0.0	0.0	present	present	present	absent	absent	absent	absent	absent	
				CAINCROSS SF14		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
				CAINCROSS SF15		0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0									
	New Control	Niche		SAT RR1	CCN4	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Not monitored	absent	absent	absent	absent	absent	absent	absent	
			SAT RR2		-	0.0	0.0	0.0	0.0	0.0	0.0	0.0										
			SAT RR3		-	0.0	0.0	0.0	0.0	0.0	0.0	0.0										

Area	Type	Data source	Site ID	MapRef	Plot activity (%)								Scat presence (per cluster)								
					Base line	2015	2016	2017	2018	2019	2020	2022	Baseline	2015	2016	2017	2018	2019	2020	2022	
Cooperabung Hill	No Mitigation	Baseline	COOPERABUNG1	COOP1	3.3	3.3	0.0	0.0	0.0	0.0	0.0	0.0	-	present	present	present	absent	absent	present	present	present
			COOPERABUNG2		0.0	23.3	3.3	0.0	0.0	3.3	0.0	0.0									
			COOPERABUNG3		10.0	0.0	0.0	0.0	0.0	10.0	10.0	3.3									
	Mitigation	Baseline_Niche relocation	COOPERABUNG4	COOP2	0.0	3.3	6.7	0.0	0.0	10.0	6.7	0.0	present	present	present	present	absent	present	present	absent	
			COOPERABUNG5		3.3	3.3	0.0	10.0	0.0	6.7	3.3	0.0									
			COOPERABUNG6		0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0									
	Control	Baseline	COOP HILL1	COOP3	6.7	0.0	0.0	0.0	0.0	3.3	0.0	0.0	present	absent	absent	absent	absent	present	present	present	
			COOP HILL2		0.0	0.0	0.0	0.0	0.0	6.7	3.3	3.3									
			COOP HILL3		0.0	0.0	0.0	0.0	0.0	10.0	13.3	3.3									
New Control	Niche	SAT FL1	COOP4	-	16.7	0.0	0.0	0.0	logged	0.0	0.0	Not monitored	present	absent	absent	absent	present	absent	absent		
		SAT ST1		-	0.0	0.0	0.0	0.0	10.0	0.0	-										
		SAT ST2		-	20.0	0.0	0.0	0.0	3.3	0.0	-										
Mingalett a to Smiths Creek	Mitigation	Baseline	MIN-SMITHS CK1	MING1	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	absent	absent	absent	absent	absent	present	present	absent	
			MIN-SMITHS CK2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
			MIN-SMITHS CK3		0.0	0.0	0.0	0.0	0.0	6.7	0.0	-									
	Control	Baseline	BALLENGARA SF1	MING2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	absent	absent	absent	absent	absent	present	absent	absent
			BALLENGARA SF2		0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0									
			BALLENGARA SF3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
	New Control	Niche	SAT BR1	MING3	-	6.7	0.0	0.0	0.0	0.0	0.0	0.0	Not monitored	present	absent	present	absent	absent	absent	absent	
			SAT BR2		-	0.0	0.0	3.3	0.0	0.0	0.0	0.0									
			SAT BR3		-	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
Kundabung Road to North of Pipers Creek	No Mitigation	Baseline	KUNDABUNG 1	KUND1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	present	absent	absent	absent	present	present	present	present	absent
			KUNDABUNG 2		10.0	0.0	0.0	0.0	6.7	3.3	3.3	0.0									
			KUNDABUNG 3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
		Baseline	KUNDABUNG 4	KUND2	33.3	0.0	fire	0.0	13.3	10.0	0.0	16.7	present	absent	Fire	present	present	present	present	present	

Area	Type	Data source	Site ID	MapRef	Plot activity (%)								Scat presence (per cluster)								
					Base line	2015	2016	2017	2018	2019	2020	2022	Baseline	2015	2016	2017	2018	2019	2020	2022	
	Mitigation		KUNDABUNG 5		13.3	0.0	fire	3.3	16.7	13.3	6.7	3.3			Fire						
			KUNDABUNG 6		10.0	0.0	0.0	0.0	0.0	0.0	0.0	-			absent						
	Control	Baseline	KUMBATINE NP1	KUND3	3.3	0.0	0.0	0.0	0.0	3.3	0.0	0.0	present	absent	absent	absent	present	present	absent	absent	
					KUMBATINE NP2	0.0	0.0	0.0	0.0	0.0	0.0	0.0									
					KUMBATINE NP3	0.0	0.0	0.0	0.0	3.3	6.7	0.0									0.0
	New Control	Niche	SAT MAC1	KUND4	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Not monitored	absent	absent	absent	absent	absent	absent	absent	
					SAT MAC2	-	0.0	0.0	0.0	0.0	0.0	0.0									
					SAT MAC3	-	0.0	0.0	0.0	0.0	0.0	0.0									
	Maria River State Forest	Part Mitigation	Baseline_Niche relocation	MARIA RIVER 1	MR1	0.0	0.0	fire	0.0	6.7	3.3	3.3	0.0	present	absent	No access - fire	present	present	present	present	absent
Baseline			MARIA RIVER 2	3.3		0.0	fire	0.0	0.0	23.3	6.7	0.0									
Baseline_Niche relocation			MARIA RIVER 3	6.7		0.0	fire	16.7	13.3	10.0	0.0	0.0									
Mitigation		Baseline	MARIA RIVER 4	MR2	0.0	0.0	fire	6.7	6.7	10.0	6.7	0.0	absent	present	No access - fire	present	present	present	present	present	
					MARIA RIVER 5	0.0	0.0	fire	0.0	0.0	3.3	6.7									3.3
					MARIA RIVER 6	0.0	3.3	fire	0.0	3.3	0.0	0.0									0.0
Control		Baseline	MARIA NP1	MR3	0.0	0.0	0.0	3.3	20.0	10.0	10.0	0.0	present	absent	present	present	present	present	present	present	
					MARIA NP2	10.0	0.0	3.3	0.0	10.0	10.0	33.3									3.3
					MARIA NP3	10.0	0.0	3.3	3.3	36.7	13.3	3.3									16.7
New Control		Niche	SAT CO1	MR4	-	0.0	fire	6.7	10.0	13.3	-	0.0	Not monitored	absent	No access - fire	present	present	present	No access – roads blocked	absent	
					SAT CO3	-	0.0	fire	3.3	0.0	3.3	-									0.0
					SAT MAR 1	-	0.0	fire	6.7	3.3	6.7	-									0.0



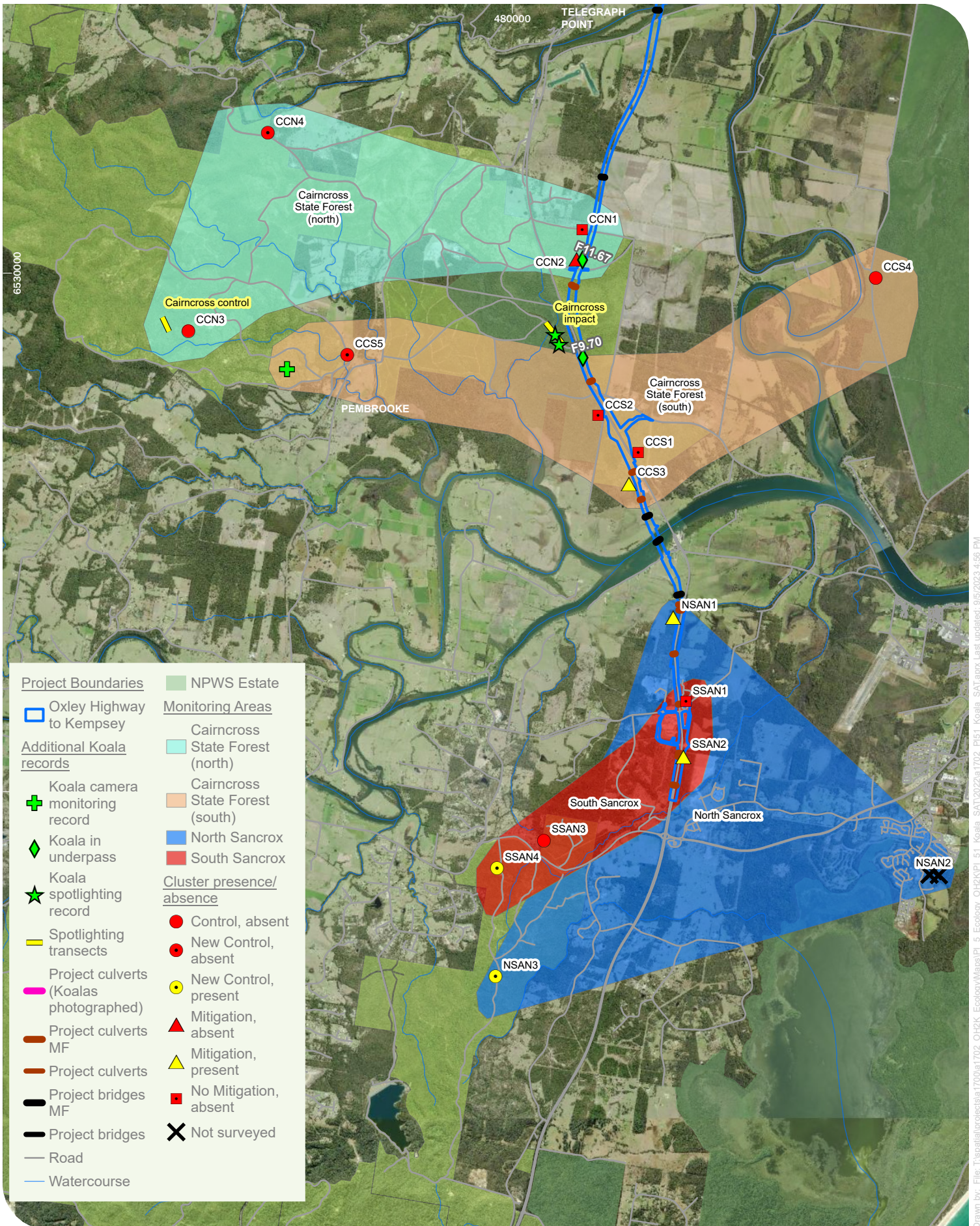
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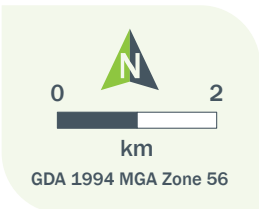
SAT cluster results and Koala records 2022 - North
Koala Monitoring: Pacific Highway Upgrade - Oxley Highway to Kempsey

Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 P15.1
 Client: Roads and Maritime Services

Figure 2a



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SAT cluster results and Koala records 2022 - South
Koala Monitoring: Pacific Highway Upgrade - Oxley Highway to Kempsey

Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 PI5.1
 Client: Roads and Maritime Services

Figure 2b

3.1.2 Activity levels

Individual plot activity levels are provided above in Table 3. A summary of the SAT activity level for plots, clusters and areas in all monitoring events is provided in Table 4 and Table 5.

Plot and cluster activity

The mean SAT activity level for all plots, measured as the percentage of trees at each plot with scats present, was 1.1% (standard deviation (SD) of 3.2) and ranged from 0 to 16.7%. This is similar to the mean activity recorded for plots during 2015, 2016, 2017 and 2020 surveys (2.0%, 0.7%, 1.8% and 1.9% respectively), but lower than the mean activity recorded during baseline surveys (4.9%), 2018 surveys (2.5%) and 2019 surveys (3.3%).

Considering the activity level within active plots only, i.e. plots where scats were found to be present, the average activity level was 6.7% (SD 5.1), which is higher than or similar to the mean activity recorded for active plots during 2016, 2017 and 2020 (4.0%, 6.8% and 6.5% respectively), but lower than the mean activity recorded for active plots during baseline surveys (10.1%) and 2015, 2018 and 2019 (8.0%, 8.0% and 7.2% respectively).

The EMP requires interpretation of site activity levels to assess areas as supporting low, medium or high Koala activity. Phillips and Callaghan (2011) used NSW BioNet Atlas data to calculate activity levels of sites where Koala scats were recorded. These data were then used to define categories of habitat use in populations of varying densities. The Port Macquarie-Hastings and Kempsey LGAs support a significant Koala population, including a concentrated population in the coastal areas, east of the Pacific Highway and south of Hastings River, as well as pockets of higher density/activity in surrounding areas, including Maria River National Park (BioLink 2013, PMHC 2017). While Phillips and Callaghan (2011) use an arbitrary definition of population densities (low = ≤ 0.1 Koala/hectare), the study area naturally consists of areas of varying densities. Discussions with Port Macquarie-Hastings Council confirmed that population density varies throughout the region and therefore one general population density cannot be attributed to all sites. In addition, as site specific density data is not available for all sites, it is not possible to designate the sites as being low or high density populations according to Phillips and Callaghan. However, in compliance with the EMP, if we consider the habitat use category of Phillips and Callaghan (2011) for low density populations on the east coast, as per the baseline studies (Lewis 2014), using activity levels of SAT plots where scats were recorded, average SAT plot activity has consistency fallen into to the “medium (normal)” use category (3.3% - 12.6%) for populations in an east coast, low density area.

Table 4: Summary of SAT activity results

Average activity	Baseline	2015	2016	2017	2018	2019	2020	2022
Average activity per plot (n = plots surveyed)	4.9% (SD8.0, n = 72)	2.0% (SD4.6, n = 93)	0.7% (SD1.6, n = 82)	1.8% (SD4.1, n = 93)	2.5% (SD5.4, n = 93)	3.3% (SD4.7, n = 89)	1.9% (SD3.1, n = 89)	1.1% (SD3.2, n = 85)
Average activity per active plot (n = plots with activity)	10.1% (SD9.0, n = 35)	8.0% (SD6.3, n = 23)	4.0% (SD1.4, n = 14)	6.8% (SD5.3, n = 25)	8.0% (SD7.0, n = 29)	7.2% (SD5.8, n = 41)	6.5% (SD2.6, n = 26)	6.7% (SD5.1, n = 14)
Average activity per cluster (n = plots surveyed)	4.9% (SD6.9, n = 24)	2.0% (SD3.5, n = 31)	0.7% (SD1.1, n = 27)	1.8% (SD2.8, n = 31)	2.5% (SD4.5, n = 31)	3.3% (SD3.5, n = 31)	1.9% (SD3.1, n = 30)	1.2% (SD2.4, n = 30)
Average activity per active cluster (n = active clusters)	5.9% (SD7.1, n = 20)	4.4% (SD4.0, n = 14)	1.9% (SD1.1, n = 10)	3.5% (SD3.0, n = 16)	4.9% (SD5.5, n = 16)	4.5% (SD4.2, n = 23)	3.3% (SD4.0, n = 17)	3.5% (SD3.2, n = 10)
Average activity per area (n = 8)	4.8% (SD4.7)	2.1% (SD2.3)	0.9% (SD0.9)	1.9% (SD2.0)	2.6% (SD3.1)	3.4% (SD2.7)	2.1% (SD2.6)	1.3% (SD1.3)

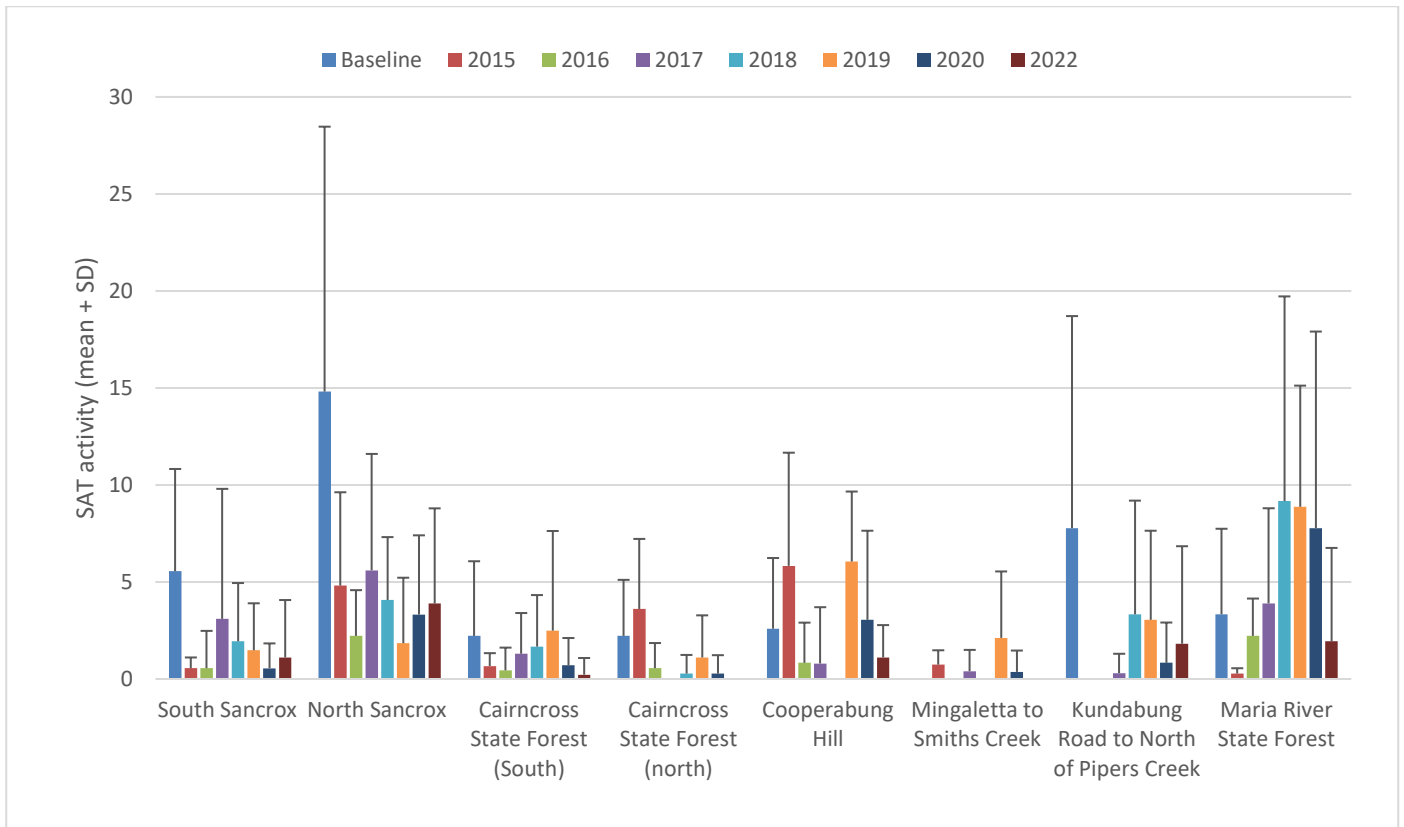
Area activity

Table 5 and Graph 3 show Koala activity at each of the eight monitoring areas. Area activity is the mean activity of all surveyed plots within the area. As for the 2018 and 2019 monitoring, SAT plot activity was highest at North Sancrox (3.9%), where scats were recorded at both of the two monitored clusters (two clusters were not monitored due to blocked access) and at three of the six SAT plots monitored.

To date, activity levels appear to fluctuate across the years within each monitoring area and a definitive increasing or decreasing activity trend within any one area is not apparent. Koala activity was recorded within six of the eight areas during the 2022 monitoring.

Table 5: Area activity levels

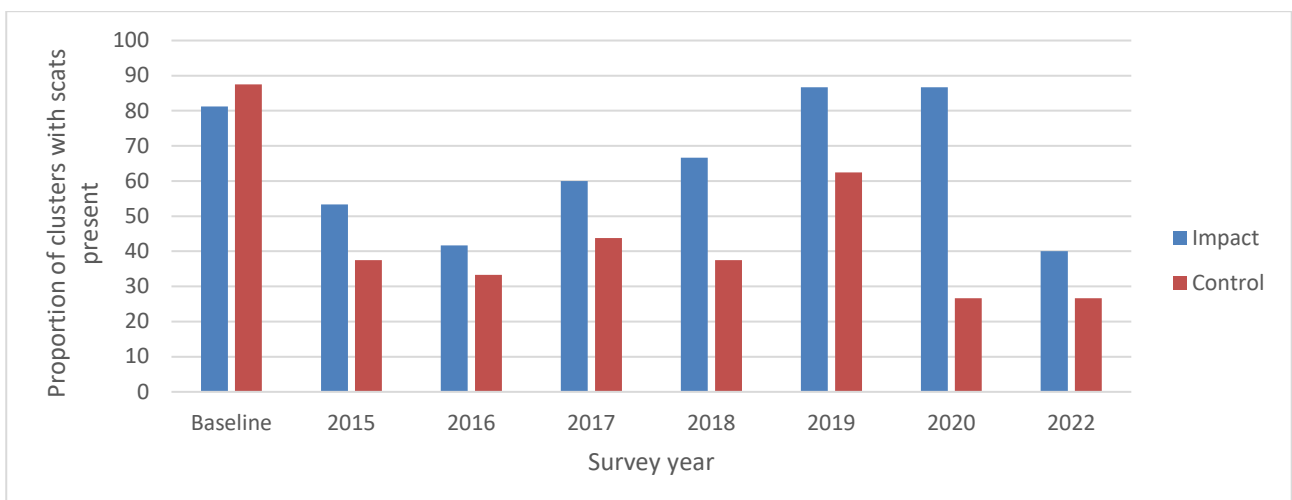
Monitoring area	Baseline	2015	2016	2017	2018	2019	2020	2022
South Sancrox	5.6% (SD5.3)	0.6% (SD1.3)	0.6% (SD1.9)	3.1% (SD6.7)	1.9% (SD3.0)	1.5% (SD2.4)	0.6% (SD1.3)	1.1% (SD3.0)
North Sancrox	14.8 (SD13.7)	4.8% (SD5.0)	2.2% (SD2.4)	5.6% (SD6.0)	4.1% (SD3.2)	1.8% (SD3.4)	3.3% (SD4.1)	3.9% (SD4.9)
Cairncross State Forest (South)	2.2% (SD3.8)	0.7% (SD1.9)	0.4% (SD1.2)	1.3% (SD2.1)	1.7% (SD2.7)	2.5% (SD5.1)	0.7% (SD1.4)	0.2% (SD0.9)
Cairncross State Forest (North)	2.2% (SD2.9)	3.6% (SD5.9)	0.6% (SD1.3)	0	0.3% (SD1.0)	1.1% (SD2.2)	0.3% (SD1.0)	0
Cooperabung Hill	2.6% (SD3.6)	5.8% (SD8.8)	0.8% (SD2.1)	0.8% (SD2.9)	0	6.1% (SD3.6)	3.1% (SD1.6)	1.1% (SD1.7)
Mingaletta to Smiths Creek	0	0.7% (SD2.2)	0	0.4% (SD1.1)	0	2.1% (3.4)	0.4% (SD1.1)	0
Kundabung Road to North of Pipers Creek	7.8% (SD10.9)	0	0	0.3% (SD1.0)	3.3% (SD5.9)	3.1% (SD4.6)	0.8% (SD2.1)	1.8% (SD5.0)
Maria River State Forest	3.3% (SD4.4)	0.3% (SD1.0)	2.2% (SD1.9)	3.9% (SD4.9)	9.2% (SD10.6)	8.9% (SD6.2)	7.8% (SD10.1)	1.9% (SD4.8)



Graph 3: Koala activity across the eight monitoring areas

3.2 Impact v Control Cluster Presence/Absence Analysis

A higher percentage of impact clusters had scats present than did control clusters during the 2022 monitoring period (40% cf 27%). This result is the same as that of the previous monitoring years (Graph 4). If we compare the Koala presence/absence results between control and impact clusters there is **no significant difference in Koala presence at impact and control clusters between the 2022 surveys and baseline, 2015, 2016, 2017, 2018, 2019 or 2020 surveys** ($\chi^2 = 0.112$, $df = 1$, $p > 0.05$; $\chi^2 = 0.854$, $df = 1$, $p > 0.003$; $\chi^2 = 0.656$, $df = 1$, $p > 0.05$; $\chi^2 = 0.795$, $df = 1$, $p > 0.05$; $\chi^2 = 0.588$, $df = 1$, $p > 0.05$; $\chi^2 = 0.814$, $df = 1$, $p > 0.05$; and $\chi^2 = 0.018$, $df = 1$, $p > 0.05$ respectively).

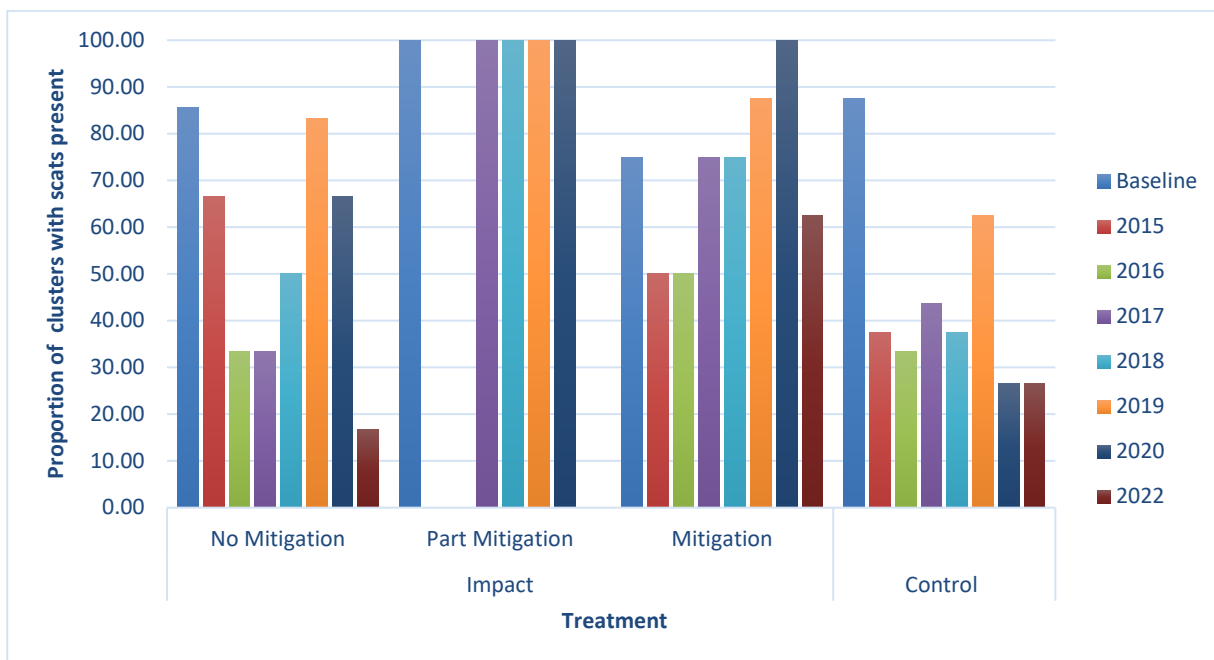


Graph 4: Koala presence at control and impact clusters

3.3 Mitigation v No Mitigation Analysis

3.3.1 Presence/absence analysis

Comparing Koala presence between mitigation and no-mitigation clusters shows **no significant difference between the 2022 surveys and baseline, 2015, 2016, 2017, 2018, 2019 or 2020 surveys** ($\chi^2 = 0.082$, $df = 1$, $p > 0.05$; $\chi^2 = 0.035$, $df = 1$, $p > 0.05$; $\chi^2 = 0.902$, $df = 1$, $p > 0.05$; $\chi^2 = 0.336$, $df = 1$, $p > 0.05$; $\chi^2 = 0.874$, $df = 1$, $p > 0.05$; $\chi^2 = 0.215$, $df = 1$, $p > 0.05$; and $\chi^2 = 0.858$, $df = 1$, $p > 0.05$, respectively). Graph 5 shows the percentage of clusters with scats present within different cluster types. There is no overall apparent trend between impact clusters with mitigation or without mitigation. While mitigation clusters appear to have a higher presence percentage in 2016, 2017, 2018, 2019, 2020 and 2022 than clusters with no mitigation, the presence percentage at clusters with no mitigation is similar to or greater than the presence percentage at control clusters during these years. This suggests that any difference is likely site specific and not necessarily related to construction activities.



Graph 5: Koala presence and cluster type

3.3.2 Treatment activity analysis

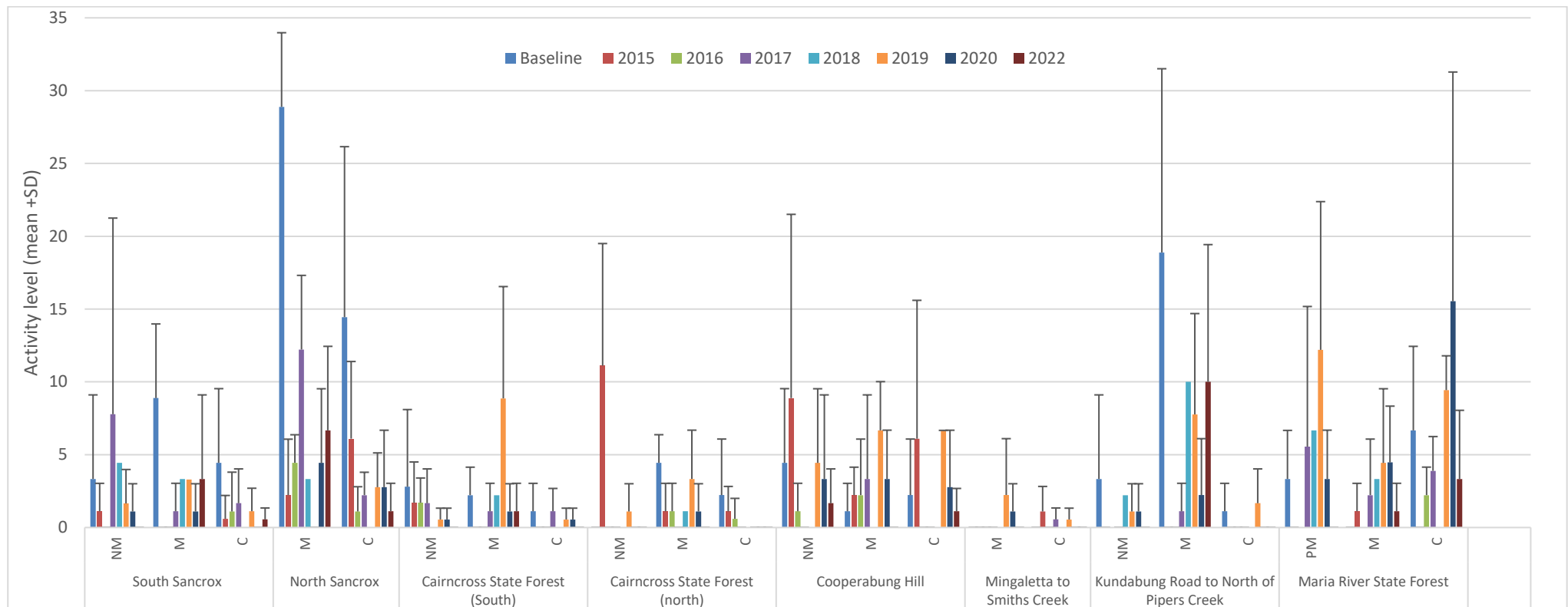
Koala activity (mean activity of plots) for the treatment types is provided in Table 6 and is shown for each area in Graph 6 (mean activity of all plots within each cluster type for each area). When considering all plots or active plots only (with scats present), average activity levels were lower than baseline levels for all treatment types. The 2022 monitoring plot activity levels were highest in clusters with mitigation and lowest in clusters with no mitigation. Lewis 2014 recommends that analyses should: “Ensure any future comparison of Koala activity levels take into account the following baseline data and with a 10% tolerance level to account for variability:

- Broader study area set at 5% activity;
- The three treatment classes of Mitigation set at 8.05%, control reference set at 4.03% and no mitigation set at 2.64%.”

When considering all plots or active plots only, activity levels for each treatment type have not decreased from the baseline surveys beyond the recommended 10% tolerance level. Nor is there a greater than 10% difference between treatment types.

Table 6: Control, mitigation and no mitigation mean plot activity levels (%)

	Control								Mitigation								No Mitigation							
	Base	2015	2016	2017	2018	2019	2020	2022	Base	2015	2016	2017	2018	2019	2020	2022	Base	2015	2016	2017	2018	2019	2020	2022
All plots (n = plots surveyed)	4.0 (24) (SD6.4)	1.9 (38) (SD4.5)	0.5 (45) (SD1.4)	1.2 (48) (SD2.1)	2.5 (48) (SD6.4)	2.8 (47) (SD4.1)	1.9 (44) (SD5.7)	0.8 (43) (SD2.7)	8.1 (24) (SD11.0)	0.8 (24) (SD1.8)	1.2 (19) (SD2.3)	2.6 (24) (SD4.7)	2.9 (24) (SD4.5)	4.7 (22) (SD5.0)	2.4 (24) (SD3.0)	2.6 (22) (SD4.7)	2.6 (24) (SD4.2)	3.5 (21) (SD6.6)	0.6 (18) (SD1.3)	2.4 (21) (SD6.2)	2.1 (21) (SD3.7)	3.2 (20) (SD5.7)	1.4 (21) (SD2.7)	0.2 (20) (SD0.7)
Active plots (n = active plots)	8.8 (11) (SD6.9)	9.0 (10) (SD5.9)	3.9 (6) (SD1.4)	4.4 (13) (SD1.6)	9.2 (13) (SD9.5)	6.8 (19) (SD3.6)	9.2 (9) (SD9.8)	5.6 (6) (SD5.4)	12.9 (15) (SD11.5)	4.0 (5) (SD1.5)	4.7 (5) (SD1.8)	7.9 (8) (SD5.0)	7.0 (10) (SD4.6)	7.9 (13) (SD4.0)	5.1 (11) (SD2.3)	8.1 (7) (SD5.0)	7.0 (9) (SD3.9)	9.2 (8) (SD8.1)	3.3 (3) (SD0.0)	12.5 (4) (SD9.2)	7.2 (6) (SD3.3)	7.0 (9) (SD6.8)	5.0 (6) (SD2.0)	3.3 (1) (SD0)



Graph 6. Mean Koala activity for cluster type within areas (mean ± SD)

NM = no mitigation; M = mitigation; C = control; PM = part mitigation.

3.4 Tree Species Use

A total of 2,550 trees were assessed across the 85 plots (30 at each plot). Koala scats were recorded at 28 (1.1%) of the trees surveyed. Surveyed trees included 28 different tree species (Table 7). The most commonly surveyed tree species were Tallowwood (*Eucalyptus microcorys*, 19.5%), Coastal Blackbutt (*E. pilularis*, 9.9%), Small-fruited Grey-Gum (*E. propinqua*, 8.9%), and Pink Bloodwood (*Corymbia intermedia*, 8.4%), together representing 51.0% of all trees surveyed. Koala scats were recorded at nine (32.1%) of the 28 different species (Table 7). Considering the percentage of individual tree species where scats were recorded, Koala scats were most commonly recorded beneath, Forest Red Gum (*E. tereticornis*, 25.0%, n = 4), Tallowwood (2.8%, n = 543) and White Stringybark (*E. globoidea*, 2.3% n = 132). Diameter at breast height for SCTs are provided in Annex 1.

The baseline study (Lewis 2014) suggests comparing activity levels at Tallowwood trees given that they are widespread, are frequently surveyed and yielded relatively high activity scores during baseline surveys (i.e. 9.5%). Use of Tallowwoods (percent of surveyed Tallowwoods with scats) was 2.68%, 0.75%, 4.7%, 5.3%, 6.6%, 4.8% and 2.8% in 2015, 2016, 2017, 2018, 2019, 2020, and 2022 respectively. As such, compared to the baseline surveys, activity at Tallowwood trees has been consistently lower. This reflects the overall lower activity levels observed since the baseline studies were undertaken.

It should be noted that interpretation of these data should be undertaken with caution, as it is unlikely to reflect the actual use of tree species by Koalas. The detectability of Koala scats is largely determined by the level of leaf litter and fallen bark around the base of trees. For example, species such as Sydney Blue Gums (*E. saligna*) and Flooded Gum (*E. grandis*) shed substantial amounts of bark in comparison to species such as Tallowwoods, resulting in dense, layered groundcover and leaf litter, amongst which scats are more difficult to find.

Table 7: Tree species surveyed – 2022 monitoring

Common name	Species name	Total surveyed	No. with scats	Percent use
Prickly-leaved Tea Tree	<i>Melaleuca styphelioides</i>	7		
Swamp Mahogany	<i>Eucalyptus robusta</i>	7		
Small-fruited Grey Gum	<i>Eucalyptus propinqua</i>	248	3	1.21
Coastal Blackbutt	<i>Eucalyptus pilularis</i>	276	1	0.36
Pink Bloodwood	<i>Corymbia intermedia</i>	234	1	0.43
Tallowwood	<i>Eucalyptus microcorys</i>	543	15	2.76
Forest Oak	<i>Allocasuarina torulosa</i>	20		
Grey Ironbark	<i>Eucalyptus siderophloia</i>	66		
Turpentine	<i>Syncarpia glomulifera</i>	205	1	0.49
White Stringy bark	<i>Eucalyptus globoidea</i>	132	3	2.27
White Mahogany	<i>Eucalyptus acmenoides</i>	49	1	2.04
Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>	9		
Thin-leaved Stringybark	<i>Eucalyptus eugenioides</i>	84		
Flooded Gum	<i>Eucalyptus grandis</i>	28		
Sydney Blue Gum	<i>Eucalyptus saligna</i>	63		
Forest Red Gum	<i>Eucalyptus tereticornis</i>	4	1	25.00
Thick-leaved Mahogany	<i>Eucalyptus carnea</i>	60		

Common name	Species name	Total surveyed	No. with scats	Percent use
Red Mahogany	<i>Eucalyptus resinifera</i>	75		
Red Bloodwood	<i>Corymbia gummifera</i>	167	2	1.20
Brush Box	<i>Lophostemon confertus</i>	38		
	<i>Allocasuarina littoralis</i>	10		
	<i>Melaleuca linariifolia</i>	24		
Scribbly Gum	<i>Eucalyptus haemostoma</i>	26		
Spotted Gum	<i>Corymbia maculata</i>	38		
Grey Ironbark	<i>Eucalyptus paniculata</i>	65		
	<i>Melaleuca sp.</i>	8		
Scribly Gum	<i>Eucalyptus signata</i>	44		
Swamp sheoak	<i>Casuarina glauca</i>	4		
Total		2550	28	

3.5 Weather Conditions

Weather conditions during the field surveys were generally warm to hot (maximum temperatures between 21.6 and 31.0 degrees) with a few light to heavy rainfall events (Port Macquarie weather station 060168, Table 8).

Table 8: Weather conditions - 2022 monitoring

Date	Rainfall (mm)	Temp (°C) (min)	Temp (°C) (max)	Wind speed at 9am (km/h)
9/12/2022	0	15.3	21.6	9
13/12/2022	7.2	10.4	24.6	15
15/12/2022	0	9.0	25.2	22
16/12/2022	0	12.8	21.8	19
6/1/2023	16.8	17.0	25.5	11
10/1/2023	0	13.6	27.4	20
11/1/2023	0	16.5	28.0	17
12/1/2023	0	18.1	26.8	2
13/2/2023	0	21.2	27.9	15
15/2/2023	0	16.7	26.4	9
20/2/2023	0	16.9	29.5	13
21/2/2023	0	19.1	28.8	6
22/2/2023	0	15.7	28.6	13
23/2/2023	58.6	17.8	25.5	20
27/2/2023	0	19.0	31.0	7
28/2/2023	3	17.1	29.0	9
2/3/2023	0	20.8	28.1	15

3.6 Road Kill

There were no Koala road kill records in 2022/2023. One Koala was identified as road kill in October 2020, within a partially fenced area of the highway on the northbound left lane near Barry’s Creek. TfNSW inspected the area of the Koala road strike within days to review the fencing integrity. Minor tree limbs were removed from fauna fencing in the general area, but it was considered unlikely that these provided a potential access point. No holes or issues with the fencing were identified during the inspection. The individual likely entered the motorway from the unfenced intersection at Mingaletta Road or fallen tree limbs on the fauna fence near the U-turn bay at Barry’s Creek, crossed from the southbound lane to the northbound land where it was hit.

Lewis 2014 notes that “During the current baseline survey only one individual was recorded during the weekly surveys performed in October and January/February. Ad hoc monitoring which spanned a 7 month period revealed additional road killed individuals but was consistent with Koala being struck every 6-8 weeks during the breeding period”. As per recommendations with the baseline report, the baseline road kill has therefore been set to 1 individual every 8 weeks. Table 9 lists the Koala road kill for the Project recorded during road kill surveys for the Project and any additional records. There rate has not exceeded baseline rate however, in accordance with the performance measures, when considering a proportional reduction in Koala activity of 62% (from 5% to 1.9%) the adjusted road kill rate to reflect the reduced activity would be 1 Koala every 21 weeks. The 2022 Koala road kill rate has not exceeded the adjusted rate.

Table 9: Koala road kill records

Monitoring	Period	Date	Easting	Northing	Notes	Survey wks
Baseline*	2013-2014	4/10/2013	482178	6540579	Where the Project passes through Ballengarra State Forest	12
Clearing	2014-2015	17/11/2014	483187	6544354	Adult female struck on Tuesday/Wednesday (11/12th Nov)	35
		17/11/2014	483187	6544354	Young struck on Tuesday/Wednesday (11/12th Nov)	
		3/12/2014			300 m North of Yarrabee Rd	
		21/7/2015			200 m North of Yarrabee Rd	
Construction	2015-2016	22/12/2015			1 km north of Ravenswood Rd	50
Construction	2016-2017	5/10/2016	483413	6555959	Adolescent	49
		12/10/2016	482816	6553852	Adolescent	
Construction	2017-2018	Nil				14
Operational	2018-2019	17/9/2018			Young male. Barry’s Creek	12
Operational	2019-2020	Nil				12
Operational	2020-2021	Oct 2020			Barry’s Creek	12

* = An additional three Koala road kill were recorded between August 2013 and February 2014, outside of the monitoring period

3.7 Additional Survey Results

3.7.1 Spotlighting

Spotlighting surveys commenced in October 2019 and were again completed in November 2020 and November 2022 for the current monitoring period. Table 10 summarises the survey results to date. To date, only one Koala has been observed at the Cairncross impact and the Maria River control site (Figure 2) during the 2019 and 2020 monitoring, respectively.

As per the EMP, a detection frequency rate of 1 Koala/spotlight hour is considered as the baseline target density. To date baseline density has been recorded only at the Cairncross impact and Maria River control sites. Scats have also been recorded in these areas during SAT plot monitoring.

Koala presence at the Ballengarra and Maria River impact sites has been previously demonstrated via SAT plot monitoring at the nearest SAT plot clusters to these spotlighting transects. The absence of Koala observations during spotlighting surveys at the Ballengarra and Cairncross control sites is consistent with the predominantly absent records during SAT plot monitoring at the nearest clusters to these transects.

Table 10: 2022 spotlighting surveys results

Site	Survey#	# Koala 2019	# Koala 2020	# Koala 2022	Note
Ballengarra SF impact	1	0	0	0	
Ballengarra SF control	1	0	0	0	
Cairncross SF impact	1	0	0	0	
Cairncross SF control	1	0	0	0	
Maria River SF impact	1	0	0	0	
Maria River SF control	1	0	0	0	
Ballengarra SF impact	2	Not surveyed- fire	0	0	
Ballengarra SF control	2	Not surveyed- fire	0	0	
Cairncross SF impact	2	1	0	0	Observed
Cairncross SF control	2	0	0	0	
Maria River SF impact	2	Not surveyed- fire	0	0	
Maria River SF control	2	Not surveyed- fire	0	0	
Ballengarra SF impact	3	Not surveyed- fire	0	0	
Ballengarra SF control	3	Not surveyed- fire	0	0	
Cairncross SF impact	3	0	0	0	
Cairncross SF control	3	0	0	0	
Maria River SF impact	3	Not surveyed- fire	0	0	
Maria River SF control	3	Not surveyed- fire	1	0	Observed

3.7.2 Additional Koala records

Additional records of Koala presence have been obtained during surveys undertaken for other monitoring components of the Project. These records are summarised below and in Table 11. All occur in areas where Koalas were detected during SAT surveys.

Fauna underpass monitoring

There are a number of culverts and bridges along the length of the Project that may provide passage for Koalas (Figure 2). Fourteen of these are being monitored as part of the Fauna Underpass Monitoring component of the Project. Koalas have been photographed on remote cameras using four of the fauna underpasses to date and these are shown on Figure 2 (Niche 2019b, Niche 2021b).

Yellow-bellied Glider monitoring

A Koala was observed during spotlighting surveys undertaken as part of the Yellow-bellied Glider monitoring component of the Project within the Cairncross State Forest impact site (Figure 2) (Niche 2019c).

Spotted-tailed Quoll monitoring

Koalas have been photographed on remote cameras as part of the Spotted-tailed Quoll monitoring component of the Project within Cairncross State Forest, Ballengarra State Forest, and Maria River (Figure 2) (Niche 2018b and Niche 2020b).

Table 11: Additional Koala records

Monitoring type	Monitoring-specific site name	Date
Underpass	F9.70	16/12/2018
Underpass	F11.67	24/11/2018
Underpass	F33.40	23/11/2018
Yellow-bellied Glider	Cairncross SF impact	27/11/2018
Spotted-tailed Quoll	MM1B	Winter 2018
Spotted-tailed Quoll	MNM1D	Winter 2018
Spotted-tailed Quoll	MREF2D	Winter 2018
Spotted-tailed Quoll	BNM2B	Winter 2018
Spotted-tailed Quoll	BM1C	Winter 2018
Spotted-tailed Quoll	BM1A	Winter 2020
Spotted-tailed Quoll	CREF1B	Winter 2020
Spotted-tailed Quoll	MREF1A	Winter 2020
Underpass	C32.35	29/11/2020

3.8 NSW BioNet Wildlife Atlas

3.8.3 Distribution analysis

A total of 1611 Koala records within a 10 km buffer of the study area were reported as part of the baseline monitoring in 2014. The majority of these records (i.e. 1249 or 77%) were recorded between 2004-2014. In the current study, a total of 4808 Koala records occurred within 10 km buffer of the study area between

2004-2014 (inclusive), and 9087 Koala records occurred within 10 km buffer of the study area between 2014-2022 (inclusive). Records are shown in Figure 3.

Koala records from both periods are broadly distributed throughout the study area with a distinct clustering of records in the south-eastern precinct, which includes Port Macquarie, Lake Innes and Thrumster areas (Figure 3). A cluster of records between 2014-2022 is also evident to the west of Kundabung within Ballengarra State Forest (E1 and F1-F3). Records are consistently distributed throughout the Project corridor, concentrated in vegetated land parcels that the Project corridor bisects. A notable increase in post-construction records can be noted in the western portion of the study area around Cooperbung Hill and Mingaletta to Smiths Creek (grids E1, F1, F2 and F3).

There has not been a notable alteration in Koala record distribution pre and post construction.

3.8.4 Density analysis

As per the baseline analysis, a grid-based analysis of record density was used to assess density. Koala density for the pre-construction and post-construction periods are presented in Table 12 and Graph 7.

Koala record density has increased post-construction in 62% (36/58) of grids, with 33% (19/58) of grids decreasing in density (and 5% (3/58) showing no change in density (Graph 8)). Those grids with a decrease in record density consist of four of the 11 grids (36%) traversed by the Project, six of the 24 grids (25%) adjacent to the Project and nine of the 23 grids (39%) further from the Project.

Grids traversed by the Project corridor have the lowest Koala density, and grids adjacent to the Project corridor have the highest Koala density in both the pre-construction and post-construction periods (Graph 9). Average record density has increased for each group of grids post construction.

When considering mitigation treatments within grids that are intersected by the Project corridor, grids that feature a mix of mitigation and no mitigation sites had the highest pre-construction density and grids that feature either only mitigation or no mitigation sites had a similar density (Graph 10). Conversely, post-construction density was highest in grids that feature only mitigation sites and lowest in grids that contained no mitigation sites. All grids that feature mitigation sites increased in density post-construction, whereas 40% of grids that feature a mix of mitigation and no mitigation sites decreased in density post-construction and 50% of grids that feature no mitigation sites decreased in density post-construction (Graph 11).

The highest density of Koala records (pre and post-construction) occurs in the south-eastern portion of the study area in the vicinity of Port Macquarie (Figure 3).

Pre-construction records were highest in grid J4 (1034), followed by grid J5 (994) and grid K5 (846). The density within these grids has increased post-construction with the highest density and second greatest post construction increase in grid J5 (+449 to 1443), the second highest density and greatest post construction increase in grid K5 (+469 to 1315) and the third highest density and 6th greatest post construction increase in grid J4 (+254 to 1288). These results support the conclusions of the baseline report that these grids are likely to support high densities of Koala.

The neighbouring grids of K3 and K4 in the Lake Innes and Thrumster area recorded 158 and 378 pre-construction records respectively. Grid K3 features both mitigation and no mitigation sites for North and South Sancrox, while grid K4 features control sites for North Sancrox. While the number of records within grid K4 more than doubled post-construction (775), the greatest post-construction decrease in Koala density was observed in grid K3 (-59 from 158 to 99) which forms the southern extent of the Project

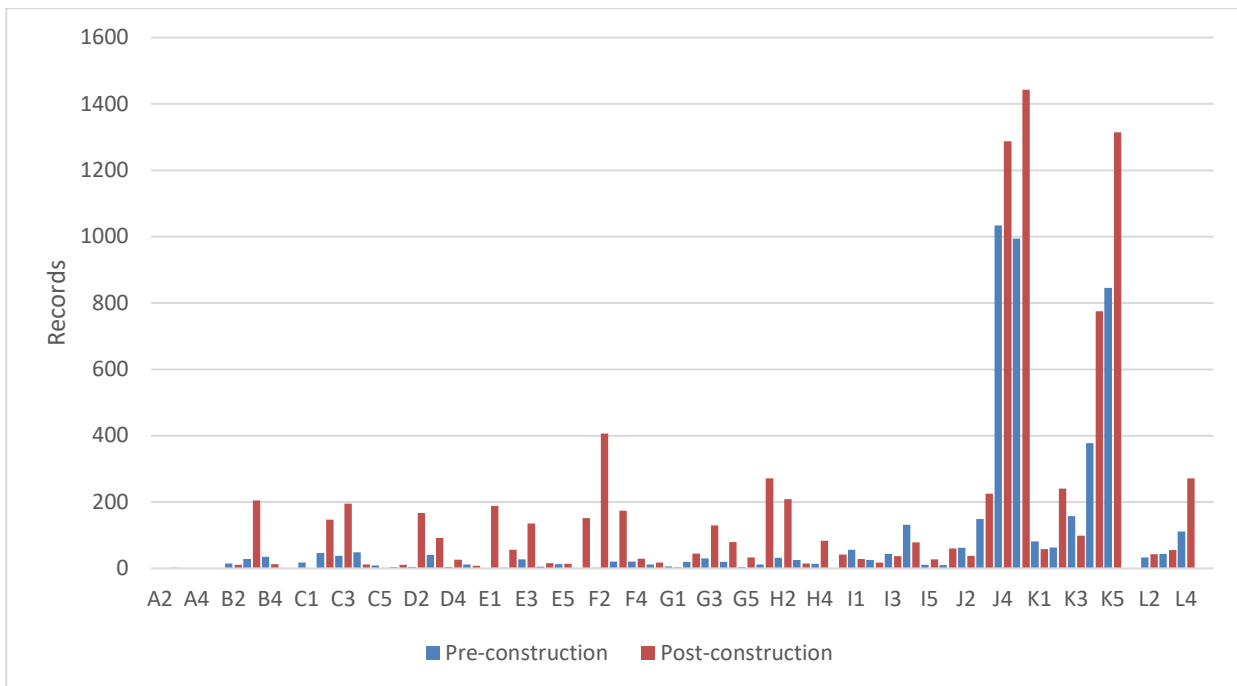
corridor. These results support the conclusions of the baseline report that these areas are likely to support medium to high densities of Koala.

Grid J3, which includes the Project corridor between Cairncross State Forest (south) and North Sancro and features both mitigation and no mitigation sites recorded the 6th highest pre-construction density with 149, and 9th highest post-construction density with 225. Grid I1 which features control sites for Cairncross State Forest (north) returned 132 pre-construction Koala records and saw the second greatest post-construction decrease in Koala density (-54 from 132 to 78). These results support the conclusions of the baseline report that these areas are likely to support medium densities of Koala.

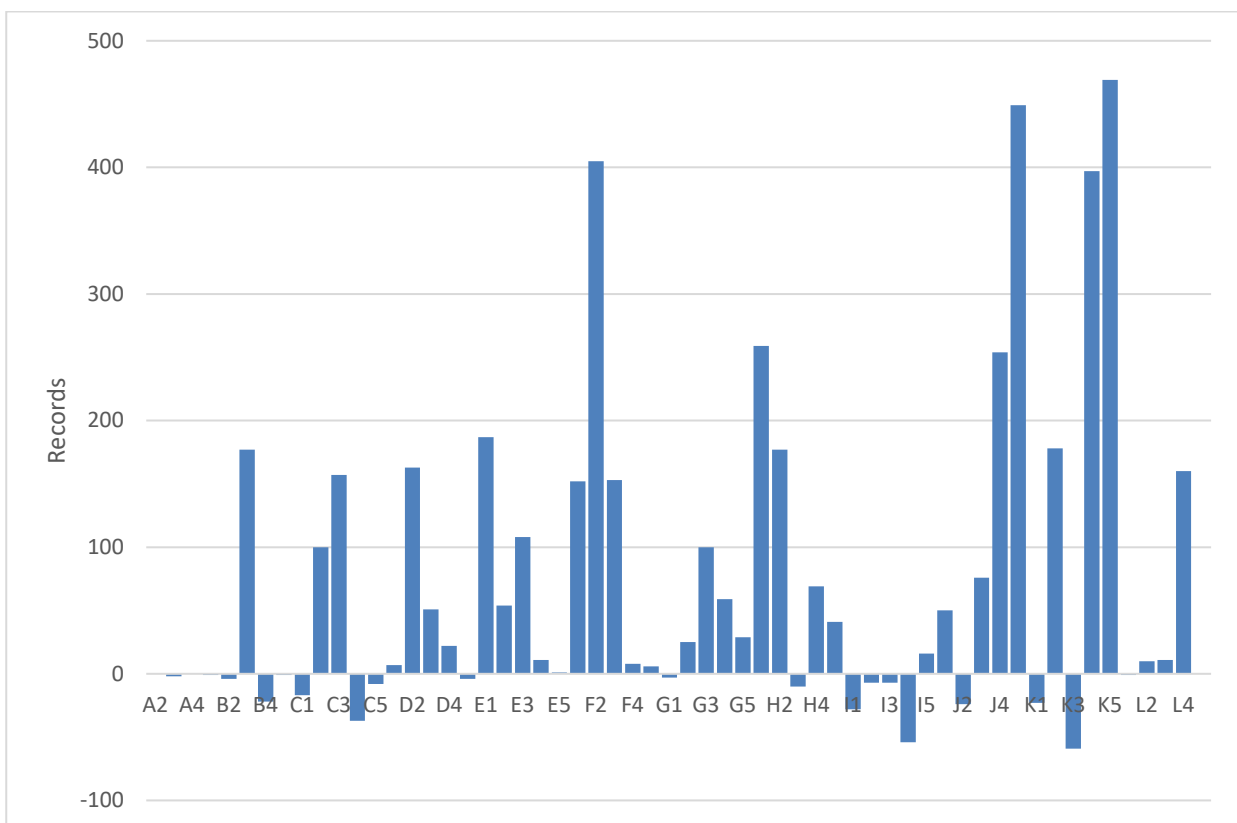
The majority of grids returned >10 records. 64% (37/58) of grids have >10 records both pre and post-construction, with 67% (39/58) of grids returning >10 pre-construction records, and 81% of grids returning >10 post-construction records.

Table 12: Koala density pre-construction and post-construction

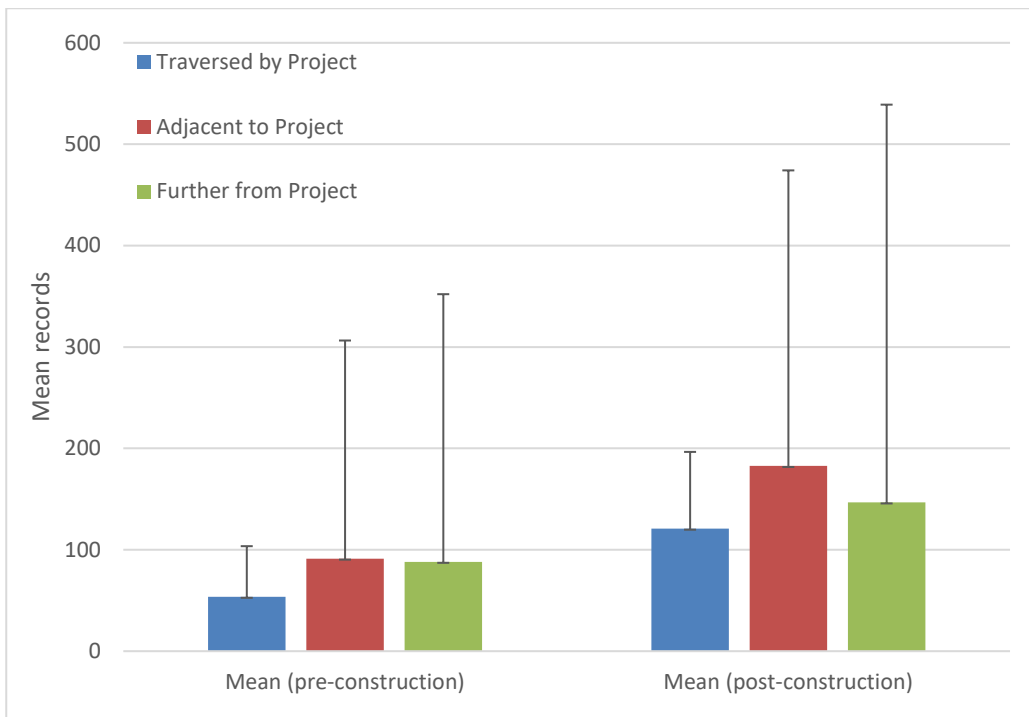
Grids traversed by Project (n = 11)		Grids adjacent to Project (n = 24)		Grids further from Project (n = 23)	
Grid	Pre-construction/post-construction (difference)	Grid	Pre-construction/post-construction (difference)	Grid	Pre-construction/post-construction (difference)
C3*	38/195 (+157)	B2	15/11 (-4)	A2	0/0 (no change)
D3^	41/92 (+51)	B3	28/205 (+177)	A3	2/0 (-2)
E3	27/135 (+108)	B4	35/13 (-22)	A4	0/0 (no change)
F3*	21/174 (+153)	C2	47/147 (+100)	B1	1/0 (-1)
G3^	30/130 (+100)	C4	49/12 (-37)	B5	1/0 (-1)
H2	32/209 (+177)	D2	4/167 (+163)	C1	18/1 (-17)
H3	25/15 (-10)	D4	4/26 (+22)	C5	9/1 (-8)
I2	25/18 (-7)	E2	2/56 (+54)	D1	4/11 (+7)
I3^	44/37 (-7)	E4	5/16 (+11)	D5	12/8 (-4)
J3^	149/225 (+76)	F2	2/407 (+405)	E1	1/188 (+187)
K3^	158/99 (-59)	F4	21/29 (+8)	E5	13/14 (+1)
		G2	20/45 (+25)	F1	0/152 (+152)
		G4	20/79 (+59)	F5	12/18 (+6)
		H1	12/271 (+259)	G1	6/3 (-3)
		H4	14/83 (+69)	G5	4/33 (+29)
		I1	56/28 (-28)	H5	1/42 (+41)
		I4	132/78 (-54)	I5	11/27 (+16)
		J2	62/38 (-24)	J1	10/60 (+50)
		J4	1034/1288 (+254)	J5	994/1443 (+449)
		K2	63/241 (+178)	K1	81/58 (-23)
		K4	378/775 (+397)	K5	846/1315 (+469)
		L2	33/43 (+10)	L1	1/0 (-1)
		L3	44/55 (+11)	L5	0/0 (no change)
		L4	111/271 (+160)		



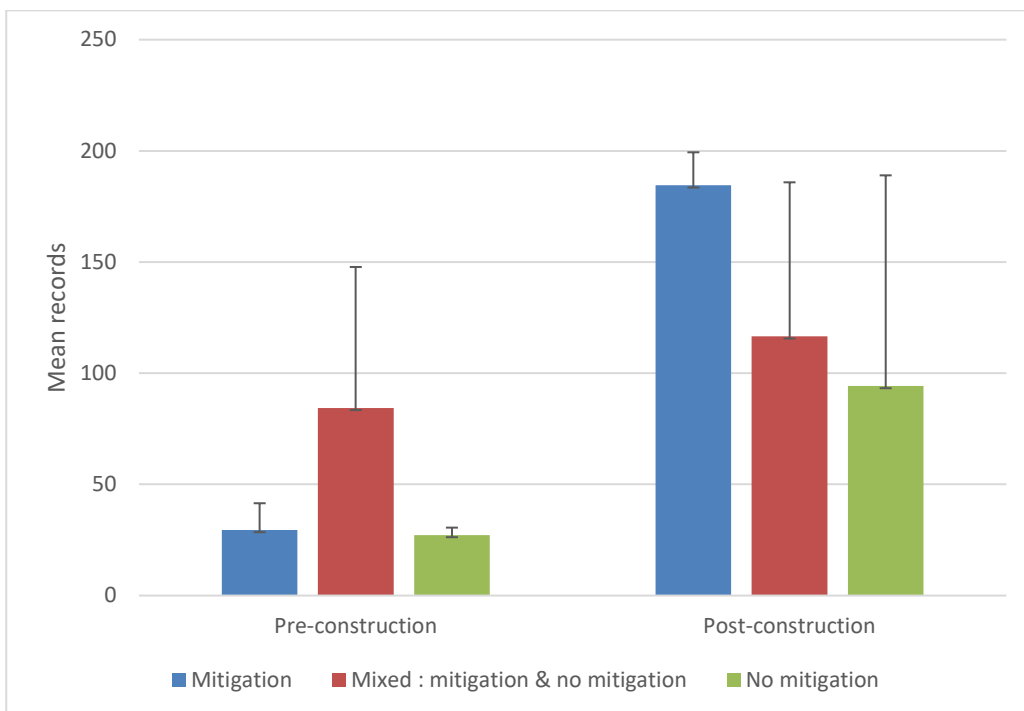
Graph 7: Koala density pre-construction and post-construction



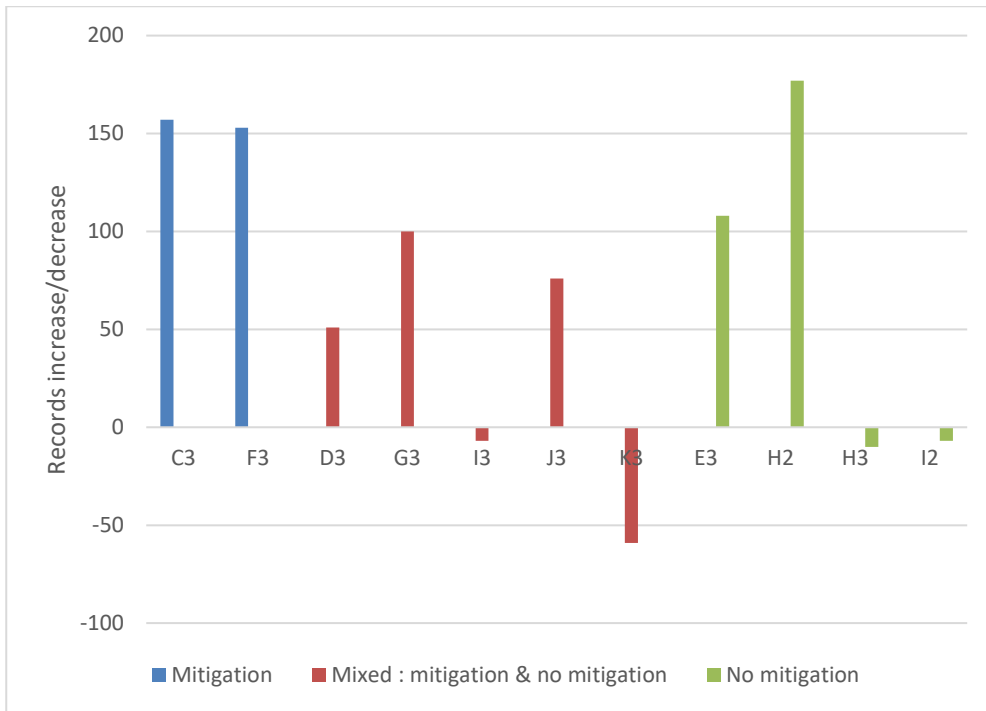
Graph 8: Koala record density increase/decrease post-construction



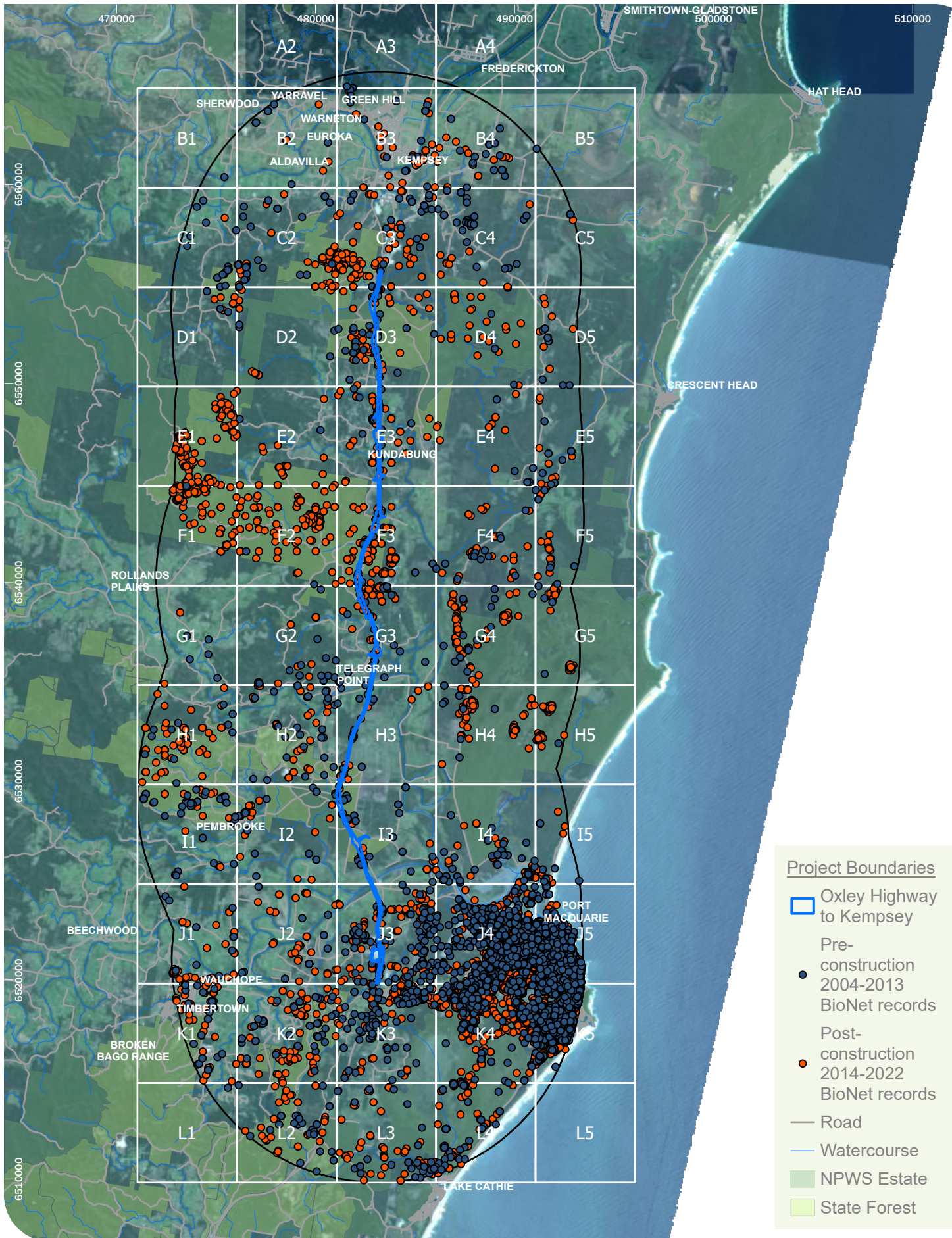
Graph 9: Koala density at different distances from the Project



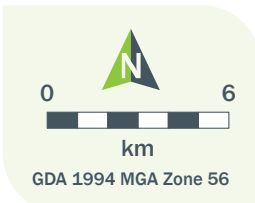
Graph 10: Koala density pre-construction and post-construction in grids traversed by the Project



Graph 11: Increase/decrease in Koala density post-construction in grids traversed by the Project



Drawn by: File: T:\spatial\project\1700\1702_0\H2K_Ecology\Maps\P1_5_Ecology_OH2K\P1_51_Koala_SAT2022\1702_P151_Koala_SAT.aprx Last updated: 8/25/2023 5:09 PM



BioNet Koala records distribution and density
 Koala Monitoring: Pacific Highway Upgrade - Oxley Highway to Kempsey

Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 P15.1
 Client: Roads and Maritime Services

Figure 3

4. Discussion

4.1 Performance Measures

A discussion of the 2022 survey results in relation to the performance measures is provided in Table 13.

Table 13: Performance measures

Performance measure	Response
Monitoring is undertaken during baseline surveys and from Year 1 – Year 6 & 8, or until mitigation measures are demonstrated to be effective.	This performance measure has been met. To date, SAT plot monitoring has been undertaken during baseline, Year 1 (2015), Year 2 (2016), Year 3 (2017), Year 4 (2018), Year 5 (2019), Year 6 (2020) and Year 8 (2022) of the Project.
Monitoring during Year 1 – Year 6 & 8 is undertaken at the Impact and Control sites where monitoring was undertaken during baseline surveys, subject to ongoing landowner agreement. Where landowner agreement cannot be obtained and the process in Section 3.1.2 of the EMP has been followed, this performance indicator will also be considered to have been met.	This performance measure has been met. Monitoring was undertaken at the same sites as surveyed in baseline surveys where access was possible. In 2015, eight of the baseline plots had to be relocated to nearby locations because they had been established in the construction site itself or because they were located on private property and access was not possible. Also, three of the baseline monitoring plots that could not be accessed could not be relocated because there weren't any suitable sites nearby. These three plots were all part of the same cluster (impact, no mitigation) located in the North Sancrox area. Details of all 96 monitoring plots are presented in Table 1 and the location of the 93 accessible monitoring plots are shown in Figure 1.
Mitigation measures are demonstrated to be effective as defined in the EPBC approval when all monitoring events are considered at Year 8.	This performance measure has been met. A summary of the efficacy of the mitigation measures to date in relation to treatment Type A: impact with mitigation (sufficiently large culverts and floppy top fencing), indicates: <ul style="list-style-type: none"> • Four of the 14 monitored culverts have recorded use by the Koala (Figure 2) • Since commencement of construction, nine Koalas have been recorded as road kill, four during clearing (2014-2015), three during construction (2015-2018) and two during operation (2018-current). The last construction Koala road kill occurred in October 2016, year 2 of the Project (Niche 2018c). The Project became operational in year 4, March 2018 and in September 2018 and October 2020 two separate Koala road kill events have occurred at Barry's Creek, between clusters MING1 and COOP2, with no recent records. In addition, areas of the Project where mitigation was implemented have all increased in Koala record density post construction.
Fauna fence is installed at a minimum in areas identified in Schedule 3 of the EPBC approval at Year 4.	This performance measure has been met. TfNSW have advised that fauna fencing is complete in all areas in accordance with Condition 3c and Schedule 3 of EPBC Approval 2012/6518.
Density: Koala spotlighting records are compared to and discussed with reference to the baseline records, with the baseline detection frequency rate of 1 Koala per spotlight hour considered as the baseline density, as recommended in the baseline report. Compare the NSW BioNet wildlife Atlas density ranking of 5 km ² grids, as per the baseline report, between pre and post-construction at Year 8.	<i>Spotlighting</i> This performance measure has been met at two sites to date: the Cairncross State Forest impact site and Maria River State Forest control site. While Koalas have not been detected during spotlighting surveys at the Maria River and Ballengarra impact sites, their presence has been previously demonstrated via SAT plot monitoring at the nearest SAT plot clusters to these spotlighting transects. <i>BioNet Atlas analysis</i> This performance measure has been met. Grids traversed by the Project corridor have the lowest Koala density, and grids adjacent to the Project corridor have the highest Koala density in both the pre-construction and post-construction periods. Average record density has increased for each group of grids post construction.

Performance measure	Response
<p>Movement: Reduction in Koala road kill compared to the baseline of 1 Koala road kill per 8 weeks for an average baseline plot activity level of 5%, whereby proportional changes in average plot activity level may be reflected in the acceptable level of koala road kill.</p>	<p>This performance measure has been met in 2022. There were no Koala road kill records during 2022/2023 monitoring.</p>
<p>Distribution: Compare the number of records and clustering of records, as per the baseline report, between pre-construction and construction/post-construction at year 8.</p>	<p>This performance measure has been met. The average density of records has increased in all areas and there has not been a notable alteration in Koala record distribution pre and post-construction.</p>
<p>Habitat Use: Koala SAT activity levels will be compared to the baseline activity levels data (below) with a 10% tolerance level, as recommended in the baseline report, to account for variability:</p> <ul style="list-style-type: none"> • Broader study area set at 5% activity; • The treatment classes of mitigation set at 8.05%, no mitigation set at 2.64% and control / reference set at 4.03% • Comparison of percent tree use with baseline tree use. 	<p>This performance measure has been met.</p> <p>When considering all plots or active plots only, activity levels for each treatment type have not decreased from the baseline surveys beyond the recommended 10% tolerance level (4.9% to 1.1% and 10.1% to 6.7%). Nor is there a greater than 10% difference between treatment type (8.05% to 2.6%; 2.64% to 0.2% and 4.0% to 0.8%, for all plots).</p> <p>Use of Tallowwoods (percent of surveyed Tallowwoods with scats) was 2.68%, 0.75%, 4.7%, 5.3%, 6.6%, 4.8% and 2.8% in 2015, 2016, 2017, 2018, 2019, 2020, and 2022 respectively. As such, compared to the baseline surveys (9.5%), per cent use of Tallowwood trees has been consistently lower. This reflects the overall lower activity levels observed since the baseline studies were undertaken.</p>

All performance measures have been met.

5. Recommendations

5.1 Contingency Measures and Recommendations

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered to be relevant to the Koala monitoring program are listed and discussed in Table 14. No additional mitigation actions are considered necessary based on the following:

- No significant changes from baseline surveys have been detected to date
- No significant change in the difference in activity between impact and control sites to date
- Koalas have been detected using four of the dedicated fauna underpasses within the Project area
- Average Koala record density has increased.

Table 14: Contingency measures

Potential problem	Contingency measure proposed in EMP	Discussion of proposed measure
Decline in presence of target species recorded at Impact sites after the upgrade has been completed, when compared to change in Control sites.	<ul style="list-style-type: none"> • Investigate cause of decline in consultation with EPA and DoTE within two weeks of results reported by ecologist. • If the cause of the decline is considered most likely attributable to the upgrade of the highway, mitigation measures will be reviewed within two months of the above consultation. 	<p>This contingency measure is not considered relevant.</p> <p>No significant change has been detected in the difference in Koala presence at control and impact sites between baseline and subsequent monitoring events.</p>
Increase in road kill rate from baseline rates when considering 62% proportional decrease in Koala activity level	<ul style="list-style-type: none"> • Commence review/modification of fauna exclusion fencing design, location or extent depending on species struck by vehicles within two weeks of results reported by ecologist. • Inspect fence for breaches and inform maintenance as necessary within two weeks of results reported by ecologist. • Any damage to fauna fencing will be temporarily repaired within one week of a breach being identified. • Permanent repair to occur as soon as possible and within two months of the breach being identified. 	<p>This contingency measure is not considered relevant.</p> <p>There were no Koala road kill records during 2022/2023 monitoring.</p>

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Annex 1. Koala SAT results – 2022 monitoring

SCT = selection criteria tree; DBH = diameter at breast height in centimetres (cm); Radial = radial distance of search area from SCT in metres (m).

Monitoring Area	Treatment	Sub-category	Site_ID	Map ref	Activity	SCT	DBH (cm)	Radial (m)	2022 note
South Sancrox	Impact	No Mitigation	SANCROX E1	SSAN1	0.0	Tallowwood	45	28	
South Sancrox	Impact	No Mitigation	SANCROX E2		0.0	Tallowwood (not tagged)	60	20	
South Sancrox	Impact	No Mitigation	SANCROX E3		0.0	Tallowwood	48	30	
South Sancrox	Impact	Mitigation	SANCROX S1	SSAN2	0.0	Blackbutt	53	20	
South Sancrox	Impact	Mitigation	SANCROX S2		10.0	Thin-leaved Stringybark	56	20	
South Sancrox	Impact	Mitigation	SANCROX S3		0.0	Flooded Gum (noy tagged)	57	25	
South Sancrox	Control	Control	COWARRA SF1	SSAN3	0.0	Small-fruited Grey Gum (tag hacked off)	45	20	
South Sancrox	Control	Control	COWARRA SF2		0.0	Blackbutt	135	20	
South Sancrox	Control	Control	COWARRA SF3		0.0	Small-fruited Grey Gum	35	15	
South Sancrox	Control	New Control	SAT COWARRA NC1	SSAN4	3.3	Blackbutt	80	20	
South Sancrox	Control	New Control	SAT COWARRA NC2		0.0	<i>E. carnea</i>	37	20	
South Sancrox	Control	New Control	SAT COWARRA NC3		0.0	Blackbutt	39	25	
North Sancrox	Impact	No Mitigation	SANCROX N1						
North Sancrox	Impact	No Mitigation	SANCROX N2						
North Sancrox	Impact	No Mitigation	SANCROX N3						
North Sancrox	Impact	Mitigation	FERNBANK CK1	NSAN1	10.0	Tallowwood	75	25	
North Sancrox	Impact	Mitigation	FERNBANK CK2		10.0	Tallowwood	40	25	
North Sancrox	Impact	Mitigation	FERNBANK CK3		0.0	Tallowwood	50	20	
North Sancrox	Control	Control	LAKE INNES1	NSAN2		Tallowwood (not tagged)			
North Sancrox	Control	Control	LAKE INNES2			Swamp Mahogany			
North Sancrox	Control	Control	LAKE INNES3			Swamp Mahogany			
North Sancrox	Control	New Control	SAT COW4	NSAN3	0.0	Blackbutt	70	25	
North Sancrox	Control	New Control	SAT COW5		0.0	Small-fruited Grey Gum	25	25	
North Sancrox	Control	New Control	SAT COW6		3.3	<i>E. acmenoides</i>	36	25	

Monitoring Area	Treatment	Sub-category	Site_ID	Map ref	Activity	SCT	DBH (cm)	Radial (m)	2022 note
Cairncross State Forest (South)	Impact	No Mitigation	CAINCROSS SF1	CCS1	0.0	Tallowwood	36	20	
Cairncross State Forest (South)	Impact	No Mitigation	CAINCROSS SF2		0.0	Tallowwood	50	20	
Cairncross State Forest (South)	Impact	No Mitigation	CAINCROSS SF3		0.0	Tallowwood	50	20	
Cairncross State Forest (south)	Impact	No Mitigation	CAINCROSS SF16	CCS2	0.0	Tallowwood	50	18	
Cairncross State Forest (south)	Impact	No Mitigation	CAINCROSS SF17		0.0	Tallowwood	36	15	
Cairncross State Forest (south)	Impact	No Mitigation	CAINCROSS SF18		0.0	Tallowwood (not tagged)	100	26	
Cairncross State Forest (South)	Impact	Mitigation	CAINCROSS SF4	CCS3	3.3	Tallowwood	60	20	
Cairncross State Forest (South)	Impact	Mitigation	CAINCROSS SF5		0.0	Tallowwood	70	18	
Cairncross State Forest (South)	Impact	Mitigation	CAINCROSS SF6		0.0	Blackbutt	80	20	
Cairncross State Forest (South)	Control	Control	LIMEBURNERS CK1	CCS4	0.0	Scribbly Gum (not tagged)	45	25	
Cairncross State Forest (South)	Control	Control	LIMEBURNERS CK2		0.0	Scribbly Gum (not tagged)	180	30	
Cairncross State Forest (South)	Control	Control	LIMEBURNERS CK3		0.0	Scribbly Gum (not tagged)	50	25	
Cairncross State Forest (South)	Control	New Control	SAT PEVI1	CCS5	0.0	Sydney Blue Gum	55	20	
Cairncross State Forest (South)	Control	New Control	SAT PEVI2		0.0	Sydney Blue Gum	55	18	
Cairncross State Forest (South)	Control	New Control	SAT PEVI3		0.0	Sydney Blue Gum		15	
Cairncross State Forest (north)	Impact	No Mitigation	CAINCROSS SF7	CCN1	0.0	Blackbutt	80	20	
Cairncross State Forest (north)	Impact	No Mitigation	CAINCROSS SF8		0.0	Forest Red Gum	50	20	
Cairncross State Forest (north)	Impact	No Mitigation	CAINCROSS SF9		0.0	Blackbutt	75	25	
Cairncross State Forest (north)	Impact	Mitigation	CAINCROSS SF10	CCN2	0.0	Swamp Mahogany	35	20	
Cairncross State Forest (north)	Impact	Mitigation	CAINCROSS SF11		0.0	Tallowwood	60	20	
Cairncross State Forest (north)	Impact	Mitigation	CAINCROSS SF12		0.0	Tallowwood	75	15	
Cairncross State Forest (north)	Control	Control	CAINCROSS SF13	CCN3	0.0	Small-fruited Grey Gum	42	20	
Cairncross State Forest (north)	Control	Control	CAINCROSS SF14		0.0	Sydney Blue Gum	35	20	
Cairncross State Forest (north)	Control	Control	CAINCROSS SF15		0.0	Sydney Blue Gum (not tagged)	85	20	
Cairncross State Forest (north)	Control	New Control	SAT RR1	CCN4	0.0	Tallowwood	45	20	
Cairncross State Forest (north)	Control	New Control	SAT RR2		0.0	Small-fruited Grey Gum	57	20	
Cairncross State Forest (north)	Control	New Control	SAT RR3		0.0	Tallowwood	56	20	

Monitoring Area	Treatment	Sub-category	Site_ID	Map ref	Activity	SCT	DBH (cm)	Radial (m)	2022 note
Cooperabung Hill	Impact	No Mitigation	COOPERABUNG1	COOP1		Tallowwood			No Access-landholder no contact
Cooperabung Hill	Impact	No Mitigation	COOPERABUNG2		0.0	Small-fruited Grey Gum	55	30	
Cooperabung Hill	Impact	No Mitigation	COOPERABUNG3		3.3	Tallowwood	55	25	
Cooperabung Hill	Impact	Mitigation	COOPERABUNG4	COOP2	0.0	Tallowwood	33	20	
Cooperabung Hill	Impact	Mitigation	COOPERABUNG5		0.0	Tallowwood	24	18	
Cooperabung Hill	Impact	Mitigation	COOPERABUNG6		0.0	Tallowwood	67	20	
Cooperabung Hill	Control	Control	COOP HILL1	COOP3	0.0	Tallowwood	45	20	
Cooperabung Hill	Control	Control	COOP HILL2		3.3	Small Fruited Grey Gum	61	20	
Cooperabung Hill	Control	Control	COOP HILL3		3.3	Tallowwood	43	20	
Cooperabung Hill	Control	New Control	SAT FL1	COOP4	0.0	Red Mahogany	50	20	
Cooperabung Hill	Control	New Control	SAT ST1			Tallowwood			No access
Cooperabung Hill	Control	New Control	SAT ST2			Tallowwood			No access
Mingaletta to Smiths Creek	Impact	Mitigation	MIN-SMITHS CK1	MING1	0.0	Blackbutt	55	18	Underscrubbed and cattle present.
Mingaletta to Smiths Creek	Impact	Mitigation	MIN-SMITHS CK2		0.0	Tallowwood	85	30	Cattle and deep litter on creek line.
Mingaletta to Smiths Creek	Impact	Mitigation	MIN-SMITHS CK3			Small-fruited Grey Gum			Property sold no access
Mingaletta to Smiths Creek	Control	Control	BALLENGARA SF1	MING2	0.0	Tallowwood	40	25	Logged trees sparse
Mingaletta to Smiths Creek	Control	Control	BALLENGARA SF2		0.0	Tallowwood	32	20	
Mingaletta to Smiths Creek	Control	Control	BALLENGARA SF3		0.0	Tallowwood	45	20	
Mingaletta to Smiths Creek	Control	New Control	SAT BR1	MING3	0.0	Sydney Blue Gum	45	25	
Mingaletta to Smiths Creek	Control	New Control	SAT BR2		0.0	Sydney Blue Gum	59	20	
Mingaletta to Smiths Creek	Control	New Control	SAT BR3		0.0	Flooded Gum	68	20	
Kundabung Road to North of Pipers Creek	Impact	No Mitigation	KUNDABUNG 1	KUND1	0.0	Flooded Gum	24	25	
Kundabung Road to North of Pipers Creek	Impact	No Mitigation	KUNDABUNG 2		0.0	Tallowwood	90	25	
Kundabung Road to North of Pipers Creek	Impact	No Mitigation	KUNDABUNG 3		0.0	Pink Bloodwood	60	20	
Kundabung Road to North of Pipers Creek	Impact	Mitigation	KUNDABUNG 4	KUND2	16.7	Small Fruited Grey Gum	76	20	
Kundabung Road to North of Pipers Creek	Impact	Mitigation	KUNDABUNG 5		3.3	Blackbutt	37	18	

Monitoring Area	Treatment	Sub-category	Site_ID	Map ref	Activity	SCT	DBH (cm)	Radial (m)	2022 note
Kundabung Road to North of Pipers Creek	Impact	Mitigation	KUNDABUNG 6			Grey Ironbark			No Access-landholder no contact
Kundabung Road to North of Pipers Creek	Control	Control	KUMBATINE NP1	KUND3	0.0	Tallowwood	30	20	
Kundabung Road to North of Pipers Creek	Control	Control	KUMBATINE NP2		0.0	Tallowwood	60	20	
Kundabung Road to North of Pipers Creek	Control	Control	KUMBATINE NP3		0.0	<i>E. carnea</i>	60	20	
Kundabung Road to North of Pipers Creek	Control	New Control	SAT MAC1	KUND4	0.0	Red Mahogany	80	20	
Kundabung Road to North of Pipers Creek	Control	New Control	SAT MAC2		0.0	Spotted Gum	50	20	
Kundabung Road to North of Pipers Creek	Control	New Control	SAT MAC3		0.0	Spotted Gum	45	20	
Maria River State Forest	Impact	Part Mitigation	MARIA RIVER 1	MR1	0.0	Pink Bloodwood	35	25	
Maria River State Forest	Impact	Part Mitigation	MARIA RIVER 2		0.0	Tallowwood	45	20	
Maria River State Forest	Impact	Part Mitigation	MARIA RIVER 3		0.0	Tallowwood	26	22	
Maria River State Forest	Impact	Mitigation	MARIA RIVER 4	MR2	0.0	Thin-leaved Stringybark	40.5	20	
Maria River State Forest	Impact	Mitigation	MARIA RIVER 5		3.3	Tallowwood	66	25	
Maria River State Forest	Impact	Mitigation	MARIA RIVER 6		0.0	Tallowwood	36	20	
Maria River State Forest	Control	Control	MARIA NP1	MR3	0.0	Tallowwood	31	15	
Maria River State Forest	Control	Control	MARIA NP2		3.3	Tallowwood	63	20	
Maria River State Forest	Control	Control	MARIA NP3		16.7	Tallowwood	23	25	
Maria River State Forest	Control	New Control	SAT CO1	MR4	0.0	White Stringbark	40	27	
Maria River State Forest	Control	New Control	SAT CO3		0.0	Blackbutt	95	20	
Maria River State Forest	Control	New Control	SAT MAR 1		0.0	Tallowwood		20	

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Appendix B – Spotted-tailed Quoll



Spotted-tailed Quoll Monitoring 2022

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

May 2023

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Cover photograph: Fauna captured on camera: Brown Bandicoot recorded in Fauna Underpass F22.32 within the Ballengarra State Forest Monitoring Area (left); Echidna recorded passing through combined culvert underpass C7.26 with Cairncross State Forest Monitoring Area (right).

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Executive summary

Context

This report documents findings of the 2022 monitoring period, the third and last, for the Spotted-tailed Quoll (*Dasyurus maculatus*), as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway upgrade project (the Project) and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022). Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project. The Spotted-tailed Quoll is one of the threatened species identified as requiring mitigation and monitoring during the operational phase of the Project.

Aim

The aim of the Spotted-tailed Quoll monitoring program is to determine whether the Project is meeting the performance indicators for the species, and provide corrective actions where required.

Method

Monitoring was undertaken in accordance with the EMP, in three broad areas of Cairncross State Forest, Ballengarra State Forest and Maria River State Forest. Cameras were deployed at fourteen fauna crossing locations within the three broad monitoring areas. Two motion-detecting cameras were deployed at each crossing location. Cameras were left to operate continuously from 1 June 2022 – 14 September 2022.

Key results

The Spotted-tailed Quoll was not recorded during the 2022 monitoring period and has not been recorded during either of two previous survey/monitoring events undertaken to date. These results are consistent with baseline findings. There were a total of 773 photo records, including 465 (61.2%) with native fauna (including the threatened Koala), 232 with (30.0%) introduced predators (including wild dogs, cats and foxes), and 50 (0.6%) with non-predatory introduced fauna.

As part of the analogous underpass monitoring program undertaken as part of the OH2K EMP, a Spotted-tailed Quoll was previously recorded during the 2018 underpass monitoring traversing underpass C36.40 (Niche 2018b).

Conclusion

The performance measure for all monitoring events has been met; monitoring was undertaken as per the EMP in Years 4, 6 and 8.

Management implications

Further monitoring is not recommended for the following reasons:

- Baseline (before construction) surveys did not record the Spotted-tailed Quoll.
- The species was detected using underpass C36.40 in 2018, a positive outcome given the low density, cryptic nature and expected low detection rate for this species.
- The detection of the species using underpass C36.40 supports the installation of box culverts as a mitigation measure to facilitate movement for this species.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW, previously Department of Environment (DoE)) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project. The Spotted-tailed Quoll (*Dasyurus maculatus*) was one threatened species identified as requiring monitoring following the completion of the Project's construction, during the operational phase.

1.1.1 Legal status

The Spotted-tailed Quoll is listed as vulnerable under the New South Wales *Biodiversity Conservation Act 2016* (BC Act) and endangered under the Commonwealth EPBC Act. Monitoring of the species is required under the Project's approval.

1.1.2 Monitoring framework

The survey design, methodology and performance indicators that define the Spotted-tailed Quoll monitoring program are specified in the EMP. The EMP requires monitoring of the Spotted-tailed Quoll on three occasions in total: in autumn or winter (preferably between March and Mid-July) in Year 4, 6 and 8 (operational phase of the Project).

After the Year 4 and 6 monitoring events (Niche 2018a, Niche 2020) the monitoring method was reviewed in consultation with the NSW Environment Protection Authority (EPA) and a revised method was approved by the EPA and DCCEEW in accordance with the recommendations provided in Niche (2020).

The result of these recommendations are as follows:

- The previous monitoring program was discontinued.
- Camera monitoring resources were redirected to mitigation structures.
- Performance measures were updated.
- The EMP was updated to reflect the change in methods and performance measures.

As such, the current and final 2022 monitoring event has been undertaken in accordance with the updated EMP (TfNSW 2022).

1.1.3 Baseline data

No Spotted-tailed Quoll were recorded during baseline surveys conducted by Lewis Ecological in August 2013 (Lewis 2014).

One Spotted-tailed Quoll was previously recorded during the 2018 underpass monitoring traversing underpass C36.40 (combined culvert C36.40) in a westerly direction (Niche 2018b).

1.1.4 Purpose of this report

This report details the findings obtained from the third and final monitoring event for the Spotted-tailed Quoll.

The aims of this report are to summarise the methods and results of the 2022 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for the Spotted-tailed Quoll:

- *Monitoring is undertaken in Year 4, 6 and 8 or until monitoring can demonstrate that mitigation measures are effective.*

1.3 Monitoring Timing

Monitoring is to be undertaken during autumn or winter, but preferably March – mid-July.

1.4 Reporting

As per the EMP, annual reporting of monitoring results will include:

- Detailed description of monitoring methodology employed.
- Results of the monitoring period.
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations.
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to DCCEEW, the NSW Department of Planning and Environment (DPE) and the EPA.

2. Methodology

2.1 Monitoring Sites

Monitoring was undertaken in the three broad areas identified in the EMP and included Cairncross State Forest, Ballengarra State Forest and Maria River State Forest.

Cameras were deployed at fourteen fauna crossing locations (Table 1, Figure 1) within the three broad monitoring areas. Monitoring locations were determined based on their proximity to monitoring areas, connectivity between vegetated areas on either side of the highway, and position relative to existing creek lines.

Table 1: Monitoring sites

Area	Monitoring sites
Cairncross State Forest (dry sclerophyll forest with some swamp forest associations)	Combined culvert underpass C7.26 Fauna underpass F9.70 Combined culvert underpass C11.14/11.08 Fauna underpass F11.67
Ballengarra State Forest (dry sclerophyll forest with some moist forest and swamp forest associations)	Fauna underpass F20.54 Fauna underpass F21.24 Fauna underpass F22.32 Barry's Creek Bridge Fauna underpass F26.40
Maria River State Forest (dry sclerophyll forest with some moist forest and swamp forest associations)	Fauna underpass F33.40 Fauna underpass F34.72 Combined culvert underpass C36.40 Maria River Bridge Stumpy Creek Bridge

2.2 Survey Method

Two motion-detecting cameras were deployed at each crossing location. Cameras were installed to provide the best field of view of traversing fauna. Cameras were left to operate continuously for a period of not less than three months during the period from May to August. Battery change and functionality checks were completed at the one and two-month stages.

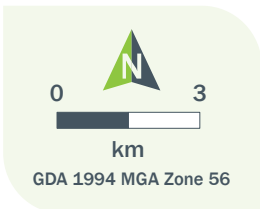
Data was collated and also added to the underpass monitoring data.

2.3 Analysis

Monitoring results were analysed in accordance with the performance measures specified within the EMP. In the case of the Spotted-tailed Quoll, performance measures are based on survey completion only; they do not specifically relate to the detection of this species and statistical analysis of data is not required.



Drawn by: Neil Berry File: T:\spatial\projects\ia1700\ia1702_OH2K\PI_5_Ecology_OH2K\Maps\PI_5_Ecology\Maps\PI_5_Quoll\Fig 1_Overview.mxd Last updated: 9/14/2022 12:01:40 PM



Oxley Highway to Kempsey - Spotted-tailed Quoll Monitoring sites

Niche PM: Radika Michniewicz
 Niche Proj. #: 7208
 Client: Transport for NSW (RMS Port Macquarie)

Monitoring sites

Figure 1

3. Results

3.1 2022 Monitoring Results

3.1.1 Monitoring details

Cameras were deployed at all 14 underpasses on 1 June 2022 and were operational for three months, until they were retrieved on 12-14 September 2022 (Table 2).

Results of the 2022 monitoring are provided in Annex 1 and a summary is provided in Table 3.

There were a total of 773 photo records, including 465 (61.2%) with native fauna, 232 (30.0%) with introduced predators (including wild dogs, cats and foxes) and 50 (6.5%) with non-predatory introduced fauna.

Table 2: Camera details

Area	Site	Deploy Date	Retrieve Date	Cam 1 #	Location/direction	No. Photos	No. fauna photos	Cam 2 #	Location/direction	No. Photos	No. fauna photos
Cairncross State Forest	C7.26	1/06/2022	14/09/2022	127	Mid/E	39	10	870	Mid/W	219	68
	F9.70	1/06/2022	14/09/2022	167	Mid/W	390	66	426	E /W	250	92
	C11.14/11.08	1/06/2022	12/09/2022	428	E	54	33	430	W	156	52
	F11.67	1/06/2022	14/09/2022	369	E	78	27	85	Mid/E	93	38
Ballengarra State Forest	F20.54	1/06/2022	14/09/2022	174	W	170	83	447	E/ W	92	53
	F21.24	1/06/2022	14/09/2022	125	Mid/E	79	33	178	Mid/W	118	26
	F22.32	1/06/2022	14/09/2022	393	E	115	61	433	W	494	154
	Barry's Creek Bridge	1/06/2022	14/09/2022	162	NE /W	678	17	141	SE/ W	90	10
	F26.4	1/06/2022	14/09/2022	382	E	503	286	374	W	506	319
Maria River State Forest	F33.40	1/06/2022	13/09/2022	397	W	132	67	424	E /W	309	123
	F34.72	1/06/2022	13/09/2022	134	E	237	79	446	East / W	307	104
	C36.4	1/06/2022	13/09/2022	65	Mid/E	39	2	378	Mid/W	46	4
	Maria River Bridge	1/06/2022	14/09/2022	155	NE /E	111	0	80	SW /E	129	52
	Stumpy Creek Bridge	1/06/2022	14/09/2022	373	NW / E NW	46	15	422	SW /E	508	21

3.1.2 Spotted-tailed Quoll

No Spotted-tailed Quoll were recorded at any of the monitoring sites during the 2022 monitoring.

As part of monitoring of mitigation measures for the Project, remotely triggered Scout Guard cameras were deployed in a number of selected combined and dedicated fauna underpasses. As mentioned, one Spotted-tailed Quoll was previously recorded during the 2018 underpass monitoring traversing underpass C36.40 (combined culvert C36.40) in a westerly direction (Niche 2018b). No Spotted-tailed Quolls were recorded during the 2022/2023 fauna underpass monitoring.

3.1.3 Other fauna

Native fauna

The most frequently recorded fauna from the Maria River and Ballengarra monitoring areas were medium ground-dwelling mammals, representing 34% of all records. Macropods and rodents and dasyurids were the next most frequently recorded native fauna, representing 25.9% and 8.4% of all records respectively. Of note was the detection of Koalas (vulnerable, BC Act and EPBC Act) at the Barrys Creek bridge and underpass F9.70 within the Ballengarra State Forest and Cairncross monitoring areas.

Introduced predatory fauna

Introduced predatory fauna, which may compete with the Spotted-tailed Quoll, included the European Red Fox (*Vulpes vulpes*), Cat (*Felis catus*), Wild (including Dingoes) and Domestic Dogs (*Canis familiaris*), and represented 26.4% of all records. All sites except three recorded predators on more than one occasion, with the Cairncross monitoring area representing 71% of the predator records across all sites.

Table 3: Summary of records

Area	Site	STQ	AM	M	MI	R&D	MGD	Bird	R	IP	Unk	Other
Cairncross	Combined culvert underpass C7.26	0		3			1		1	28		
	Fauna underpass F9.70	0	1	4			1			65		
	Combined culvert underpass C11.14/11.08	0		1			4			30		
	Fauna underpass F11.67	0		10	1					22		
Ballengarra	Fauna underpass F20.54	0		25		1	21		1			1
	Fauna underpass F21.24	0		6		1	14			2	3	
	Fauna underpass F22.32	0		9		6	46		3	11	1	
	Barry's Creek Bridge	0	3	7						3	2	
	Fauna underpass F26.4			64		44	83	2		31	2	2
Maria	Fauna underpass F33.40	0		54		1	16				2	
	Fauna underpass F34.72	0				5	71		1	5		
	Combined culvert underpass C36.4	0		8						2		
	Maria River Bridge	0	13	3		6	6					
	Stumpy Creek Bridge	0		6		1			1	5		
	total	0	17	200	1	65	263	3	6	204	10	3

STQ = Spotted-tailed Quoll; AM = arboreal mammals (Possums and Koala); M = macropods; MI = Microbat, R&D = rodents and dasyurids; MGD = medium ground dwelling mammals (Echidna, Bandicoot); R = reptile; IP = Introduced predator (Fox, Cat, Wild and Domestic Dog); Unk = Unknown/unidentified fauna; Other= non-native and non-fauna categories such as people, cars, cows, pigs, hares and horses.

4. Discussion and Recommendations

4.1 Performance Measures

A summary of the 2022 survey results in relation to the performance measures are provided in Table 4.

Table 4: Summary of performance measures for the 2022 monitoring period.

Performance measure	Discussion
Monitoring is undertaken in Year 4, 6 and 8 or until monitoring can demonstrate that mitigation measures are effective.	This performance measure has been met for all Years.

4.2 Recommendations

The EMP lists potential problems and contingency measures for various components of the monitoring program. There are no measures relevant to the Spotted-tailed Quoll monitoring program.

Further monitoring is not recommended for the following reasons:

- Baseline (before construction) surveys did not record the Spotted-tailed Quoll.
- The species was detected using underpass C36.40 in 2018, a positive outcome given the low density, cryptic nature and expected low detection rate for this species.
- The detection of the species using underpass C36.40 supports the installation of box culverts as a mitigation measure to facilitate movement for this species.

References

Lewis (2014). Pacific Highway Upgrade: Oxley Highway to Kempsey Pre-construction Spring and Summer Baseline Monitoring. Report prepared for RPS-RMS by Lewis Ecological Surveys.

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Niche (2020). Spotted-tailed Quoll Monitoring 2020. Oxley Highway to Kempsey Pacific Highway upgrade. Prepared by Niche Environment and Heritage Pty Ltd for Roads and Maritime Services, Port Macquarie, NSW.

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Annex 1. Field Data – 2022 results

Monitoring Site	Cairncross State Forest				Ballengarra State Forest					Maria River State Forest				
Underpass	C7.26	F9.70	C11.14/ 11.08	F11.67	F20.54	F21.24	F22.32	Barry's Ck	F26.4	F33.40	F34.72	C36.40	Maria River	Stumpy Ck
Species/ fauna group														
Small ground-dwelling mammals														
<i>Rattus rattus</i>							Y (1)		Y (39)				Y (5)	Y (1)
Rodent/Marsupial					Y (1)		Y (3)		Y (4)	Y (1)	Y (4)			
Rodent						Y (1)	Y (2)		Y (1)		Y (1)		Y (1)	
Medium ground -dwelling mammals														
Echidna (<i>Tachyglossus aculeatus</i>)	Y (1)		Y (4)			Y (2)	Y (4)		Y (3)	Y (1)			Y (4)	
Long-nosed Bandicoot (<i>Perameles nasuta</i>)					Y (5)	Y (1)	Y (8)	Y (1)	Y (12)	Y (4)	Y (8)		Y (1)	
Bandicoot		Y (1)			Y (16)	Y (2)	Y (34)		Y (67)	Y (11)	Y (57)			
Northern Brown Bandicoot (<i>Isodon macrourus</i>)						Y (9)			Y (1)		Y (6)		Y (1)	
Arboreal mammals														
Brush-tail Possum													Y (3)	
Common Brush-tail Possum (<i>Trichosurus vulpecula</i>)								Y (2)					Y (10)	
Koala (<i>Phascolarctos cinereus</i>)		Y (1)						Y (1)						
Macropods														
Eastern Grey Kangaroo (<i>Macropus giganteus</i>)	Y (3)	Y (2)	Y (2)	Y (5)	Y (14)	Y (5)		Y (2)	Y (33)	Y (5)	Y (5)		Y (1)	
Macropod sp.			Y (1)		Y (5)	Y (1)	Y (3)		Y (11)	Y (11)				
Swamp Wallaby (<i>Wallabia bicolor</i>)				Y (1)	Y (3)		Y (6)	Y (4)	Y (14)	Y (5)	Y (2)		Y (1)	Y (5)
Red-necked Wallaby (<i>Macropus rufogriseus</i>)													Y (1)	
Wallaby				Y (4)	Y (3)			Y (1)	Y (6)	Y (6)	Y (1)			Y (1)

Monitoring Site	Cairncross State Forest				Ballengarra State Forest					Maria River State Forest				
Underpass	C7.26	F9.70	C11.14/ 11.08	F11.67	F20.54	F21.24	F22.32	Barry's Ck	F26.4	F33.40	F34.72	C36.40	Maria River	Stumpy Ck
Species/ fauna group														
Reptiles														
Lace Monitor (<i>Varanus varius</i>)	Y (1)				Y (1)		Y (3)				Y (1)			
Introduced predators														
Fox (<i>Vulpes vulpes</i>)	Y (6)	Y (53)	Y (9)	Y (15)		Y (1)	Y (11)		Y (25)	Y (26)	Y (1)	Y (2)		Y (5)
Wild Dog (<i>Canis lupus</i>)	Y (22)	Y (13)	Y (21)	Y (7)		Y (1)		Y (3)	Y (2)					
Cat (<i>Felis catus</i>)									Y (4)	Y (1)	Y (4)			
Other														
Unknown						Y (3)	Y (1)	Y (2)	Y (2)	Y (2)				
Microbat				Y (1)										
Rabbit (<i>Oryctolagus cuniculus</i>)														
Bird					Y (1)				Y (2)					Y (1)
Pig									Y (2)					

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Appendix C – Giant-barred Frog



Giant Barred Frog Monitoring 2022/2023

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

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Cover photograph: Giant Barred Frog

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Executive summary

Context

This report documents findings of the final of five operational monitoring periods for the Giant Barred Frog (*Mixophyes iteratus*), as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project), and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022). Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project. The Giant Barred Frog is one of the threatened species identified as requiring mitigation and monitoring throughout the course of the construction and operational periods of the Project.

Aims

The aim of the Giant Barred Frog monitoring program is to determine, through evaluation of the performance indicators outlined in the EMP, if the Project is having an impact on the species and whether corrective actions are required.

Methods

Six sites (two reference and four impact) were monitored in spring 2022 and summer 2023 and five sites (two reference and three impact) in autumn 2023, due to access constraints. Each site consists of a one kilometre transect along the creek line, divided into 10 x 100 metre zones. At the impact sites, the transects cross beneath the carriageway, the carriageway being the midpoint of the transect. Each monitoring location was surveyed in accordance with the monitoring method and design specified in the EMP. Surveys were undertaken after a sufficient rainfall trigger event (> 10 millimetres within a 24 hour period) and involved passive listening, call playback (upon arrival and at intervals during searches), active searching (within 20 metres of each creek bank) and habitat surveys within each of the 100 metre zones.

Key results

Surveys were undertaken on the 25 - 27 October 2022 (spring), 15 - 17 February 2023 (summer) and 3 - 4 April 2023 (autumn) after suitable rainfall. A total of 54 Giant Barred Frogs were recorded during the 2022/2023 monitoring period and 9% (n = 9) of those captured were recaptures.

Frogs were absent from the Cooperabung Creek reference site in all seasons. The highest mean number of Giant Barred Frogs was recorded at Pipers Creek reference site.

Evidence of breeding via the presence of juveniles or sub-adults, gravid females or reproductive males was observed at all sites where frogs were recorded during at least one survey event during 2022/2023 monitoring.

Analysis of frog movement in relation to the highway found that 12 (23%) of the 52 recaptures from impact sites have been captured on both sides of the carriageway over successive monitoring events. At the reference sites, 12 (27%) of the 44 recaptures have been captured on both sides of the transect midpoint over successive monitoring events.

Conclusions

Performance measures relating to undertaking monitoring have been met.

The performance measure relating to continued presence of Giant Barred Frogs during each survey event where it was identified during baseline surveys was met for three of the six sites. Giant Barred Frogs were:

- Not recorded at the Cooperabung reference sites, where it was recorded during all three baseline surveys.
- Not recorded at Smiths Creek impact site in summer or autumn 2022/2023 and Maria River impact site in spring 2022, where it was recorded during baseline surveys.

The performance measure relating to changes in density and mean records was not met. The number and location of Giant Barred Frogs recorded has varied between season and year at all sites. All sites show fluctuating densities. However, as trends are evident at both impact and reference sites, it is not possible to attribute these changes to the Project.

Management implications

Given the number and location of Giant Barred Frogs recorded has varied between season and year at all sites and that trends are evident at both impact and reference sites, it is not possible to attribute these changes to the Project, therefore further monitoring is not recommended.

However, it is recommended that maintenance actions are carried out in order to maintain the ongoing integrity of the frog fence.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the Commonwealth Department of Climate Change, Energy the Environment and Water (DCCEEW, previously the Department of Environment (DoE)) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project.

Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project. The Giant Barred Frog (*Mixophyes iteratus*) was one threatened species identified as requiring mitigation and monitoring through the course of the Project's construction and operational periods.

1.1.1 Legal status

The Giant Barred Frog is listed as endangered under the New South Wales *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth EPBC Act. Monitoring of the species is required under the Project's approval.

1.1.2 Monitoring framework

The design, methods and performance indicators that define the Giant Barred Frog monitoring program are specified in the EMP and Giant Barred Frog Management Strategy (GBFMS, Lewis 2013). Where there are discrepancies between the EMP and the GBFMS, the EMP takes precedence (Section 1.2 TfNSW 2022).

The EMP required monitoring of the Giant Barred Frog three times a year (spring, summer and autumn) in years 1, 2 and 3 once substantial construction commenced. Following completion of the Project, surveys are to be undertaken for five consecutive years, in spring, summer and autumn of Year 4, 5, 6, 7 and 8 (operational phase) or until mitigation measures can be demonstrated to have been effective. To date, these monitoring events have been undertaken and reported as follows:

- Construction phase monitoring:
 - *Autumn 2015* (Year 1): Niche 2015a
 - *Spring 2015, summer and autumn 2016* (Year 1): Niche 2016
 - *Spring 2016, summer and autumn 2017* (Year 2): Niche 2017
 - *Spring 2017, summer 2018* (Year 3): Niche 2018.
- Operational phase monitoring:
 - *Autumn 2018* (Year 3): Niche 2018
 - *Spring 2018, (summer 2019 insufficient rainfall) and autumn 2019* (Year 4): Niche 2019
 - *Spring 2019, summer and autumn 2020* (Year 5): Niche 2020
 - *Spring 2020, summer and autumn 2021* (Year 6): Niche 2021
 - *Spring 2021, summer and autumn 2022* (Year 7): Niche 2022
 - *Spring 2022, summer and autumn 2023* (Year 8): Current report.

This report addresses the fifth round (Year 8) of operational phase monitoring for the Project and is the final of nine monitoring reports for the Giant Barred Frog.

Water quality monitoring was previously conducted within Giant Barred Frog habitat and potential habitat. Water quality monitoring commenced prior to construction, continued during construction and continued for three years during the operational phase, with the final monitoring occurring in March 2021 (Niche 2021). All water monitoring results for the Giant Barred Frog impact sites have been included in previous reports.

1.1.3 Baseline data

The EMP specifies the following regarding the Giant Barred Frog:

“The Giant Barred Frog was recorded at Maria River and suitable habitat was identified at Smiths Creek, Pipers Creek and Cooperabung Creek during surveys undertaken to inform the Environmental Assessment (GHD 2010). Targeted surveys undertaken over eight nights between late November 2012 and late January 2013, involving spotlighting, call-playback and tadpole searches, identified the Giant Barred Frog at Cooperabung Creek (south), Cooperabung Creek downstream at Haydons Wharf Road, Smiths Creek, Pipers Creek and Maria River. Areas of suitable habitat for the Giant Barred Frog were also identified at both Stumpy Creek and Barrys Creek”

The EMP lists six sites to be monitored:

- Four impact sites: Cooperabung Creek, Smiths Creek, Pipers Creek, and Maria River.
- Two reference sites: Sun Valley Road (where it crosses Cooperabung Creek), and Old Coast Road (where it crosses Pipers Creek).

Baseline surveys (Niche 2015b) recorded a total of 152 Giant Barred Frogs, at all six monitoring sites in spring and summer and at four sites in autumn. Frogs were absent from the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey.

1.1.4 Purpose of this report

The purpose of this report is to summarise the methods and results of the 2022/2023 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for the Giant Barred Frog:

- *Monitoring is undertaken during baseline surveys and Years 1 – 8 or until monitoring can demonstrate that mitigation measures are effective.*
- *Monitoring during Years 1 – 8 is undertaken at the Impact and Control sites where baseline monitoring was undertaken, subject to landowner agreement.*
- *Continued presence of Giant Barred Frogs during each survey event in Years 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.*
- *Mitigation measures are effective as defined in the EPBC approval when all monitoring events are considered at Year 8.*
- *Median values of all downstream water quality monitoring at GBF habitat or potential habitat locations during construction and operation (Year 1 – 6) is less than the 80th percentile value of the upstream site (where 80th percentile is the value at which median values at the downstream site are above 80% of the recorded background water quality records), where this change is found to be attributable to construction or operation.*

- *At Year 8, no change to GBF densities, distribution, habitat use and movement patterns compared to baseline data.*

1.3 Monitoring Timing

Monitoring is to occur three times a year: spring, summer and autumn. Monitoring is to occur in the middle of the season, within one week of rainfall of 10 millimetres within a 24 hour period.

1.4 Reporting

As per the EMP, annual reporting of monitoring results will include:

- Detailed description of monitoring methodology
- Results of the monitoring period
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations
- If contingency measures should be implemented.

This report prepared under the EMP will be submitted to NSW Department of Planning and Environment (DPE), the NSW Environment Protection Authority (EPA) and DCCEEW.

1.5 Limitations

The following limitations to the monitoring procedure were encountered:

- As previously reported, Giant Barred Frogs have become difficult to detect and access in some areas along the transects due to the density of streamside vegetation including the growth of Lantana.
- Monitoring at Maria River Impact Site upstream (zone 1-5) was not undertaken in 2022/2023 as access to the transect was not possible due to the growth of lantana along the banks.
- Sections of the transect at Piper's Creek Impact Site upstream was not accessible during 2022/2023 surveys. Access was achieved where possible by going around large patches of lantana and circling back to the transect.

2. Methodology

2.1 Monitoring Sites

Monitoring was undertaken at the four impact and two reference sites in spring, summer and autumn. Each site consists of a one kilometre transect along the creek line.

Where possible, impact site transects extend 450 metres upstream and 450 metres downstream of the Project footprint (assumes Project boundary width of 100 metres) and are divided into 10 x 100 metre zones, resulting in four to five zones downstream of the Project footprint, one within the Project footprint, and four to five upstream of the Project footprint. As for previous monitoring events, the Cooperabung Creek impact site was not surveyed for the full kilometre as access agreements with landowners could not be obtained for the final downstream zone, and for the first two upstream zones.

The two reference sites are located several kilometres upstream of the Project footprint within Cooperabung Creek and Pipers Creek.

The location of all monitoring sites is shown in Figure 1, with detailed locations for each site transect provided in Figure 2 to Figure 7.

2.2 Giant Barred Frog Survey Method

Surveys were undertaken in accordance with the EMP after sufficient rainfall events.

A two hour minimum search time, using two ecologists, at each site was employed, however access and movement difficulties due to dense vegetation often resulted in increased survey time. Surveys involved passive listening, call playback (upon arrival and at intervals during searches), active searching (within 20 metres of creek bank) and habitat surveys. In accordance with the EMP, the following habitat data was collected within each of the 100 metre zones:

- Overstorey vegetation cover (OS, expressed as per cent cover)
- Shrub cover (expressed as per cent cover)
- Ground cover (expressed as per cent cover)
- Leaf litter cover (expressed as per cent cover)
- Bare soil/earth (expressed as per cent cover)
- Presence of cattle (based on hoof marks, manure and whether it is recent or aged evidence)
- Number of pools and riffles within the zone
- Approximate depth of the deepest pool within the zone
- Number of breaches in frog fencing, if applicable.

The location of all observed Giant Barred Frogs was recorded and, where possible, individuals were captured. Captured individuals were checked for recapture status and fitted with a Passive Integrated Transponder (PIT) tag if the individual was previously unknown. In accordance with the EMP, the following data were collected for captured individuals:

- Location according to demarcated survey zone
- Distance from stream edge
- Sex (male, female, unknown)
- Breeding condition with:
 - Males assessed on the colouration of their nuptial pads (i.e. no colour, light, moderate, dark)

- Females based on whether they are gravid or not gravid (egg bearing).
- Snout-vent length (millimetres)
- Weight (grams).

Temperature and humidity, per cent cloud cover and broad wind level (scale of 0-3 where 0 = no wind) were recorded for each survey. Rainfall (millimetres) within the previous 24 hours was recorded from the Port Macquarie Airport (Station No. 060168) and Kempsey Airport (Station No. 059007) Bureau of Meteorology weather stations.

2.3 Water Quality

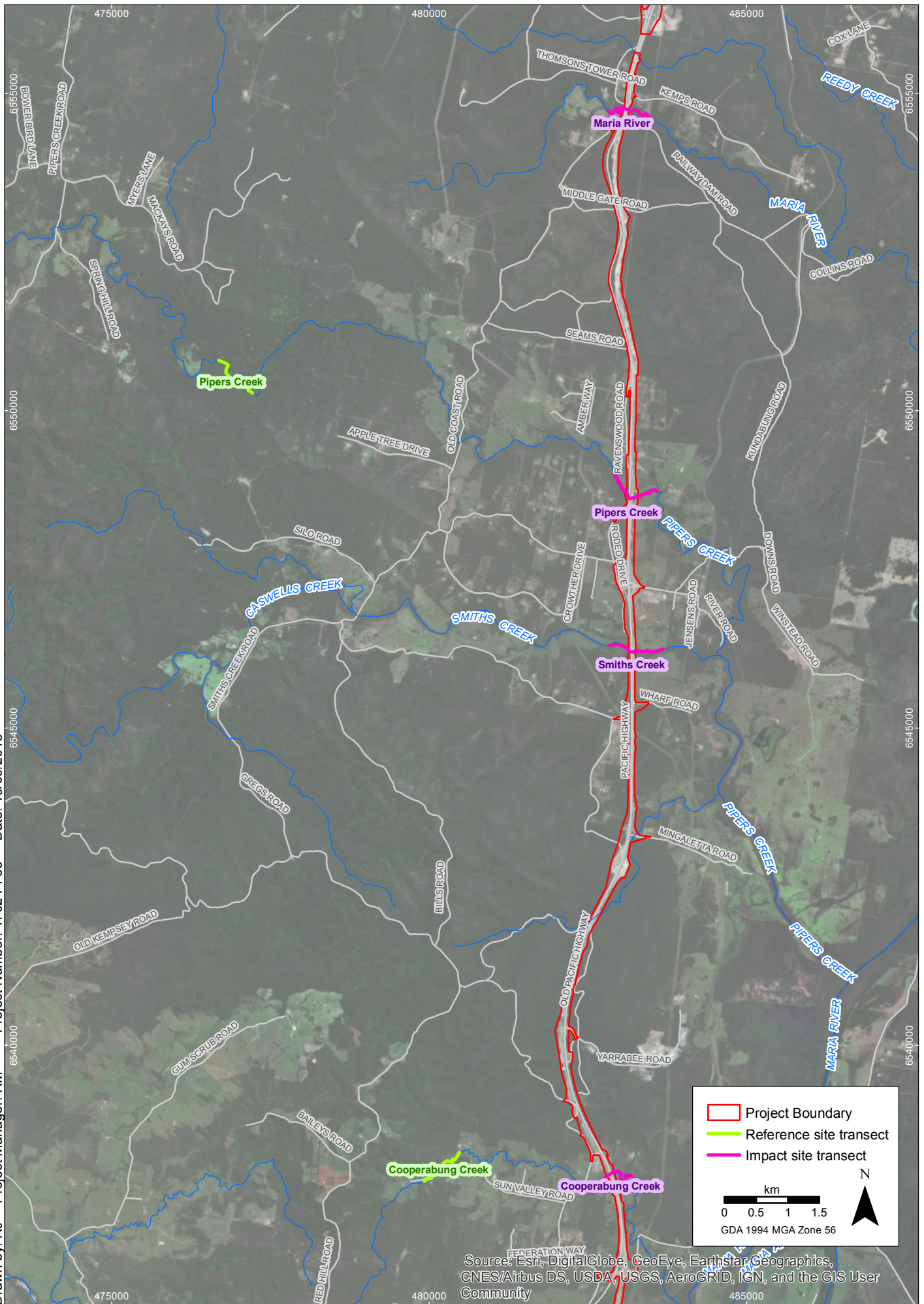
Water quality monitoring was not undertaken during the 2022/2023 monitoring period. The final operational water quality monitoring period and associated report was completed in 2021 (TfNSW 2021). A summary of the water quality data extracted from TfNSW (2021) from both upstream and downstream sites for Cooperabung Creek, Smiths Creek, Pipers Creek, and Maria River was included in the 2021/2022 monitoring period report (Niche 2021).

2.4 Analysis

For consistency with Baseline analyses and previous reporting, the Minimum Number Known Alive (MNA) (see Sutherland 2006) was calculated for each of the sites. The MNA is based on the number of new individuals encountered over multiple visits, where any new animals are summed, providing an aggregate total. As this method does not account for any migration out of the population or any death, it may overestimate the total population size if counts are completed over a long period of time. As baseline studies commenced in 2013 it is possible that considering cumulative records over the subsequent survey periods, which extend over a period of seven years, may result in overestimation of the actual population. Data is provided for the annual new captures and a cumulative MNA over the years is also provided, however this data should be approached with caution, as the lifespan of the Giant Barred Frog may not extend beyond four or five years (Michael Mahony unpublished data).

Changes in Giant Barred Frog density within the zones and distribution along transects across the years were investigated by considering mean annual records within each specific zone. In addition, movement of individuals between zones was examined for recaptured frogs.

Drawn by: RJ Project Manager: RM Project Number: 1702 PI 53 Date: 19/09/2018



Source: Esri, DigitalGlobe, GeoEye, EarthStar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Giant Barred Frog Monitoring Sites: overview
Pacific Highway Upgrade - Oxley Highway to Kempsey



Giant Barred Frog monitoring: Cooperabung Creek impact site
 Pacific Highway Upgrade - Oxley Highway to Kempsey

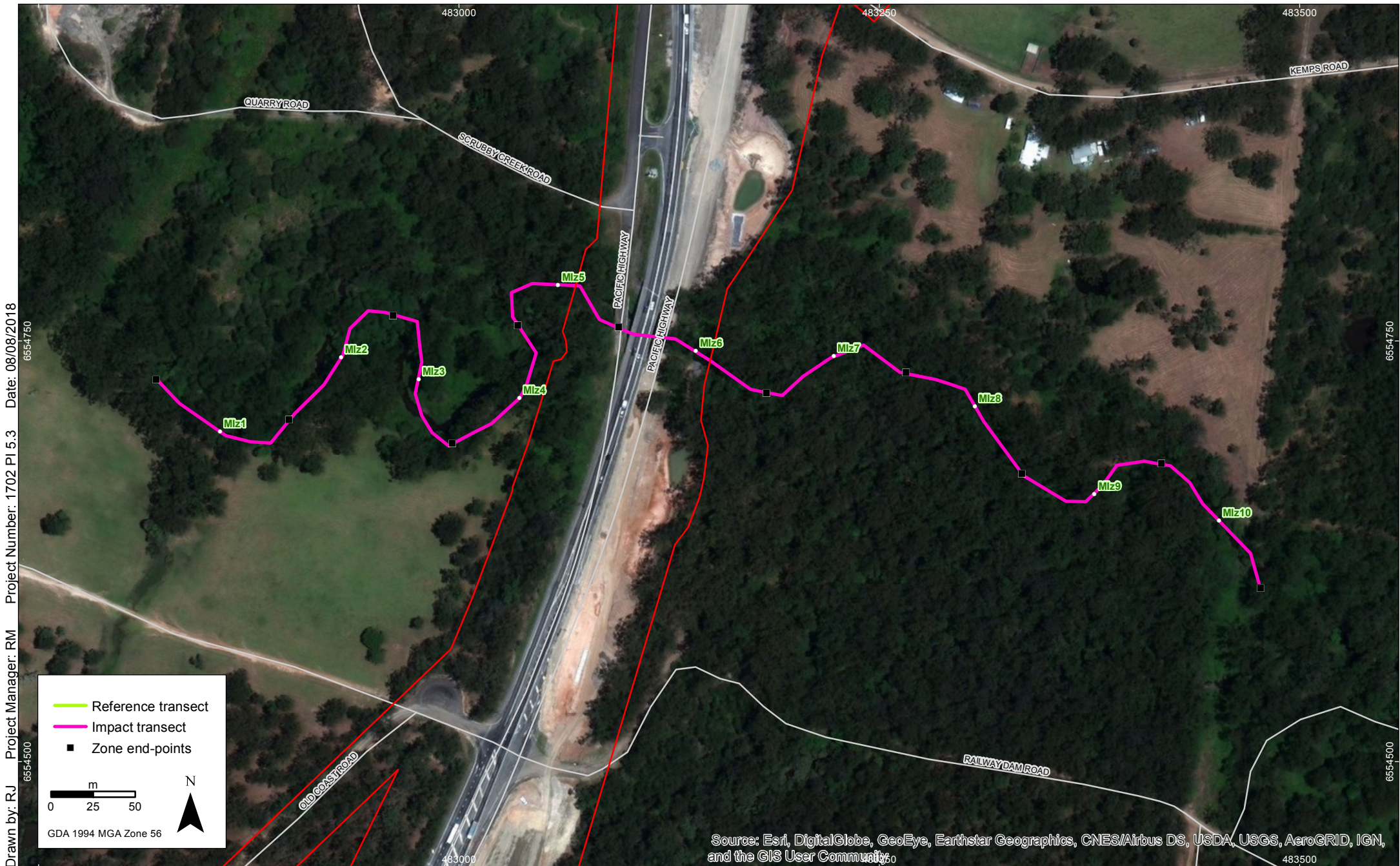


Giant Barred Frog monitoring: Smiths Creek impact site
 Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 3
 Imagery: (c) DigitalGlobe



Giant Barred Frog monitoring: Pipers Creek impact site
Pacific Highway Upgrade - Oxley Highway to Kempsey



Giant Barred Frog monitoring: Maria River impact site
 Pacific Highway Upgrade - Oxley Highway to Kempsey



Giant Barred Frog monitoring: Cooperabung Creek reference site
 Pacific Highway Upgrade - Oxley Highway to Kempsey



Giant Barred Frog monitoring: Pipers Creek reference site
Pacific Highway Upgrade - Oxley Highway to Kempsey

3. Results

3.1 2022/2023 Giant Barred Frog Monitoring Results

Field data are presented in Annex 1 and Annex 2. Survey dates and trigger rainfall events measured at Port Macquarie Airport (Station No. 060168) weather station for summer and autumn and Kempsey Weather Station (Station No. 059007) for spring were as follows:

- 25 – 27 October 2022 (spring): 37.4 millimetres recorded on 24 October 2022 prior to surveys
- 15 - 17 February 2023 (summer): 21.6 millimetres recorded on 15 February 2023 prior to surveys
- 3 - 4 April 2023 (autumn): 22.8 millimetres recorded on 29 March 2023 prior to surveys.

3.1.1 Survey results

A total of 54 Giant Barred Frogs were recorded in spring, summer and autumn during the 2022/2023 monitoring surveys. Giant Barred Frogs were recorded at four of the six sites during spring, summer and autumn surveys (Table 1). Of the 54 frogs recorded, 44 were captured, of which four were recaptures (9%). Frogs were absent from the Cooperabung Creek reference site in all seasons. In spring, frogs were recorded at Pipers Creek impact site (1), Pipers Creek reference site (15), Smiths Creek impact site (3) and Cooperabung impact site (2). In summer, frogs were recorded at Cooperabung Creek impact site (2), Maria River impact site (3), Pipers Creek impact site (2) and Pipers Creek reference site (14). In autumn, frogs were recorded at Cooperabung Creek impact site (1), Maria River impact site (1), Pipers Creek impact site (1) and Pipers Creek reference site (9). The Pipers Creek reference site recorded the highest mean number of Giant Barred Frogs, with frogs recorded in spring, summer and autumn.

The cumulative MNA (10 years) is highest at the Pipers Creek reference site (MNA = 228) and Smiths Creek impact site (MNA = 125). As mentioned in Section 2.4, this estimate of MNA is likely an overestimate of the population as calculation of the MNA does not take dispersal or deaths into account.

Table 1: Giant Barred Frogs recorded at each site during 2022/2023 surveys

Data set	Cooperabung Creek impact	Smiths Creek impact	Pipers Creek impact	Maria River impact	Cooperabung Creek reference	Pipers Creek reference
Spring (2022)	2	3	1	0	0	15
Summer (2023)	2	0	2	3	0	14
Autumn (2023)	1	0	1	1	0	9
Mean number of frogs over the monitoring period	1.7	1	1.3	1.3	0	12.7
Standard Error (SE)	0.6	1.7	0.6	1.5	0	3.2
Recaptures	1	0	1	0	0	2
New captures	4	3	3	3	0	27
Uncaptured	0	0	0	1	0	9
Total	5	3	4	4	0	38
Cumulative MNA	63	125	56	99	74	228

3.1.2 Evidence of breeding

Table 2 presents records of breeding evidence. Evidence of breeding via the presence of juveniles or sub-adults, gravid females or reproductive males was observed at all sites where frogs were recorded during at least one survey event during 2022/2023.

Table 2: Breeding evidence records 2022/2023

Monitoring site	Season	Juveniles	Sub-adults	Gravid females	Nuptial pads
Cooperabung Creek impact	Spring			2	
	Summer				
	Autumn	1			
Maria River impact	Spring				
	Summer				
	Autumn				
Pipers Creeks impact	Spring				
	Summer			1	
	Autumn				
Smiths Creek impact	Spring			1	1
	Summer				
	Autumn				
Cooperabung Creek reference	Spring				
	Summer				
	Autumn				
Pipers Creek reference	Spring		3		
	Summer	1			
	Autumn	1			

3.1.3 Weather conditions

The prevailing weather conditions encountered during the field surveys are summarised in Table 3 (Port Macquarie Airport, Station No. 060168). Additional details of the prevailing micrometeorological conditions at the six sites during the field surveys are presented in Annex 1.

Table 3: Weather conditions: 2022/2023 surveys

Date	Min temp (°C)	Max temp (°C)	Humidity (%)	Rainfall 24 hours prior (mm)	Rainfall 7 days (mm)	Rainfall 30 days (mm)
25/10/2022*	14.7	28.5	57	14.6	113	152.4
26/10/2022*	14.4	29.7	48	6.2	119	158.6
27/10/2022*	14.2	30.5	56	0	114.2	158.4
15/02/2023	16.7	26.4	62	21.6	22.8	107.8
16/02/2023	13.3	27.2	58	0	22.8	103
17/02/2023	13.7	28.1	60	0	22.8	98.2
03/04/2023	15.4	21.1	86	6.4	70.2	259.6
04/04/2023	15.9	22.3	93	11.6	42.8	271.2
05/04/2023	17.5	24.8	71	21.6	41.6	291.2

*= Weather taken from Kempsey Weather Station due to missing weather data for the Port Macquarie Weather Station.

3.1.4 Habitat use

Habitat information collected for each site is presented in Annex 1. Microhabitat use was highly variable. Frogs were recorded on, and buried within, leaf litter, using flood debris as shelter, on bare ground or creek banks and under logs and vegetation. Most frogs were captured between 1-10 metres from the creeks, with the furthest frog being found 20 metres from the creek.

No frogs were found to have breached the frog fences at any sites (i.e. observed on the wrong side of the fence).

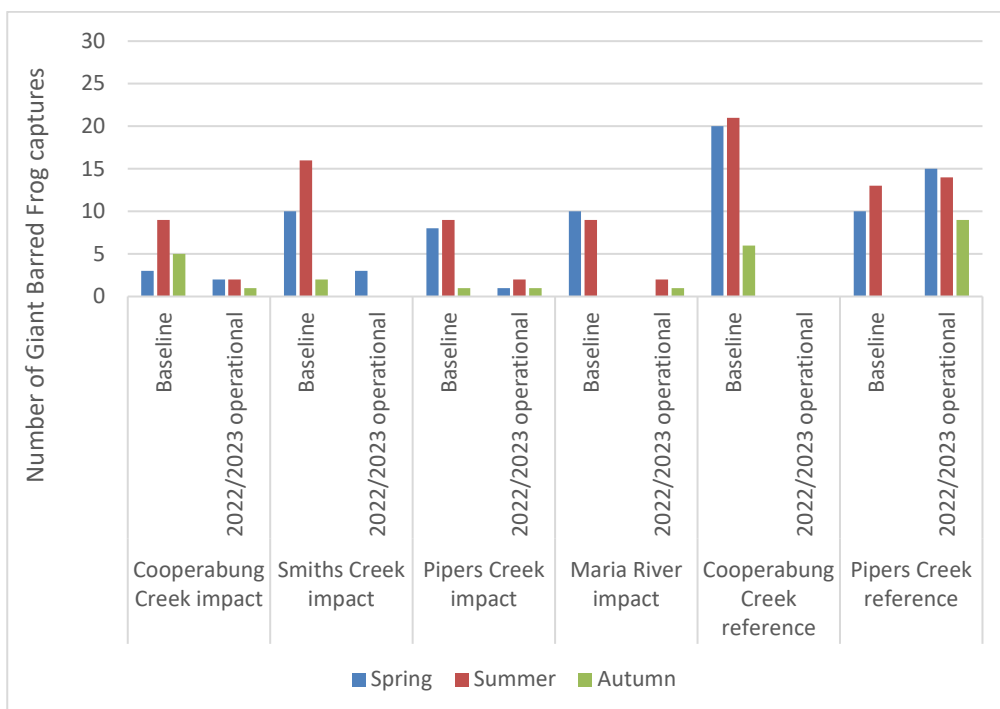
3.2 Comparison with Previous Surveys

3.2.1 Baseline and 2022/2023 surveys

Graph 1 presents the Giant Barred Frog records for baseline and the 2022/2023 operational monitoring surveys.

The Giant Barred Frog was recorded at all six monitoring sites in spring and summer and at four sites in autumn during baseline surveys. Giant Barred Frogs were not recorded at the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey.

Giant Barred Frogs were recorded at four of the six sites during spring, summer and autumn during 2022/2023 surveys. Giant Barred Frogs were not recorded at Cooperabung Creek reference site during the 2022/2023 surveys, where it was recorded during baseline surveys. Giant Barred Frogs were not recorded at Maria River impact site in spring or Smiths Creek impact site in summer and autumn where it was recorded during baseline surveys.



Graph 1: Giant Barred Frog records: baseline and 2022/2023 monitoring

3.2.2 Annual mean records

The mean number of records each year for each site is shown in Graph 2. All sites have demonstrated a general decreasing trend in the average number of captures at each monitoring event since 2018/2019.

The mean number of Giant Barred Frogs recorded at Cooperabung Creek impact site and Cooperabung Creek reference site has decreased annually since 2015/2016. However, frogs were recorded at the Cooperabung Creek impact site in the last two monitoring years after not being detected for two consecutive years (2019/2020 and 2020/2021). Frogs were again not detected at Cooperabung Creek reference site and have not been detected there since summer 2020.

A similar annual decrease is evident at Pipers Creek impact site, however the mean number of frogs captured increased during 2021/2022 monitoring period and remained at the same level during the 2022/2023 monitoring period.

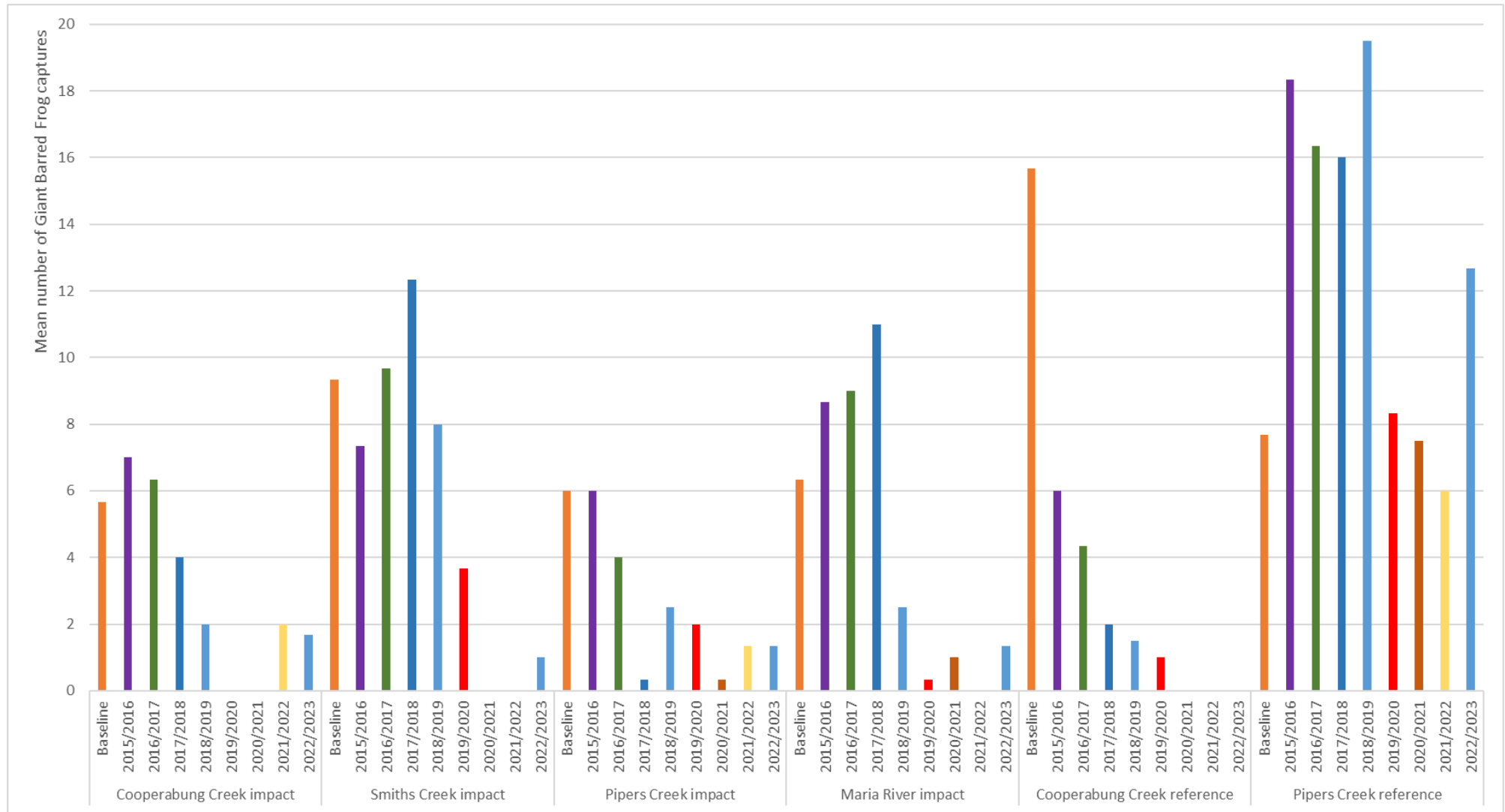
The mean number of Giant Barred Frogs recorded at Pipers Creek reference site increased substantially above baseline during the 2015/2016 monitoring period, where it remained stable, until decreasing back to baseline levels in 2019/2020 and subsequently below baseline in 2020/2021 and 2021/2022 monitoring periods. During 2022/2023 monitoring recorded another substantial increase, taking the mean number of frogs above baseline.

The mean number of Giant Barred Frogs recorded at Smiths Creek impact site and Maria River impact site increased annually from 2015/2016 until 2018/2019. After this time the mean decreased substantially at both these sites and has continued to decrease, such that no frogs were recorded at Smiths Creek impact and Maria River impact sites during 2021/2022. The 2022/2023 monitoring recorded low levels of frogs recorded again at both Maria River and Smiths Creek.

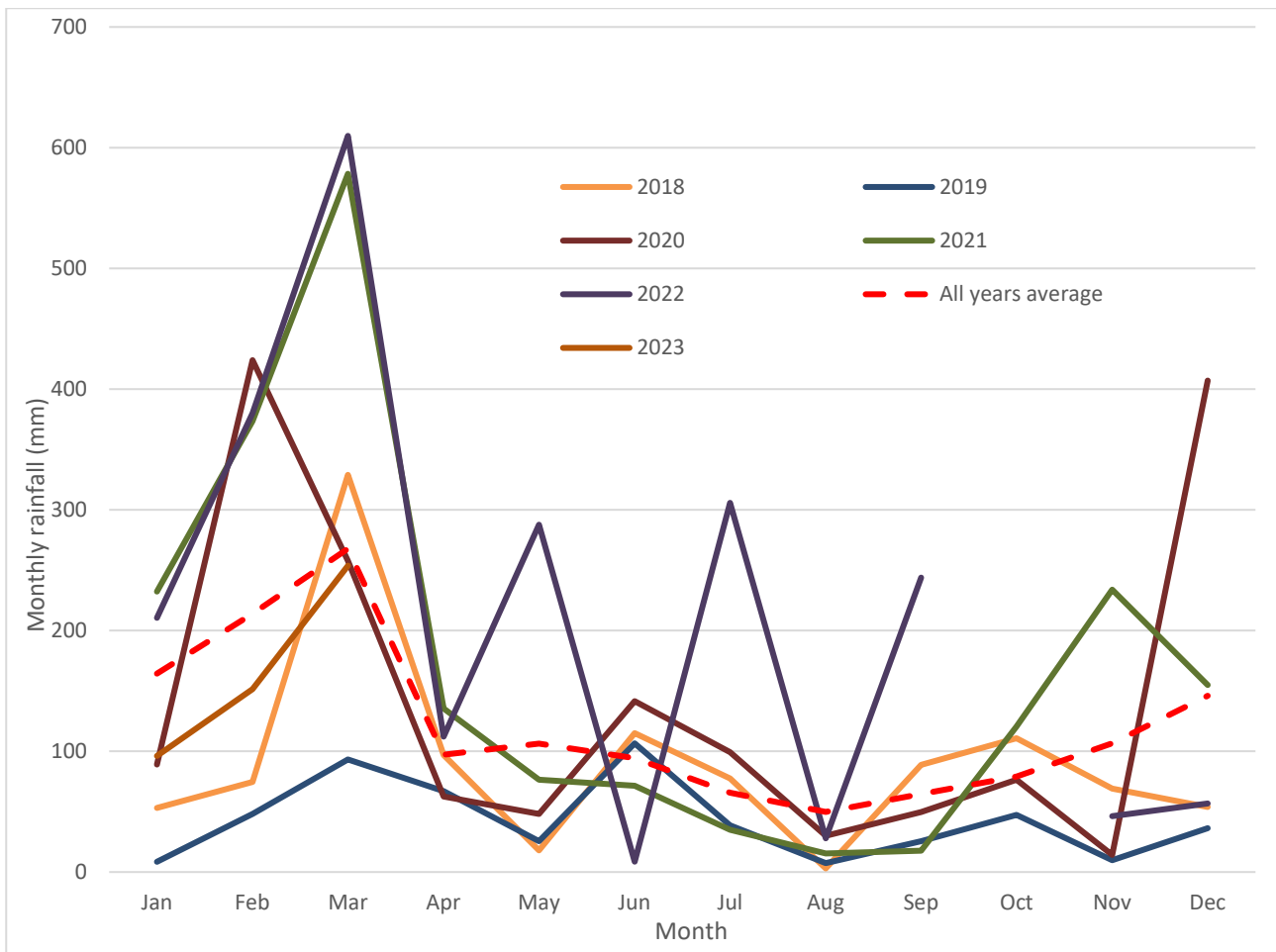
The mean number of Giant Barred Frogs recorded during the current monitoring period increased from the previous monitoring event at three of the six sites, Smiths Creek impact, Maria River impact and Pipers Creek reference. The remaining three sites decreased or remained the same. Mean records at all sites except for the Pipers Creek reference sites are currently lower than baseline and decreasing trends have been evident at both reference and impact sites.

The above-average rainfall conditions observed over the spring/summer periods of 2020/2021 and 2021/2022 follow the long-term drought conditions experienced across the Project area in 2019. It is possible that the population changes observed at all sites are in response to these changing conditions. A population response to improved waterway conditions after the 2020/2021 and 2021/2022 rainfall may be evidenced by the increased capture rates at some sites, but also hindered by difficult (flooding) survey conditions.

Given the lack of a distinct difference in population trends between impact and reference sites, it is not possible to attribute observed changes in frog numbers to the Project.



Graph 2: Mean annual Giant Barred Frog records by site



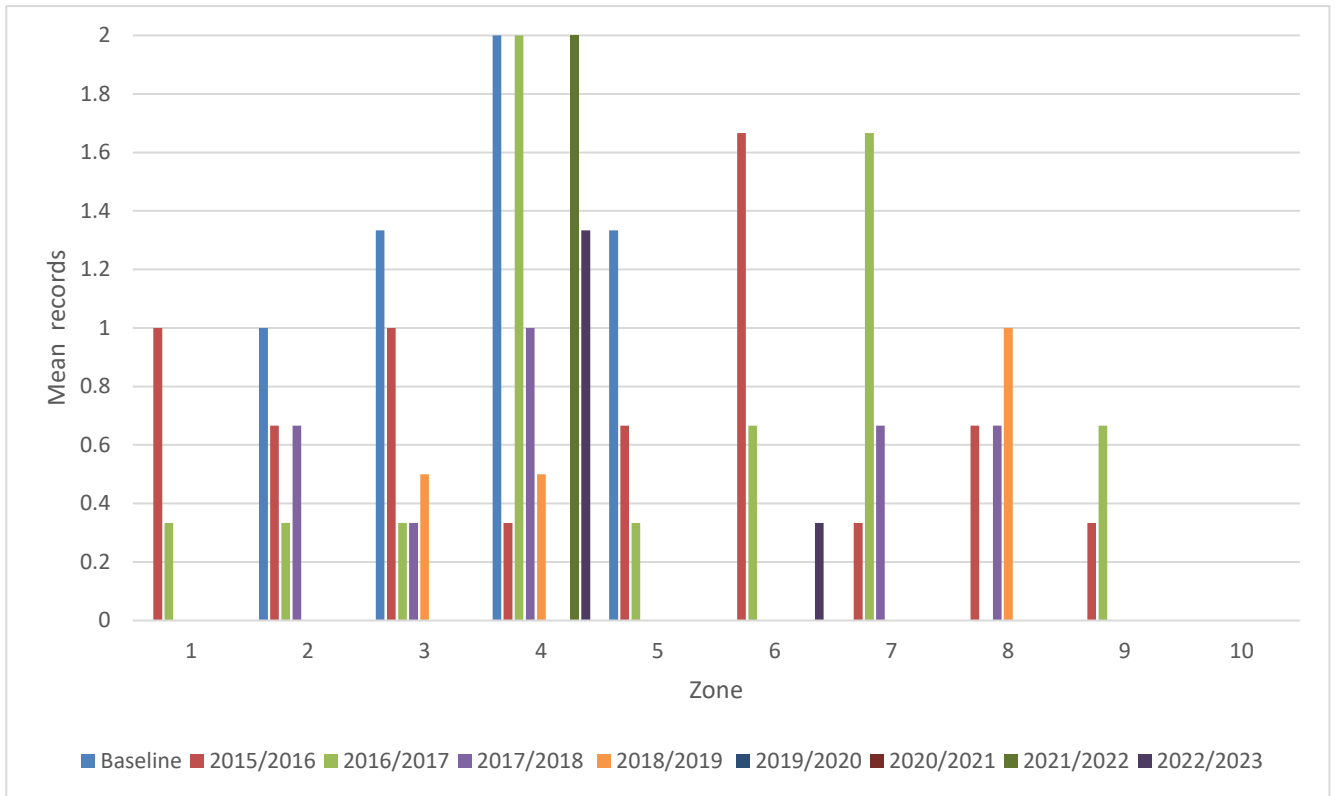
Graph 3: Monthly rainfall – All years monthly average and 2018-2023 monthly total rainfall

3.3 Density and Distribution

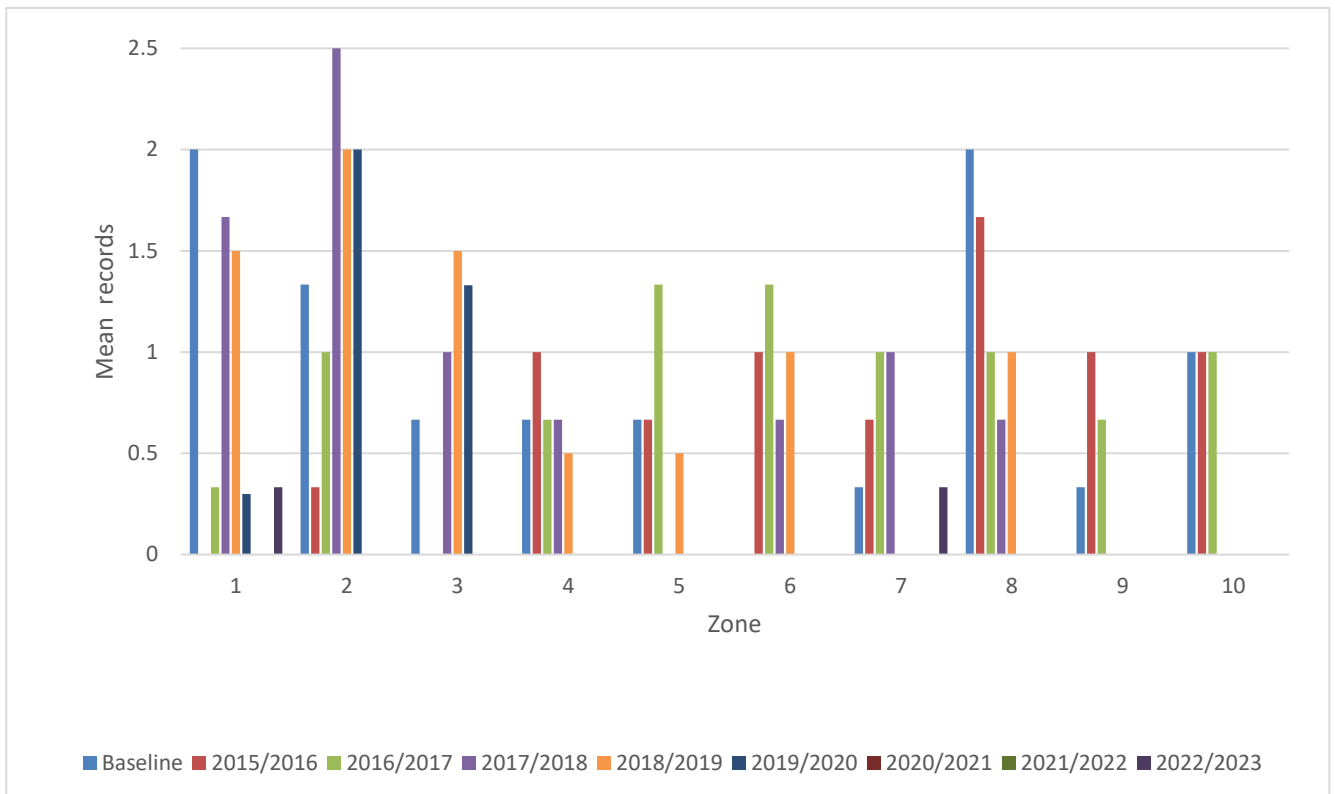
Graph 4 - Graph 9 present the density (*annual mean number of Giant Barred Frog records per zone*) and distribution of Giant Barred Frog records along the survey transect for each site and each monitoring period. Figure 8 - Figure 13 show the total number of captures within each zone over all monitoring periods.

The density of Giant Barred Frogs has been considered as the *mean number of records per year per zone* (Graph 4 to Graph 9). While the zones may vary in size slightly due to the nature of the creek’s bank formation and the non-linear nature of the creek line, the zones themselves are consistent between years. As such comparisons can be made within the same zone between years to help identify trends in changing frog numbers. There is no consistent trend evident at any site for frogs to be found in any particular zone. Density appears to be highly variable across the years and along the transect and there is no evidence of lower frog densities within zones 5 and 6, i.e. under the carriageway and immediately adjacent.

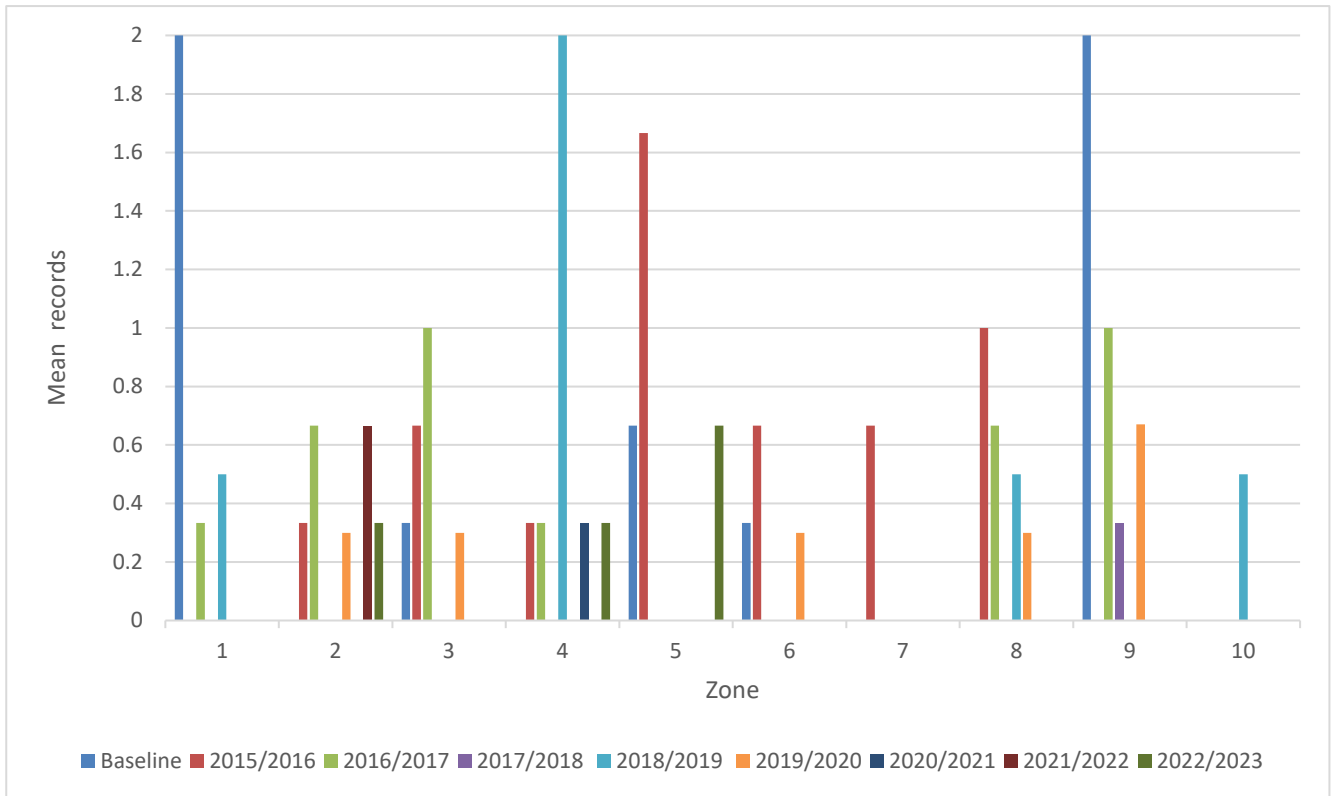
Figure 8 - Figure 13 show all capture records (i.e. cumulative records), whereby capture records (including recaptures) are shown as count ranges, where larger circles indicate larger frog counts. While density data indicates that frog distribution along the transects varies from year to year, when considering all years, frogs mostly appear to be using the entire length of the transect and there is no evidence of frogs being recorded only in one particular zone. In addition, there is no evidence of frogs being absent from zones 5 and 6. While capture frequencies within zones directly under the carriageway consistently fall into the lower range category (1-7 frogs), the low capture frequency range occurs regularly along the transects and at all sites.



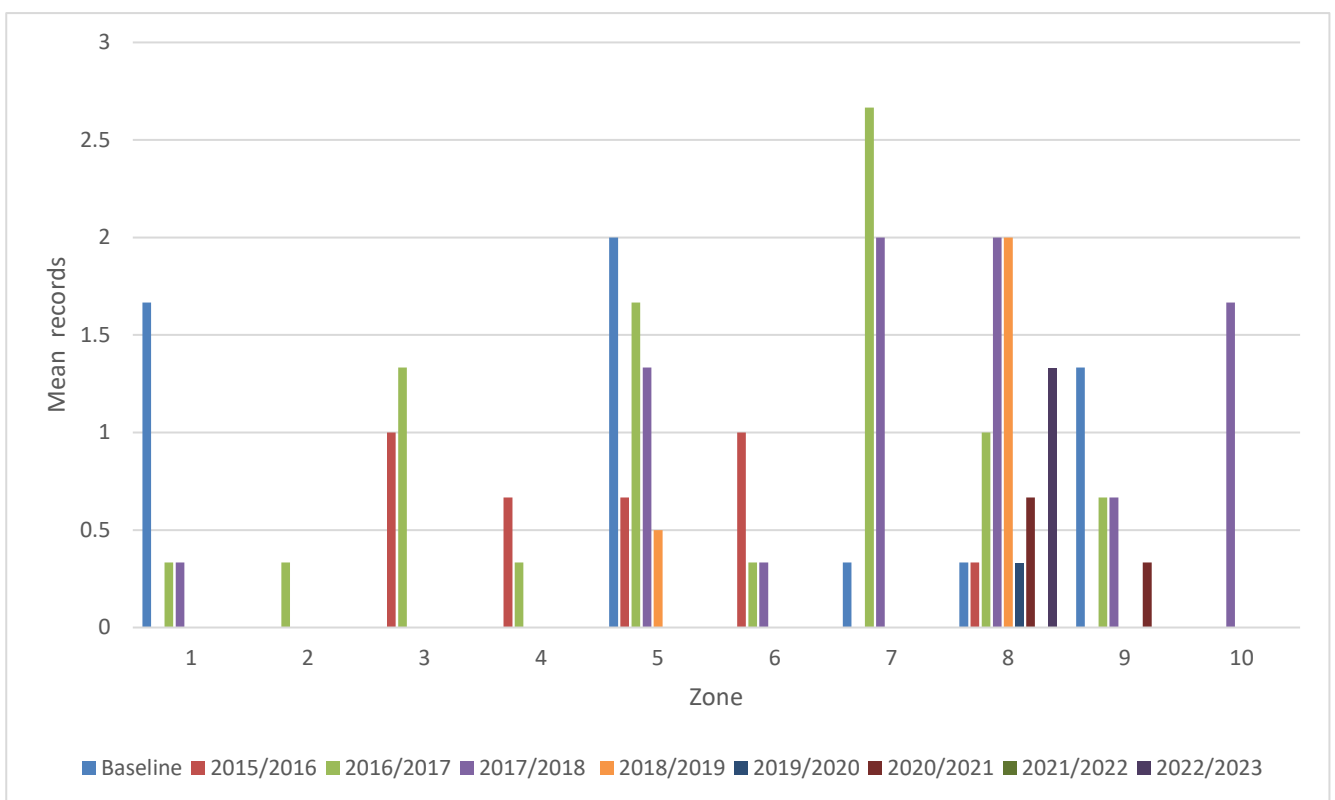
Graph 4: Cooperabung Creek impact site: mean number of Giant Barred Frogs per zone



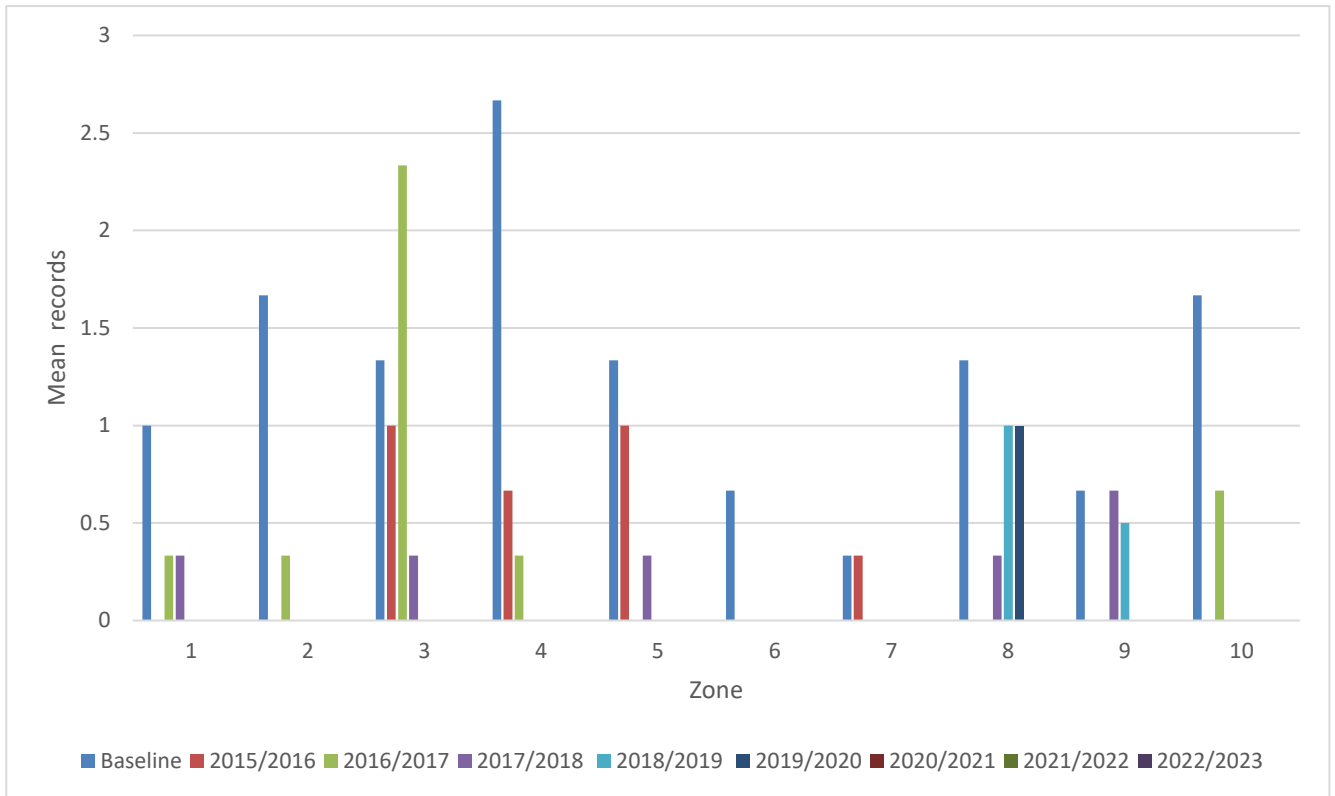
Graph 5: Smiths Creek impact site: mean number of Giant Barred Frogs per zone



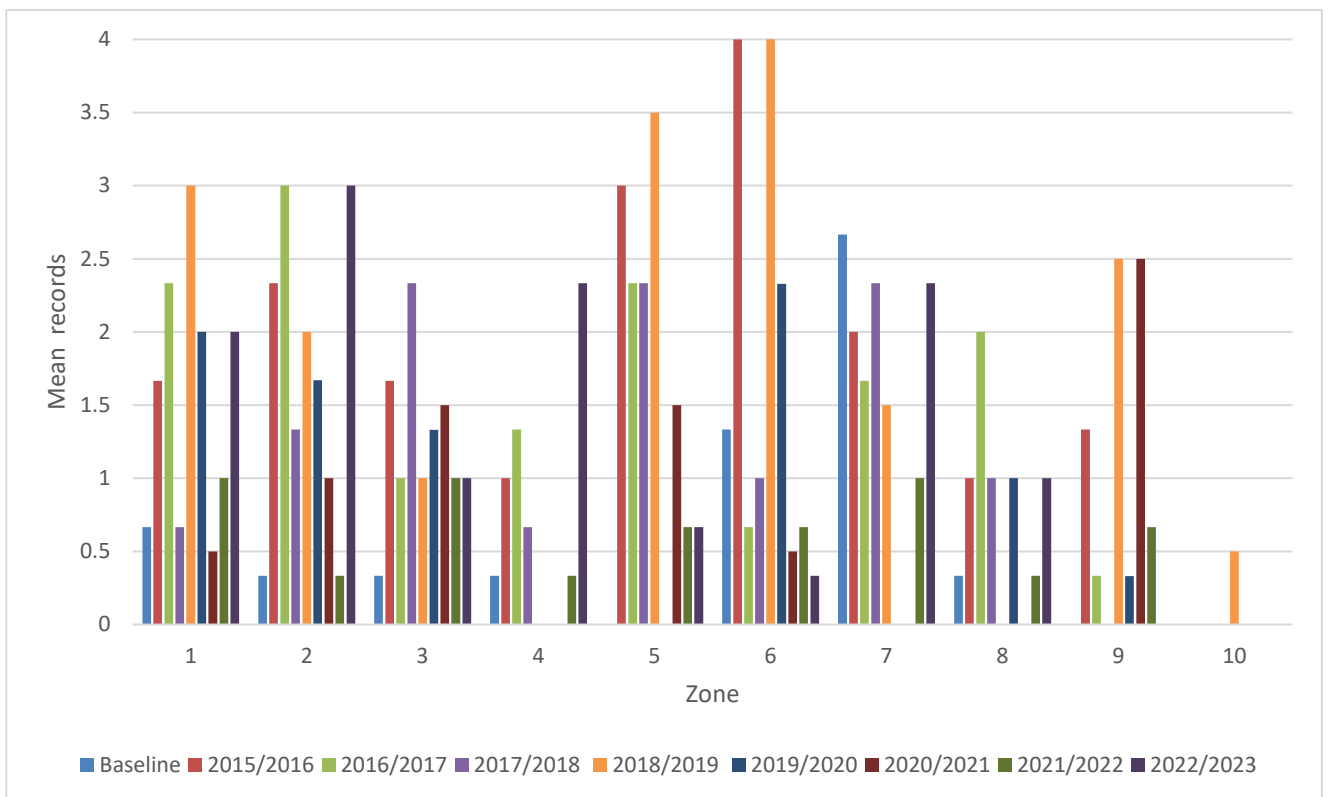
Graph 6: Pipers Creek impact site: mean number of Giant Barred Frogs per zone



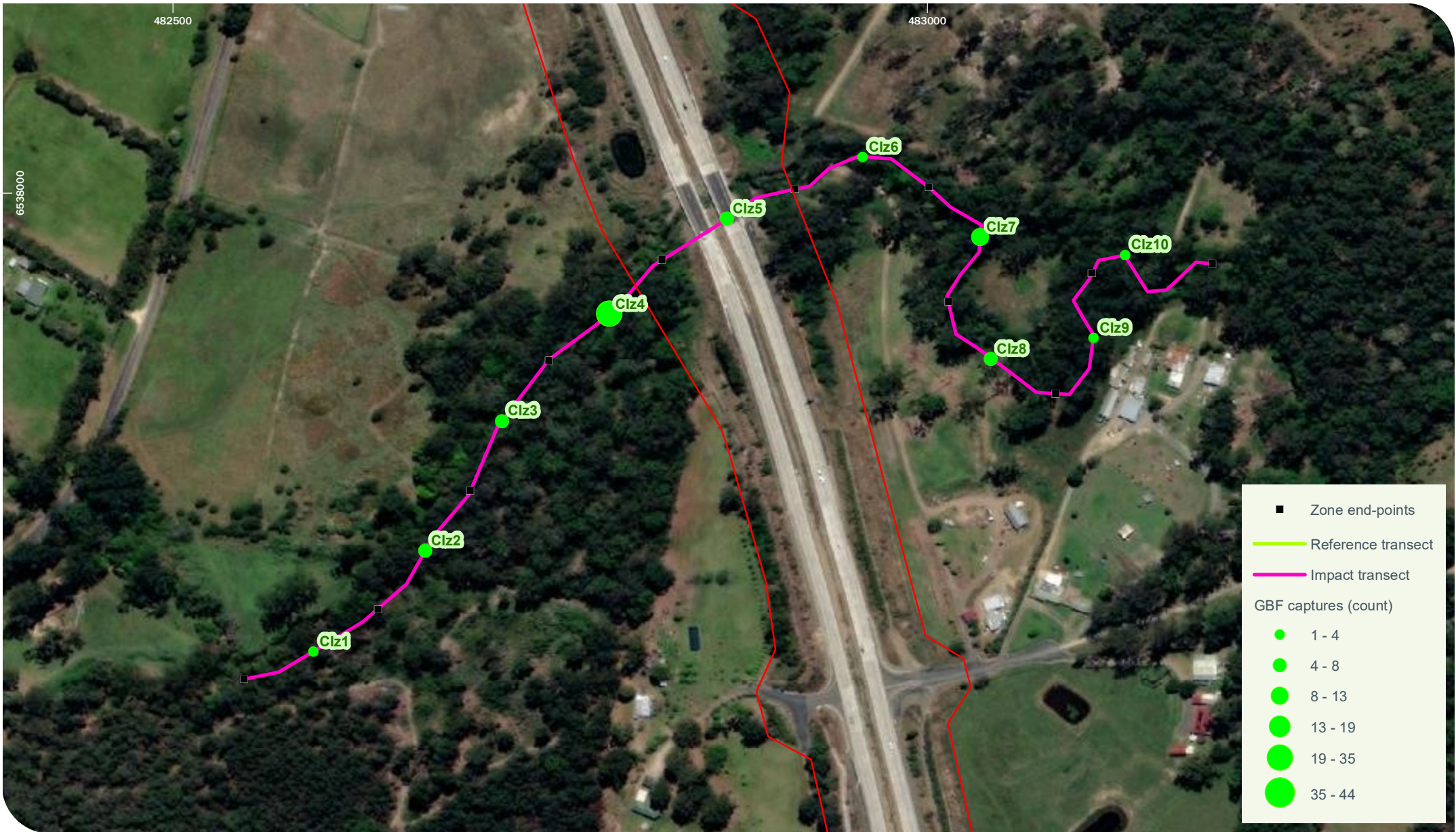
Graph 7: Maria River impact site: mean number of Giant Barred Frogs per zone



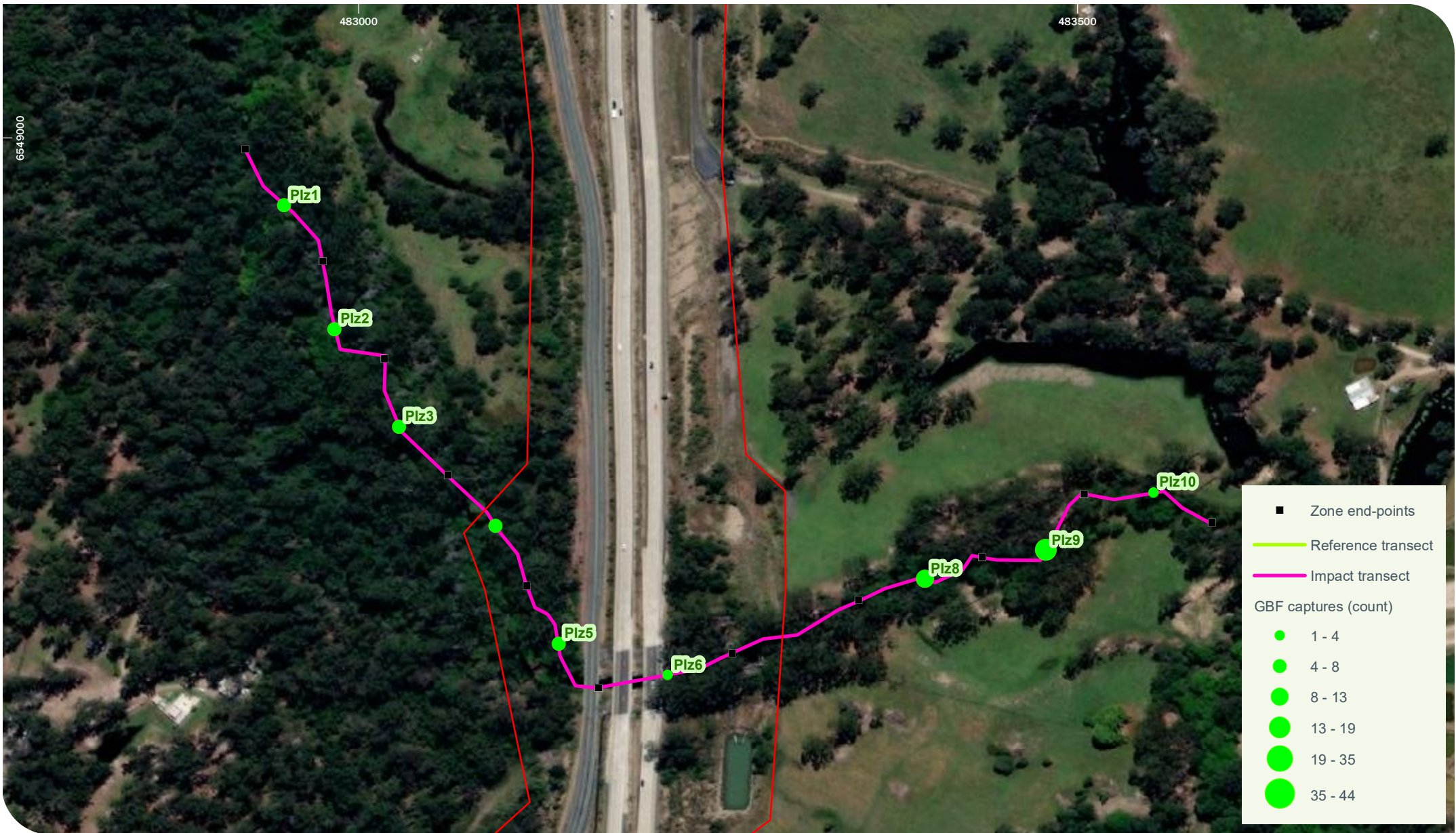
Graph 8: Cooperabung Creek reference site: mean number of Giant Barred Frogs per zone

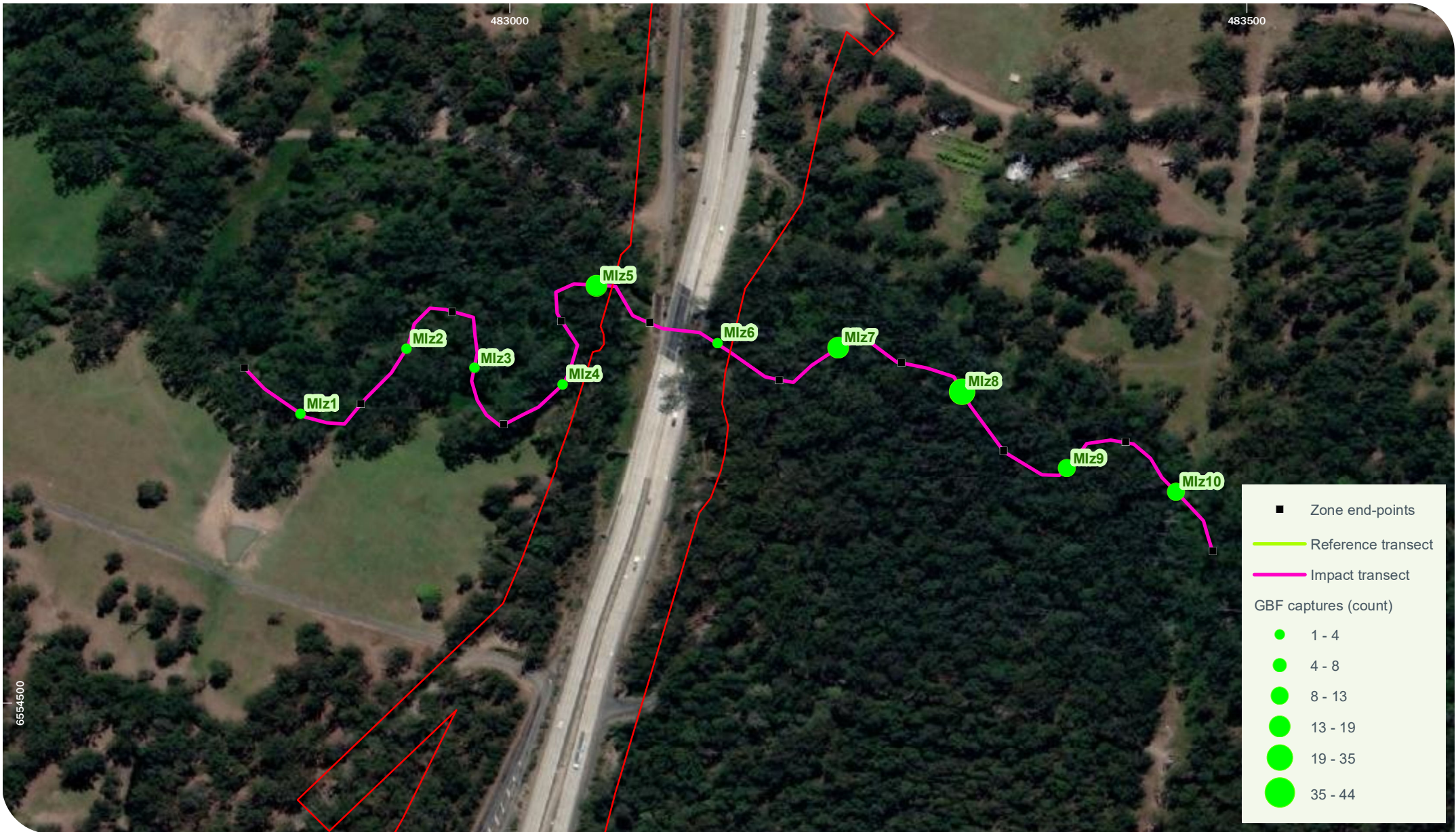


Graph 9: Pipers Creek reference site: mean number of Giant Barred Frogs per zone













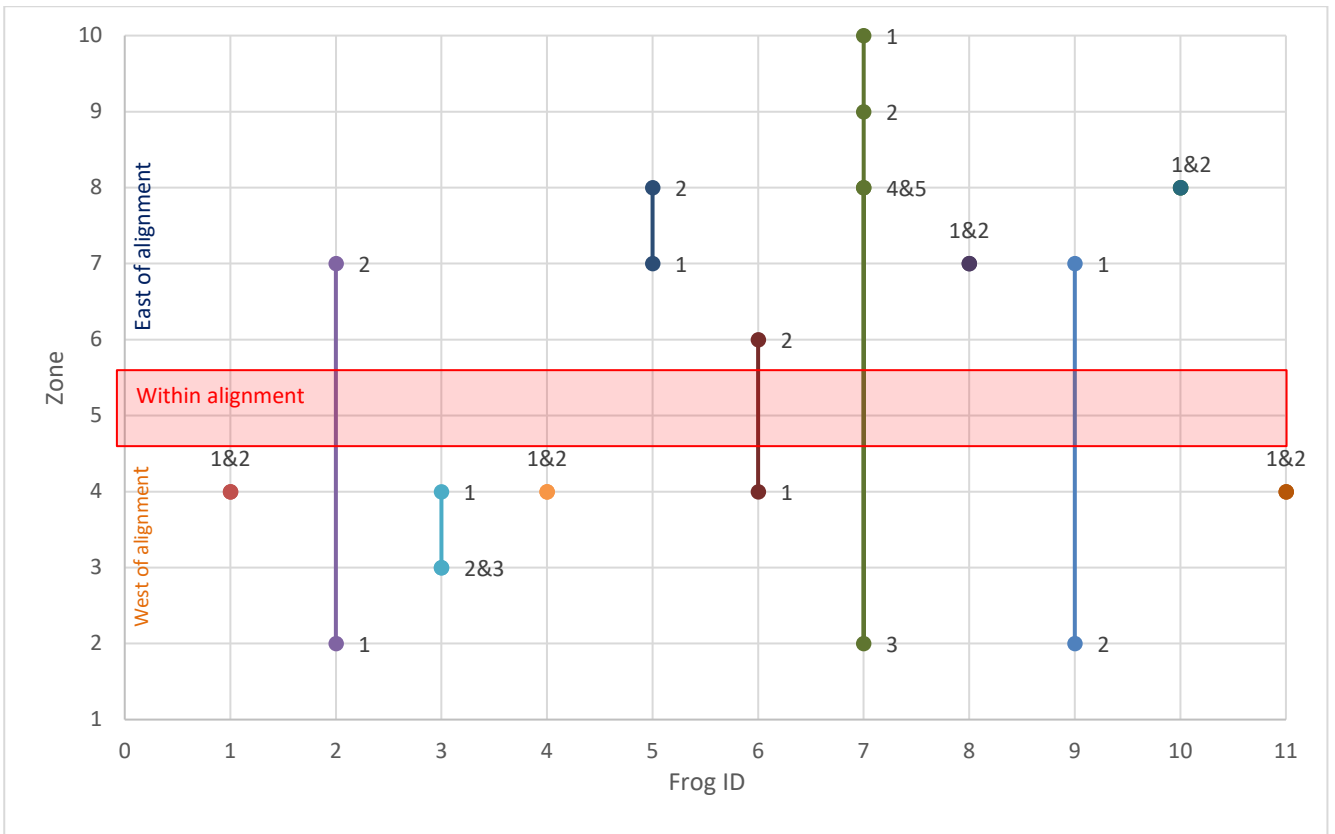
3.4 Movement

Recapture data of PIT-tagged individuals was used to determine movements along the transects, and notably, past the midpoint of the transect i.e. from one side of the carriageway to the other at the impact sites. It should be noted that this analysis does not imply that individuals that have not been found on opposite sides of the carriageway have not traversed at some time. Graph 10 - Graph 15 show the movement patterns of individual recaptured Giant Barred Frogs at each site and the data is summarised for each site below. As reference sites by their nature do not traverse the carriageway, a transect midpoint has been included to provide an indication of movements along the transects and permit comparison between reference and impact sites. The reference transect midpoint was chosen as the arbitrary location by which to assess movement along the transect (i.e. equal zones on either side). It should be noted that comparisons made between impact and reference sites do not take into account other potentially confounding factors such as site specific population ecology. Capture order is indicated by the numbers beside each capture point and a single capture point indicates recaptures within the same zone.

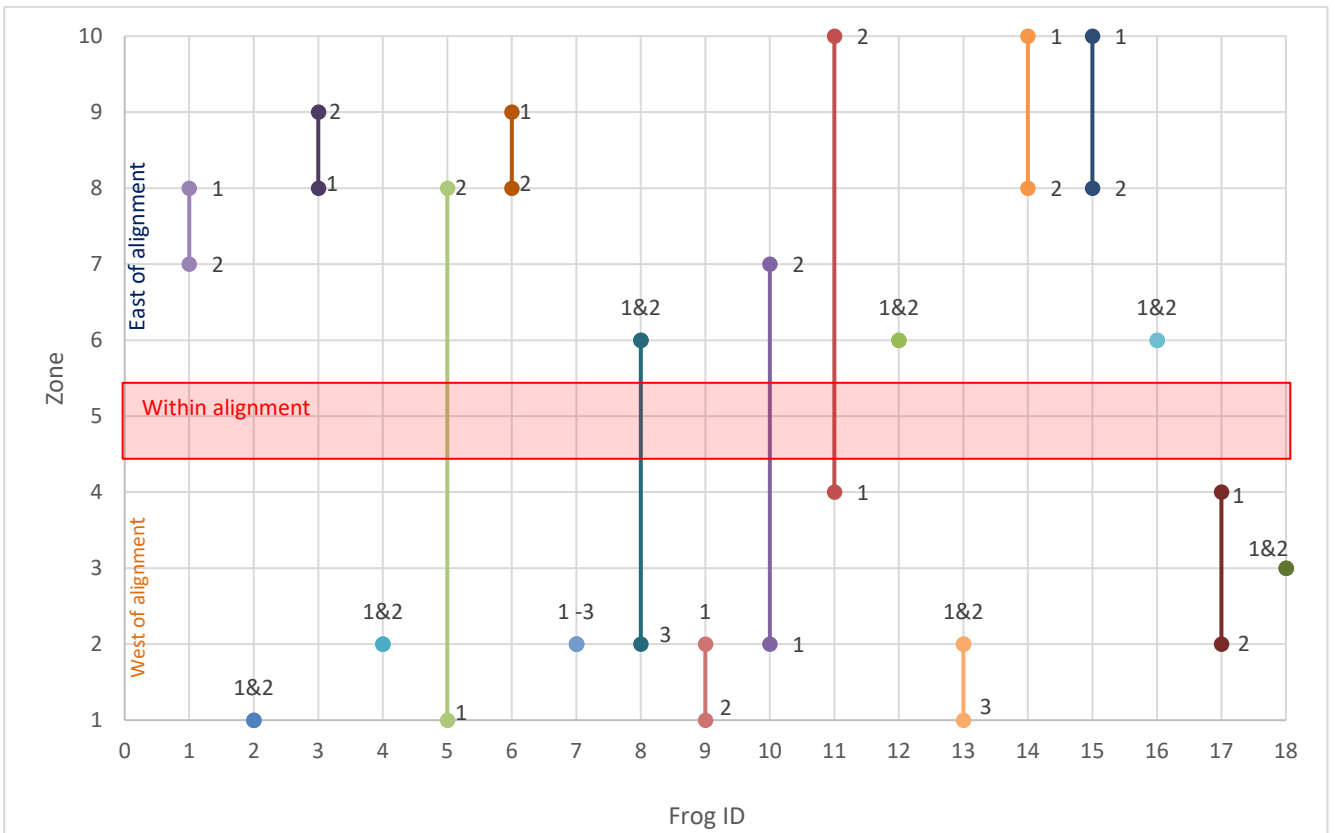
A total of 96 individuals have been recaptured on at least one occasion over all monitoring events. Of these, 52 recaptures have occurred at the impact sites. Twelve (23%) of these individuals from impact sites have been captured on both sides of the carriageway over successive monitoring events, demonstrating retained connectivity for this species under the carrageway. Of the 44 recaptures at the reference sites, 12 (27%) have been captured on both sides of the midpoint over successive monitoring events. The results at each of the monitoring sites are as follows:

- *Cooperabung Creek impact site*: Eleven Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, four (36%) have been captured on both sides of the carriageway, including one individual (ID#7) that traversed on at least two occasions.
- *Smiths Creek impact site*: Eighteen Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, four (22%) have been captured on both sides of the carriageway.
- *Pipers Creek impact site*: Fourteen Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, three (21%) have been captured on both sides of the carriageway.
- *Maria River impact site*: Nine Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, one (11%) has been captured on both sides of the carriageway.
- *Cooperabung Creek reference site*: Nine Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, two (22%) have been captured on both sides of the transect midpoint.
- *Pipers Creek reference site*: Thirty-five Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, ten (29%) have been captured on both sides of the transect midpoint, including three individuals (ID#18, 19 and 23) that have traversed on at least two occasions.

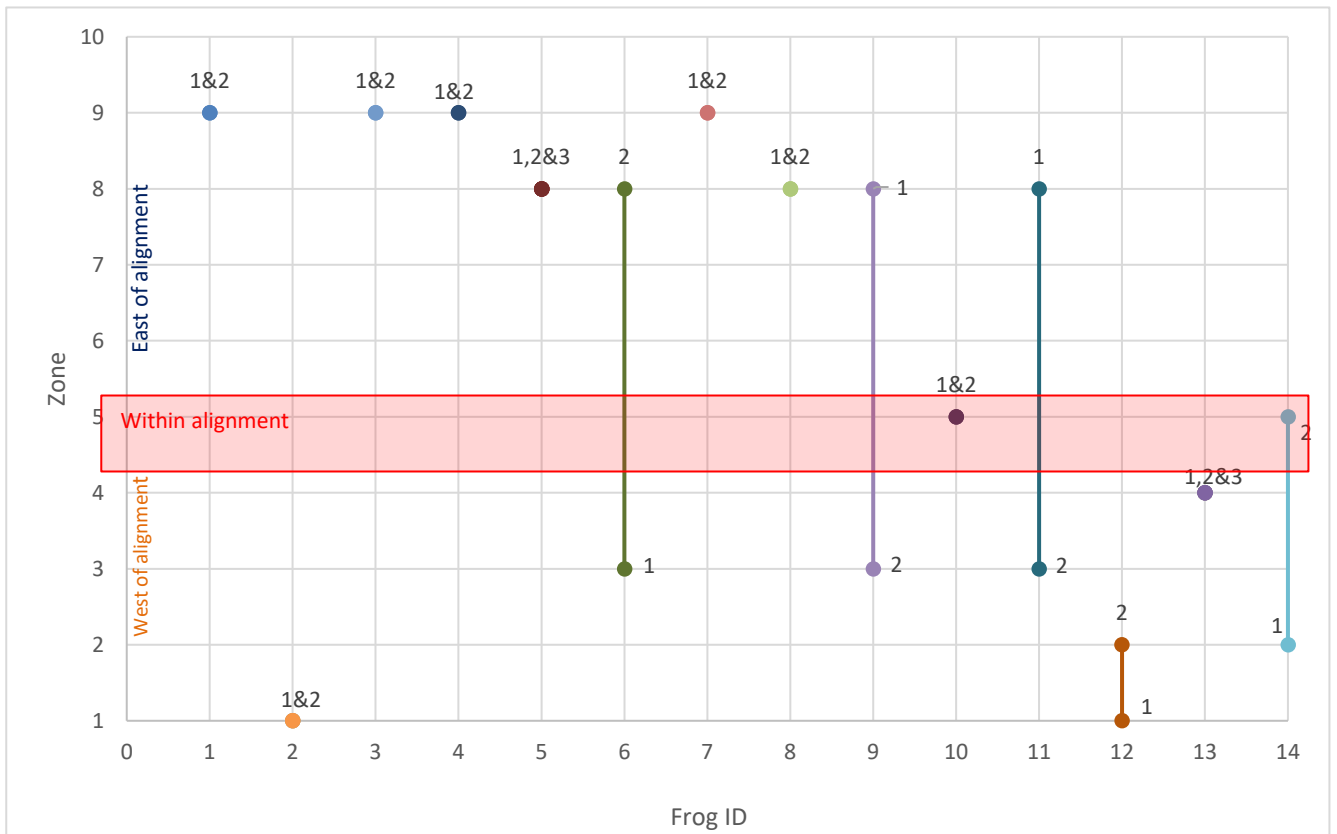
At the impact sites, while the monitored waterways continue uninterrupted under the carriageway, there is a distinct change in streamside vegetation within the area immediately under the carriageway. Under the carriageway at all impact sites, streamside vegetation ranges from limited to moderately dense, represented by patches of shrubs and/or *Lomandra* spp. The streamside habitat in these areas consists of native vegetation, large rocks and boulders or bare ground. Despite changes in streamside habitat immediately under the carriageway, a number of Giant Barred Frogs have been recorded traversing the carriageway. The percentage of Giant Barred Frogs found to have traversed the impact site midpoints do not appear to differ substantially from the percentage of Giant Barred Frogs found to have traversed the reference site midpoints.



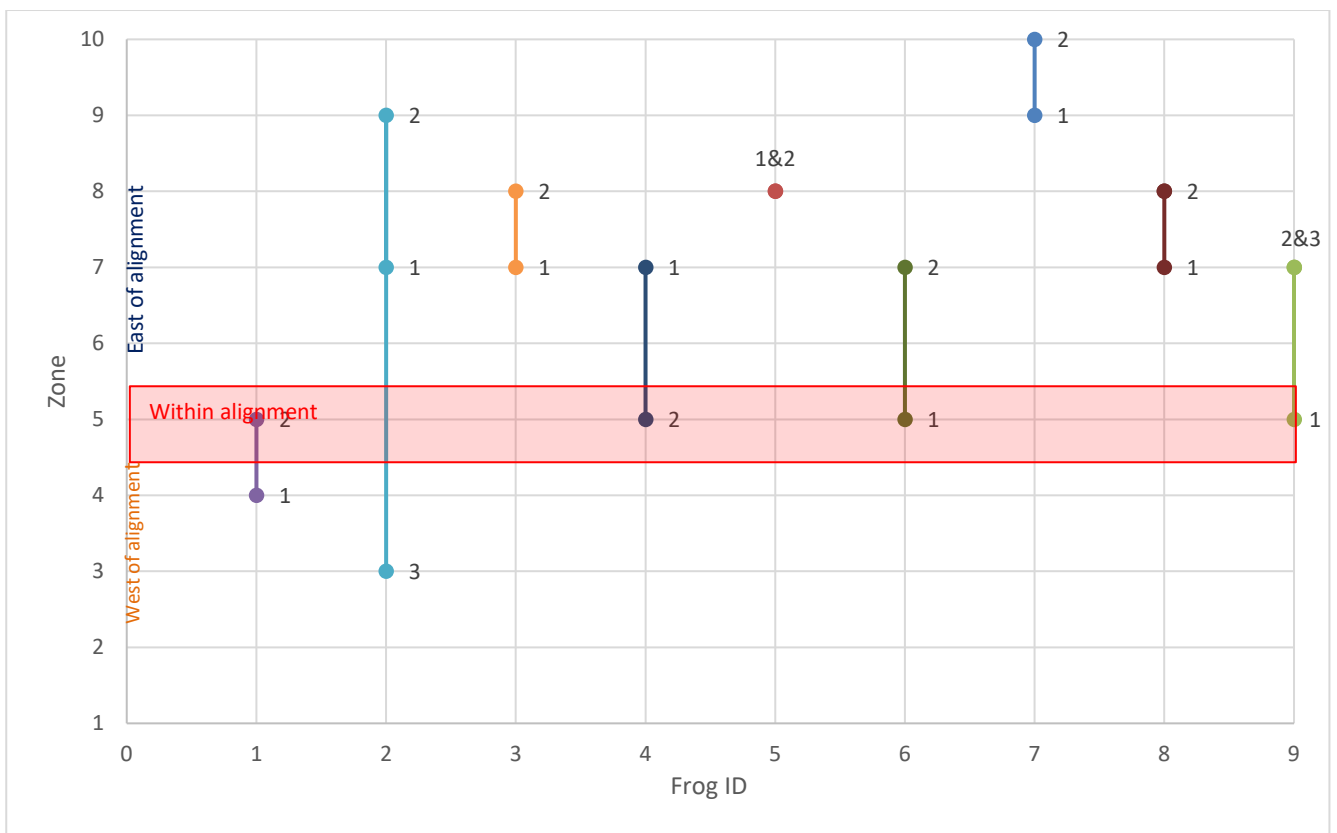
Graph 10: Cooperabung Creek impact site: recapture movement patterns



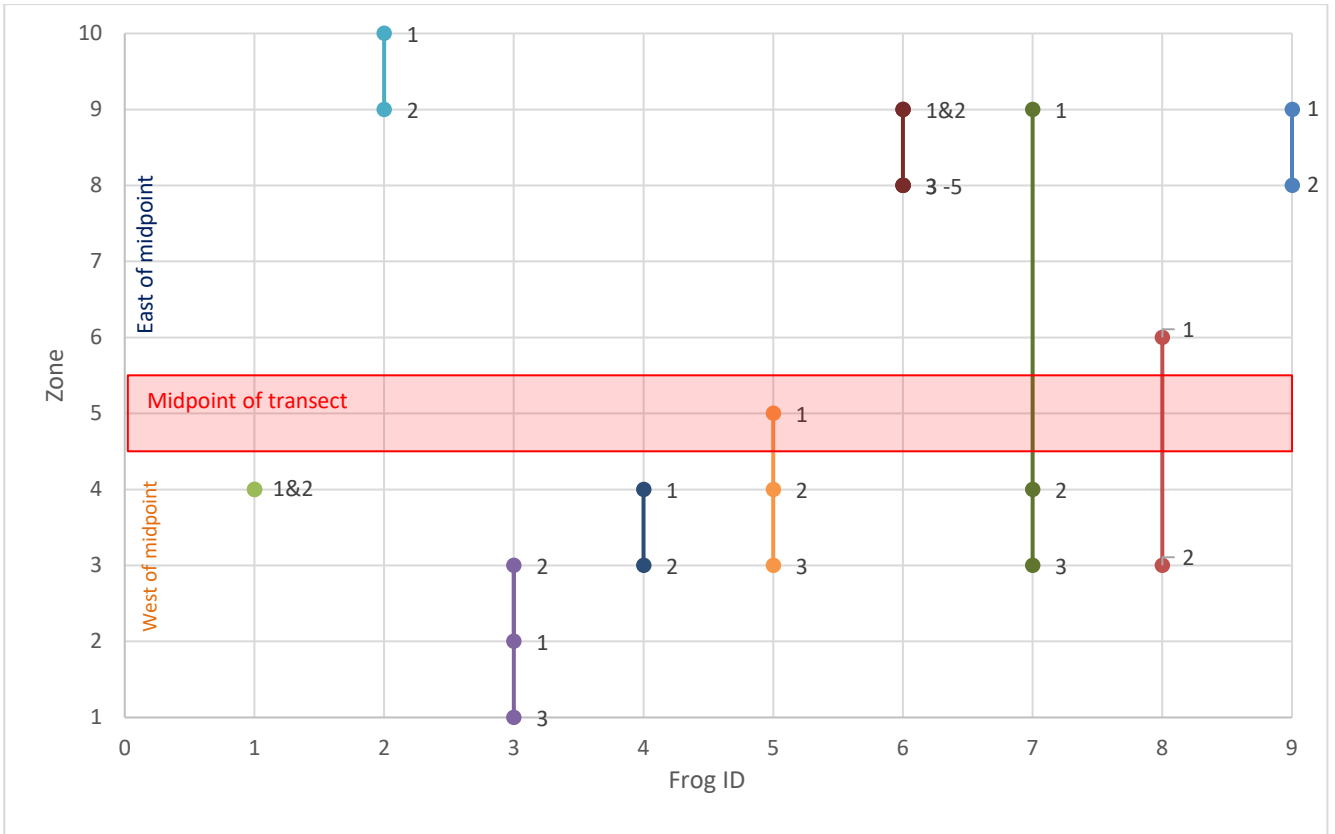
Graph 11: Smiths Creek impact site: recapture movement patterns



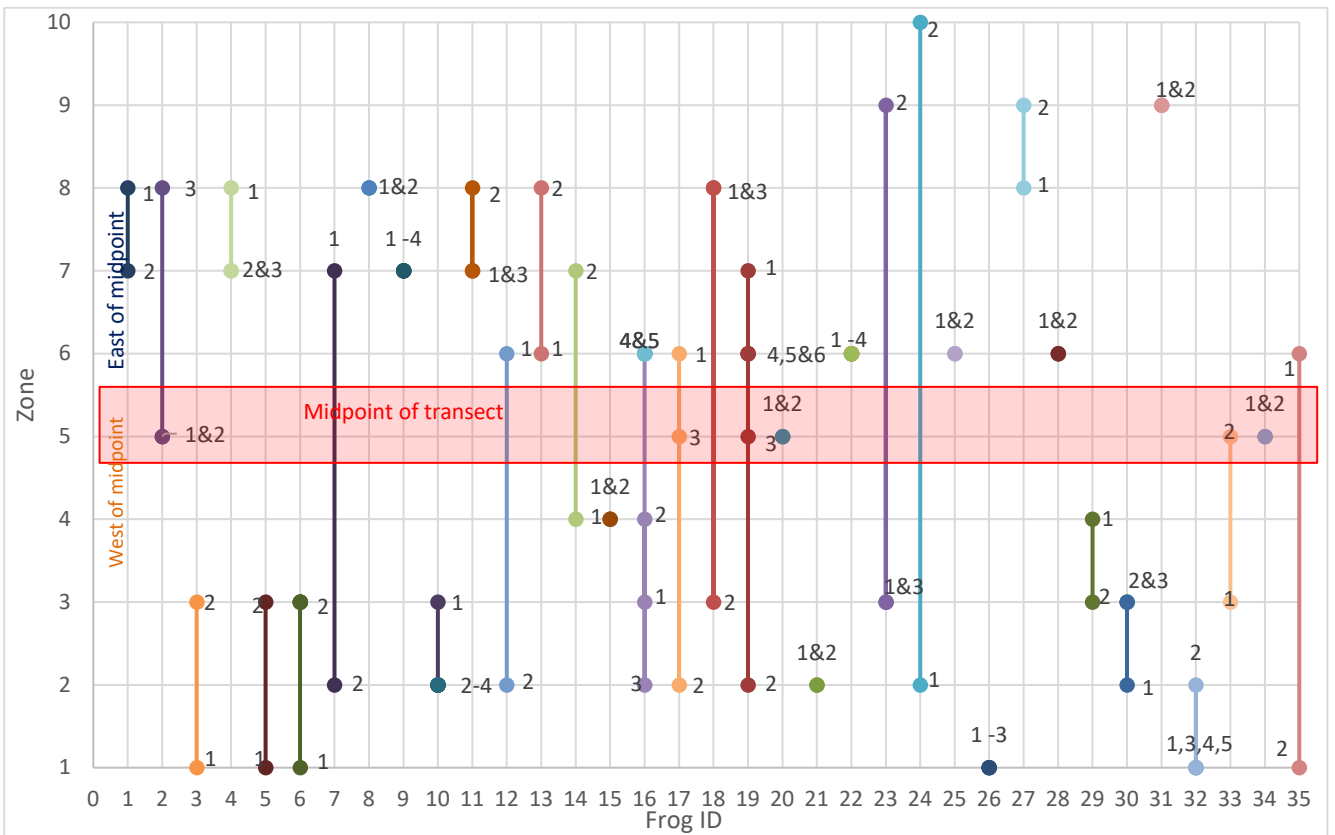
Graph 12: Pipers Creek impact site: recapture movement patterns



Graph 13: Maria River impact site: recapture movement patterns



Graph 14: Cooperabung Creek reference site: recapture movement patterns



Graph 15: Pipers Creek reference site: recapture movement patterns

4. Discussion

4.1 Performance Measures

A summary of Year 1 (2015/2016), Year 2 (2016/2017), Year 3 (2017/2018), Year 4 (2018/2019), Year 5 (2019/2020), Year 6 (2020/2021), Year 7 (2021/2022) and Year 8 (2022/2023) survey results in relation to the performance measures is provided in Table 5.

Table 4: Performance measures and discussion of results.

Performance measure	Discussion
Monitoring is undertaken during baseline surveys and Years 1 – 8 or until monitoring can demonstrate that mitigation measures are effective.	This performance measure has been met for all years. Giant Barred Frog monitoring has been undertaken at all six baseline sites at least twice during the monitoring period according to the EMP to date.
Monitoring during Year 1 – 8 is undertaken at the Impact and Control sites where baseline monitoring was undertaken, subject to landowner agreement.	This performance measure has been met for all years. Giant Barred Frog monitoring has been undertaken at all six baseline sites at least twice during the monitoring period, where landowner agreement permitted.
Continued presence of Giant Barred Frogs during each survey event in Year 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.	<p>This performance measure has been met for all sites in Year 1 (2015/2016), 5 of 6 sites in Year 2 (2016/2017), Year 3 (2017/2018), Year 4 (2018/2019), 3 of 6 sites in Year 5 (2019/2020), 2 of 6 sites in Year 6 (2020/2021), 1 of 6 sites in Year 7 (2021/2022) and 3 of 6 sites in Year 8.</p> <p>Baseline: Giant Barred Frogs were recorded at all six monitoring sites in spring and summer and at four sites in autumn. Giant Barred Frogs were not recorded at the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey.</p> <p>Year 1 (2015/2016): Giant Barred Frogs were detected at all six sites during all surveys.</p> <p>Year 2 (2016/2017): Giant Barred Frogs were detected at all six sites in spring and summer and five sites in autumn. Not recorded at Pipers Creek impact site during the autumn 2017 survey where it was detected during baseline surveys.</p> <p>Year 3 (2017/2018): Giant Barred Frogs were detected at all six sites in spring and five sites in summer and autumn. Not recorded at Pipers Creek impact site during summer and autumn 2018 where it was detected during baseline surveys.</p> <p>Year 4 (2018/2019): Giant Barred Frogs were detected at five sites in spring and all six sites in autumn. Not recorded at Cooperabung Creek reference site during spring 2018 where it was detected during baseline surveys.</p> <p>Year 5 (2019/2020): Giant Barred Frogs were not recorded at Cooperabung Creek impact site, where it was recorded during all three baseline surveys. Not recorded at Maria River impact during summer 2020, where it was recorded during baseline surveys and not recorded at Cooperabung Creek reference site during spring 2019, where it was detected during baseline surveys.</p> <p>Year 6 (2020/2021): Giant Barred Frogs were not recorded at Cooperabung Creek impact, Smiths Creek impact and Cooperabung reference sites during 2020/2021 surveys. Giant Barred Frogs were not recorded during autumn surveys (Pipers Creek reference site was not surveyed). Giant Barred Frogs were detected in summer at Maria River impact, Pipers Creek impact and Pipers Creek reference sites. Giant Barred Frogs were detected during spring surveys only at Maria River impact and Pipers Creek reference sites.</p> <p>Year 7 (2021/2022): Giant Barred Frogs were not recorded at Smiths Creek impact, Maria River impact and Cooperabung reference sites during 2021/2022 surveys. Giant Barred Frogs were not recorded in spring at Cooperabung impact site or autumn at Pipers Creek impact site.</p>

Performance measure	Discussion
	<p>Year 8 (2022/2023): Giant Barred Frogs were not recorded at the Cooperabung reference site during 2022/2023 surveys. Giant Barred Frogs were not recorded in summer or autumn at Smiths Creek impact site or spring at Maria River impact site.</p>
<p>Mitigation measures are effective as defined in the EPBC approval when all monitoring events are considered at Year 8.</p>	<p>This performance measure has been met.</p> <p>Mitigation measures for the Giant Barred Frog include protection of habitat during clearing and construction, pre-clearing surveys, installation of Giant Barred Frog fence and an unexpected finds procedure (Lewis 2013).</p> <p>Construction related mitigation measures were successfully implemented and may be deemed to have been effective as frogs observed during works were captured and released safely, and no threatened fauna mortalities due to clearing operations were reported.</p> <p>The effectiveness of the Giant Barred Frog Fence is assessed using the outcomes of road kill surveys and targeted threatened frog searches. To date, Giant Barred Frogs have not been identified as road kill. However, surveys of the frog fence note a number of maintenance issues that may impair the integrity of the frog fence (Niche 2023). Recommendations have been made below.</p> <p>Results (review of movement patterns of re-captured individuals showing records along the creek on either side of the carriageway) indicate that Giant Barred Frogs are moving underneath the road. It is unknown if they used the underpasses, however, no breaches of the frog fencing were observed during surveys.</p>
<p>Median values of all downstream water quality monitoring at GBF habitat or potential habitat locations during construction and operation (Year 1 – 6) is less than the 80th percentile value of the upstream site (where 80th percentile is the value at which median values at the downstream site are above 80% of the recorded background water quality records), where this change is found to be attributable to construction or operation.</p>	<p>This performance measure is not applicable for Year 8.</p>
<p>No change to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Year 1 – 8, and then when all monitoring events are considered at Year 8.</p>	<p>This performance measure has not been met.</p> <p>The number and location of Giant Barred Frogs recorded has varied between season and year at all sites. All sites show fluctuating densities. However, as trends are evident at both impact and reference sites, it is not possible to attribute these changes to the Project.</p> <p>As discussed, the high rainfall experience in 2020/2021 and 2021/2022 resulted in highly variable water levels, waterway flooding and expansive water flows across floodplains. The above-average rainfall conditions observed over the spring/summer periods of 2020/2021 and 2021/2022 follow the long-term drought conditions experienced across the Project area in 2019. It is possible that the population changes observed at all sites are in response to these changing conditions. Low capture rates may be a result of population impacts from drought conditions followed by waterway flooding, which is also likely to reduce capture and observation rates simply due to the likely dispersal of individuals across a broader wet area. A population response to improved waterway conditions after the 2020/2021 rainfall may be evidenced by the increased capture rates at some sites, but also hindered by difficult (flooding) survey conditions.</p> <p>Within-year movement patterns that would permit comparison between baseline and subsequent monitoring events is not possible due to lack of data (surveys and captures are too infrequent), however, assessment of movement patterns of recaptured individuals over all surveys show that 25% of recaptured frogs have been found to traverse from one side of the carriageway to the other.</p>

5. Recommendations

5.1 Contingency Measures

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered relevant to the Giant Barred Frog monitoring program are listed and discussed in Table 6.

Table 5: Contingency measures

Potential problem	Contingency measure proposed in EMP	Discussion of proposed measure
Decline in presence of target species recorded at Impact sites after the upgrade has been completed, when compared to change in Control sites.	<p>The cause of the decline in populations at impacts sites will be investigated in consultation with EPA and DoTE within two weeks of results reported by ecologist.</p> <p>If the cause of decline is considered most likely attributed to the upgrade of the highway (and not another event such as bushfire), mitigation measures, such as the location and types of fauna crossings and fauna fencing will be reviewed within two months of the above consultation being completed.</p>	<p>The number and location of Giant Barred Frogs recorded has varied between season and year at all sites. All sites show fluctuating densities. However, as trends are evident at both impact and reference sites, it is not possible to attribute these changes to the Project.</p> <p>The potential influence of environmental variables, such as drought and widespread flooding, may have contributed to the decreasing trend in records/observations.</p> <p>This contingency measure is not considered relevant.</p>

5.2 Recommendations

A summary of those performance indicators that were not met in the 2022/2023 monitoring period, recommended corrective actions and general recommendations are provided in Table 7.

Given the number and location of Giant Barred Frogs recorded has varied between season and year at all sites and that trends are evident at both impact and reference sites, it is not possible to attribute these changes to the Project, therefore further monitoring is not recommended.

However, it is recommended that maintenance actions specified within the Fauna Fence and Roadkill Monitoring 2022/2023 Report (Niche 2023) are carried out in order to maintain the ongoing integrity of the frog fence.

Table 6: Recommendations

Performance measure	Action
Continued presence of Giant Barred Frogs during each survey event in Year 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.	<p>This performance measure has been met for 3 of 6 sites in Year 8 (2022/2023).</p> <p>Giant Barred Frogs were</p> <ul style="list-style-type: none"> Not recorded at the Cooperabung Creek reference site, where it was recorded during all three baseline surveys. Not recorded at Smiths Creek impact site in summer or autumn 2022/2023 and Maria River impact site in spring 2022, where it was recorded during baseline surveys. <p>The Project area experienced drought conditions in 2019 with below average rainfall followed by substantially higher than average rainfall during 2020/2021 and 2021/2022 resulting in waterway flooding and highly variable water levels. Frogs have since been recorded at all impact sites in at least one season during Year 8 monitoring, including at sites where they had not been recorded for a number of years, demonstrating continued presence at these sites. Recent records likely reflect natural population fluctuations associated with extreme climatic conditions experienced from Year 4 to Year 6 (2019 to 2022).</p>

Performance measure	Action
	<p>Given the number and location of Giant Barred Frogs recorded has varied between season and year at all sites and that trends are evident at both impact and reference sites, it is not possible to attribute these changes to the Project, therefore further monitoring is not recommended.</p>
<p>No change to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Year 1 – 8, and then when all monitoring events are considered at Year 8.</p>	<p>This performance measure has not been met.</p> <p>Given the number and location of Giant Barred Frogs recorded has varied between season and year at all sites and that trends are evident at both impact and reference sites, it is not possible to attribute these changes to the Project, therefore further monitoring is not recommended.</p>

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Niche (2015b). Giant Barred Frog monitoring: Baseline Surveys – Oxley Highway to Kempsey, Pacific Highway Upgrade. Report prepared for Roads and Maritime Services by Niche Environment and Heritage Pty Ltd.

Niche (2016). Giant Barred Frog monitoring: 2015/2016 – Oxley Highway to Kempsey, Pacific Highway Upgrade. Report prepared for Roads and Maritime Services by Niche Environment and Heritage Pty Ltd.

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Annex 1 – 2022/2023 data summary for each monitoring site

Cooperabung Creek impact site

Table 7: Summary of surveys and prevailing abiotic variables: Cooperabung Creek impact site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
25/10/2022	Start	22:22	18.6	16	96	150	1	0	0
	Finish	01:00	16	16	88	50	0	0	0
016/02/2023	Start	22:25	21	21	82	50	0	0	0
	Finish	01:00	21	21	82	50	0	0	0
03/04/2023	Start	22:15	18	20	unk	1	0	90	1
	Finish	01:10	17	20	unk	1	0	70	1

Table 8: Habitat details: Cooperabung Creek impact site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
3	75	5	80	5	2	no	1	2	100	yes	no	Unk
4	80	5	70	38	10	no	1	0	100	yes	yes	Unk
5	50	25	60	25	0	no	1	1	100	yes	no	Unk

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 9: Summary of captures: Cooperabung Creek impact site

	Spring 2022	Summer 2023	Autumn 2023
Number of frogs recorded	2	2	0
Number of adult males	0	0	0
Number of adult females	2	2	0
Number of sub-adults	0	0	0
Number of juveniles	0	0	1
Number of recaptures	0	0	0

Habitat: Microhabitat within these zones included flood debris as overhang shelter, lomandra and leaf litter.

Smiths Creek impact site

Table 10: Summary of surveys and prevailing abiotic variables: Smiths Creek impact site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
25/10/2022	Start	19:38	19.7	17	88	100	1	100	2
	Finish	19:38	17.1	17	100	100	1	5	0
16/02/2023	Start	23:00		21					0
	Finish	01:30		21					0
05/04/2023	Start	21:39	17	20	35	1	0	20	0
	Finish	23:55	16	20			1	20	0

Table 11: Habitat details: Smiths Creek impact site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
1	30	5	10	5	80	no	1	0	200	yes	yes	Unk
2	50	5	20	15	20	no	1	1	200	yes	yes	Unk
3	80	5	2	80	10	no	1	0	200	yes	no	Unk
4	70	30	70	50	1	no	1	0	200	yes	no	Unk
5	2	20	50	10	0	no	2	1	200	yes	no	Unk
6	15	2	50	2	50	yes	1	1	200	yes	no	Unk
7	25	2	80	15	10	yes	3	1	100	yes	yes	Unk
8	60	2	80	5	15	yes	2	1	100	yes	no	Unk
9			50	25	1	yes	2	0	100	yes	no	Unk
10	2	1	80	5	15	yes	1	0	150	yes	no	Unk

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 12: Summary of captures: Smiths Creek impact site

	Spring 2022	Summer 2023	Autumn 2023
Number of frogs recorded	3	0	0
Number of adult males	1	0	0
Number of adult females	2	0	0
Number of sub-adults	0	0	0
Number of juveniles	0	0	0
Number of recaptures	0	0	0

Habitat: Microhabitat within these zones included leaf litter, flood debris under log and on bare ground.

Pipers Creek impact site

Table 13: Summary of surveys and prevailing abiotic variables: Pipers Creek impact site

Date	Time	Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
27/10/2022	Start	22:21	18.2	17	96	100	0	0
	Finish	1:21	17.3	17	98	50	0	0
16/02/2023	Start	20:15		21				0
	Finish	23:00		21				0
05/04/2023	Start	18:27	21	20	60		0	30
	Finish	21:27	17	20			0	10

Table 14: Habitat details: Pipers Creek impact site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
1	98	10	5	2	95	no	0	0	200	yes	no	Unk
2	95	30	25	2	75	no	0	1	200	yes	yes	Unk
3	80	50	2	90	10	no	1	1	200	yes	no	Unk
4	85	15	5	85	10	no	0	0	100	yes	yes	Unk
5	50	35	70	50	0	no	1	2	100	yes	yes	Unk
6	50	60	90	5	5	yes	0	0	100	yes	no	Unk
7	5	2	50	1	50	yes	0	0	100	yes	no	Unk
8	50	1	90	5	5	yes	0	1	200	yes	no	Unk
9	20	2	50	2	50	yes	0	1	60	yes	no	Unk
10	15	10	80	2	20	yes	0	0	100	yes	no	Unk

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish, - = unknown

Table 15: Summary of captures: Pipers Creek impact site

	Spring 2022	Summer 2023	Autumn 2023
Number of frogs recorded	1	2	1
Number of adult males	1	0	0
Number of adult females	0	2	1
Number of sub-adults	0	0	0
Number of juveniles	0	0	0
Number of recaptures	0	0	1

Habitat: Microhabitat use included leaf litter and on bare ground at tree base.

Maria River impact site

Table 16: Summary of surveys and prevailing abiotic variables: Maria River impact site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
27/10/2022	Start	0:38	17.3	17	100	50	0	0	0
	Finish	03:20	15.7	17	100	100	0	0	0
15/02/2023	Start	1:46	15.2	21	100	50	0	0	0
	Finish	3:46	14.8	21	100	50	0	0	0
04/04/2023	Start	0:48	18	20	unk	1	0	100	0
	Finish	1:11	18	20	100	1	1	100	1

Table 17: Habitat details: Maria River impact site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
6	30	80	5	10	80	no	1	0		yes	no	Unk
7	90	60	5	45	50	no	1	0		yes	no	Unk
8	70	60	10	95	5	no	1	0		no	yes	Unk
9	85	70	50	10	20	no	1	0		yes	no	Unk

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 18: Summary of captures: Maria River impact site

	Spring 2022	Summer 2023	Autumn 2023
Number of frogs recorded	0	3	1
Number of adult males	0	2	1
Number of adult females	0	1	0
Number of sub-adults	0	0	0
Number of juveniles	0	0	0
Number of recaptures	0	0	0

Habitat: Microhabitat within these zones included under grass and leaf litter. Lantana is very abundant along both side of the river banks and is the dominant vegetation from Miz1 to Miz5. Lantana has also increased it's dominance of the downstream side throughout all zones. Access in 2022/2023 to certain areas of the transect was not possible due to increased lantana.

Cooperabung Creek reference site

Table 19: Summary of surveys and prevailing abiotic variables: Cooperabung Creek reference site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
25/10/2022	Start	22:22	18.6	17	96	150	1	0	0
	Finish	0:30	16	17	88	50	0	0	0
9/12/2021	Start	22:25	21	21	82	50	0	0	0
	Finish	22:25	21	21	82	50	0	0	0
03/04/2023	Start	18:57	19	18		30	0	50	0
	Finish	23:46	18	18		30	0	40	0

Table 20: Habitat details: Cooperabung Creek reference site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	Frogs detected	EF	FB
1	30	25	5	80	0	no	1	2	20	no	yes	Unk
2	50	2	70	30	5	yes	1	2	50	no	yes	Unk
3	80	15	5	35	60	no	1	4	40	no	yes	Unk
4	90	40	20	70	10	yes	2	3	50	no	yes	Unk
5	50	35	20	15	20	yes	2	2	50	no	yes	Unk
6	80	15	50	38	10	no	2	3	50	no	yes	Unk
7	20	5	90	10	0	yes	0	2	0	no	yes	Unk
8	50	50	60	20	0	yes	0	2	0	no	yes	Unk
9	95	2	1	50	50	yes	2	3	50	no	yes	Unk
10	95	10	1	20	80	no	0	3	50	no	yes	Unk

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 21: Summary of captures: Cooperabung Creek reference site

	Spring 2022	Summer 2023	Autumn 2023
Number of frogs recorded	0	0	0
Number of adult males	0	0	0
Number of adult females	0	0	0
Number of sub-adults	0	0	0
Number of juveniles	0	0	0
Number of recaptures	0	0	0

Habitat: Microhabitat found being used included grass and *Lomandra longifolia*.

Pipers Creek reference site

Table 22: Summary of surveys and prevailing abiotic variables: Pipers Creek reference site

Date	Time	Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
26/10/2022	Start	19:46	21.3		40	0	50	0
	Finish	23:47	17.5		100	0	5	0
15/02/2023	Start	20:37	15.8		20	0	0	0
	Finish	1:04	14		40	0	8	0
04/04/2023	Start	18:33	20		50	0	100	1
	Finish	0:01	18		50	0	100	1

Table 23: Habitat details: Pipers Creek reference site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
1	90	10	30	50	2	no	3	3	150	yes	yes	NA
2	20	2	50	2	5	no	2	2	150	yes	yes	NA
3	50	15	60	5	10	no	3	3	200	yes	yes	NA
4	98	20	5	95	5	no	2	3	200	yes	yes	NA
5	80	30	5	75	15	no	2	3	200	yes	yes	NA
6	90	50	15	50	15	no	2	3	200	yes	yes	NA
7	70	15	100	2	0	no	2	2	200	yes	yes	NA
8	10	50	80	15	10	no	1	2	150	yes	yes	NA

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 24: Summary of captures: Pipers Creek reference site

	Spring 2022	Summer 2023	Autumn 2023
Number of frogs recorded	15	14	9
Number of adult males	4	9	4
Number of adult females	4	4	4
Number of sub-adults	3	0	0
Number of juveniles	0	1	1
Number of recaptures	0	0	0

Habitat: Microhabitat within these zones included within leaf litter, sheltering under *Lomandra longifolia*, and on the creek bed, bank or bare ground.

Annex 2 - Giant Barred Frog individual capture data

L = length (mm); W = weight (g); DW = distance to water (m); Z = Zone; U = unknown; M = male; F = female; J = juvenile

Table 25: Giant Barred Frog capture data

Site	Location	Season	Sex	Age	Reproductive status	L	W	DW	pit_tag_code	Capture status	Z	Activity	Microhabitat
Impact	Cooperabung Creek	Spring	Female	Adult	Gravid	110	197	3.5	00079EA6E1	Recapture	4	Sitting	tree base
Impact	Cooperabung Creek	Spring	Female	Adult	Gravid	110	225	10	0007E032F1	First time capture	4	Sitting	tree base
Impact	Cooperabung Creek	Summer	Female	Adult	Light Nuptial Pads	84	97	4	Not tagged	First time capture	4	Sitting	tree base
Impact	Cooperabung Creek	Summer	Female	Adult	Not Gravid	96	161	2	0007E0E1DE	First time capture	6	Sitting	bank
Impact	Cooperabung Creek	Autumn	Unk	Juvenile	Immature	43	25	3	Not tagged	First time capture	4	Sitting	leaf litter
Impact	Maria River	Summer	Male	Adult	Light Nuptial Pads	71	65	3	0007A3E0F9	First time capture	8	Sitting	leaf litter,lomandra
Impact	Maria River	Summer	Male	Adult	n/a	Unk	Unk	5	Not tagged	Uncaptured	8	Buried	leaf litter
Impact	Maria River	Summer	Female	Adult	Not Gravid	99	163	4	0007E0512A	First time capture	8	Sitting	leaf litter
Impact	Maria River	Autumn	Male	Adult	Unk	75	65	8	Not tagged	First time capture	8	Sitting	creek bank
Impact	Pipers Creek	Spring	Male	Adult	Light Nuptial Pads	71	62	3	0007A3A4E9	First time capture	4	Sitting	bank
Impact	Pipers Creek	Summer	F	Adult	Non-gravid	89	133	15	0007A3EB3F	First time capture	5	Jumping	Grass/Shrubs
Impact	Pipers Creek	Autumn	Female	Adult	Not Gravid	98	180	6	0007E0E1CD	Recapture	5	Sitting	leaf litter
Impact	Pipers Creek	Summer	F	Adult	Possible Gravid	103	185	5	0007E0E1CD	First time capture	2	Active	Grassy
Reference	Pipers Creek Ref	Spring	Female	Adult	Not Gravid	86	98	2.5	0007E0AE19	First time capture	1	Sitting	leaf litter
Reference	Pipers Creek Ref	Spring	Unk	Sub Adult	Immature	60	25	3	0007A3BB2F	First time capture	1	Sitting	leaf litter
Reference	Pipers Creek Ref	Spring	Female	Adult	Not Gravid	90	130	5	0007E0B7D7	First time capture	2	Sitting	tree base
Reference	Pipers Creek Ref	Spring	Unk	Sub Adult	Immature	56	28	1	0007E0E327	First time capture	2	Jumping	lomandra
Reference	Pipers Creek Ref	Spring	Unk	Sub Adult	Immature	55	25	2	Not tagged	First time capture	2	Sitting	bare ground

Site	Location	Season	Sex	Age	Reproductive status	L	W	DW	pit_tag_code	Capture status	Z	Activity	Microhabitat
Reference	Pipers Creek Ref	Spring	Male	Adult	Unk	73	70	2.5	0007E0A8BD	First time capture	2	Sitting	bare ground
Reference	Pipers Creek Ref	Spring	Male	Adult	Light Nuptial Pads	71	61	4	0007A0F03B	First time capture	6	Sitting	tree base
Reference	Pipers Creek Ref	Spring	Female	Adult	Not Gravid	91	128	10	00079EAA9B	First time capture	8	Sitting	leaf litter
Reference	Pipers Creek Ref	Spring	Female	Adult	n/a	Unk	Unk	4	Not tagged	Uncaptured	2	Sitting	bare ground
Reference	Pipers Creek Ref	Spring	Female	Adult	n/a	Unk	Unk	4	Not tagged	Uncaptured	1	Sitting	bare ground
Reference	Pipers Creek Ref	Spring	Male	Adult	n/a	Unk	Unk	4	Not tagged	Uncaptured	4	Sitting	bank
Reference	Pipers Creek Ref	Spring	Male	Adult	n/a	Unk	Unk	5	Not tagged	Uncaptured	7	Sitting	bank
Reference	Pipers Creek Ref	Spring	Unk	Adult	n/a	Unk	Unk	3	Not tagged	Uncaptured	7	Sitting	bank
Reference	Pipers Creek Ref	Spring	Unk	Adult	n/a	Unk	Unk	4	Not tagged	Uncaptured	7	Sitting	bank
Reference	Pipers Creek Ref	Spring	Unk	Adult	n/a	Unk	Unk	1	Not tagged	Uncaptured	8	Sitting	lomandra
Reference	Pipers Creek Ref	Summer	Male	Adult	n/a	69	65	6	0007A0F03B	Recapture	1	Sitting	flood debri
Reference	Pipers Creek Ref	Summer	Male	Adult	Light Nuptial Pads	72	64	2	0007E032BF	First time capture	1	Buried	leaf litter
Reference	Pipers Creek Ref	Summer	Female	Adult	Not Gravid	96.5	152	5	0007A386B4	First time capture	2	Sitting	bank
Reference	Pipers Creek Ref	Summer	Male	Adult	Light Nuptial Pads	79	70	5	0007A389E0	First time capture	2	Sitting	leaf litter
Reference	Pipers Creek Ref	Summer	Male	Adult	Light Nuptial Pads	77	63	4	0007E0E35D	First time capture	2	Sitting	lomandra
Reference	Pipers Creek Ref	Summer	Male	Adult	Light Nuptial Pads	75	71	3	0007A3E102	First time capture	3	Buried	leaf litter
Reference	Pipers Creek Ref	Summer	Female	Adult	Not Gravid	93	140	10	0007E03552	First time capture	4	Jumping	leaf litter
Reference	Pipers Creek Ref	Summer	Male	Adult	Light Nuptial Pads	74	62	3	0007E0E36E	First time capture	4	Sitting	lomandra
Reference	Pipers Creek Ref	Summer	Male	Adult	Light Nuptial Pads	66	65	1.5	0007E0AB3C	Recapture	4	Sitting	tree base
Reference	Pipers Creek Ref	Summer	Female	Adult	Not Gravid	91	140	3	0007DF01D8	First time capture	5	Jumping	leaf litter
Reference	Pipers Creek Ref	Summer	Unk	Juvenile	Immature	20	Unk	2	Not tagged	First time capture	5	Sitting	leaf litter
Reference	Pipers Creek Ref	Summer	Female	Adult	Not Gravid	94	160	10	0007E0E536	First time capture	7	Sitting	leaf litter
Reference	Pipers Creek Ref	Summer	Male	Adult	Light Nuptial Pads	65	65	3	0007A0EBE1	First time capture	7	Sitting	leaf litter
Reference	Pipers Creek Ref	Summer	Male	Adult	n/a	Unk	Unk	4	Not tagged	Uncaptured	7	Buried	bank
Reference	Pipers Creek Ref	Autumn	Unk	Juvenile	Unk	46	15	20	Not tagged	First time capture	1	Sitting	tree base,leaf litter
Reference	Pipers Creek Ref	Autumn	Female	Adult	Unk	92	130	16	Not tagged	First time capture	2	Sitting	leaf litter,tree base

Site	Location	Season	Sex	Age	Reproductive status	L	W	DW	pit_tag_code	Capture status	Z	Activity	Microhabitat
Reference	Pipers Creek Ref	Autumn	Male	Adult	Unk	71	70	10	Not tagged	First time capture	3	Sitting	creek bank
Reference	Pipers Creek Ref	Autumn	Female	Adult	Unk	74	60	10	Not tagged	First time capture	3	Sitting	leaf litter
Reference	Pipers Creek Ref	Autumn	Female	Adult	Not Gravid	70	Unk	7	Not tagged	First time capture	4	Jumping	under log
Reference	Pipers Creek Ref	Autumn	Female	Adult	Not Gravid	84	75	5	Not tagged	First time capture	4	Sitting	leaf litter
Reference	Pipers Creek Ref	Autumn	Male	Adult	Unk	69	70	5	Not tagged	First time capture	7	Sitting	leaf litter
Reference	Pipers Creek Ref	Autumn	Male	Adult	Unk	74	60	17	Not tagged	First time capture	8	Sitting	leaf litter
Reference	Pipers Creek Ref	Autumn	Male	Adult	n/a	n/a	n/a	n/a	Not tagged	Uncaptured	4	Sitting	creek bank
Impact	Smiths Creek	Spring	Female	Adult	Gravid	105	150	10	0007E03183	First time capture	2	Sitting	leaf litter
Impact	Smiths Creek	Spring	Female	Adult	Not Gravid	102	158	5	0007A39C16	First time capture	1	Sitting	leaf litter
Impact	Smiths Creek	Spring	Male	Adult	Moderate Nuptial Pads	69	47	2.5	0007A38A08	First time capture	7	Sitting	tree base

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Appendix D – Yellow-bellied Glider



Yellow-bellied Glider Monitoring 2022

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

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Cover photograph: Yellow-bellied Gliders (*Petaurus australis*) in a nest box north of the Project, immediately east of Tamban State Forest, summer 2018.

Executive summary

Context

This report documents findings for the 2022 monitoring period, the final of three operational monitoring periods for the Yellow-bellied Glider (*Petaurus australis*), as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project) and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022). Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project. The Yellow-bellied Glider is one of the threatened species identified as requiring monitoring during the operational phase of the Project.

Aims

The aim of the Yellow-bellied Glider monitoring program is to determine whether the Project is meeting the performance indicators for the species, and provide corrective actions where required.

Methods

Call playback and spotlighting surveys were carried out over three non-consecutive nights at three paired impact and reference sites (Ballengarra, Cairncross and Maria River). Call playback involved 10 minutes of active listening for vocalisations, intermittent call playback for 15 minutes followed by 10 minutes of active listening. Spotlighting was carried out along established 500 metre transects, with the observer walking at a rate of 30 minutes/500 metres.

Key results

During the 2022 monitoring period no Yellow-bellied Gliders were detected at either impact or reference sites. Monitoring to date (including additional data collected in association with the Project) has demonstrated presence of Yellow-bellied Gliders at the Ballengarra (not confirmed during baseline surveys) and Maria River impact sites. The species has not been recorded at the Cairncross impact site, where the species was recorded during two of the three baseline surveys.

Conclusions

Performance measures for the 2022 monitoring period were partially met. Surveys were undertaken before and after the Project's construction at impact and reference sites, successfully meeting two of the three performance measures. The continued presence of Yellow-bellied Gliders at sites where it was identified during baseline surveys was not met in 2022. However, to date has been met at the Maria River impact site only. The species has also been detected previously at the Ballengarra impact site (Niche 2020), where there were no confirmed records during the baseline surveys. Yellow-bellied Gliders were not recorded during surveys at the remaining three sites where the species was recorded during baseline surveys (Cairncross impact site, Ballengarra and Maria River reference sites).

Management implications

While the species has not been recorded during operational monitoring at the Cairncross impact site, where it was recorded during baseline surveys, further monitoring is not recommended as:

- The species was not recorded at the Maria River and Ballengarra reference sites, where it was recorded during baseline surveys, indicating that changes in detection rates at the survey transects cannot be attributed to the Project.
- The ongoing presence of species in habitat adjacent to the Project has been demonstrated, including at one site where it was not detected during baseline surveys (Ballengarra).

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the then Commonwealth Department of Environment (DoE) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project. The Yellow-bellied Glider (*Petaurus australis*) was one threatened species identified as requiring monitoring following the completion of the Projects' construction, during the operational phase.

1.1.1 Legal status

The Yellow-bellied Glider is listed as vulnerable under the New South Wales *Biodiversity Conservation Act 2016* (BC Act). In addition to the state listing the species was listed as vulnerable under the Commonwealth EPBC Act in March 2022. Monitoring of the species is required under the Project's approval for the State Government, however, given the recent listing under the EPBC Act, there are no requirements for the monitoring or reporting of this species under the Commonwealth Government approvals for the Project.

1.1.2 Monitoring framework

The design, methods and performance indicators that define the Yellow-bellied Glider monitoring program are specified in the EMP.

The EMP requires monitoring to occur in spring prior to commencement of construction and in August-December in Year 4, 6 and 8 (operational phase). To date, these monitoring events have been reported as follows:

- *Spring 2013*: Baseline report (Lewis 2014)
- *Spring 2018*: Year 4 (Niche 2019)
- *Spring 2020*: Year 6 (Niche 2021).
- *Spring 2022*: Year 8 (current report).

This report therefore represents the final of three reports required for the operational phase monitoring.

1.1.3 Baseline data

Baseline surveys were conducted in spring prior to the commencement of construction by Lewis Ecological in 2013 (Lewis 2014). Surveys confirmed presence of Yellow-bellied Gliders at four of the six monitoring sites on at least one occasion (Table 1). Individuals were primarily detected by calling, with only one site recording an observation.

Table 1: Baseline survey results for the Yellow-bellied Glider in the Project area

Site	Baseline results
Cairncross impact	Recorded during two surveys. Detected during spotlighting. Responded to call playback.
Cairncross reference	No Yellow-bellied Gliders confirmed (unconfirmed calls recorded).
Ballengarra impact	No Yellow-bellied Gliders confirmed (unconfirmed calls recorded).

Ballengarra reference	Recorded during a single survey. Responded to call playback.
Maria River impact	Recorded during a single survey. Responded to call playback.
Maria River reference	Recorded during all three surveys. Responded to call playback.

1.1.4 Purpose of this report

This report details the findings of the third of three operational monitoring events for the Yellow-bellied Glider. The aims of this report are to summarise the methods and results of the 2022 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for the Yellow-bellied Glider:

- *Monitoring is undertaken before and after construction of the upgrade*
- *Monitoring is undertaken at impact and control sites*
- *Continued presence of Yellow-bellied Gliders at sites where it was identified during baseline surveys.*

1.3 Monitoring Timing

Monitoring is to be undertaken between August and December in Year 4, 6 and 8 of the Project’s operational phase. Surveys are to be undertaken in spring to coincide with high movement periods for the species, which breeds between July and September and disperses between spring and summer.

1.4 Reporting

As per the EMP, the annual reporting of monitoring results will include:

- Detailed description of monitoring methodology
- Results of the monitoring period
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA).

1.5 Limitations

Road noise at impact sites may negatively impact the ability to hear Yellow-bellied Gliders calling at a distance, particularly at the Maria River impact site, where the transect lies adjacent to the highway and passes behind residential properties.

2. Survey Methods

2.1 Monitoring Sites

Monitoring was undertaken at impact and reference sites previously selected during baseline surveys (Lewis 2014) as shown in Figure 1. Impact sites were established within known Yellow-bellied Glider habitat and paired with reference sites of similar vegetation and habitat type.

Table 2: Yellow-bellied Glider paired monitoring sites (adapted from Table 5-1 of Lewis 2014)

Monitoring area	Treatment	Impact site	Paired reference site
Cairncross	Impact with mitigation (widened median)	Rawdon Creek Nature Reserve, west of carriageway	Cairncross State Forest approximately 10 kilometres west of impact site
Ballengarra	Impact with mitigation (aerial crossing structure)	Ballengarra State Forest, west of carriageway at Barry's Creek	Ballengarra State Forest approximately 5 kilometres west of impact site
Maria River	Impact with mitigation (reduced clearing limits)	Kalateenee State Forest, west of carriageway at Maria River	Maria River National Park approximately 5 kilometres east impact site

2.2 Survey Method

Surveys were undertaken in accordance with the EMP. At each monitoring site, call playback and spotlighting surveys were carried out over three non-consecutive nights in spring with a minimum of seven days between consecutive surveys.

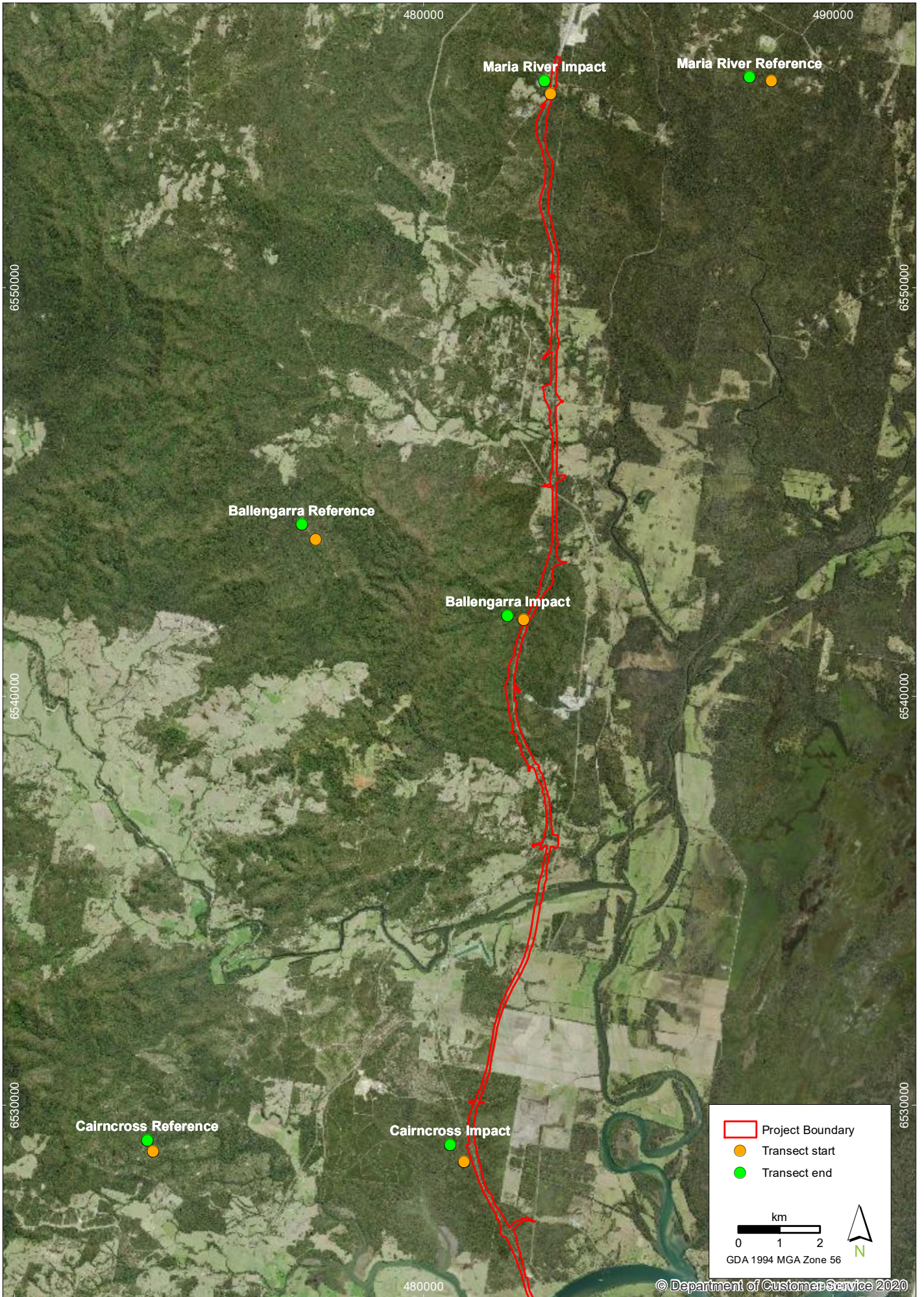
2.2.1 Call playback

Upon arrival at site, 10 minutes of active listening for vocalisations was carried out followed by call playback. As per baseline surveys, Yellow-bellied Glider calls were played intermittently for 15 minutes to provoke a response. Calls of the Powerful Owl, Masked Owl and Sooty Owl were then used when the Yellow-bellied Glider calls failed to elicit a response. Call playback was followed by another 10 minute period of active listening. Vocalisations of this species can be heard up to 400 metres away.

2.2.2 Spotlighting

Spotlighting was conducted along 500 metre transects, with the observer walking at a rate of 30 minutes/500 metres and continually listening for vocalisations. Transects were located along forest trails indicated by start and end points established during baseline surveys. Although this species is considered spotlight-shy, it may be detected by its frequent movements during foraging activities.

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Yellow-bellied Glider monitoring sites

Pacific Highway Upgrade - Oxley Highway to Kempsey: Yellow-bellied Glider Monitoring



FIGURE 1
Imagery: (c) LPI 2014

3. Results

Figure 2 shows the Yellow-bellied Glider 2018, 2020 and 2022 monitoring records, and includes additional incidental Yellow-bellied Glider observations collected during other ecological monitoring programs required by the Project.

3.1 Monitoring Results

3.1.1 2022 monitoring results

Results of call playback and spotlighting surveys are provided in Annex 1. A summary of the species detected at each site is provided below in Table 3.

Survey dates and weather conditions are provided in Annex 1. All surveys were undertaken during calm evenings without notable rainfall.

No Yellow-bellied Gliders were detected during spotlighting surveys during the 2022 surveys. A number of species, including the Sugar Glider (*Petaurus breviceps*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Common Brushtail Possum (*Trichosurus vulpecula*), White-throated Nightjar (*Eurostopodus mystacalis*), Barn Owl (*Tyto alba*) and Tawny Frogmouth (*Podargus strigoides*) were observed during spotlighting surveys.

3.1.2 Cumulative monitoring results

A summary of the fauna species recorded during the Yellow-bellied Glider monitoring to date (excluding baseline surveys) is provided in Table 3.

Table 3: Summary of species detected during 2018, 2020 and 2022 surveys

Monitoring area	Impact site	Reference site
Cairncross	Feathertail Glider (<i>Acrobates pygmaeus</i>) Common Ringtail Possum Koala (<i>Phascolarctos cinereus</i>)	Sooty Owl (<i>Tyto tenebricosa</i>) Boobook (<i>Ninox novaeseelandiae</i>) Sugar Glider White-throated Nightjar Eastern Grey Kangaroo (<i>Macropus giganteus</i>) Grey-headed Flying-fox Barn Owl Tawny Frogmouth
Ballengarra	Yellow-bellied Glider (2018 monitoring) Sugar Glider Tawny Frogmouth (<i>Podargus strigoides</i>)	Macropod species Green-thighed Frog (<i>Litoria brevipalmata</i>) Laughing Kookaburra (<i>Dacelo novaeguineae</i>) Common Brushtail Possum White-throated Nightjar
Maria River	Common Brushtail Possum Echidna (<i>Tachyglossus aculeatus</i>) Sugar Glider Feathertail Glider (<i>Acrobates pygmaeus</i>) Yellow-bellied Glider (2020 monitoring) Tawny frogmouth	Common Ringtail Possum Common Brushtail Possum Koala (<i>Phascolarctos cinereus</i>) Sugar Glider

3.2 Additional Data

Nest boxes

Yellow-bellied Gliders have been recorded on seven occasions occupying nest boxes during the nest box monitoring program that forms part of the Project’s ecological monitoring requirements. Six of the seven nest boxes, listed in Table 4, occur within close proximity (within 100 metres) to two of the Yellow-bellied Glider impact sites; Maria River impact site and Ballengarra impact site (Figure 2).

Incidental records

During 2018 Giant Barred Frog surveys that form part of the Project’s ecological monitoring requirements, the Yellow-bellied Glider was heard calling from the Giant Barred Frog Maria River impact site (located approximately 105 metres to the east of the Yellow-bellied Glider Maria River impact site) and observed at the Giant Barred Frog Piper’s Creek reference site (approximately 6.2 kilometres south of the Yellow-bellied Glider Ballengarra reference site). The Yellow-bellied Glider was again recorded during 2022 Giant Barred Frog surveys at the Piper’s Creek reference site.

Table 4: Yellow-bellied Glider nest box records

Nest box type	No. Individuals	Survey period	Area
Large glider	2	Summer 2017	Maria River
Possum	2	Winter 2017	Maria River
Small Owl	1	Summer 2018	Maria River
Large Glider	1	Summer 2018	Ballengarra
Cockatoo	1	Summer 2020	Ballengarra
Large Glider	1	Summer 2020	Ballengarra
Small Glider	2-3	Winter 2022	5km north of Ballengarra

3.3 Comparison to Baseline Surveys

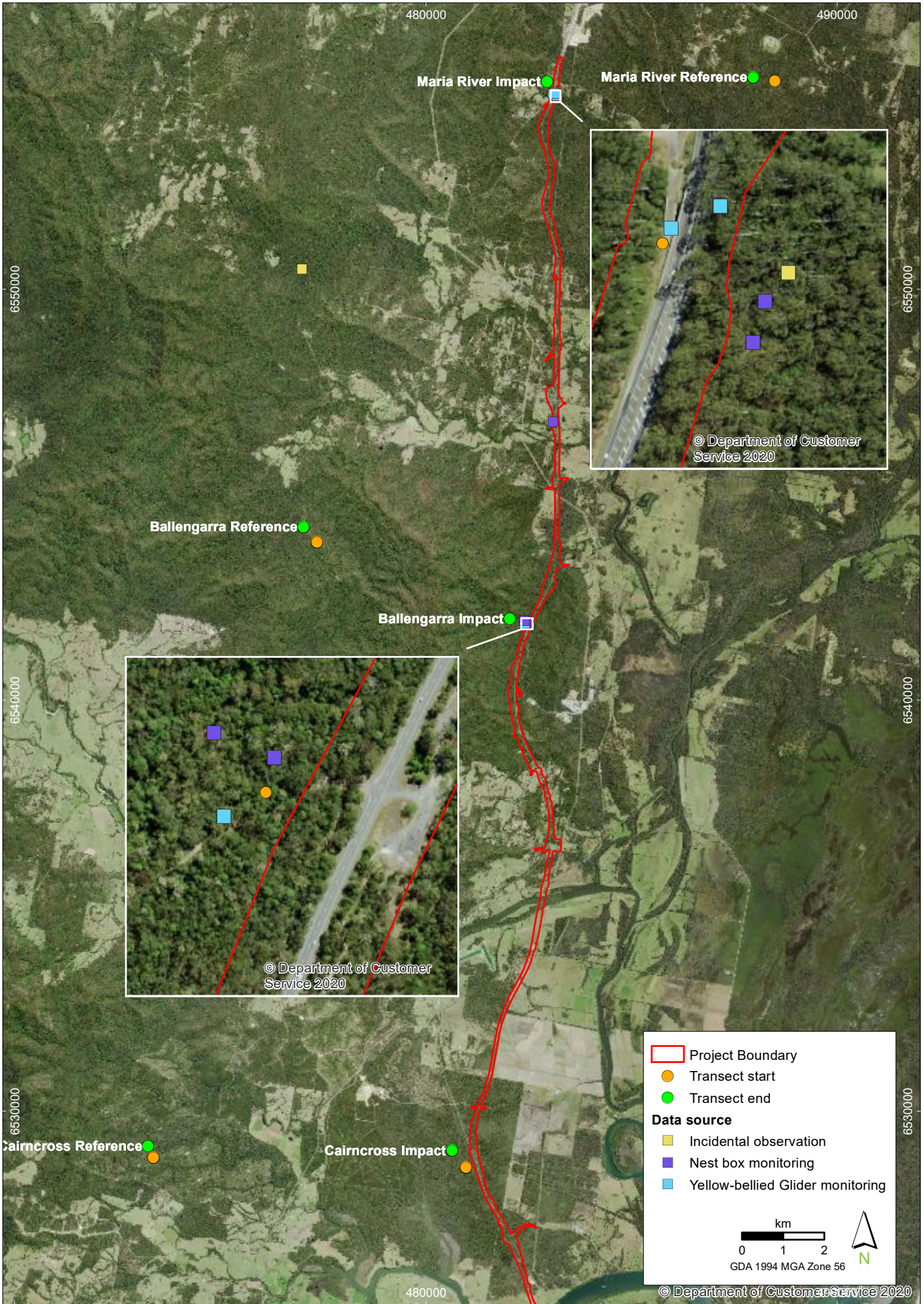
Table 5 provides a comparison of baseline survey results with the monitoring and additional records to date. The additional records have been included in the determination of ongoing presence of the species in monitoring areas. An additional record was considered as representing presence in a monitoring area when that record occurred within 500 metres of the transect location. This is based on a conservative estimate of Yellow-bellied Glider home ranges of 20 hectares and their call range (OEH 2017).

Table 5: Summary of Yellow-bellied Glider records across the Project area

Site	Baseline surveys (2013)	Operational monitoring	Additional data
Cairncross impact	Present (2)	0	0
Cairncross reference	0	0	0
Ballengarra impact	0	Present (1)	Present (3)
Ballengarra reference	Present (1)	0	0
Maria River impact	Present (1)	Present (1)	Present (4)
Maria River reference	Present (3)	0	0

(#) = Number of surveys recording/incidental records of Yellow-bellied Gliders.

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Yellow-bellied Glider records

Pacific Highway Upgrade - Oxley Highway to Kempsey: Yellow-bellied Glider Monitoring

FIGURE 2

Imagery: (c) LPI 2014

4. Discussion

4.1 Performance Measures

A summary of the survey results in relation to the performance measures is provided in Table 6.

Table 6: Summary of performance measures

Performance measure	Discussion
Monitoring is undertaken before and after construction of the upgrade.	<p>This performance measure has been met.</p> <p>Baseline monitoring was undertaken prior to construction in 2013 (Lewis 2014) and after completion of the upgrade (operational) in spring 2018, 2020 and 2022. 2022 surveys represent the final monitoring period (Year 8).</p>
Monitoring is undertaken at Impact and Control sites.	<p>This performance measure has been met.</p> <p>Monitoring was undertaken at the paired impact-control (reference) sites established during baseline surveys.</p>
Continued presence of Yellow-bellied Gliders at sites where it was identified during baseline surveys.	<p>This performance measure has not been met.</p> <p>Yellow-bellied Gliders were confirmed at four of the six sites during the baseline surveys; Maria River impact and reference site, Cairncross impact site and Ballengarra reference site. The species was not recorded at Ballengarra impact or Cairncross reference sites during baseline surveys.</p> <p>Monitoring to date (including additional data) has demonstrated presence of Yellow-bellied Gliders at the Ballengarra (not confirmed during baseline surveys) and Maria River impact sites during 2018 and 2020 monitoring. However, presence was not detected during 2022 monitoring.</p> <p>The species has not been detected at the remaining three sites where it was identified during baseline surveys: Ballengarra and Maria River reference sites and Cairncross impact site. Therefore, this performance measure has not been met for these three sites.</p>

5. Recommendations

5.1 Contingency Measures and Recommendations

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered relevant to the Yellow-bellied Glider monitoring are listed and discussed in Table 7.

While the species has not been recorded during operational monitoring at the Cairncross impact site, where it was recorded during baseline surveys, further monitoring is not recommended as:

- The species was not recorded at the Maria River and Ballengarra reference sites, where it was recorded during baseline surveys, indicating that changes in detection rates at the survey transects cannot be attributed to the Project.
- The ongoing presence of species in habitat adjacent to the Project has been demonstrated, including at one site where it was not detected during baseline surveys (Ballengarra).

Table 7: Contingency measures

Potential Problem	Contingency measure	Discussion of proposed measure
Decline in presence of target species recorded at impact sites after the upgrade has been complete, compared to change in control sites.	<p>The cause of decline in populations at impact sites will be investigated in consultation with EPA and DOTE within two weeks of results reported by ecologist.</p> <p>If the cause of decline is considered most likely attributed to the upgrade of the highway (and not another event such as bushfire), mitigation measures, such as the location and types of fauna crossings and fauna fencing will be reviewed within two months of the above consultation being completed.</p>	<p>While the species was not recorded at the Cairncross impact site, where it was recorded during baseline surveys, it was also not recorded at the Maria River and Ballengarra reference sites, where it was recorded during baseline surveys. This absence of records and change in detection rates cannot therefore be attributed to the Project as detection was lower at both impact and reference sites.</p> <p>Monitoring to date has confirmed presence at two of the three impact sites. A notable absence of records occurs at Cairncross impact site, where the species was recorded during two of the three baseline surveys. It should be noted however that the species has now been detected in close proximity to the Project corridor where it was not recorded during baseline surveys (Ballengarra), notably using nest boxes on both sides of the Project corridor.</p> <p>Additional records also demonstrate ongoing presence of the species in habitat immediately adjacent to the Project.</p> <p>This contingency measure is not considered relevant.</p>

References

Lewis (2014). *Oxley Highway to Kempsey. Pre-construction Baseline Monitoring: Winter-Summer*. Prepared by Lewis Ecological.

Niche (2019). *Yellow-bellied Glider monitoring 2018 – Oxley Highway to Kempsey Pacific Highway Upgrade*. Prepared by Niche Environment and Heritage Pty Ltd.

Niche (2020). *Yellow-bellied Glider monitoring 2020 – Oxley Highway to Kempsey Pacific Highway Upgrade*. Prepared by Niche Environment and Heritage Pty Ltd.

OEH (2017). *Yellow-bellied Glider - Profile*. Available online: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10601> accessed 5 March 2019.

TfNSW (2022). *Oxley Highway to Kempsey Pacific Highway Upgrade Ecological Monitoring Program. Roads and Maritime Update to report prepared by SMEC Hyder Joint Venture, February 2022*.

Annex 1 – Monitoring Results

Table 8: 2022 Yellow-bellied Glider monitoring results

Date	Site	Site type (reference/ impact)	ID type (seen/heard)	Fauna type	Species
31/10/2022	Cairncross	reference	heard	Mammal	Grey-heading Flying-fox
1/11/2022	Ballengarra	reference	seen	Mammal	Common Brushtail Possum
14/11/2022	Cairncross	reference	heard	Bird	White-throated Nightjar
15/11/2022	Maria River	reference	seen	Mammal	Sugar Glider
16/11/2022	Ballengarra	reference	heard	Bird	White-throated Nightjar
13/12/2022	Cairncross	reference	heard	Bird	Barn Owl
13/12/2022	Cairncross	reference	heard	Mammal	Sugar Glider
13/12/2022	Cairncross	reference	seen	Bird	Tawny Frogmouth
14/12/2022	Maria River	impact	seen	Bird	Tawny Frogmouth

Table 9: 2022 Yellow-bellied Glider survey conditions

Site	Replicate	Date	Temp (°C)	Rain (mm)	Wind (km/h)
Ballengarra SF impact	1	1/11/2022	20	0	13
Ballengarra SF reference	1	1/11/2022	21.3	0	22
Cairncross SF impact	1	31/10/2022	22.8	0	17
Cairncross SF reference	1	31/10/2022	22.8	0	17
Maria River SF impact	1	2/11/2022	13	0	9
Maria River SF reference	1	2/11/2022	17	0	13
Ballengarra SF impact	2	16/11/2022	16	0	19
Ballengarra SF reference	2	16/11/2022	15	0	7
Cairncross SF impact	2	14/11/2022	21	0	9
Cairncross SF reference	2	14/11/2022	21	0	7
Maria River SF impact	2	15/11/2022	21	0	0
Maria River SF reference	2	15/11/2022	21	0	6
Ballengarra SF impact	3	12/12/2022	23	0	9
Ballengarra SF reference	3	12/12/2022	23	0	9
Cairncross SF impact	3	13/12/2022	17	0	7
Cairncross SF reference	3	13/12/2022	17	0	7
Maria River SF impact	3	14/12/2022	16	0	9
Maria River SF reference	3	14/12/2022	19	0	9

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Appendix E – Brush-tailed Phascogale



Brush-tailed Phascogale Monitoring 2022/2023

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

May 2023

Document control

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Project Manager:	Radika Michniewicz
Authors:	Jodie Danvers
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Cover photograph: Brush-tailed Phascogale captured at Site 2 control site during 2022/2023 summer surveys (left) and Brush-tailed Phascogale with young captured at Site 2 control site during 2022/2023 winter surveys (right).

Executive summary

Context

This report documents findings for the 2022/2023 monitoring period, the final of three operational monitoring periods for the Brush-tailed Phascogale (*Phascogale tapoatafa*), as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project), and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022).

Aims

The aim of the Brush-tailed Phascogale monitoring program is to determine if mitigation measures are being used by the species and whether the Project is having a local negative impact on the species. The aims of this report are to summarise the methods and results of the 2022/2023 monitoring period and determine if performance measures are being met, as per the EMP.

Methods

Four paired impact and control sites were monitored in winter (July/August) 2022 and summer (January/February) 2023. Each monitoring location was surveyed in accordance with the monitoring method and design specified in the EMP. Arboreal trapping was undertaken for four nights over approximately two hectares of habitat using 20 Elliot B traps baited with oats, honey and peanut butter. Hair tubes were also attached to trees in a grid formation baited with honey, peanut butter and oats and left for 14 consecutive nights.

Key results

A total of five Brush-tailed Phascogales were recorded during the 2022/2023 surveys at Site 2 Control (four captures) and Site 3 Impact (one capture). Additional species captured included the Black Rat (*Rattus rattus*), Common Brushtail Possum (*Trichosurus vulpecula*) and Brown Antechinus (*Antechinus stuartii*).

Hair tube sample analysis indicated presence of two genera: the Brushtail Possum (*Trichosurus* sp.) and *Rattus* sp.

No Brush-tailed Phascogales have been identified occupying nest boxes established as part of associated ecological monitoring for the Project within the vicinity of the survey sites.

Conclusion

Performance measures have been met. Surveys were undertaken before and after the Project's construction and at impact and reference sites. Presence of the Brush-tailed Phascogale has been demonstrated during Brush-tailed Phascogale monitoring.

Management implications

It is not possible to establish a decline in presence of Brush-tailed Phascogales at the survey sites due to the absence of records from baseline data. The subsequent positive outcome of the detection of individuals at Site 3 impact site during 2019 and 2023 surveys, Site 2 control during 2022/2023 surveys and additional records would indicate that the species is present in the Project Area, albeit not all at the exact monitoring locations. As such, adaptive management actions or further monitoring beyond Year 8 (2022/2023) are not recommended.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the then Commonwealth Department of Environment (DoE) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project. The Brush-tailed Phascogale (*Phascogale tapoatafa*) was one threatened species identified as requiring monitoring following the completion of the Projects' construction, during the operational phase of the Project.

1.1.1 Legal status

The Brush-tailed Phascogale is listed as vulnerable under the New South Wales *Biodiversity Conservation Act 2016* (BC Act). Monitoring of the species is required under the Project's approval conditions.

1.1.2 Monitoring framework

The design, methods and performance indicators that define the Brush-tailed Phascogale monitoring program are specified in the EMP.

The EMP requires monitoring to occur in summer prior to the commencement of construction and in winter and summer in Year 4, 6 and 8 of the Project (operational phase). To date, these monitoring events have been reported as follows:

- *Summer 2014*: Baseline report (Lewis 2014)
- *Winter and Summer 2018/2019*: (Niche 2019)
- *Winter and Summer 2020/2021*: (Niche 2021)
- *Winter and Summer 2022/2023*: Current Report

This report therefore represents the final of three reports required for the operational phase monitoring.

1.1.3 Baseline data

Baseline surveys were undertaken in summer prior to the commencement of construction by Lewis Ecological (Lewis 2014). No Brush-tailed Phascogales were recorded during baseline surveys.

1.1.4 Purpose of this report

This report details the findings of the final of three operational monitoring periods for the Brush-tailed Phascogale. The aims of this report are to summarise the methods and results of the 2022/2023 monitoring period and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for the Brush-tailed Phascogale:

- *Monitoring is undertaken before and after the construction of the upgrade.*
- *Monitoring is undertaken at impact and control sites.*

- *Presence of Brush-tailed Phascogales during Brush-tailed Phascogale monitoring and/or nest box monitoring.*

1.3 Monitoring Timing

Monitoring is to be undertaken in winter and summer in Year 4, 6 and 8, during high movement periods for the species, between May and July and in mid-summer.

1.4 Reporting

Annual reporting of monitoring results will include:

- Detailed description of monitoring methodology
- Results of the monitoring period
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA).

2. Survey Methods

2.1 Monitoring Sites

Monitoring areas were identified during baseline surveys within four broad areas containing Moist Slopes Forest and Dry Ridgetop Forest habitat, where the species was considered likely to occur (GHD 2010, GHD 2011). They include:

- Site 1: Cairncross State Forest
- Site 2: Ballengarra State Forest South
- Site 3: Ballengarra State Forest North
- Site 4: Maria River State Forest.

Each site consists of an impact site and a paired control site. Impact sites were established during baseline surveys, however control sites were not. Control sites were therefore selected prior to the 2018/2019 monitoring period and located a minimum distance of 500 metres to one kilometre, where access permitted, from the paired impact site within contiguous vegetation. Monitoring site locations are shown in Figure 1 and trap locations at each site are shown in Figure 2- Figure 5.

2.2 Methods

2.2.1 Arboreal trapping

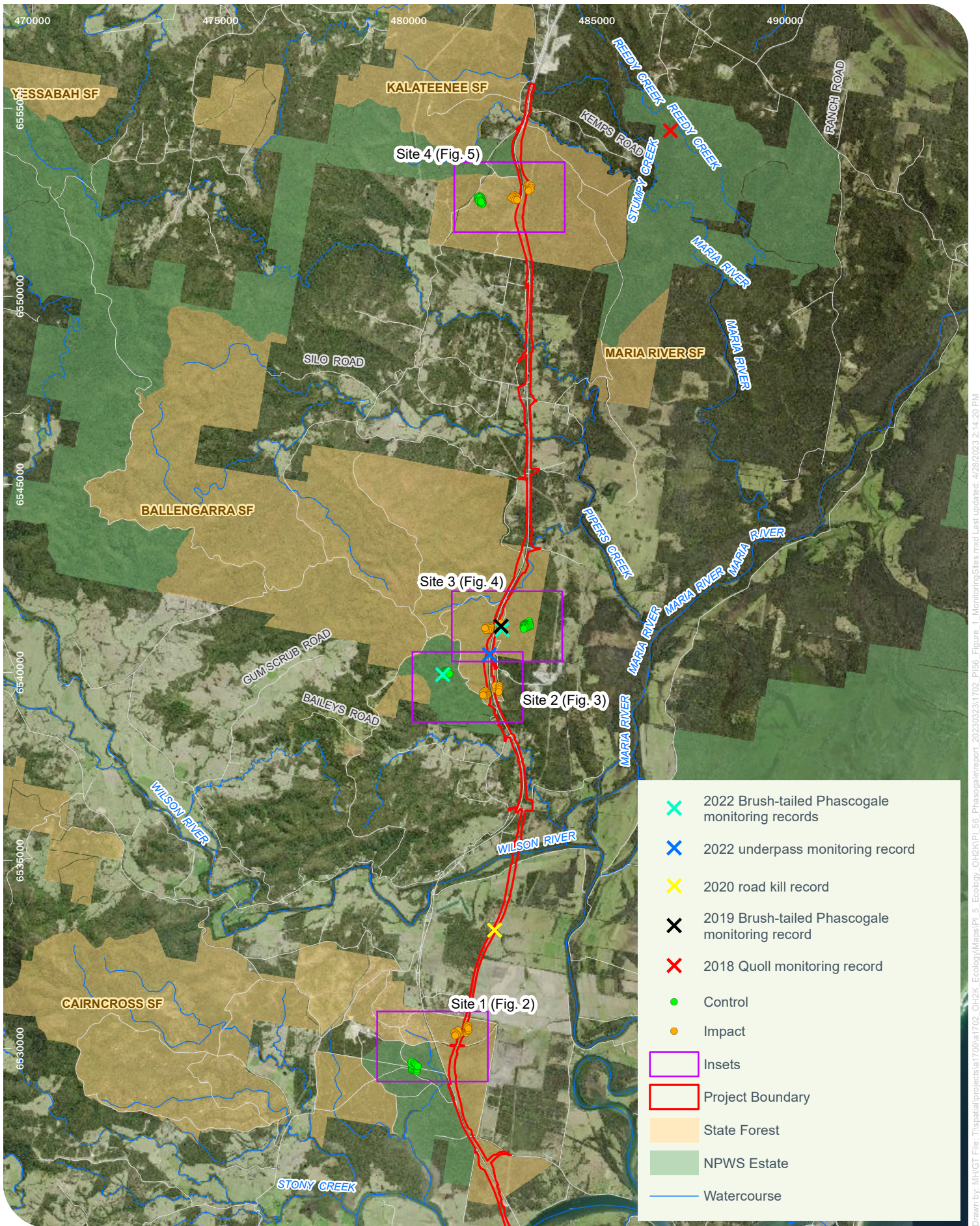
In accordance with the EMP, arboreal trapping was undertaken using a grid configuration of 20 tree-mounted Elliot B traps distributed over approximately two hectares of habitat for four consecutive nights at each control and impact site. At impact sites, 10 traps were deployed on either side of the carriageway. Traps were positioned on brackets and installed approximately two metres above the ground on a range of mature canopy tree species and baited with a mixture of oats, peanut butter and honey. The host tree was sprayed with a mixture of honey water above the trap as an additional attractant. Traps were checked each morning and bait was replaced as necessary.

The following details were recorded for any captured fauna, where this could be determined with minimal animal handling:

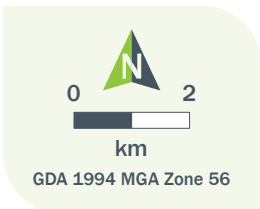
- Trap location
- Sex
- Age class
- Mass
- Breeding condition.

2.2.2 Hair tubes

Hair tubes were attached to the same host trees used for arboreal trapping, therefore following the same grid configuration with 20 hair tubes over approximately two hectares of habitat. Hair tubes were baited with a mixture of oats, peanut butter and honey and left for 14 consecutive nights. Hair samples were sent to Robyn Carter (RC Hair ID) for analysis, and were identified to species level where possible.



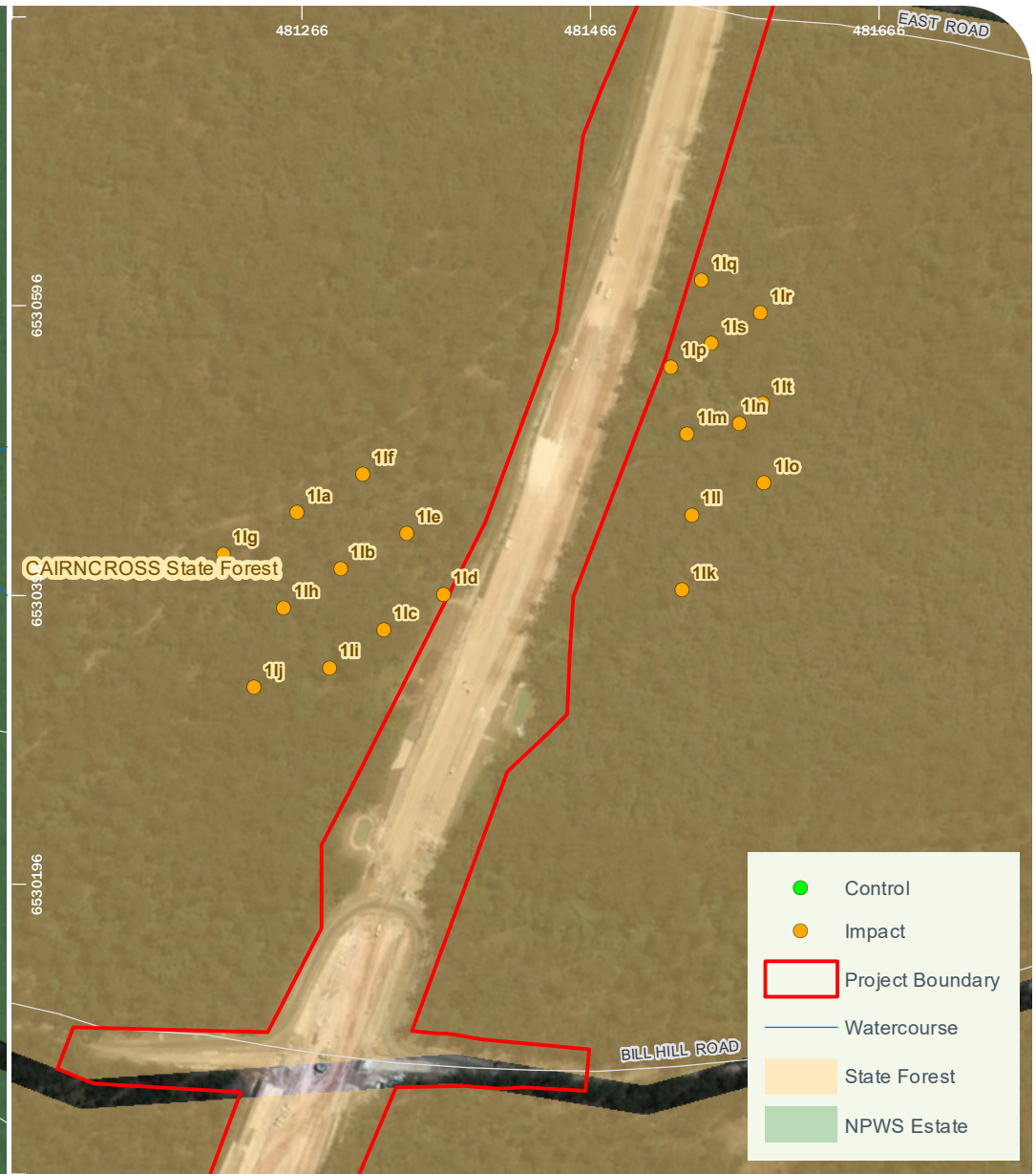
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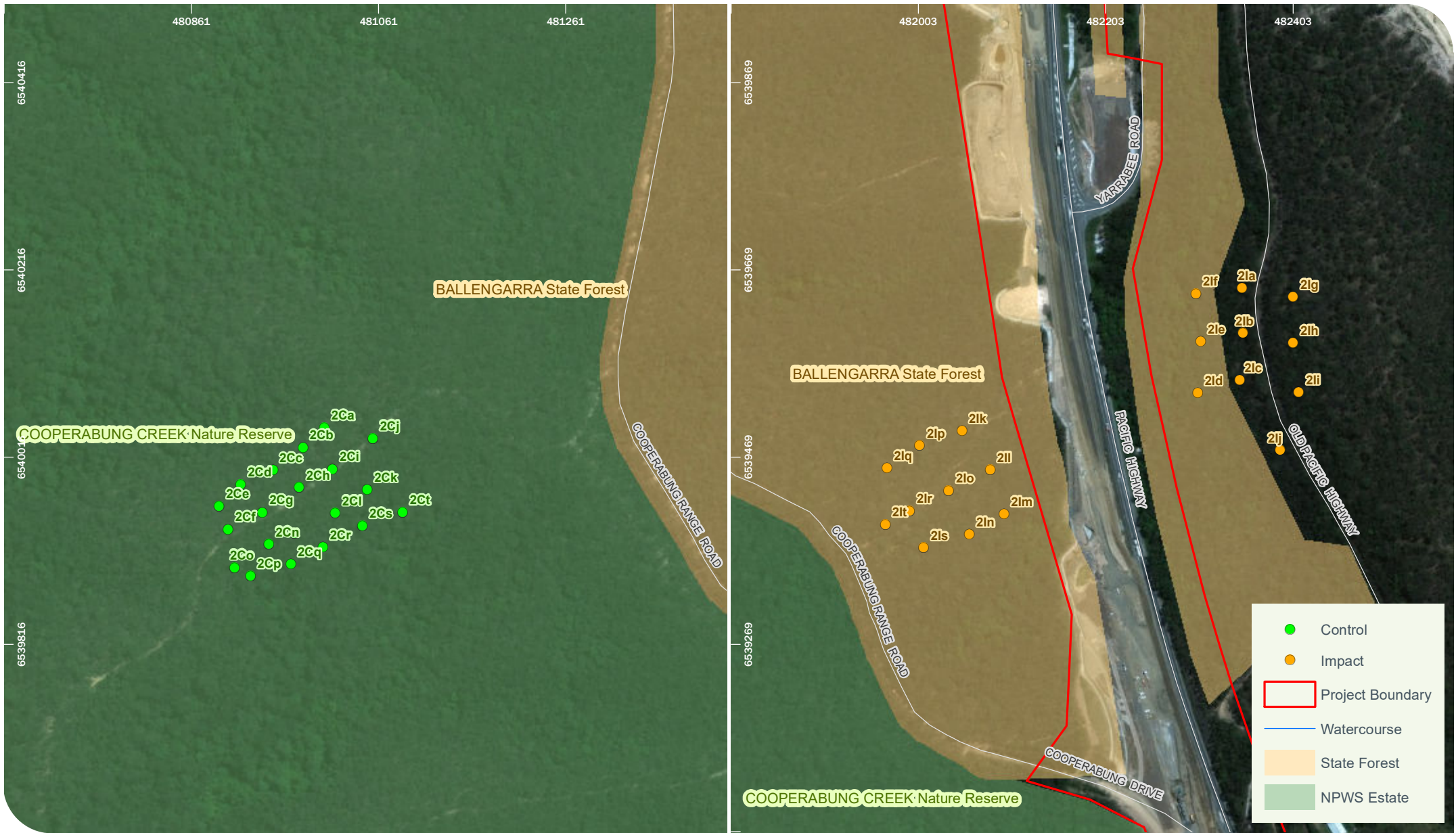


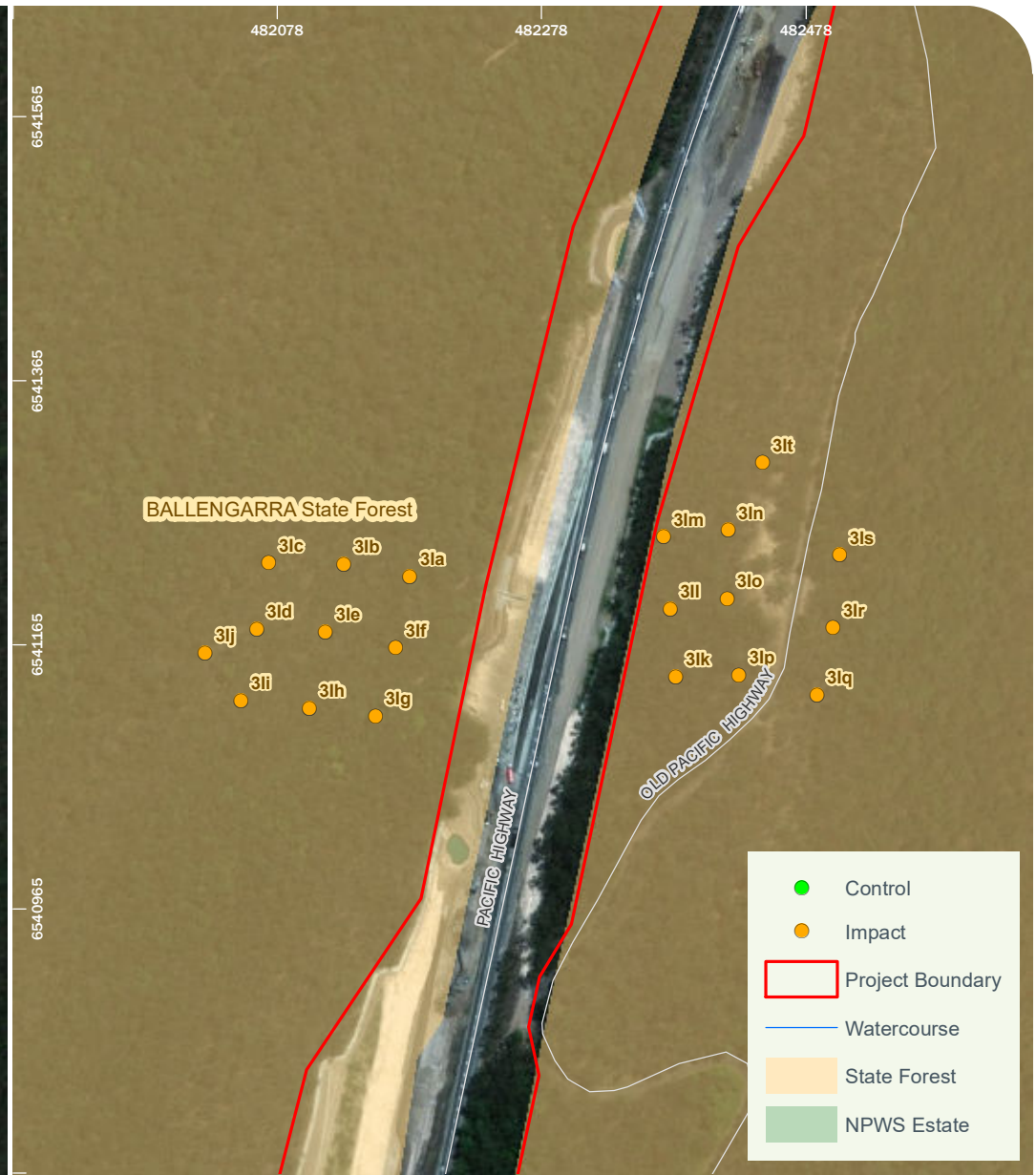
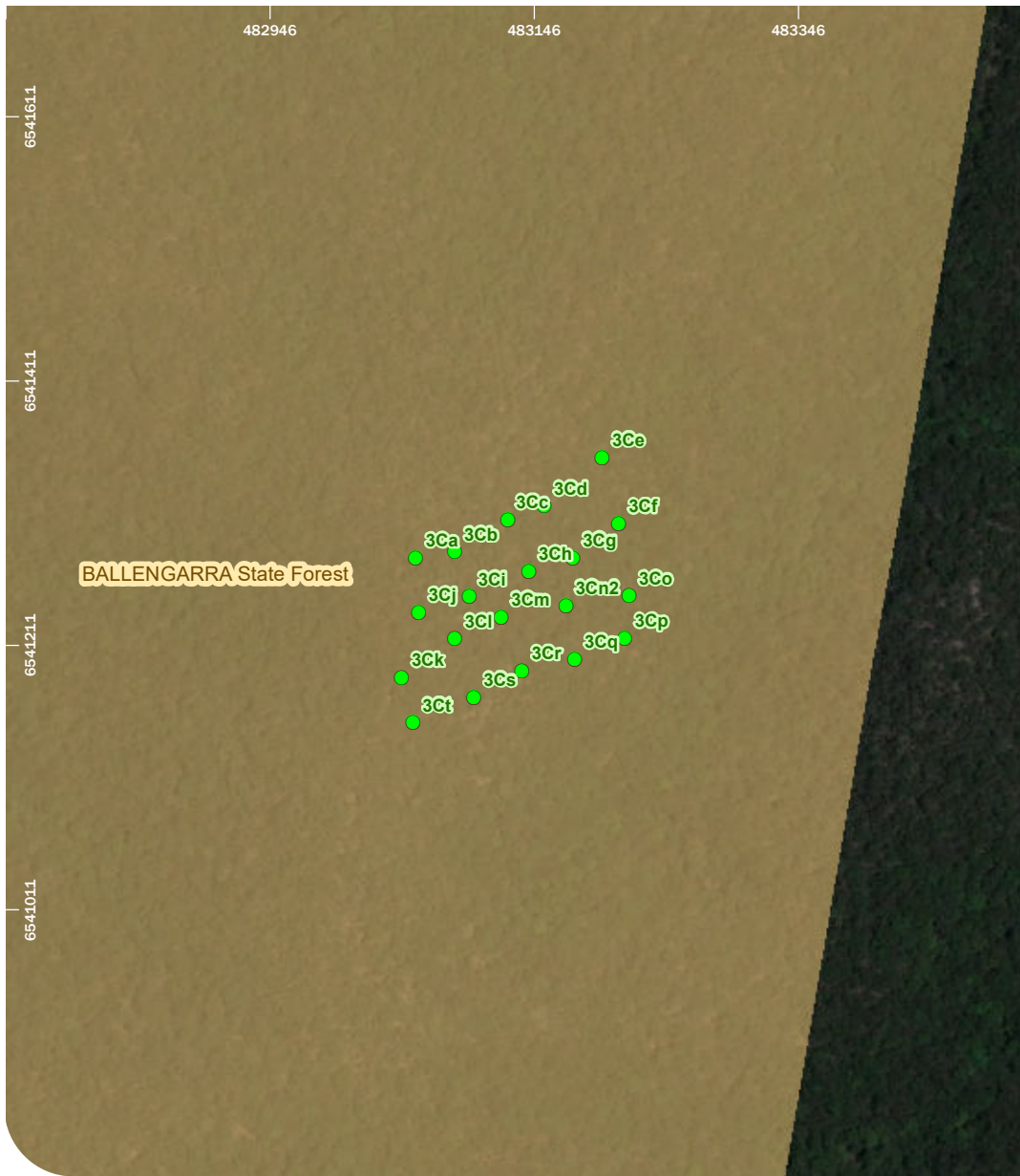
Overview of monitoring sites and Brush-tailed Phascogale records
Brush-tailed Phascogale Monitoring:
Pacific Highway Upgrade – Oxley Highway to Kempsey

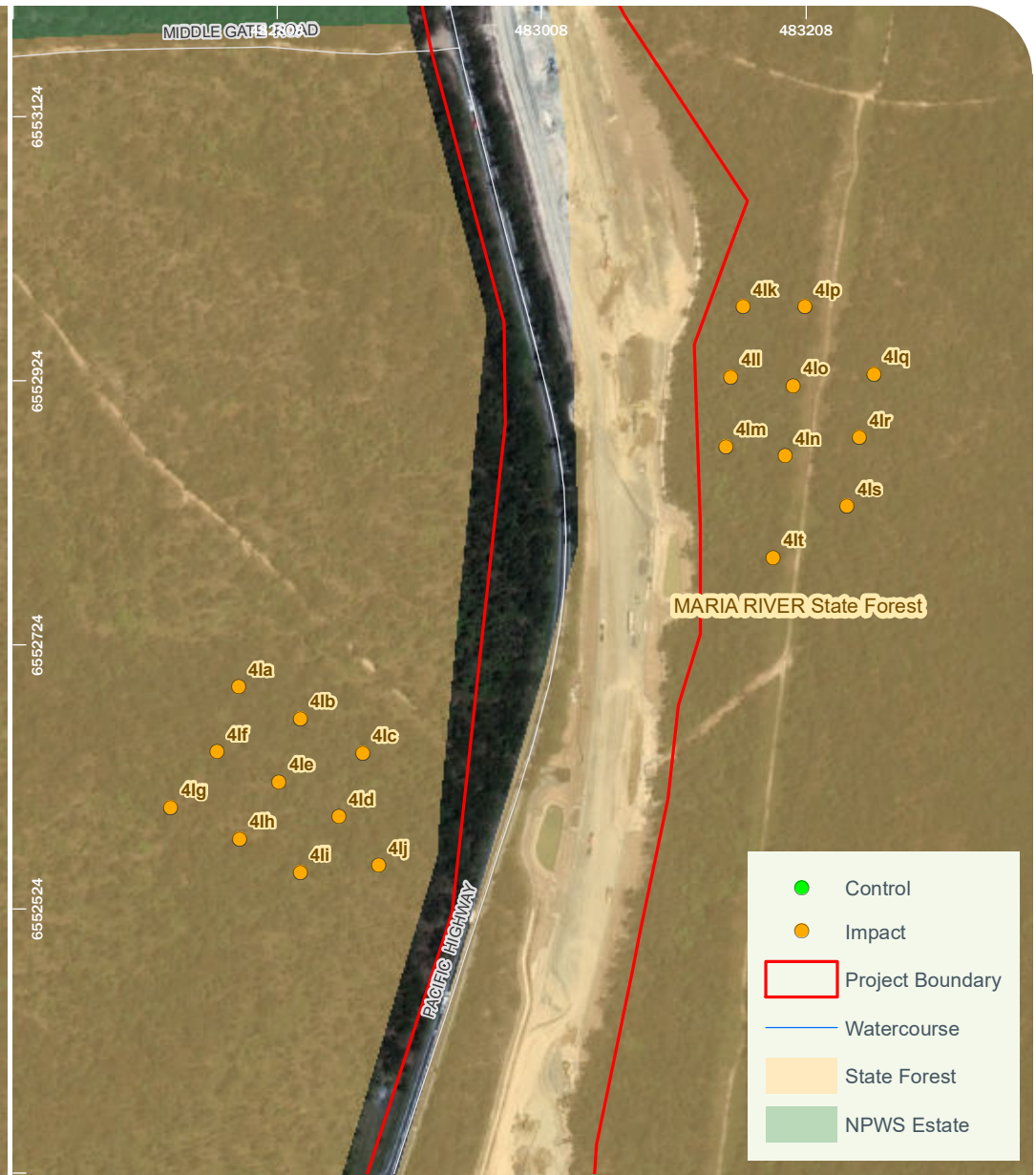
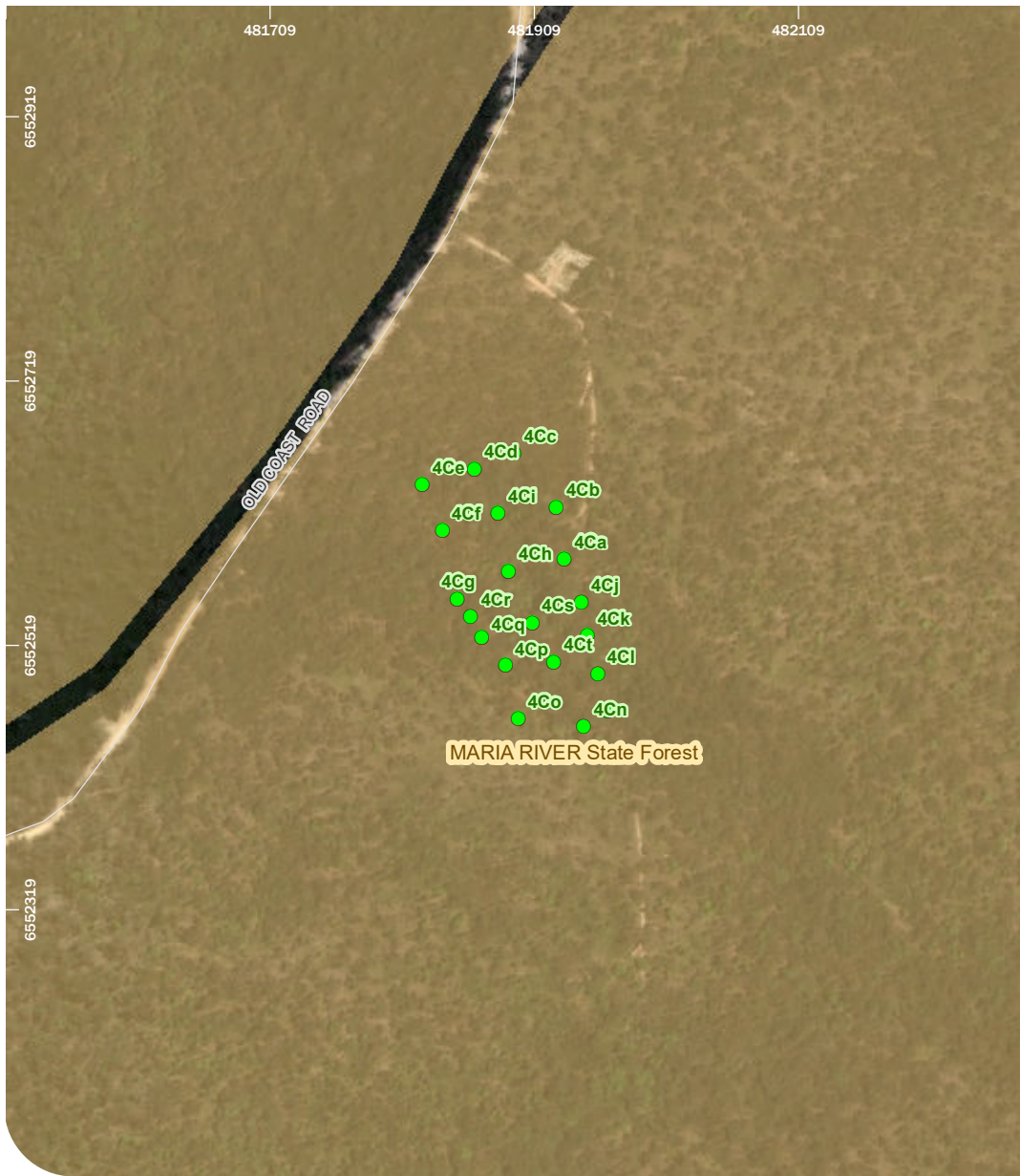
Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 PI5.6
 Client: Roads and Maritime Services

Figure 1









3. Results

3.1 Timing and Conditions

Weather conditions (Port Macquarie Airport, station ID 060139) during the arboreal trapping surveys are provided in Table 1.

Arboreal trapping surveys were undertaken as follows:

- Winter: Sites 1 and 2 from 1-5 August 2022; Sites 3 and 4 from 11-15 July 2022.
- Summer: Sites 1 and 2 from 9-13 January 2023; Sites 3 and 4 from 31 January - 3 February 2023.

Hair tube surveys were undertaken as follows:

- Winter: Hair tubes were deployed on 2 August 2022 and 13 July 2022 and retrieved 18 August 2022 and 28 July 2022 for Sites 1 and 2 and Sites 3 and 4 respectively.
- Summer: Hair tubes were deployed on 2 February 2023 and 10 January 2023 for Sites 1 and 2 and Sites 3 and 4 respectively. Hair Tubes were retrieved on 31 January 2023 for Site 3, 1 March 2023 for Site 2 and 3 March 2021 for Site 4.

Table 1: Arboreal trapping survey weather conditions 2022/2023

Date range	Min temperature (°C)	Max temperature (°C)	24 hour rainfall (mm)
1/08/22 – 5/08/22	6.5	22.3	3.8
11/07/22 – 15/07/22	6.6	18.1	52.8
30/01/23 – 3/02/23	16.9	32.2	45.4
9/01/21 – 13/01/23	13.6	28.0	0

3.2 2022/2023 Monitoring Results

Field results for the 2022/2023 monitoring period are provided in Annex 1. The outcomes of the arboreal trapping and hair tube surveys are summarised below.

3.2.1 Arboreal trapping

A summary of the species captured at each site is provided in Table 2. Arboreal trapping yielded low to moderate capture rates with a total of four different species detected. The target species Brush-tailed Phascogale was captured at Site 2 control in both winter (one capture) and summer (three captures) and Site 3 impact during summer (one capture) (Figure 1). The Brown Antechinus (*Antechinus stuartii*) was the most commonly captured species, with 12 and 32 individuals captured during winter and summer respectively, with recorded presence at all except one site (Site 4). The Common Brushtail Possum (*Trichosurus vulpecula*) and introduced Black Rat (*Rattus rattus*) were also captured.

Table 2: Summary of species captured during 2022/2023 surveys

Monitoring area	Site	Impact		Control	
		Winter	Summer	Winter	Summer
Cairncross State Forest	1	Brown Antechinus (6)	Brown Antechinus (6)	Brown Antechinus (1)	Brown Antechinus (9) Black Rat (2)
Ballengarra State Forest South	2	Brown Antechinus (3) Black Rat (1)	Brown Antechinus (7) Common Brush-tail Possum (1)	Brush-tailed Phascogale (1)	Brush-tailed Phascogale (3) Brown Antechinus (1)
Ballengarra State Forest North	3	No captures	Brush-tailed Phascogale (1) Black Rat (1)	Brown Antechinus (2) Common Brush-tail Possum (1) Black Rat (1)	Brown Antechinus (9) Black Rat (1)
Maria River State Forest	4	No captures	Common Brush-tail Possum (1)	No captures	No captures

(#) = number of individuals captured

3.2.2 Hair tubes

A complete list of hair tube results for the 2022/2023 monitoring period is provided in Annex 1 and a summary of the species detected is provided in Table 3. No Brush-tailed Phascogales were detected using hair tube sampling. From a total of 160 hair tubes deployed, 59 hair tubes (37%) contained hair samples in winter and 80 (50%) in summer. The Brushtail Possum (*Trichosurus* sp.) was the most commonly detected species identified from hair samples from all sites, accounting for 83 (50.7%) of the winter samples and 44 (80.5%) of the summer samples.

Table 3: Hair tube analysis results 2022/2023

Species	Site 1		Site 2		Site 3		Site 4	
	impact	control	impact	control	impact	control	impact	control
<i>Trichosurus</i> sp.	✓	✓	✓	✓	✓	✓	✓	✓
<i>Rattus rattus</i> (Black Rat)	✓	✓	✓	✓	✓	✓	✓	✓
<i>Rattus</i> sp.	✓		✓	✓	✓	✓	✓	✓
Unidentified Rodent	✓							✓

3.3 Additional data

Brush-tailed Phascogale record locations are shown in Figure 1. In addition to the 2022/2023 monitoring data, additional data may be summarised as follows:

- One individual was captured at Site 3 impact site during the summer 2019 Brush-tailed Phascogale monitoring.
- The Brush-tailed Phascogale was recorded during Spotted-tailed Quoll monitoring in 2018 within Maria River National Park (east of Site 4 control)
- Recorded during underpass monitoring in summer 2022 passing under the highway between Site 2 and Site 3 impact sites.

- No Brush-tailed Phascogales have been recorded occupying nest boxes during the nest box monitoring program that forms part of the Project’s ecological monitoring requirements. Nest boxes have to date been monitored on eight occasions; in winter 2016 and summer and winter of 2017, 2018 and 2020 and winter of 2022.
- A dead Brush-tailed Phascogale was observed on 8 April 2020 in the southbound left lane on a bridge known as Wilson’s River Floodplain Bridge (approximately halfway between Sites 1 and 2, Niche 2020). Transport for NSW (TfNSW) was immediately notified of the event and vegetation control works were undertaken.

3.4 Cumulative result summary

Baseline survey records and records to date are provided in Table 4.

Table 4: Cumulative results

Monitoring area	Site	Baseline	Operational	
		Impact	Impact	Control
Cairncross State Forest	1	0	2020 road kill record approximately 2.2 km north.	0
Ballengarra State Forest South	2	0	0	Brush-tailed Phascogale (4)
Ballengarra State Forest North	3	0	Brush-tailed Phascogale (1)	0
Maria River State Forest	4	0	2018 Quoll monitoring record approximately 3 km east.	

4. Discussion

4.1 Performance Measures

A summary of survey results to date in relation to the performance measures is provided in Table 5.

Table 5: Summary of performance measures

Performance measure	Discussion
Monitoring is undertaken before and after construction of the upgrade.	This performance measure has been met. Baseline monitoring was undertaken prior to construction (Lewis 2014) and after completion of the upgrade (during operational phase) in winter and summer 2018/2019 (Niche 2019), 2020/2021 (Niche 2021) and 2022/2023 (current report). 2022/2023 was the final year of monitoring (Year 8).
Monitoring is undertaken at impact and control sites.	This performance measure has been met. Control sites were not established/monitored during baseline surveys. Baseline impact sites were monitored and control sites were established and monitored during the 2018/2019, 2020/2021 and 2022/2023 monitoring periods.
Presence of Brush-tailed phascogales during Brush-tailed Phascogale monitoring and/or nest box monitoring.	This performance measure has been met. Presence of the Brush-tailed Phascogale has been demonstrated during Brush-tailed Phascogale monitoring.

5. Recommendations

5.2 Contingency Measures and Recommendations

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered relevant to the Brush-tailed Phascogale monitoring are listed and discussed in Table 6.

It is not possible to establish a decline in presence of Brush-tailed Phascogales at the survey sites due to the absence of records from baseline data. The subsequent positive outcome of the detection of one individual at Site 3 impact site during both the 2019 and 2022/2023 surveys, four individuals at Site 2 control site during 2022/2023 surveys and additional records would indicate that the species is present in the Project Area, albeit not all at the exact monitoring locations. As such, adaptive management actions or further monitoring beyond Year 8 (2022/2023) are not recommended.

Table 6: Contingency measures

Potential Problem	Contingency measure proposed in the EMP	Discussion of proposed measure
Decline in presence of target species recorded at Impact sites after the upgrade has been complete, compared to change in Control sites.	<p>The cause of decline in populations at impact sites will be investigated in consultation with EPA and DOTE within two weeks of results reported by ecologist.</p> <p>If the cause of decline is considered most likely attributed to the upgrade of the highway (and not another event such as bushfire), mitigation measures, such as the location and types of fauna crossings and fauna fencing will be reviewed within two months of the above consultation being completed.</p>	<p>Due to the absence of records from Brush-tailed Phascogale baseline data, it is not possible to determine a decline in presence of this species.</p> <p>One individual was recorded at Site 3 impact site during the 2018/2019 and 2022/2023 surveys. Four individuals were recorded at the Site 2 control site during 2022/2023 surveys.</p> <p>This contingency measure is not considered relevant.</p>

References

GHD (2010). Oxley Highway to Kempsey Upgrading the Pacific Highway Environmental Assessment. Report prepared by GHD on behalf of RTA, September 2010.

GHD (2011). Pacific Highway Upgrade - Oxley Highway to Kempsey. Supplementary Flora and Fauna Assessment. Report prepared by GHD on behalf of RTA, February 2011.

Lewis (2014). Oxley Highway to Kempsey. Pre-construction Baseline Monitoring: Winter-Summer. Prepared by Lewis Ecological.

Niche (2019). Brush-tailed Phascogale Monitoring 2018/2019. Oxley Highway to Kempsey, Pacific Highway Upgrade. Prepared for Roads and Maritime.

Niche (2020). Road Kill Monitoring 2019/2020. Oxley Highway to Kempsey, Pacific Highway Upgrade. Prepared for Transport for NSW.

Niche (2021). Brush-tailed Phascogale Monitoring 2020/2021. Oxley Highway to Kempsey, Pacific Highway Upgrade. Prepared for Roads and Maritime.

TfNSW (2022). Oxley Highway to Kempsey Pacific Highway Upgrade Ecological Monitoring Program. Transport for NSW Update to report prepared by SMEC Hyder Joint Venture, February 2022.

Annex 1 – 2022/2023 field data

Table 7: Arboreal trapping data

Site	Season	Date	Imp/cont	SOC	Trap ID	Species	Sex	Age
1	Winter	5/08/2022	Control	W	S	Brown Antechinus	Unk	adult
1	Winter	2/08/2022	Impact	E	R	Brown Antechinus	Unk	adult
1	Winter	3/08/2022	Impact	E	C	Brown Antechinus	Unk	adult
1	Winter	5/08/2022	Impact	E	R	Brown Antechinus	Unk	adult
1	Winter	5/08/2022	Impact	E	S	Brown Antechinus	Unk	adult
1	Winter	5/08/2022	Impact	E	P	Brown Antechinus	Unk	adult
1	Winter	5/08/2022	Impact	E	M	Brown Antechinus	Unk	adult
1	Summer	1/02/2023	Control	W	J	Brown Antechinus	Unk	adult
1	Summer	1/02/2023	Control	W	E	Brown Antechinus	Unk	adult
1	Summer	1/02/2023	Control	W	S	Brown Antechinus	Unk	adult
1	Summer	2/02/2023	Control	W	O	Brown Antechinus	Unk	adult
1	Summer	3/02/2023	Control	E	A	Black Rat	Unk	adult
1	Summer	3/02/2023	Control	E	P	Brown Antechinus	Unk	adult
1	Summer	3/02/2023	Control	E	D	Brown Antechinus	Unk	adult
1	Summer	3/02/2023	Control	E	Q	Brown Antechinus	Unk	adult
1	Summer	3/02/2023	Control	E	N	Brown Antechinus	Unk	adult
1	Summer	3/02/2023	Control	E	J	Black Rat	Unk	adult
1	Summer	2/02/2023	Control	W	Q	Brown Antechinus	Unk	adult
1	Summer	31/01/2023	Impact	E	T	Brown Antechinus	Unk	adult
1	Summer	31/01/2023	Impact	E	Q	Brown Antechinus	Unk	adult
1	Summer	1/02/2023	Impact	W	A	Brown Antechinus	Unk	adult
1	Summer	1/02/2023	Impact	W	H	Brown Antechinus	Unk	adult
1	Summer	3/02/2023	Impact	W	A	Brown Antechinus	Unk	adult
1	Summer	3/02/2023	Impact	E	P	Brown Antechinus	Unk	adult
2	Winter	4/08/2022	Control	W	R	Brush-tailed Phascogale	F	Adult with young
2	Winter	3/08/2022	Impact	E	E	Black Rat	Unk	adult
2	Winter	4/08/2022	Impact	E	E	Brown Antechinus	Unk	adult
2	Winter	5/08/2022	Impact	E	F	Brown Antechinus	Unk	adult
2	Winter	5/08/2022	Impact	E	E	Brown Antechinus	Unk	adult
2	Summer	31/01/2023	Control	W	N	Brown Antechinus	Unk	adult
2	Summer	31/01/2023	Control	W	J	Brush-tailed Phascogale	F	adult
2	Summer	3/02/2023	Control	W	H	Brush-tailed Phascogale	F	adult
2	Summer	3/02/2023	Control	W	F	Brush-tailed Phascogale	F	adult
2	Summer	31/01/2023	Impact	W	P	Brown Antechinus	Unk	adult

Site	Season	Date	Imp/cont	SOC	Trap ID	Species	Sex	Age
2	Summer	1/02/2023	Impact	E	C	Brown Antechinus	Unk	adult
2	Summer	1/02/2023	Impact	E	E	Brown Antechinus	Unk	adult
2	Summer	2/02/2023	Impact	W	M	Brown Antechinus	Unk	adult
2	Summer	2/02/2023	Impact	E	C	Brown Antechinus	Unk	adult
2	Summer	3/02/2023	Impact	W	M	Brown Antechinus	Unk	adult
2	Summer	3/02/2023	Impact	W	K	Brown Antechinus	Unk	adult
2	Summer	4/02/2023	Impact	W	K	Common Brushtail Possum	Unk	adult
3	Winter	13/07/2022	Control	E	L	Common Brushtail Possum	Unk	adult
3	Winter	14/07/2022	Control	E	H	Brown Antechinus	Unk	adult
3	Winter	15/07/2022	Control	E	H	Brown Antechinus	Unk	adult
3	Winter	15/07/2022	Control	E	T	Black Rat	Unk	YA
3	Summer	11/01/2023	Control	E	A	Brown Antechinus	M	adult
3	Summer	11/01/2023	Control	E	D	Brown Antechinus	M	adult
3	Summer	11/01/2023	Control	E	H	Brown Antechinus	Unk	adult
3	Summer	12/01/2023	Control	E	D	Brown Antechinus	Unk	adult
3	Summer	12/01/2023	Control	E	G	Brown Antechinus	Unk	adult
3	Summer	12/01/2023	Control	E	Q	Brown Antechinus	Unk	adult
3	Summer	13/01/2023	Control	E	A	Brown Antechinus	Unk	adult
3	Summer	13/01/2023	Control	E	D	Brown Antechinus	Unk	adult
3	Summer	13/01/2023	Control	E	G	Brown Antechinus	Unk	adult
3	Summer	13/01/2023	Control	E	E	Black Rat	Unk	adult
3	Summer	11/01/2023	Impact	E	Q	Brush-tailed Phascogale	M	adult
3	Summer	13/01/2023	Impact	W	J	Black Rat	Unk	adult
4	Summer	13/01/2023	Impact	W	J	Common Brushtail Possum	Unk	adult

SOC = side of carriageway; E = east; W = west; M = male; F = female; YA = young adult; Unk = unknown

Table 8: Hair tube field results

Area	HT ID	Site	Site type	SOC	Winter deploy date	Winter retrieve date	Winter species ID	Summer deploy date	Summer retrieve date	Summer species ID
Cairncross State Forest	1Ca	1	Control	W	2/08/2022	18/08/2022	<i>Rattus</i> sp.	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1Cb	1	Control	W	2/08/2022	18/08/2022	<i>Rattus</i> sp.	2/02/2023	3/03/2023	<i>Rattus</i> sp.
Cairncross State Forest	1Cc	1	Control	W	2/08/2022	18/08/2022	<i>Rattus</i> sp.	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1Cd	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Ce	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cf	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cg	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Ch	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Ci	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cj	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Ck	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cl	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cm	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cn	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Co	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cp	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cq	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cr	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Cs	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1Ct	1	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1la	1	Impact	W	2/08/2022	18/08/2022	<i>Rattus</i> sp. <i>Trichosurus</i> sp.	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1lb	1	Impact	W	2/08/2022	18/08/2022	Rodent	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1lc	1	Impact	W	2/08/2022	18/08/2022	<i>Rattus rattus</i>	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.

Area	HT ID	Site	Site type	SOC	Winter deploy date	Winter retrieve date	Winter species ID	Summer deploy date	Summer retrieve date	Summer species ID
Cairncross State Forest	1ld	1	Impact	W	2/08/2022	18/08/2022	<i>Rattus</i> sp.	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1le	1	Impact	W	2/08/2022	18/08/2022	<i>Rattus</i> sp.	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1lf	1	Impact	W	2/08/2022	18/08/2022	Rodent	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1lg	1	Impact	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1lh	1	Impact	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1li	1	Impact	W	2/08/2022	18/08/2022	Rodent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1lj	1	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1lk	1	Impact	E	2/08/2022	18/08/2022	Rodent	2/02/2023	3/03/2023	<i>Trichosurus</i> sp.
Cairncross State Forest	1ll	1	Impact	E	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1lm	1	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1ln	1	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1lo	1	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1lp	1	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1lq	1	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1lr	1	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1ls	1	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Cairncross State Forest	1lt	1	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	3/03/2023	no hair not sent
Ballengarra State Forest South	2Ca	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cb	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cc	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cd	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Ce	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cf	2	Control	W	2/08/2022	18/08/2022	<i>Rattus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cg	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.

Area	HT ID	Site	Site type	SOC	Winter deploy date	Winter retrieve date	Winter species ID	Summer deploy date	Summer retrieve date	Summer species ID
Ballengarra State Forest South	2Ch	2	Control	W	2/08/2022	18/08/2022	<i>Rattus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Ci	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cj	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Ck	2	Control	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cl	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cm	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Cn	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Co	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Cp	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Cq	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Cr	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Cs	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Ct	2	Control	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Ia	2	Impact	E	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Ib	2	Impact	E	2/08/2022	18/08/2022	Rodent	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Ic	2	Impact	E	2/08/2022	18/08/2022	<i>Rattus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Id	2	Impact	E	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Ie	2	Impact	E	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2If	2	Impact	E	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	<i>Rattus</i> sp.
Ballengarra State Forest South	2Ig	2	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Ih	2	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest South	2Ii	2	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Ij	2	Impact	E	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Ik	2	Impact	W	2/08/2022	18/08/2022	<i>Trichosurus</i> sp.	2/02/2023	1/03/2023	no hair not sent

Area	HT ID	Site	Site type	SOC	Winter deploy date	Winter retrieve date	Winter species ID	Summer deploy date	Summer retrieve date	Summer species ID
Ballengarra State Forest South	2Il	2	Impact	W	2/08/2022	18/08/2022	Rodent	2/02/2023	1/03/2023	<i>Trichosurus</i> sp. <i>Rattus</i> sp.
Ballengarra State Forest South	2Im	2	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	<i>Trichosurus</i> sp. <i>Rattus</i> sp.
Ballengarra State Forest South	2In	2	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Io	2	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Ip	2	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Iq	2	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Ir	2	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2Is	2	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest South	2It	2	Impact	W	2/08/2022	18/08/2022	no hair not sent	2/02/2023	1/03/2023	no hair not sent
Ballengarra State Forest North	3Ca	3	Control	E	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Cb	3	Control	E	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Rattus</i> sp.
Ballengarra State Forest North	3Cc	3	Control	E	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Cd	3	Control	E	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ce	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Cf	3	Control	E	13/07/2022	28/07/2022	<i>Rattus</i> sp.	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Cg	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ch	3	Control	E	13/07/2022	28/07/2022	<i>Rattus</i> sp.	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ci	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Cj	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ck	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Cl	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Cm	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Cn	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.

Area	HT ID	Site	Site type	SOC	Winter deploy date	Winter retrieve date	Winter species ID	Summer deploy date	Summer retrieve date	Summer species ID
Ballengarra State Forest North	3Co	3	Control	E	13/07/2022	28/07/2022	<i>Rattus</i> sp. <i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Cp	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Cq	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Cr	3	Control	E	13/07/2022	28/07/2022	undiagnostic	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Cs	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ct	3	Control	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ia	3	Impact	W	13/07/2022	28/07/2022	<i>Rattus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Ib	3	Impact	W	13/07/2022	28/07/2022	Rodent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp. <i>Rattus</i> sp.
Ballengarra State Forest North	3Ic	3	Impact	W	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Rattus</i> sp.
Ballengarra State Forest North	3Id	3	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp. <i>Rattus</i> sp.
Ballengarra State Forest North	3Ie	3	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Rattus</i> sp.
Ballengarra State Forest North	3If	3	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ig	3	Impact	W	13/07/2022	28/07/2022	<i>Rattus</i> sp.	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ih	3	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ii	3	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ij	3	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ik	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Il	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Ballengarra State Forest North	3Im	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3In	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Io	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3Ip	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent

Area	HT ID	Site	Site type	SOC	Winter deploy date	Winter retrieve date	Winter species ID	Summer deploy date	Summer retrieve date	Summer species ID
Ballengarra State Forest North	3lq	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3lr	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3ls	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Ballengarra State Forest North	3lt	3	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Ca	4	Control	W	13/07/2022	28/07/2022	<i>Rattus rattus</i>	10/01/2023	1/02/2023	Rodent
Maria River State Forest	4Cb	4	Control	W	13/07/2022	28/07/2022	Rodent	10/01/2023	1/02/2023	<i>Rattus rattus</i>
Maria River State Forest	4Cc	4	Control	W	13/07/2022	28/07/2022	Human	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Cd	4	Control	W	13/07/2022	28/07/2022	Possum	10/01/2023	1/02/2023	<i>Rattus</i> sp.
Maria River State Forest	4Ce	4	Control	W	13/07/2022	28/07/2022	<i>Rattus</i> sp.	10/01/2023	1/02/2023	<i>Rattus</i> sp.
Maria River State Forest	4Cf	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Rattus rattus</i> <i>Trichosurus</i> sp.
Maria River State Forest	4Cg	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Rattus rattus</i> Rodent
Maria River State Forest	4Ch	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	Rodent <i>Rattus</i> sp.
Maria River State Forest	4Ci	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Cj	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Ck	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Cl	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Cm	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Cn	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Co	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Cp	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Cq	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Cr	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent

Area	HT ID	Site	Site type	SOC	Winter deploy date	Winter retrieve date	Winter species ID	Summer deploy date	Summer retrieve date	Summer species ID
Maria River State Forest	4Cs	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Ct	4	Control	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Ia	4	Impact	W	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Ib	4	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Ic	4	Impact	W	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Id	4	Impact	W	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Ie	4	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4If	4	Impact	W	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Ig	4	Impact	W	13/07/2022	28/07/2022	<i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Ih	4	Impact	W	13/07/2022	28/07/2022	Rodent <i>Trichosurus</i> sp.	10/01/2023	1/02/2023	<i>Rattus</i> sp. Rodent
Maria River State Forest	4Ii	4	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Ij	4	Impact	W	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	<i>Trichosurus</i> sp.
Maria River State Forest	4Ik	4	Impact	E	13/07/2022	28/07/2022	<i>Rattus rattus</i>	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Il	4	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Im	4	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4In	4	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Io	4	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Ip	4	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Iq	4	Impact	E	13/07/2022	28/07/2022	<i>Rattus</i> sp.	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Ir	4	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4Is	4	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent
Maria River State Forest	4It	4	Impact	E	13/07/2022	28/07/2022	no hair not sent	10/01/2023	1/02/2023	no hair not sent

SOC = side of carriageway; E = east; W = west

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Appendix F – Squirrel Glider



Squirrel Glider Monitoring 2022

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

May 2023

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Project Manager:	Radika Michniewicz
Authors:	Jodie Danvers
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Local Government Area:	Kempsey and Port Macquarie Hastings

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Cover photograph: Sugar/Squirrel Glider (left) and baited arboreal trap (right) in Maria River State Forest.

Executive summary

Context

This report documents findings for the 2022 monitoring period, the third and final, for the Squirrel Glider (*Petaurus norfolcensis*), as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway upgrade project (the Project) and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022). Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project. The Squirrel Glider is one of the threatened species identified as requiring monitoring during the operational phase of the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade.

Aim

The aim of the Squirrel Glider monitoring program is to determine whether the Project is meeting the performance indicators for the species, and provide corrective actions where required.

Method

Monitoring sites were established in four broad areas. Each site consisted of an impact site with a paired control site. Surveys were undertaken in accordance with the EMP and involved arboreal trapping for four consecutive nights using 20 Elliot B traps deployed at each control and impact site over approximately two hectares of habitat. Traps were baited with a mixture of oats, honey and peanut butter.

Key results

No Squirrel Gliders were recorded during the 2022 monitoring. Species recorded included the native Brown Antechinus (*Antechinus stuartii*), Brush-tailed Phascogale (*Phascogale tapoatafa*), Common Brushtail Possum (*Trichosurus vulpecula*) and the introduced Black Rat (*Rattus rattus*).

Squirrel Gliders were not recorded during baseline, 2018, 2020 or 2022 monitoring surveys.

Conclusion

Performance measures relating to monitoring requirements have been met.

The performance measure relating to the presence of Squirrel Gliders within habitat adjacent to the Project has been met through observations of individuals in nest boxes as part of broader nest box monitoring for the Project. Squirrel Glider records have not been confirmed for aerial crossings or use of the widened median.

Management implications

While Squirrel Gliders were not recorded during 2018, 2020 and 2022 targeted Squirrel Glider monitoring, the species has been recorded occupying nest boxes within 75 metres (m) of the Project Corridor within the Cairncross State Forest and Maria River State Forest monitoring areas. As per the performance measure, this suggests that the home ranges of the local population includes habitat immediately adjacent to the Project.

Given that no Squirrel Gliders were recorded prior to the 2017 nest box monitoring, and records exist demonstrating use of adjacent habitat by the species, contingency measures are not considered relevant.

As such, adaptive management actions or further monitoring beyond Year 8 (2022/2023) are not recommended.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW, previously the Department of Environment (DoE)) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project. The Squirrel Glider (*Petaurus norfolcensis*) was one threatened species identified as requiring monitoring following the completion of the Project's construction, during the operational phase.

1.1.1 Legal status

The Squirrel Glider is listed as vulnerable under the New South Wales *Biodiversity Conservation Act 2016* (BC Act). Monitoring of the species is required under the Project's approval.

1.1.2 Monitoring framework

The survey design, methodology and performance indicators that define the Squirrel Glider monitoring program are specified in the EMP. The EMP requires monitoring of the Squirrel Glider on three occasions: between April and August in Years 4, 6 and 8, after the completion of construction. This represents the third and last of the monitoring periods – Year 8, winter 2022. Baseline surveys (not required by the EMP) were undertaken by Niche in autumn 2014.

To date, these monitoring events have been undertaken and reported as follows:

- Baseline monitoring: Niche (2015)
- Operational phase monitoring:
 - Year 4 (2018): Niche (2018a)
 - Year 6 (2020): Niche (2021)
 - Year 8 (2022): current report.

1.1.3 Baseline data

While the EMP notes that the Squirrel Glider has not been identified within the Project area, the environmental assessment considered the species as highly likely to occur in the area (GHD 2010, GHD 2011). Baseline surveys (not required by the EMP) were undertaken by Niche in autumn 2014 (Niche 2015). No Squirrel Gliders were recorded during those baseline surveys.

1.1.4 Purpose of this report

This report details the findings obtained from the third and last monitoring period for the Squirrel Glider. The aims of this report are to summarise the methods and results of the 2022 monitoring and determine if performance measures have been met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for the Squirrel Glider:

- Monitoring is undertaken after construction of the upgrade.
- Monitoring is undertaken at Impact and Control sites.
- There is no statistically significant difference in presence of Squirrel Glider between Impact and Control sites during the operation monitoring phase of the Project.
 - Where statistical analysis is not possible due to low trapping success, detection of the Squirrel Glider using aerial crossings and/or the widened median.
 - Where statistical analysis is not possible due to low trapping success, detection of the Squirrel Glider within 75 metres (m) (assuming conservative minimum home range size of 2 ha) of the Project corridor, so that it may be inferred that the local population may be incorporating habitat immediately adjacent to the Project within their home ranges.

1.3 Monitoring Timing

Monitoring is to occur annually between April and August, ideally in gaps in flowering resource availability.

1.4 Reporting

As per the EMP, the annual reporting of monitoring results will include:

- Detailed description of monitoring methodology employed.
- Results of the monitoring period.
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations.
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA).

2. Methodology

2.1 Monitoring Sites

Monitoring sites were established within four broad areas containing Moist Slopes Forest and Dry Ridgetop Forest habitat, where the species was considered likely to occur (GHD 2010, GHD 2011). They included:

- Cairncross State Forest: Site 1
- Ballengarra State Forest South: Site 2
- Ballengarra State Forest North: Site 3
- Maria River State Forest: Site 4

Each site consists of an impact site and a paired control site. Control sites were located a minimum of 500 m to one kilometre (km), where access permitted, from the paired impact site within continuous vegetation. Trap locations are shown in Figure 1 - Figure 5.

2.2 Survey Method

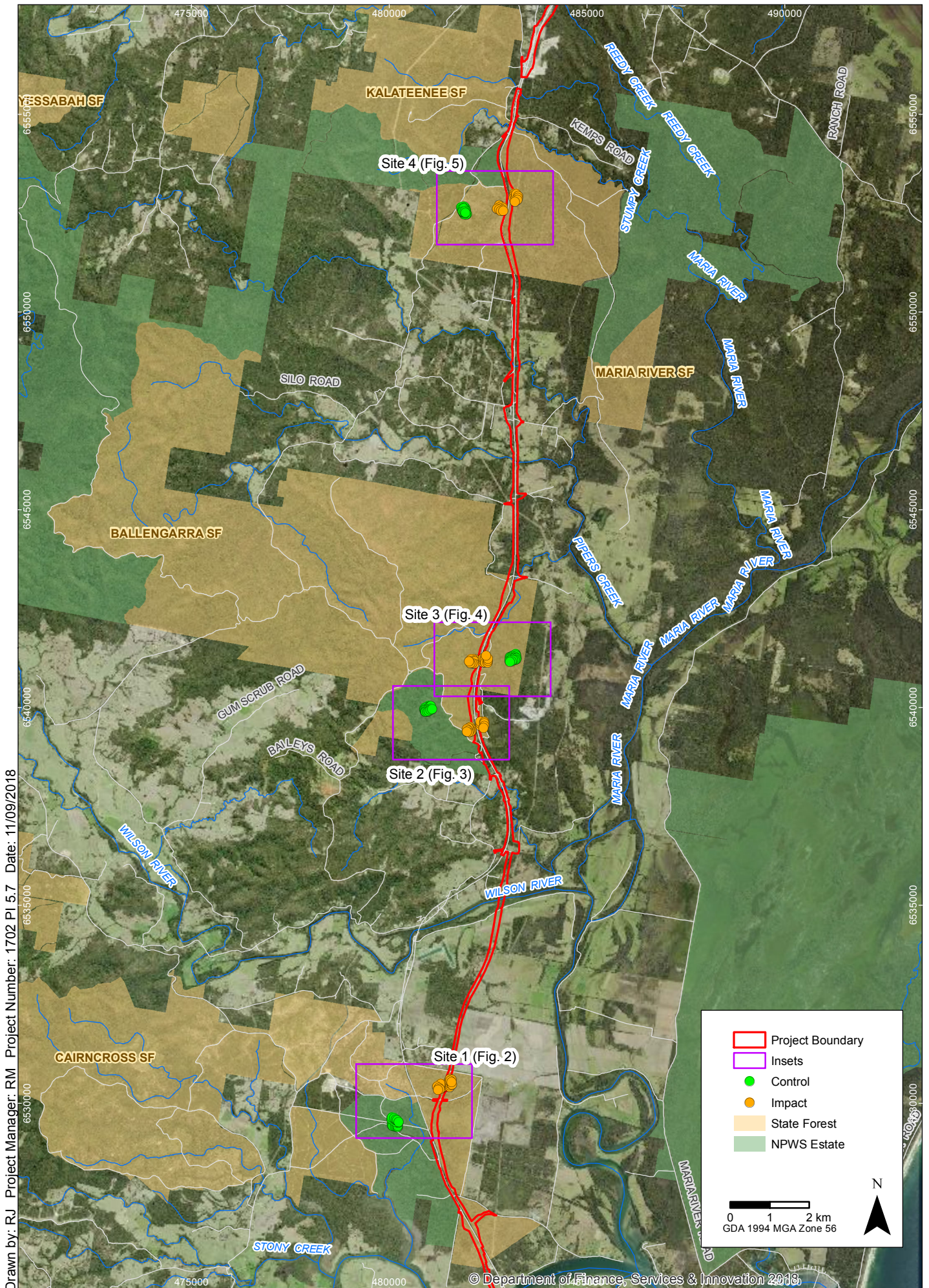
In accordance with the EMP, arboreal trapping was undertaken using a grid configuration of 20 tree-mounted Elliot B traps distributed over approximately two hectares of habitat for four consecutive nights at each control and each impact site. At impact sites, 10 traps were deployed on either side of the carriageway. Traps were positioned on brackets and installed approximately two to three metres above the ground on a range of mature canopy species and baited with a mixture of oats, peanut butter and honey. The host tree was sprayed with a mixture of honey water above the trap as an additional attractant. Traps were checked each morning and bait was replaced as necessary.

The following details were recorded for any captured fauna where this could be determined with minimal animal handling:

- Trap location
- Sex
- Age class
- Mass
- Breeding condition.

2.3 Analysis

Monitoring results were analysed in accordance with the performance indicators specified within the EMP. However, undertaking statistical analysis of trapping results to determine a statistically significant difference between control and impact sites requires a relatively high trapping success rate to achieve reasonable sample sizes and sufficient statistical power. Trapping success was not sufficient during the current surveys to allow for such analysis. As such, trapping results are presented as capture numbers in this instance.

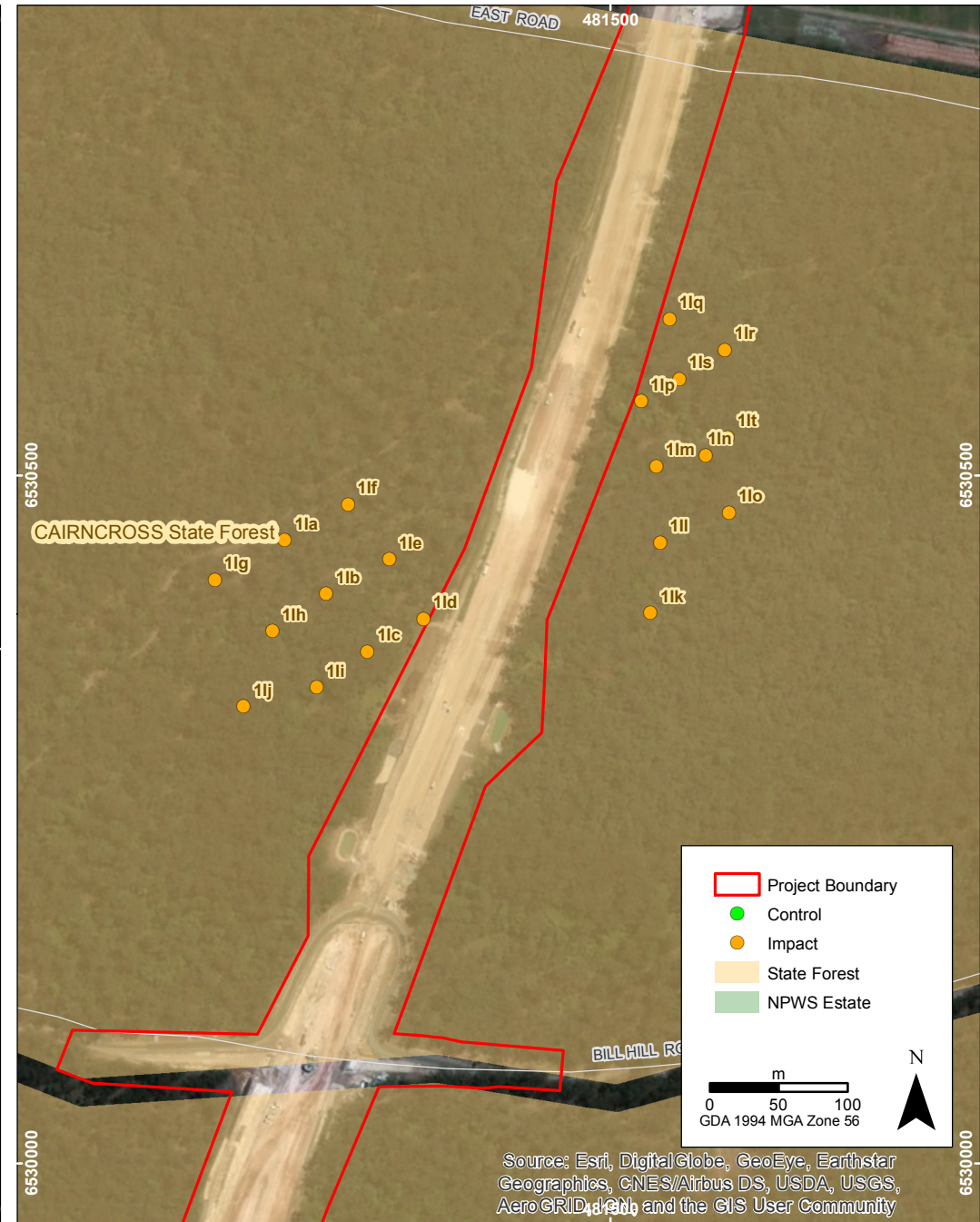


Overview of monitoring sites

Squirrel Glider Monitoring: Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1

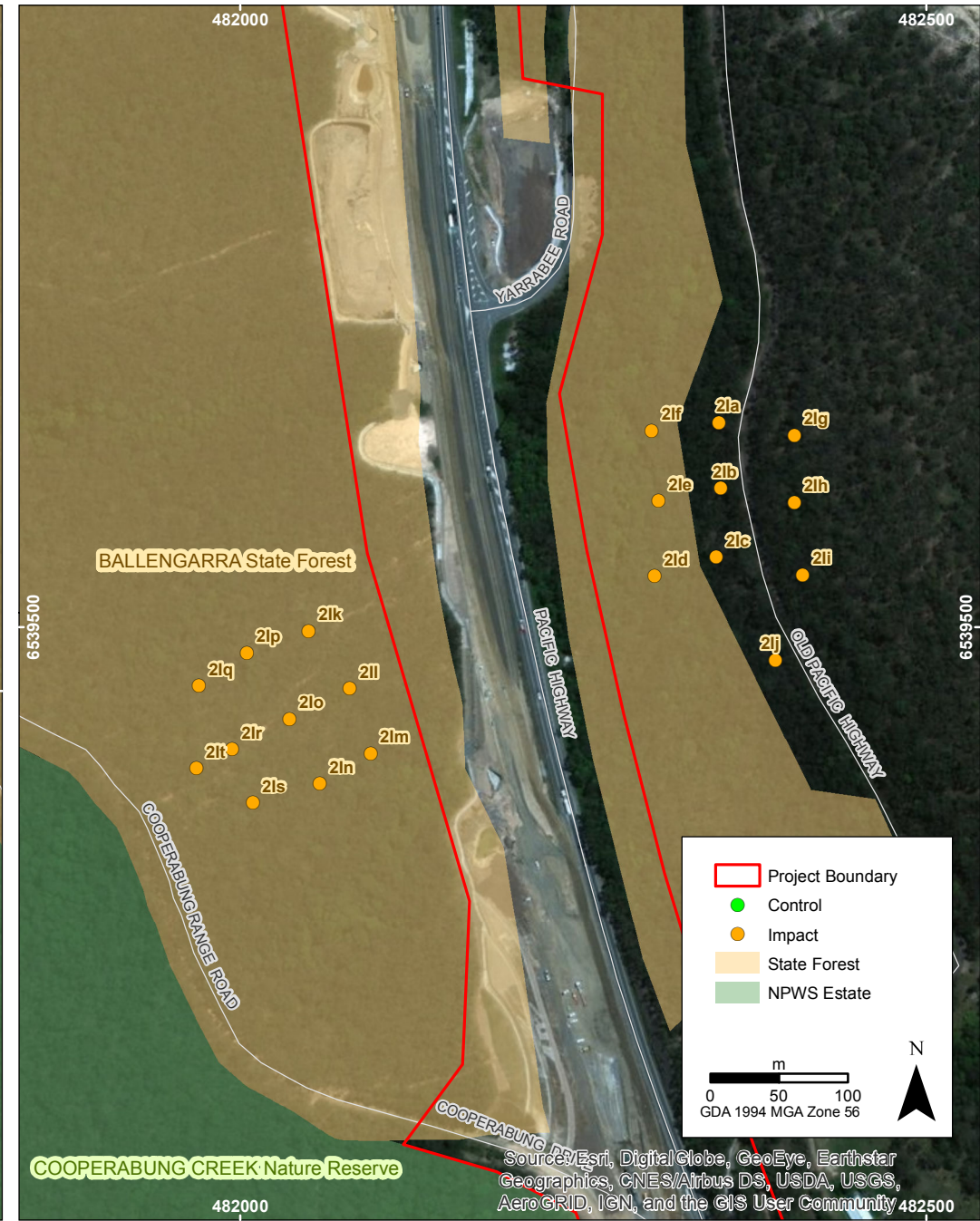
Imagery: (c) LPI 2014-6-10



Cairncross State Forest: Site 1 trap locations
Squirrel Glider Monitoring: Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 2

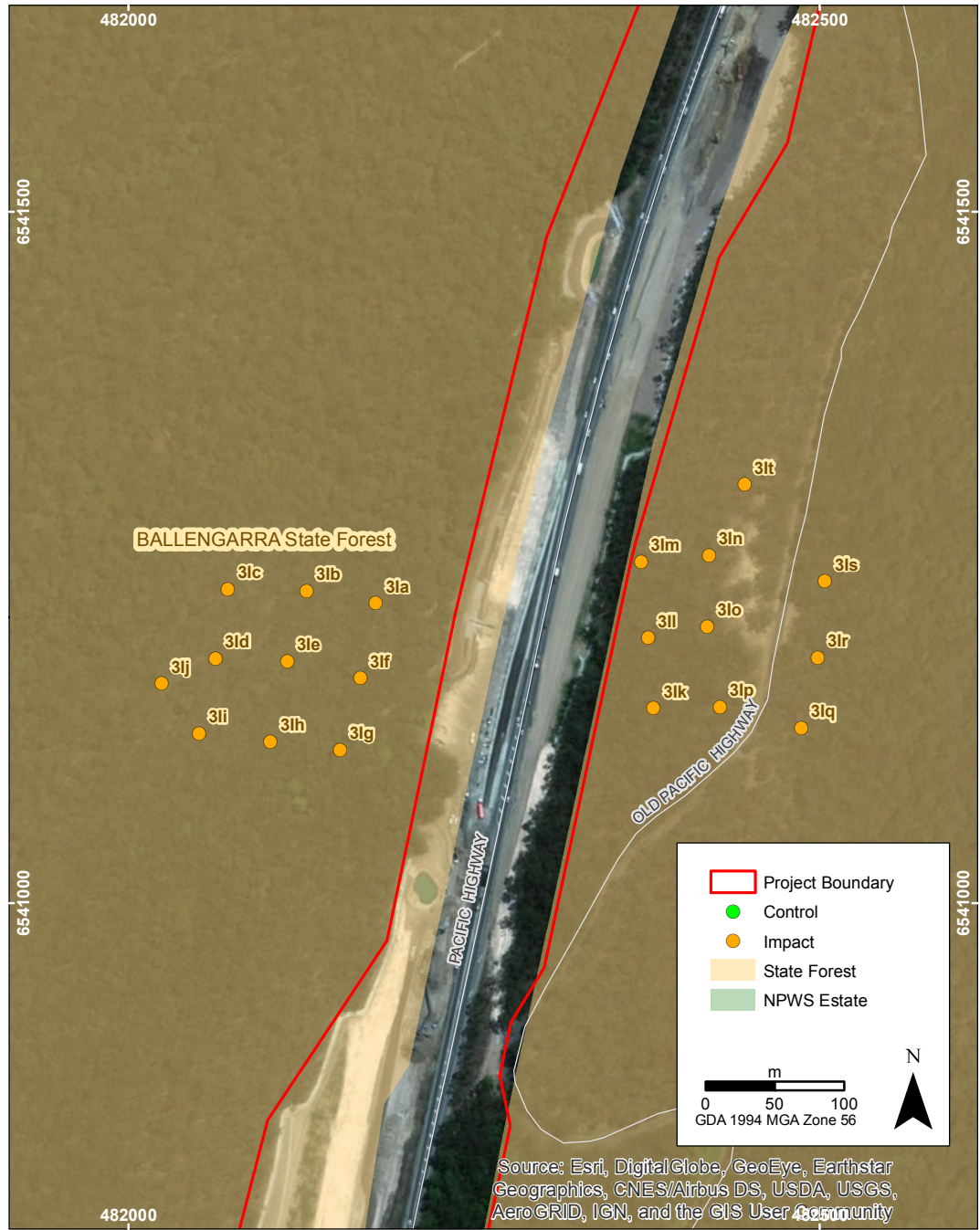
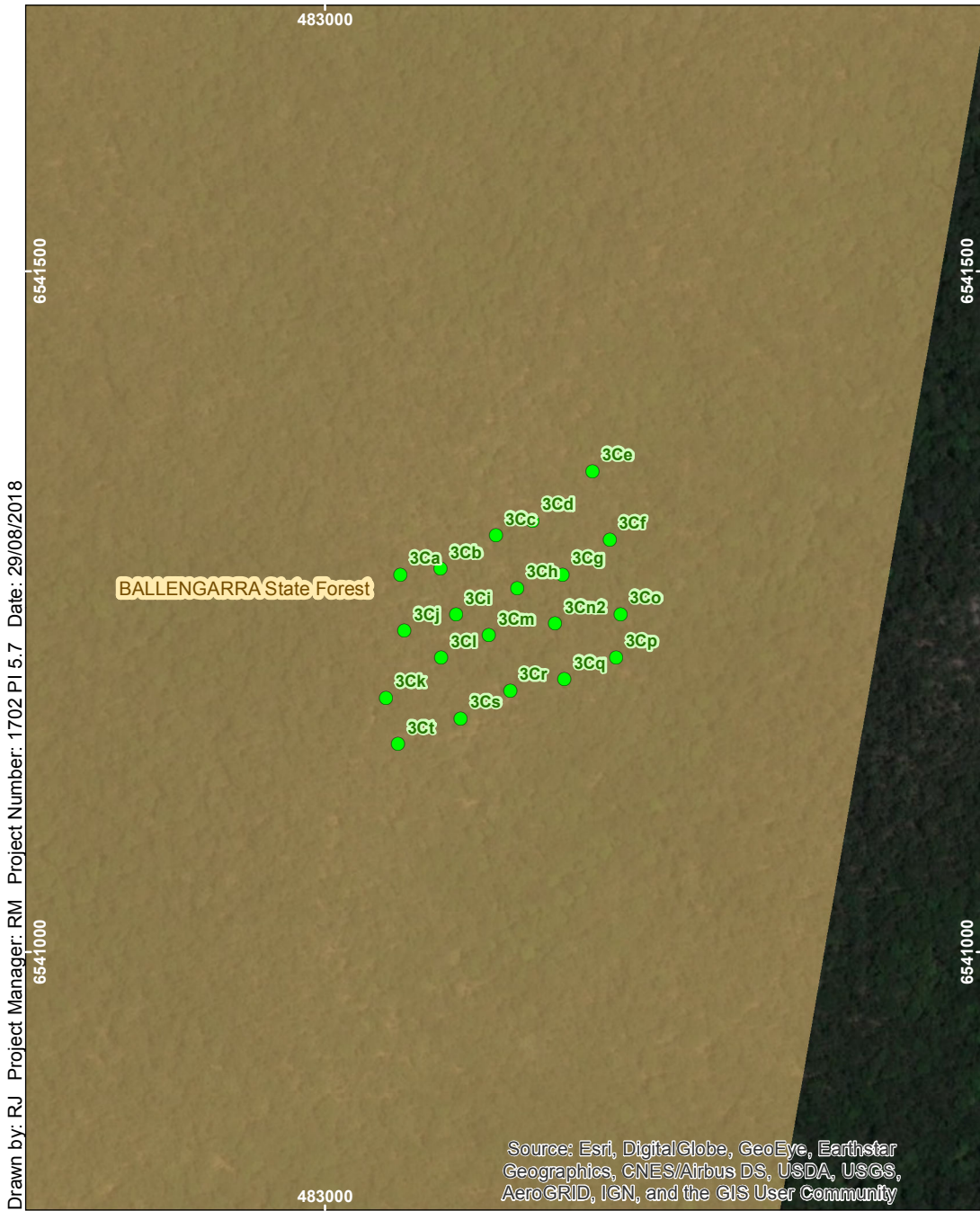
Imagery: (c) DigitalGlobe 2015-11-25



Ballengarra State Forest South: Site 2 trap locations
Squirrel Glider Monitoring: Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 3

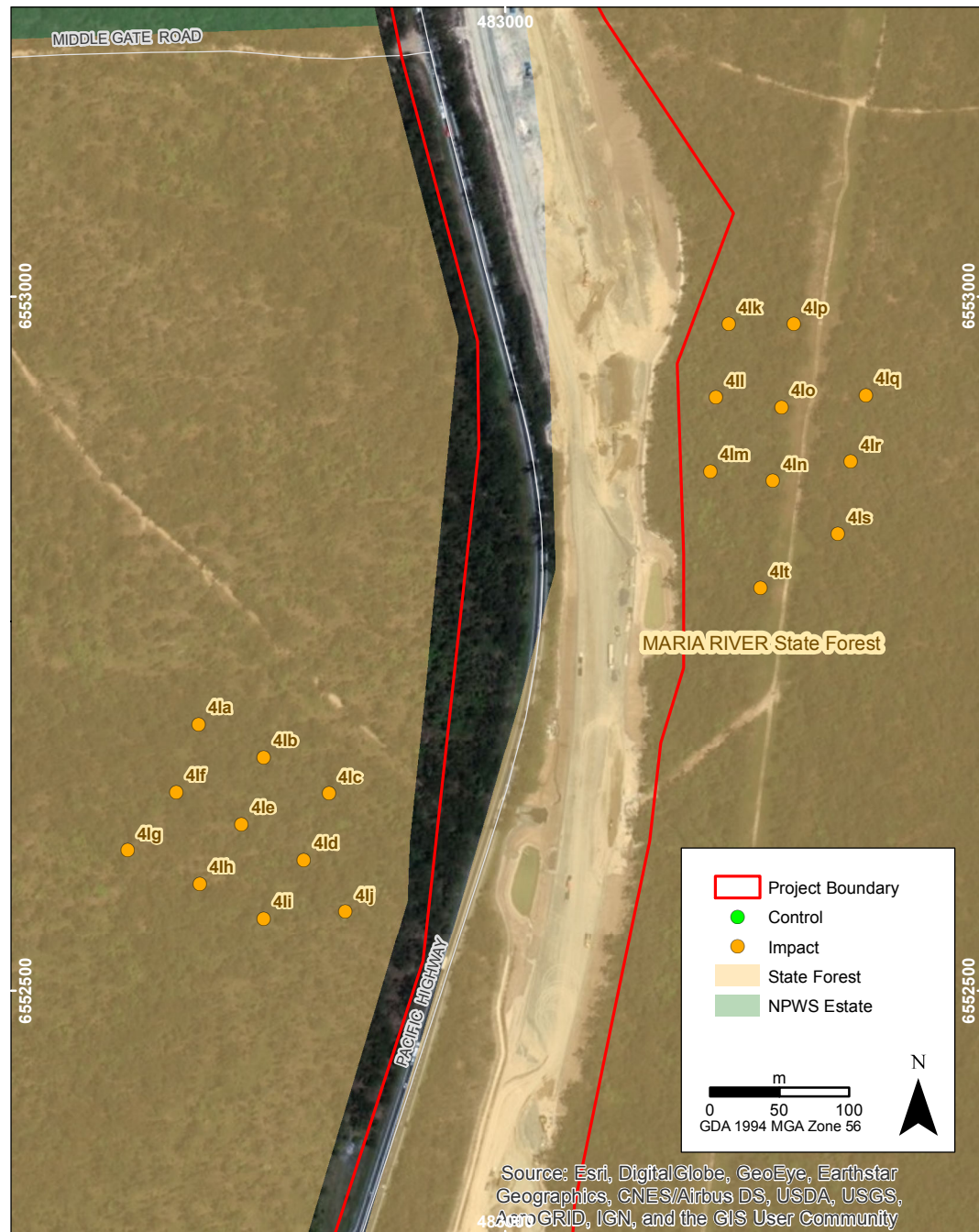
Imagery: (c) DigitalGlobe 2015-11-25



Ballegarra State Forest North: Site 3 trap locations
Squirrel Glider Monitoring: Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 4

Imagery: (c) DigitalGlobe 2015-11-25



Maria River State Forest: Site 4 trap locations
 Squirrel Glider Monitoring: Pacific Highway Upgrade – Oxley Highway to Kempsey

3. Results

3.1 Timing and Conditions

Trapping was undertaken from 1-5 August 2022 for Sites 1 and 2 and from 11-15 July 2022 for Sites 3 and 4. Table 1 shows the weather conditions recorded at Port Macquarie Airport (station ID 060168) for these periods.

Table 1: Weather conditions 2022

Date range	Min temp (°C)	Max temp (°C)	Rainfall (mm)
1/08/22 – 5/08/22	6.5	22.3	3.8
11/07/22 – 15/07/22	6.6	18.1	52.8

3.2 2022 Trapping Results

Results of the trapping are presented in Table 2.

No Squirrel Gliders were captured during the 2022 monitoring period. Four species were recorded, including the native Brown Antechinus (*Antechinus stuartii*), Brush-tailed Phascogale (*Phascogale tapoatafa*), Common Brushtail Possum (*Trichosurus vulpecula*) and the introduced Black Rat (*Rattus rattus*).

Site 1 impact had the highest number of captures (six) consisting of one species, the Brown Antechinus. Similarly, captures at Site 2 and Site 3 consisted of three different species including, the Brush-tailed Phascogale, Common Brushtail Possum, Black Rat and Brown Antechinus. There were no captures at Site 4.

Table 2: 2022 arboreal trapping results

Site	Date	Site type	SOC	Trap ID	Species	Sex	Age
1	5/08/2022	Control	W	S	Brown Antechinus	Unk	adult
1	2/08/2022	Impact	E	R	Brown Antechinus	Unk	adult
1	3/08/2022	Impact	E	C	Brown Antechinus	Unk	adult
1	5/08/2022	Impact	E	R	Brown Antechinus	Unk	adult
1	5/08/2022	Impact	E	S	Brown Antechinus	Unk	adult
1	5/08/2022	Impact	E	P	Brown Antechinus	Unk	adult
1	5/08/2022	Impact	E	M	Brown Antechinus	Unk	adult
2	4/08/2022	Control	W	R	Brush-tailed Phascogale	F	adult
2	3/08/2022	Impact	E	E	Black Rat	Unk	adult
2	4/08/2022	Impact	E	E	Brown Antechinus	Unk	adult
2	5/08/2022	Impact	E	F	Brown Antechinus	Unk	adult
2	5/08/2022	Impact	E	E	Brown Antechinus	Unk	adult
3	13/07/2022	Control	E	L	Common Brushtail Possum	Unk	adult
3	14/07/2022	Control	E	H	Brown Antechinus	Unk	adult
3	15/07/2022	Control	E	H	Brown Antechinus	Unk	adult
3	15/07/2022	Control	E	T	Black Rat	Unk	adult

SOC = side of carriageway; E = east of carriageway; W = west of carriageway; M = male; F = female, unk = unknown

3.3 Cumulative Results

3.3.1 Trapping data

As for the baseline, 2018 and 2020 surveys, the Squirrel Glider was not recorded at any of the monitoring sites during the 2022 monitoring. Table 3 summarises the species recorded during the 2018, 2020 and 2022 monitoring events.

Table 3: Cumulative results for 2018, 2020 and 2022 monitoring events

Species	Site 1 Impact	Site 1 Control	Site 2 Impact	Site 2 Control	Site 3 Impact	Site 3 Control	Site 4 Impact	Site 4 Control
Brown Antechinus (<i>Antechinus stuartii</i>)	Y (26)	Y (5)	Y (8)	Y (1)	Y (3)	Y (6)		
Black Rat (<i>Rattus rattus</i>)	Y (5)		Y (3)			Y (1)		Y (1)
Bush Rat (<i>Rattus fuscipes</i>)					Y (1)	Y (1)		
Brush-tail Possum (<i>Trichosurus</i> sp.)	Y*	Y*	Y*	Y*	Y*	Y*	Y*	Y*
Common Brush-tail Possum (<i>Trichosurus vulpecula</i>)						Y (1)		
Brush-tailed Phascogale (<i>Phascogale tapoatafa</i>)				Y (1)	Y (1)			
House Mouse (<i>Mus musculus</i>)							Y*	

Y = yes recorded, (#) = number of records of species at each site, * species recorded by hair tube traps in association with Brush-tailed Phascogale monitoring.

3.3.2 Additional monitoring data

Hair tubes

As part of the Project's monitoring requirements for the Brush-tailed Phascogale and the widened median, hair tube surveys were undertaken at the same sites during the 2018, 2020 and 2022 monitoring periods and within the widened median in 2018 and 2020. Hair tube results have not produced Squirrel Glider records to date (Niche, unpublished data).

Nest boxes

Squirrel Gliders have been recorded during inspections of installed nest boxes in 2017 (Niche 2018b) and 2018 (Niche 2018c). Squirrel Gliders were observed occupying nest boxes in the Maria River State Forest area, approximately 700 m south of Site 4; in Cairncross State Forest area, approximately one kilometre south of Site 1; and in the Fernbank Creek area, approximately seven kilometres south of Site 1. The occupied nest boxes (NEW ZONE NBT96 (possum box), G3 NBT209 (scansorial box) and C2 NBT219 (small glider box) occur within 60, 20 and 110 m, respectively, of the Project corridor.

Spotlighting

As part of the Project's monitoring requirements for the widened median and Yellow-bellied Glider/Koala monitoring, spotlighting surveys were undertaken within and adjacent to the widened median and within the broad Squirrel Glider monitoring areas, respectively. A number of possible Squirrel Glider records have been noted during spotlighting within the widened median and vegetation immediately adjacent, however, the accurate identification of Squirrel Gliders during spotlighting surveys was not always possible due to distinguishing features being hidden from view, distance from which observations were made and rapid movement of individuals.

Widened Median

As part of the Project’s monitoring requirements for the widened median monitoring, arboreal camera monitoring was undertaken within and adjacent to the widened median. A number of possible Squirrel Glider records have been noted during camera monitoring within the widened median and vegetation immediately adjacent, however, the accurate identification of Squirrel Gliders was not always possible due to distinguishing features being hidden from view and rapid movement of individuals.

Aerial crossings

As part of the Project’s monitoring requirements for the aerial crossing structures, three rope bridges (RB1, RB2 and RB3) and three glider pole (GP1, GP2 and GP3) crossings in the northern Kundabung to Kempsey (Ku2K) section of the Project were monitored. There have been no confirmed Squirrel Gliders recorded as a part of the aerial crossing monitoring to date.

3.4 Summary

A summary of Squirrel Glider records to date in relation to the broad monitoring areas is provided in Table 4.

Table 4: Summary of additional monitoring data records

Site	Monitoring area	Baseline trapping records	All Years trapping records	Hair tube records	Nest box records	Spotlighting records	Widened median records	Aerial crossing records
1	Cairncross State Forest	0	0	0	Yes, at 1 km from site (20 m from Project corridor)	Possible (widened median)	Possible (widened median)	0
2	Ballengarra State Forest South	0	0	0	0	0		0
3	Ballengarra State Forest North	0	0	0	0	0		0
4	Maria River State Forest	0	0	0	Yes, within 700 m from site (60 m from Project corridor)	0		0

4. Discussion

4.1 Performance Measures

A summary of the 2022 survey results in relation to the performance measures are provided in Table 5.

Table 5: Summary of performance measures for the 2022 monitoring period

Performance measure	Discussion
Monitoring is undertaken after construction of the upgrade.	<p>This performance measure has been met.</p> <p>The final stage of the Project became operational on 29 March 2018. Three rounds of operational monitoring have been undertaken as per the EMP in 2018, 2020 and 2022.</p>
Monitoring is undertaken at Impact and Control sites.	<p>This performance measure has been met.</p> <p>Three rounds of operational monitoring have been undertaken as per the EMP in 2018, 2020 and 2022.</p>
<p>There is no statistically significant difference in presence of Squirrel Glider between Impact and Control sites during the operation phase of the project.</p> <ul style="list-style-type: none"> Where statistical analysis is not possible due to low trapping success, detection of the Squirrel Glider using aerial crossings and/or the widened median. Where statistical analysis is not possible due to low trapping success, detection of the Squirrel Glider within 75 m (assuming conservative minimum home range size of 2 ha) of the Project corridor, so that it may be inferred that the local population may be incorporating habitat immediately adjacent to the Project within their home ranges. 	<p>This performance measure has been met for use of adjacent habitat.</p> <p>No Squirrel Gliders were recorded at either the control or impact sites in 2018, 2020 or 2022, therefore there is no apparent difference between impact and control sites at this stage.</p> <p>Use of aerial crossings and/or widened median: Squirrel Gliders have not been detected using aerial crossings. Possible Squirrel Glider records have been noted during widened median spotlighting surveys and arboreal camera monitoring.</p> <p>Detection of the Squirrel Glider within 75 m of the Project corridor: Squirrel Gliders have been recorded occupying nest boxes within 60, 20 and 110 m of the Project corridor.</p>

5. Recommendations

5.1 Contingency Measures/Recommendations

The EMP lists potential problems and contingency measures for various components of the monitoring program, however specific contingency measures for the Squirrel Glider have not been provided within the EMP. While Squirrel Gliders were not recorded during 2018, 2020 and 2022 targeted Squirrel Glider monitoring events, the species has been recorded occupying nest boxes within 75 m of the Project Corridor within the Cairncross State Forest and Maria River State Forest monitoring areas, inferring, as per the performance measure, that the home ranges of the local population includes habitat immediately adjacent to the Project.

Given that no Squirrel Gliders were recorded prior to 2017 nest box monitoring, and records exist demonstrating use of adjacent habitat by the species, contingency measures are not considered relevant.

As such, adaptive management actions or further monitoring beyond Year 8 (2022/2023) are not recommended .

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Appendix G – Fauna Fence and Road Kill



Fauna Fence and Road Kill Monitoring 2022/2023

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

June 2023

Document control

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Project Manager:	Radika Michniewicz
Authors:	Jodie Danvers
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Cover photograph: Standard fauna fence with Lace monitor (left), frog fence with Green Tree Snake (right).

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Bulli
Newcastle
Port Macquarie
Brisbane
Cairns

Executive summary

Context

This report documents findings of the 2022/2023 monitoring period, which includes the final of three monitoring periods for the fauna fence and the final of four operational monitoring periods for road kill, as required by the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022).

Aims

The aim of the fauna fence and road kill monitoring program is to determine if purpose built fauna fences are preventing fauna from crossing the road, thereby reducing road kill. The aims of this report are to summarise the methods and results of the 2022/2023 monitoring period and determine if performance measures are being met and provide corrective actions where required, as per the EMP.

Methods

Monitoring of the fauna fences involved surveying the fence lines on foot to identify breaches, damage and maintenance issues. The following sections of fencing were surveyed:

- 200 metres north and south of the nominated underpasses on both sides of the carriageway where it adjoins a fauna underpass monitored as part of the fauna underpass monitoring component of the Project
- The entire length of frog and Phascogale fencing
- Searches for threatened frogs on both sides of the entire length of frog fencing.

Road kill monitoring was undertaken along the entire length of the Project. Surveys involved observations made from a vehicle travelling at approximately 80 kilometres per hour (km/h). Road kill fauna observed on the road and within three metres of the road verge were recorded using a GPS.

Key Results

Key results of the 2022/2023 fauna fence and road kill monitoring were:

- A number of maintenance issues were identified including vegetation encroachment, fallen trees, fence damaged by floods and gaps underneath the fence (caused by environmental factors i.e. water or erosion, plating or netting lifting and detached Phascogale panels).
- No threatened frog species were identified during searches for threatened frogs, fence monitoring or road kill surveys.
- There were a total of 43 road kill records for the autumn, spring and summer 2022/2023 road kill monitoring events, including 20 in autumn, 11 in spring and 12 in summer. Birds, small mammals, reptiles, and medium mammals were the most commonly recorded fauna groups.
- Of the 30 road kill records (excluding birds) from the 2022/2023 monitoring period, nine (30%) records were within and 21 (70%) records were outside fenced areas. Considering the data with regard to the extent of fencing along the highway, calculation of a road kill per kilometre rate (excluding birds) showed the rate of road kill in unfenced areas (6.4 kilometres; 3.28 records/kilometre) to be substantially higher than the rate in fenced areas (30.6 kilometres; 0.29 records/kilometre).
- Of the 43 road kill records, only one arboreal mammal was recorded. The single arboreal mammal was recorded within 200 metres of an aerial crossing. Considering all road kill records, six were recorded within 200 m of an aerial crossing. Calculation of a *road kill per kilometre* rate therefore showed the rate of road kill within 200 metres of aerial crossings (5.2 kilometres; 1.15 records/kilometre) to be similar to outside this boundary (31.8 kilometres; 1.16 records/kilometre).

- Of the 30 road kill records (excluding birds) eight occurred within 200 metres of underpasses. The rate of road kill within 200 metres of fauna underpasses/bridges (19.2 kilometres; 0.42 records/kilometre) was lower than the rate outside this boundary (17.8 kilometres; 1.23 records/kilometre).
- The overall average weekly road kill rate for the same three seasons has decreased from baseline values (8.0) to 2018/2019 (7.7), 2019/2020 (3.8), 2020/2021 (5.8) and 2022/2023 (3.6).

Conclusions

All performance measures for both the fauna fence and road kill monitoring have been met:

- There were no records of Giant Barred Frog or Green-thighed Frog road kill
- Rates of road kill were lower within fenced areas compared to unfenced areas
- Incidence of road kill has reduced from baseline surveys
- Transport for NSW have advised that fauna fencing is complete
- Rates of road kill were lower in proximity to underpasses and similar in proximity to aerial crossings.

Management Implications

Given that all performance measures were met there are no recommendations based on the outcomes of the completed monitoring. Further monitoring is not considered necessary.

However, it is recommended that maintenance be undertaken as required to maintain the integrity of the fauna fence and minimise the opportunity for fence breaches.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the then Commonwealth Department of Environment (DoE) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project.

Fauna fences were installed to prevent fauna crossing the road surface, thereby reducing road kill and guiding animals towards safe wildlife crossing structures (underpasses and aerial crossing structures). The fauna fence and road kill are to be monitored to assess the effectiveness of the fauna fence in reducing fauna road kill, as required by the EMP.

1.1.1 Monitoring framework

The design, methods and performance indicators that define the fauna fence and road kill monitoring program are specified in the EMP and summarised below.

Fauna fence

The EMP requires fauna fence monitoring to occur during the operational phase of the Project in Years 4, 6 and 8.

To date, these monitoring events have been conducted and reported as follows:

- Autumn 2018 and spring/summer 2018/2019: Year 4 surveys (Niche 2019)
- Autumn 2020 and spring/summer 2020/2021: Year 6 surveys (Niche 2021).
- Autumn 2022 and spring/summer 2022/2023: Year 8 surveys (current report).

This report represents the final of three reports required for the fauna fence monitoring and constitutes the Year 8 autumn 2022 and spring/summer 2022/2023 monitoring.

Road kill

Road kill monitoring was required for baseline, during clearing, during construction and upon completion of the Project (operational) in Years 4, 5, 6 and 8. The road kill monitoring framework provided within the EMP and the reporting status to date is shown in Table 1. The 2022/2023 monitoring period represents the fourth operational monitoring period and includes autumn (April 2022), spring (October 2022) and summer (January 2023). This report represents the final of four reports required for the operational phase monitoring.

Table 1: Road kill monitoring

Project phase	Monitoring event: report	Timing of survey	Location
Baseline	<i>spring 2013, summer 2014, autumn 2014:</i> Niche (2015)	Weekly during October (spring), January (summer) and April (autumn) prior to commencement of construction (12 weeks).	Entire length of existing highway in Project area
During clearing operations	<i>November 2014- July 2015:</i> Niche (2015)	Daily	Portion of existing highway adjacent to clearing operations
One month following clearing operations			
For the duration of construction	<i>8 August 2015 – 22 July 2016:</i> Niche (2016a) <i>27 July 2016 – 28 July 2017:</i> Niche (2017a) <i>4 August 2017 – March 29 2018:</i> Niche (2018)	Weekly (Note: as the opening of the Project occurred in three stages, weekly monitoring of the Project continued in the unopened sections of the Project to satisfy construction monitoring requirements.)	Entire length of existing highway in Project area
Within one month of opening of the Project	Twelve week post-opening periods were as follows: <ul style="list-style-type: none"> • Ku2K: from 3 November 2017 • OH2Ku Stage 1: from 17 November 2017 • OH2Ku Stage 2: from 30 March 2018 All in Niche (2018).	Weekly for 12 weeks. If this period does not coincide with the season (i.e. October (spring), January (summer) and April (autumn) in which baseline surveys were undertaken, also undertake weekly surveys during the first survey period (April, October or January) to occur after the opening of the Project (to allow for comparison to baseline results).	Entire length of completed Project
Upon completion of the Project (operational phase)	Year 4: <ul style="list-style-type: none"> • Spring (October 2018) • Summer (January 2019) • Autumn (April 2019) All in Niche (2019). Year 5: <ul style="list-style-type: none"> • Spring (October 2019) • Summer (January 2020) • Autumn (April 2020) All in Niche (2020). Year 6: <ul style="list-style-type: none"> • Spring (October 2020) • Summer (January 2021) • Autumn (April 2021) Year 8: <ul style="list-style-type: none"> • Autumn (April 2022) • Spring (October 2022) • Summer (January 2023) Current report.	Weekly during October (spring), January (summer) and April (autumn (12 weeks) in Year 4, 5, 6 and 8, or until mitigation measures can be demonstrated to have been effective as defined in the EPBC approval.	Entire length of completed Project

1.1.2 Background data

The fauna fence aims to prevent animals crossing the road surface and to guide animals towards safe fauna crossing structures. Three types of fauna fencing have been installed as per the EMP as follows:

- Standard floppy-top fencing: *Permanent floppy top fencing will comprise of a heavily galvanised, floppy-top mesh fauna fence. Mesh one metre wide will be attached to the base of the fauna fencing and laid over the ground away from the carriageway to provide an effective barrier to burrowing animals. The mesh must be pinned to the ground with metal pins every metre without any gaps between the mesh and the ground. Fauna exclusion fencing at underpass entrances will have wide angled openings to encourage usage by fauna and must have a minimum length of 200 metres of fauna fencing on each side of the underpass and on each side of the carriageway or road.*
- Frog fencing:

- *Giant Barred Frog fencing is to be at least 900 millimetres in height and will comprise of gauze size 30-40 millimetres to prevent frogs from moving through the fence, yet allow for the flow of overland water. The gauze will include a small return of not less than 150 millimetres on the ground.*
- *Green-thighed Frog fencing is to comprise of 500 millimetres high neoprene rubber sheeting (>4 millimetre thickness) including a small rubber return of not less than 100 millimetres on the ground. The fence must consist of a hot dip galvanized pressed sheet metal or powder coated aluminium pressed sheet mounted on a galvanized star picket. This fencing was unsuccessful and has since been replaced. Transport for NSW (TfNSW) removed the neoprene sheeting and replaced it with vermin-proof mesh, as approved on the Pacific Highway Upgrade between Woolgoolga and Ballina. These frog fencing replacement works were completed in November 2018.*
- *Where both frog species occur in association the frog fencing must account for both morphologies.*
- *Phascogale fencing: Phascogale fencing is attached to floppy top fauna fencing. At the base of floppy top fauna fences, a second layer of mesh is installed to 200 millimetres above ground level height, offset from the first layer of mesh to create maximum opening size of 25 millimetres. Above 200 millimetres, 600 millimetre hot dip galvanised pressed steel sheet or powder coated aluminium pressed sheet are affixed to the floppy top fauna fencing.*

Standard fauna fencing was installed within State Forests, where the Project traverses regional corridors, between dual carriageway bridges and culverts and on the outside of all spill containment/water quality treatment basins. Targeted threatened species fauna fencing was installed in areas of known or high potential habitat with high risk of fauna accessing the carriageway.

1.1.3 Purpose of this report

This report documents findings of the 2022/2023 monitoring period, which includes the final of three monitoring periods for the fauna fence and the final of four operational monitoring periods for road kill. The aims of this report are to summarise the methods and results of the 2022/2023 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for fauna fence monitoring:

- *No records of Giant Barred Frog or Green-thighed Frog road kill on the main carriageways directly adjacent to installed frog fencing in any monitoring event during Years 4, 6 & 8*
- *Lower rates of road kill in proximity to fauna fencing than in sections of the upgrade not near fauna fencing during all monitoring events (Year 4, 6 & 8)*
- *Reduced incidence of road kill from baseline conditions*
- *Fauna fence is installed at a minimum in areas identified in Schedule 3 of the EPBC approval at Year 4.*

The EMP specifies the following performance measures for road kill monitoring:

- *Lower rates of road kill in proximity (i.e. areas of the main carriageways within areas adjacent to installed fauna fencing, and within 200 metres of rope bridges and fauna underpasses) to fauna fencing, rope bridges and fauna underpasses than in sections of the upgrade not near wildlife crossing structures or fauna fences in Year 1 – 6 & 8 monitoring events*
- *Reduced incidence of road kill from baseline conditions during monitoring events in Years 1-6 & 8 and when all monitoring events are considered at Year 8*

- *Fauna exclusion fencing is installed at a minimum in the locations identified in Schedule 3 of the EPBC approval at Year 4.*

1.3 Monitoring Timing

Fauna Fence monitoring is to be undertaken in Years 4, 6 and 8 of the Project's operational phase. Fauna fence monitoring is to occur in late autumn and late spring/early summer and searches for threatened frogs are to be undertaken in spring and summer.

Operational road kill monitoring is required weekly for four weeks during October (spring), January (summer) and April (autumn) in Years 4, 5, 6 and 8.

1.4 Reporting

Annual reporting of monitoring results will outline:

- Detailed description of monitoring methodology employed
- Results of the monitoring period
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA).

1.5 Limitations

- Identification and detection of road kill was limited to what can be observed whilst travelling at 80 kilometres per hour (km/hr) as it is not considered safe to stop on the operational highway. As such:
 - Some road kill fauna were identified to the vertebrate group level only.
 - Some records were classified as 'unknown' as road kill fauna could not be identified as a result of extensive collision damage.
 - It is possible that small fauna such as frogs, snakes, small mammals and birds have been undercounted as small-sized road kill fauna have the potential to be partially or wholly removed by scavenger animals, resulting in impossible identification from the vehicle.
- Safety issues prevent the removal of road kill following each survey and therefore, despite efforts, road kill may have been recorded multiple times over the four weekly surveys resulting in double-counting and 'unknown' records as the condition of the animal deteriorated.

2. Methodology

2.1 Monitoring Sites

Monitoring of the fauna fence involved surveys of the following sections of fencing:

- 200 metres north and south of the underpass and on both sides of the carriageway where it adjoins one of the 14 fauna underpasses monitored as part of the fauna underpass monitoring component of the Project.
- The entire length of frog and phascogale fencing.
- Searches for threatened frogs on both sides of the entire length of frog fencing.

Road kill monitoring was undertaken along the entire length of the Project.

2.2 Survey Methods

Surveys were undertaken in accordance with the EMP and are outlined below.

2.2.1 Fauna fence inspections

Fauna fence monitoring was completed in autumn 2022 (April-May 2022) and summer 2022/2023 (February 2023). Surveys involved inspection of the fauna fence on foot for 200 metres north and south of the monitored underpasses and on both sides of the carriageway. In addition, the entire length of phascogale and frog fence was surveyed as well as the edge of the highway in proximity to fencing where possible and safe to do so. Possible breaches, damage and maintenance issues, such as impinging vegetation growth, were noted and their location recorded.

2.2.2 Frog searches

Searches for threatened frog species were undertaken on both sides of the frog fence in spring 2022 (October 2022) and summer 2022/2023 (February 2023) to identify the presence of any frogs that may have breached the frog fence. Surveys were timed to follow rainfall in order to coincide with frog movement where possible. Table 2 shows the rainfall recorded by Bureau of Meteorology (BOM) weather stations prior to surveys.

Table 2: Threatened frog survey dates and 24 hour rainfall

Survey date	Season	Previous 24hr rainfall Kempsey Airport (mm)	Previous 24hr rainfall Port Macquarie Airport (mm)
21/10/2022	Spring	4.2	3.6
16/02/2023	Summer	12.4	21.6

2.2.3 Road kill surveys

Road kill surveys of the entire Project were undertaken once a week for four weeks during April 2022 (autumn), October 2022 (spring) and January/February 2023 (summer). These surveys involved observations made from a vehicle travelling at approximately 80 km/hr. Road kill fauna observed on the road and within three metres of the road verge were recorded by the passenger. Due to the safety issues associated with the operational highway, it was not possible to stop the vehicle to closer inspect or remove road kill. Road kill records were grouped into general fauna groups for analysis.

2.3 Data analysis

Weekly road kill rates were calculated to compare changes in the rate of road kill between years. An analysis of the number of road kill events (excluding bird records) that occurred within or outside of fenced sections of the Project was undertaken by calculating a *road kill per kilometre* rate. A similar analysis was undertaken to compare road kill rates within 200 metres of fauna crossings. Fauna crossing zones were created by grouping fauna crossings that occurred within 400 metres of each other (i.e. their 200 metre boundary overlapped) and included 200 metres north and south of the crossing/s. The road kill records that occurred within the zones were compared to road kill records outside of the zones. Aerial crossings and underpasses (including bridges and culverts) were analysed separately.

3. Results

3.1 Fence Inspections

Detailed fauna fence inspection results/required actions were provided to TfNSW for maintenance purposes. All high priority items, such as damage or gaps in the fauna fence, or where the fence is not functioning properly or missing panels, have been rectified. Medium and lower priority items, such as vegetation maintenance, are programmed as part of the ongoing highway maintenance works. Results of the autumn 2022 and summer 2023 inspections are summarised below.

3.1.1 Maintenance

Maintenance actions were categorised as vegetation clearing, fence maintenance or fence gaps. A number of maintenance issues were identified during the 2022/2023 monitoring, the majority of which relate to vegetation clearing. There were 24 priority maintenance actions (where the integrity of the fence had been compromised) identified, four of which relate to flood damaged fencing where total replacement of sections is required, seven of which relate to fallen trees damaging the fence or providing a means of traversing the fence and 13 of which relate to gaps in the fence due to lifting or missing Phascogale panelling. Priority works are expected to be completed by the end of 2023, noting that high priority works identified as part of the autumn 2022 summer 2023 inspection have been programmed to be completed by the end of June 2023, where possible. The remaining actions are considered to be preventative maintenance actions to ensure ongoing fence integrity. Preventative maintenance will be actioned throughout the remainder of 2023/2024 financial year and are subject to other network priorities.

3.1.2 Possible breaches

No breaches or evidence of breaches were observed during 2022/2023 monitoring.

While no fauna was recorded on the highway-side of the fauna fence during fence inspections, undertaking maintenance to address identified gaps, clear vegetation and ensure secure fastening of the base netting or phascogale panels is required to prevent breaches from occurring.

3.2 Threatened Frog Searches

Diurnal targeted searches for threatened frogs were undertaken on the 21 October 2022 (spring) and 16 February 2023 (summer). No threatened frog species were identified during the targeted surveys. Similarly, no threatened frog species were identified during the fence monitoring or road kill surveys.

3.3 Road Kill Surveys

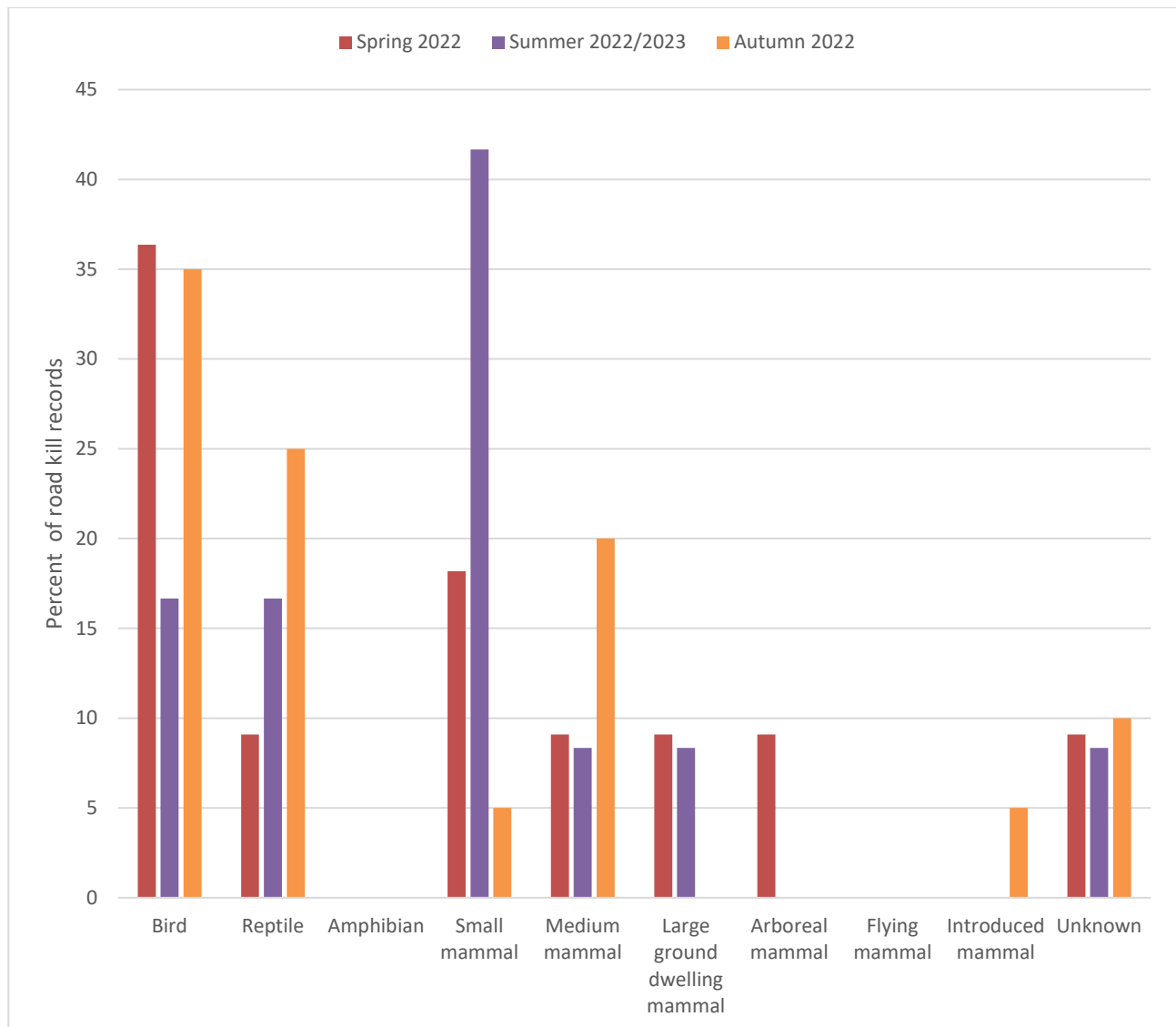
Road kill results are provided in Annex 1. The distribution of road kill records is shown in Figure 1.

3.3.3 Total alignment

Fauna categories for analysis were defined as follows:

- Arboreal mammals
- Flying mammals (i.e. bats)
- Introduced mammals
- Small mammals
- Medium mammals
- Large ground dwelling mammals
- Amphibians
- Reptiles
- Birds
- Unknown

There were a total of 43 road kill records for the autumn, spring and summer 2022/2023 road kill monitoring events, including 20 in autumn, 11 in spring and 12 in summer. The percentage of road kill records for each fauna category for the current monitoring period is presented in Graph 1. Combining spring, summer and autumn results, birds (30.2% of road kill, n = 13), small mammals (18.6% of road kill, n = 8), reptiles (18.6% of roadkill, n = 8) and medium mammals (14.0%, n = 6), were the most commonly recorded fauna groups.



Graph 1: 2022/2023 road kill records

3.3.4 Threatened fauna

Table 3 lists the threatened species identified as road kill throughout the Project to date. Two Koala’s were reported as roadkill in 2018/2019 and 2020/2021 (reported in Niche 2019 and 2021) and one Brush-tailed Phascogale in 2019/2020 (reported in Niche 2020) during the operational monitoring.

The baseline monitoring report (Lewis 2014) states that, based on baseline Koala road kill records, “*the baseline count for road kill should be set at 1 individual per 8 weeks*”. Koala road kill has therefore not increased from the baseline count since the start of the Project.

No threatened species have been recorded as road kill since October 2020.

Table 3: Threatened species road kill to date

Monitoring type (report)	Monitoring period	Threatened species identified as road kill (number recorded)
Baseline (Lewis 2014)	2013-2014	<ul style="list-style-type: none"> • Koala (1*) • Grey-headed Flying Fox (2)
Clearing (Niche 2015)	2014-2015	<ul style="list-style-type: none"> • Koala (4) • Grey-headed Flying Fox (1) • Masked Owl (2) • Spotted-tail Quoll (1)
Construction (Niche 2016b)	2015-2016	<ul style="list-style-type: none"> • Koala (1)
Construction (Niche 2017b)	2016-2017	<ul style="list-style-type: none"> • Koala (2)
Construction (Niche 2018)	2017-2018	Nil
Operational (Niche 2019)	2018-2019	<ul style="list-style-type: none"> • Koala (1)
Operational (Niche 2020)	2019-2020	<ul style="list-style-type: none"> • Brush-tail Phascogale (1)
Operational (Niche 2021)	2020-2021	<ul style="list-style-type: none"> • Koala (1)

* = An additional three Koala road kill were recorded between August 2013 and February 2014, outside of the monitoring period.

3.3.5 Fauna fence

A total of approximately 30,600 metres (82.7%) of the 37,000 metres of the Project is fenced with a minimum of standard fauna fence (data provided by Transport for NSW).

An analysis of the number of road kill events (excluding the bird records) that occurred either within or outside of fenced sections of the Project was undertaken. Road kill observations made at the edge of a fenced area, or in an area where fencing was present on one side of the carriageway only, were considered to be outside of the fenced area. Of the 30 road kill records (excluding birds) from the 2022/2023 monitoring period, nine (30%) records were within and 21 (70%) records were outside fenced areas. Considering the data with regard to the extent of fencing along the highway, calculation of a *road kill per kilometre* rate (excluding birds) showed the rate of road kill in unfenced areas (6.4 kilometres; 3.28 records/kilometre) to be substantially higher than the rate in fenced areas (30.6 kilometres; 0.29 records/kilometre).

3.3.6 Fauna crossings

An analysis of road kill within 200 metres of fauna crossing structures has been undertaken in order to address the trigger for contingency measures. As discussed in Section 2.3, fauna crossing zones were created by grouping fauna crossings that occurred within 400 metres of each other (i.e. their 200 metre boundary overlapped). The road kill records that occurred within these zones were compared to road kill records outside of these zones. Aerial crossings and underpasses (including bridges and culverts) were analysed separately.

Aerial crossings

There are 18 aerial crossings along the entire length of the Project that fall into nine separate zones. Both rope bridges and glider pole crossings were considered in this analysis. The Project consists of 5,176 metres that fall within 200 metres of an aerial crossing, and therefore 31,824 metres outside of these zones.

Of the 43 road kill records, only one arboreal mammal was recorded. Other records are considered to be irrelevant for the analysis of road kill in proximity of aerial crossings as ground-dwelling fauna (for example,

macropods, Echidnas, bandicoots, reptiles) or birds/bats. The single arboreal mammal was recorded within 200 metres of an aerial crossing during the 2022/2023 road kill surveys. Considering all road kill records, six were recorded within 200 m of an aerial crossing. Calculation of a *road kill per kilometre* rate therefore showed the rate of road kill within 200 metres of aerial crossings (5.2 kilometres; 1.15 records/kilometre) to be similar to outside this boundary (31.8 kilometres; 1.16 records/kilometre).

Underpasses

There are 42 culverts and 12 bridge areas throughout the Project that are considered to provide fauna passage under the carriageway, which fall into 39 separate zones. The Project consists of 19,175 metres that fall within 200 metres of an underpass/bridge, and therefore 17,825 metres outside of these zones. Of the 30 road kill records (excluding birds) from the 2022/2023 monitoring period, eight occurred within 200 metres of underpasses, while the remaining 22 occurred outside this boundary. Calculation of a *road kill per kilometre* rate (excluding birds) found the rate of road kill within 200 metres of fauna underpasses/bridges (19.2 kilometres; 0.42 records/kilometre) to be lower than the rate outside this boundary (17.8 kilometres; 1.23 records/kilometre).

3.3.7 Comparison with baseline and previous monitoring

Baseline surveys were undertaken prior to the commencement of construction for 12 weeks in spring 2013, summer 2014 and autumn 2014. Monitoring took place weekly for four weeks in each of the seasons as required by the EMP. Baseline surveys recorded 96 animals as road kill during the three monitoring events, representing 33 species and an average weekly road kill for spring, summer and autumn of 9.5, 11.8 and 3.3 respectively.

The average weekly road kill for all monitoring periods is presented in Table 4.

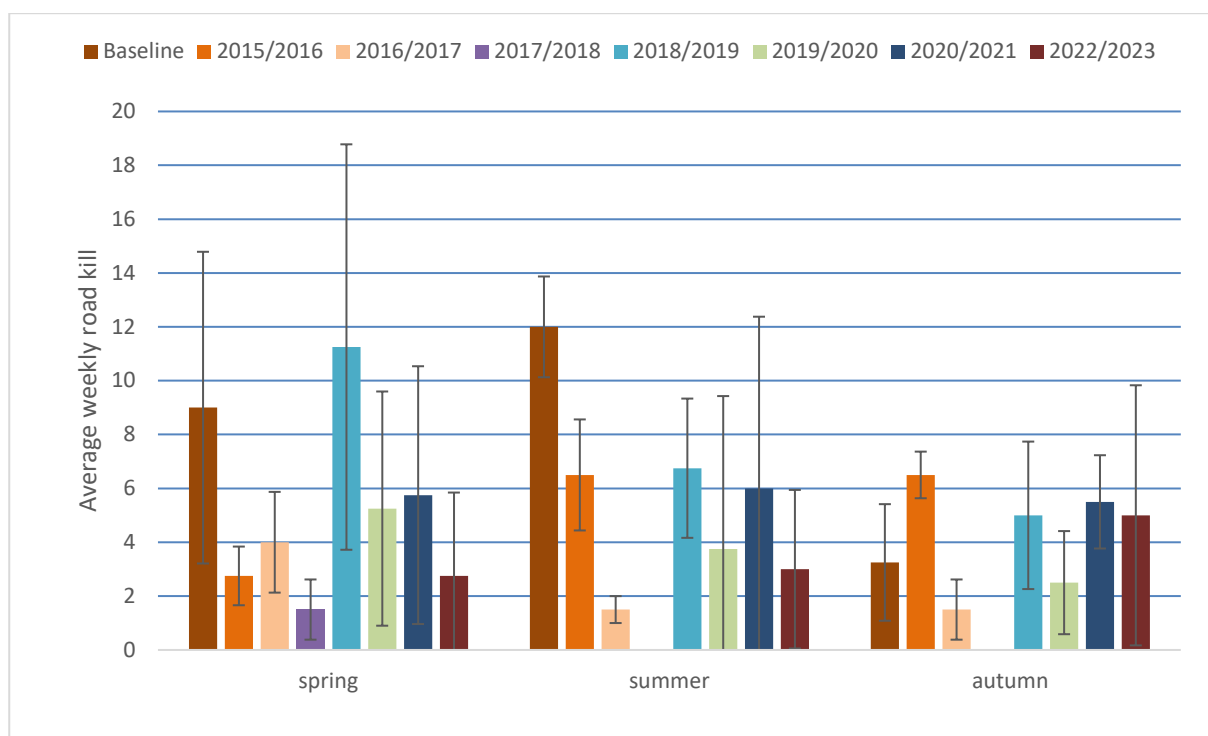
In order to compare the results of the baseline surveys with that of subsequent monitoring periods, the average weekly road kill for the four survey weeks undertaken in each season of the baseline surveys (spring (October), summer (January), autumn (May)), was compared to the same four weeks of each subsequent monitoring event. While autumn weekly road kill rates were higher in the 2022/2023 monitoring period (5.0) than during baseline (3.3), spring and summer weekly road kill rates were lower in the 2022/2023 monitoring period (2.8 and 3.0 respectively) compared to baseline (9.0 and 11.8 respectively). Therefore, the overall average weekly road kill rate has decreased from baseline surveys with a value of 8.0 to 3.6 for the same three seasons.

Graph 2 shows the seasonal average weekly road kill for each of the same four week periods for all monitoring events. Winter has been excluded from the graph as winter surveys were not undertaken during baseline surveys and do not form part of the operational road kill monitoring.

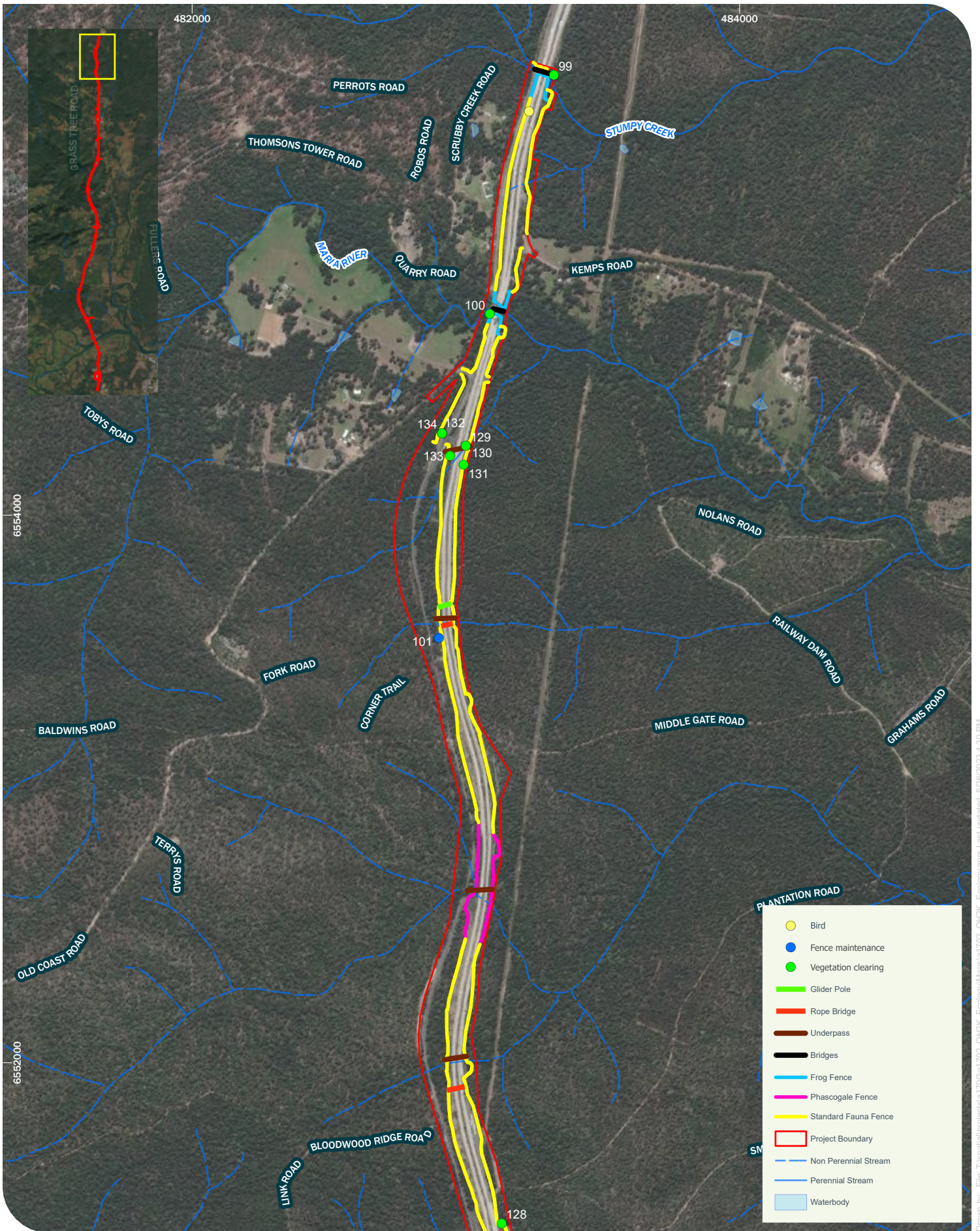
Table 4: Weekly road kill rates for monitoring undertaken along the entire Project alignment

Monitoring period		Spring (n)	Summer (n)	Autumn (n)	Winter (n)	Annual (n)
Baseline	2013/2014	9.5 (4)	11.8 (4)	3.3 (4)	No surveys	8.0 (12)
Construction phase	2015/2016 (all surveys)	4.2 (13)	5.8 (14)	6.7 (13)	4.1 (12)	5.0 (52)
	2015/2016 (4 weeks)	2.75 (4)	6.5 (4)	6.5 (4)	3.0 (4)	
	2016/2017 (all surveys)	3.3 (13)	2.6 (13)	2.0 (12)	2.2 (14)	2.3 (52)
	2016/2017 (4 weeks)	4.0 (4)	1.5 (4)	1.5 (4)	2.5 (4)	
	2017/2018 (all surveys)	2.9 (9)	No surveys*	No surveys*	3.3 (4)	3.0 (13)
	2017/2018 (4 weeks)	1.5 (4)	No surveys*	No surveys*	3.3 (4)	
12-week post-opening	2017/2018 (all sections combined)					4.5 (12)
Operational	2018/2019	11.3 (4)	6.8 (4)	5.0 (4)	No surveys	7.7 (12)
Operational	2019/2020	5.3 (4)	3.8 (4)	2.5 (4)	No surveys	3.8 (12)
Operational	2020/2021	5.8 (4)	6.0 (4)	5.5 (4)	No surveys	5.8 (12)
Operational	2022/2023	2.8 (4)	3.0 (4)	5.0 (4)	No surveys	3.6 (12)

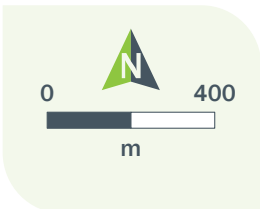
n = number of survey weeks; * = construction partially complete



Graph 2: Average (\pm SD, n = 4) weekly road kill in spring, summer and autumn



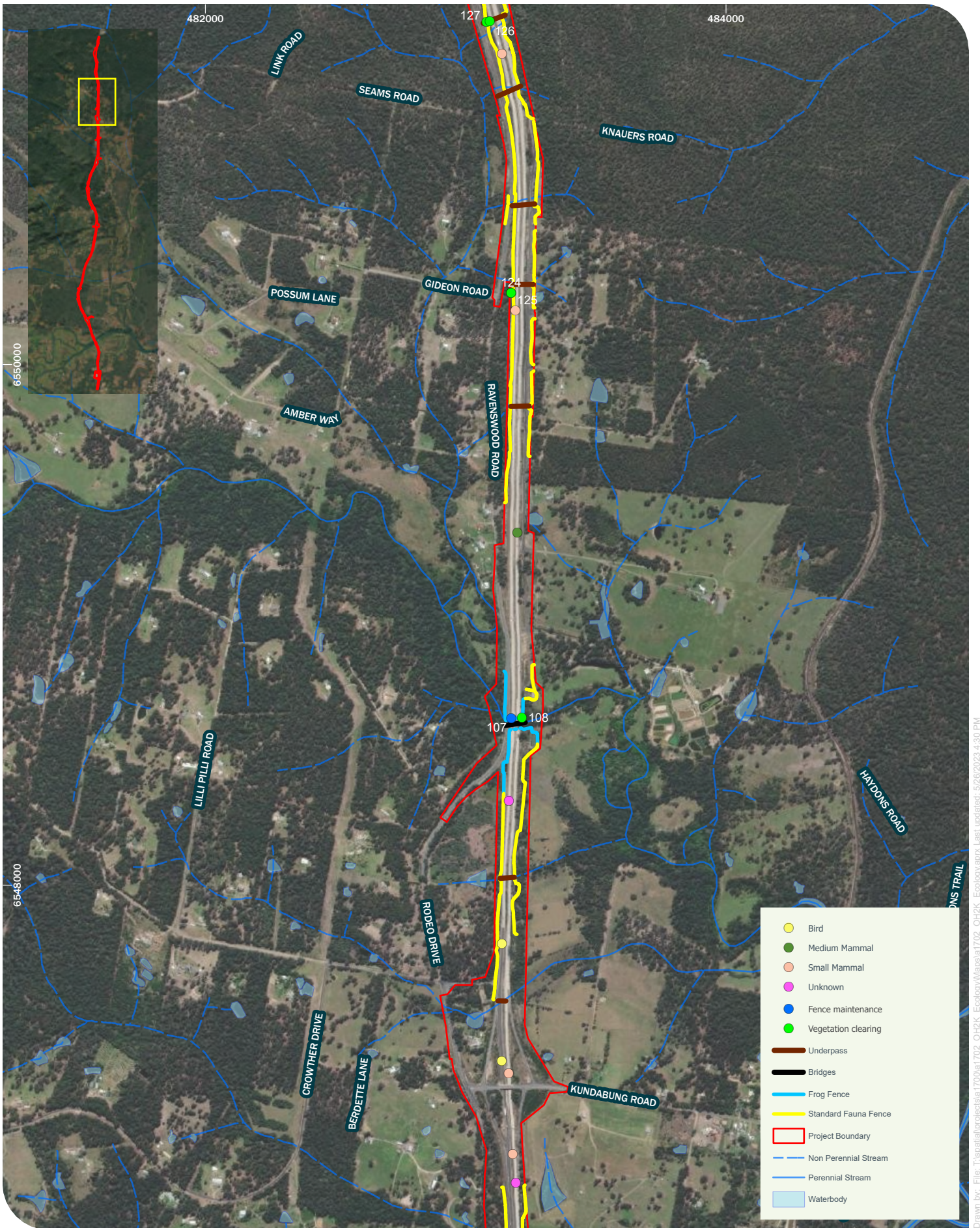
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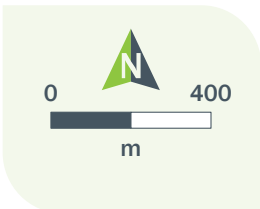
Fauna fence maintenance actions - Summer 2022/2023 1
Oxley Highway to Kempsey Pacific Highway Upgrade

Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 PI 5.11
 Client: TfNSW

Figure 1.1



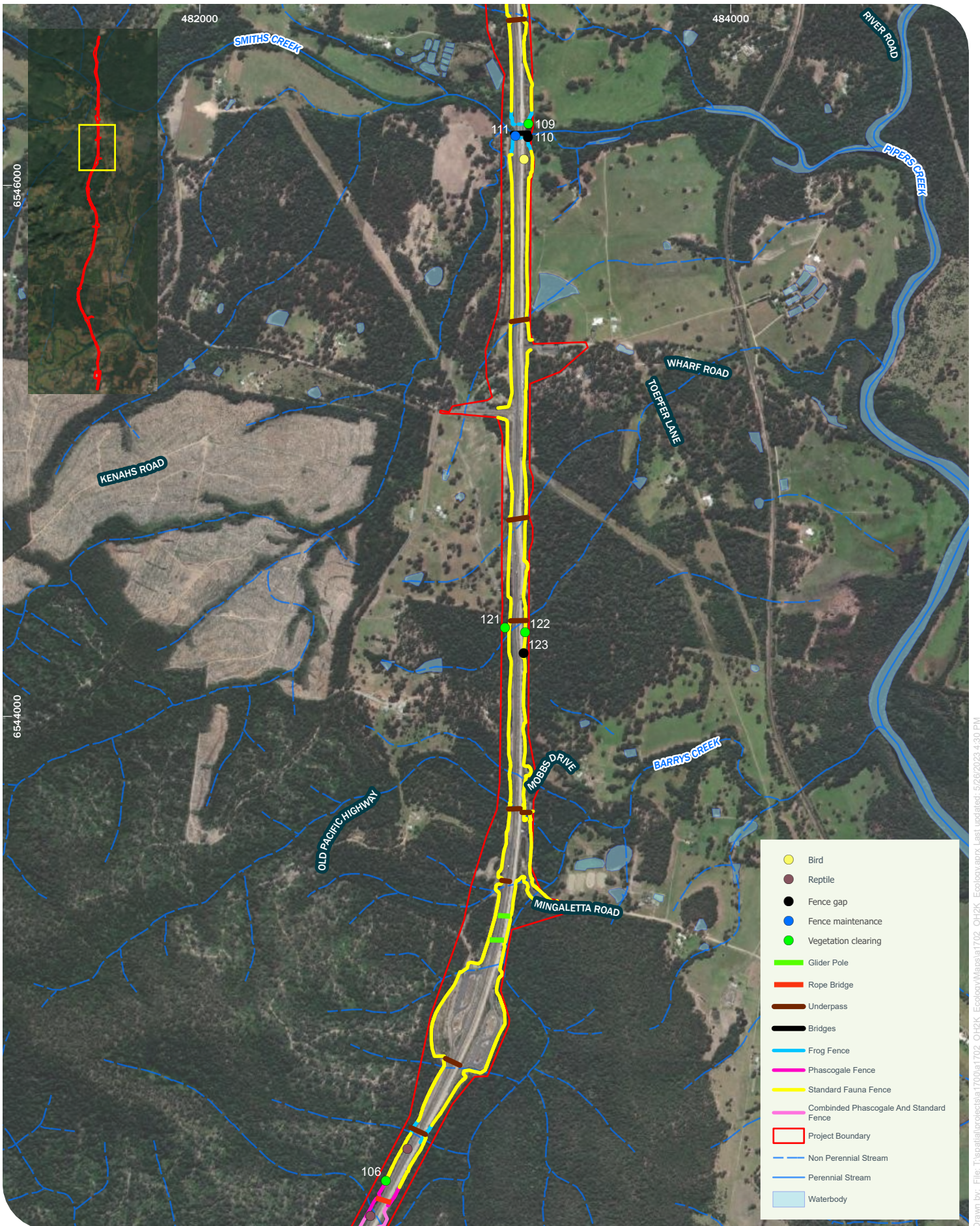
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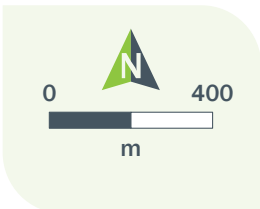
Fauna fence maintenance actions - Summer 2022/2023 2
Oxley Highway to Kempsey Pacific Highway Upgrade

Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 PI 5.11
 Client: TfNSW

Figure 1.2



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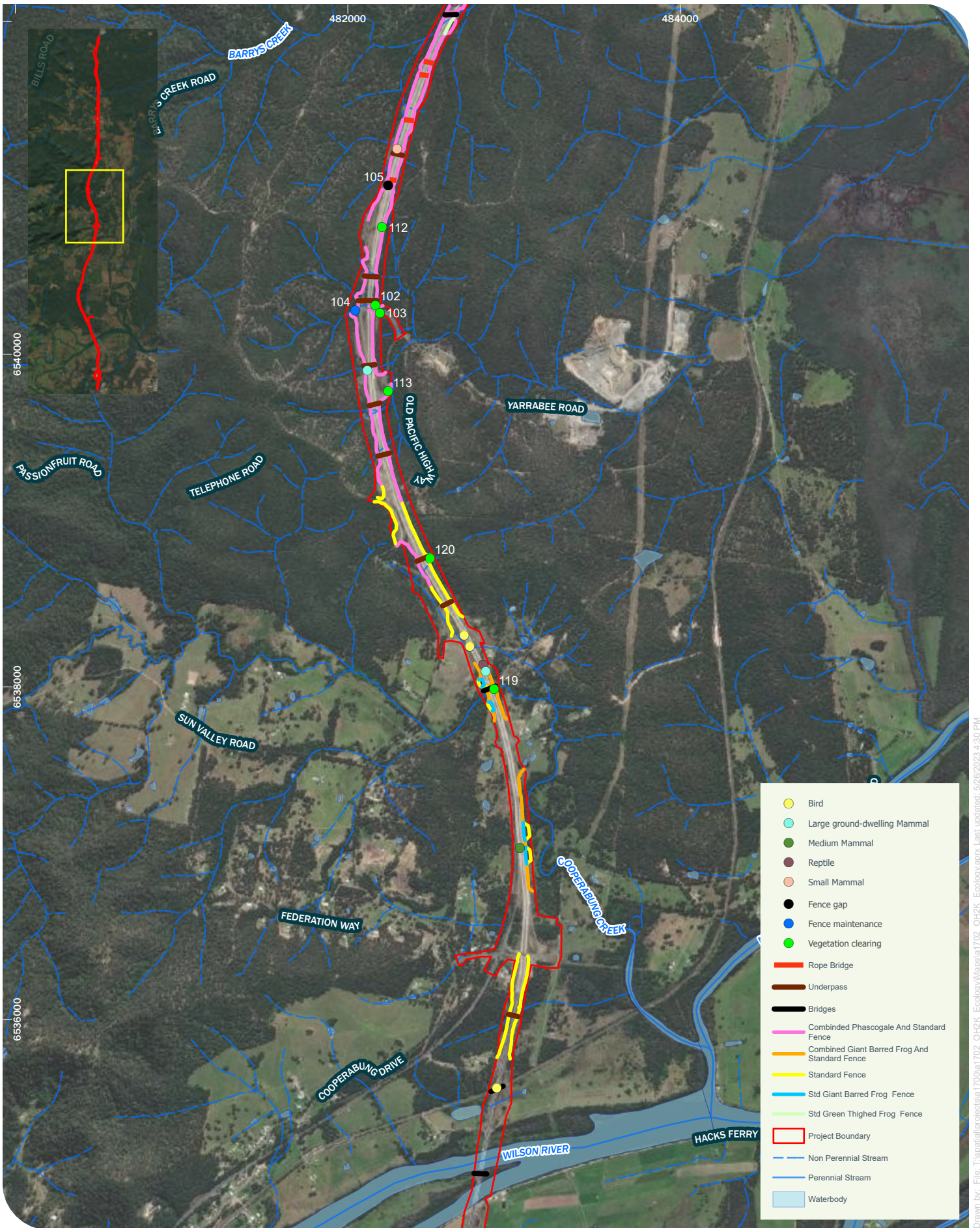


Fauna fence maintenance actions - Summer 2022/2023 3
Oxley Highway to Kempsey Pacific Highway Upgrade

Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 PI 5.11
 Client: TfNSW

Figure 1.3

Imagery: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community



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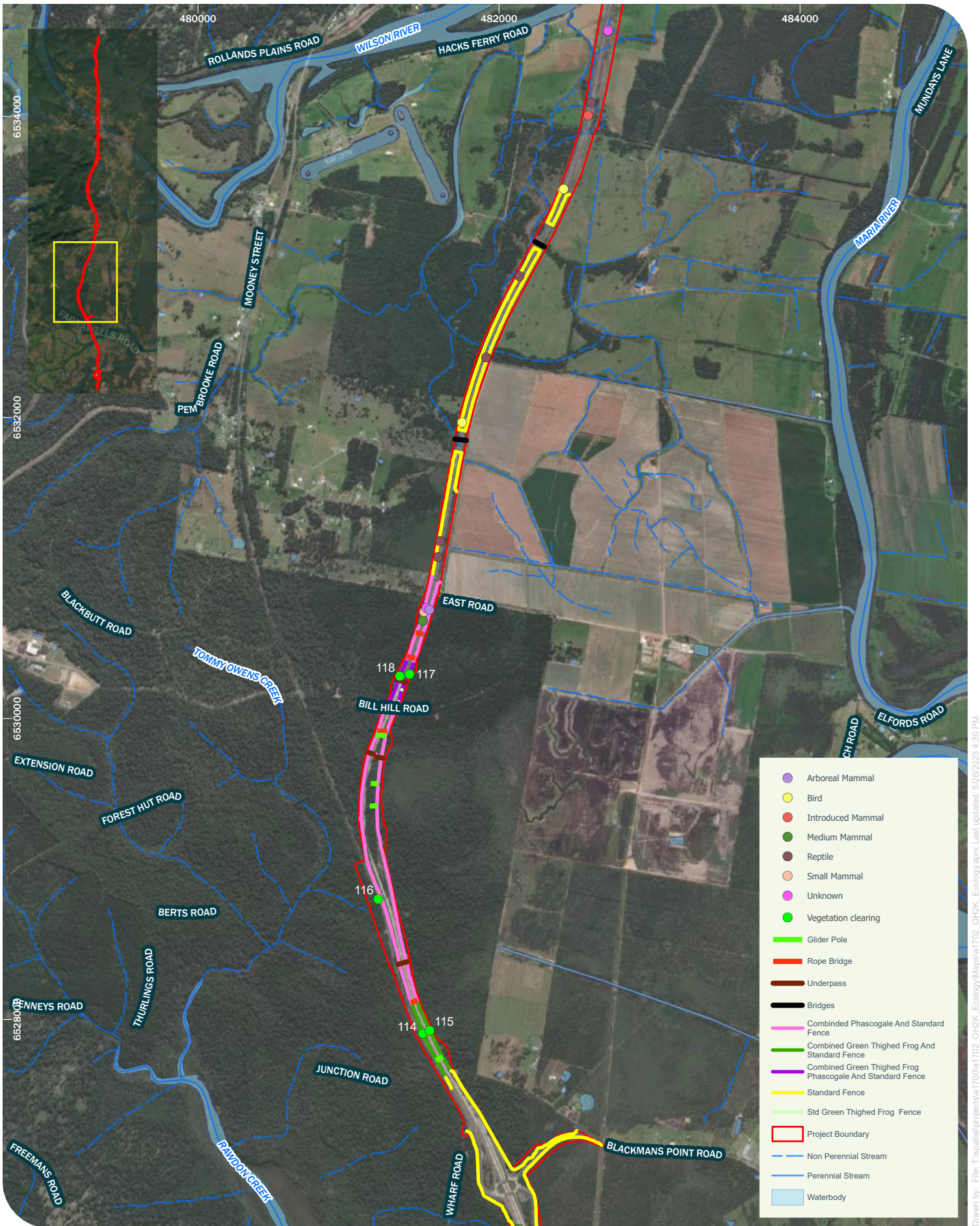


Fauna fence maintenance actions - Summer 2022/2023 4
Oxley Highway to Kempsey Pacific Highway Upgrade

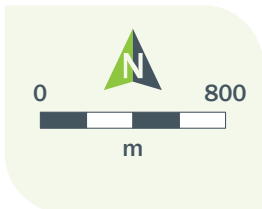
Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 PI 5.11
 Client: TfNSW

Figure 1.4

Imagery: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community



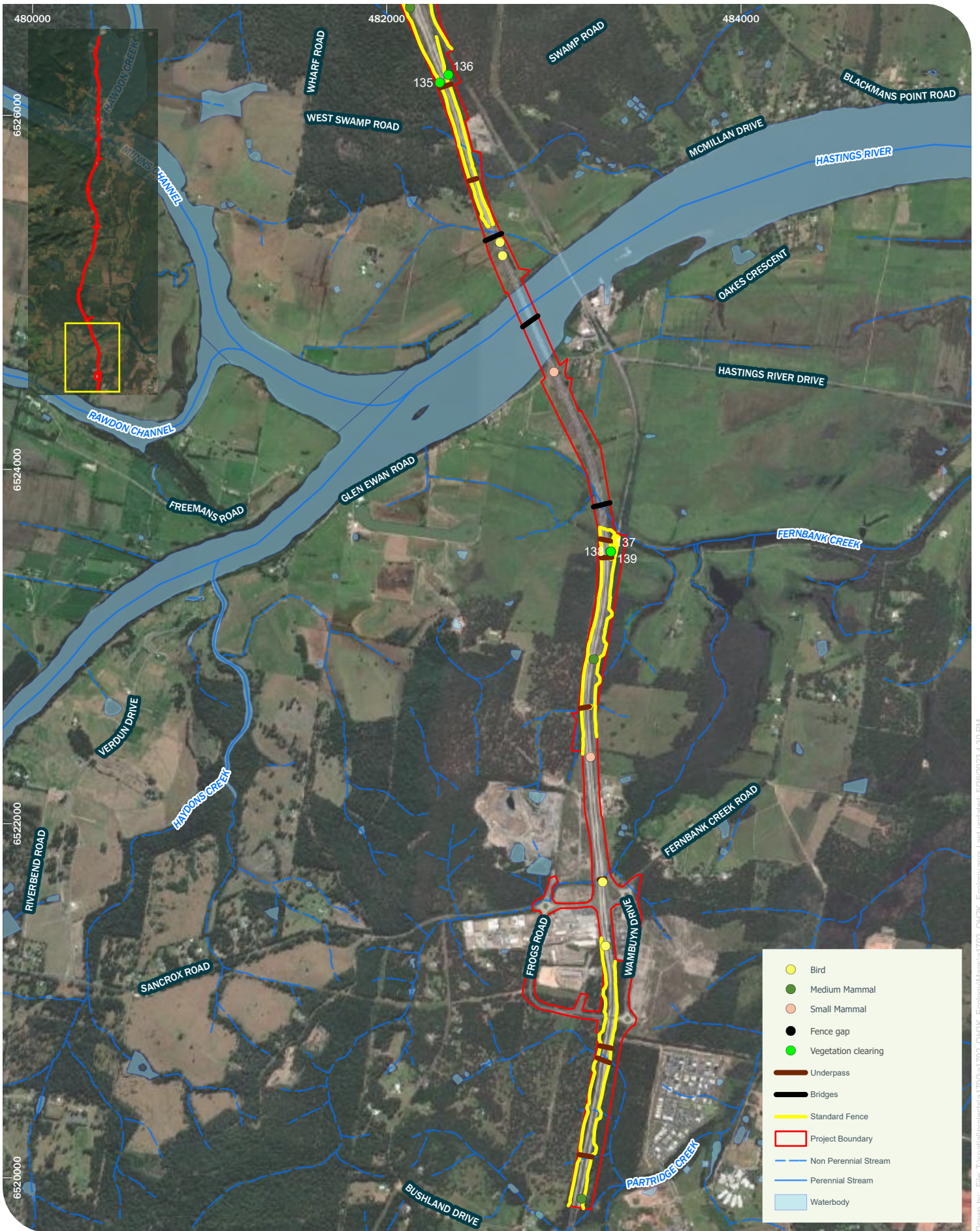
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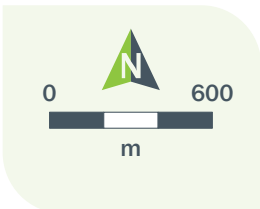
Fauna fence maintenance actions - Summer 2022/2023 5 Oxley Highway to Kempsey Pacific Highway Upgrade

Niche PM: Radika Michniewicz
Niche Proj. #: 1702 PI 5.11
Client: TfNSW

Figure 1.5



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Fauna fence maintenance actions - Summer 2022/2023 6
Oxley Highway to Kempsey Pacific Highway Upgrade

Niche PM: Radika Michniewicz
 Niche Proj. #: 1702 PI 5.11
 Client: TfNSW

Figure 1.6

Imagery: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

4. Discussion

4.1 Performance Measures

4.1.1 Fauna fence

A summary of survey results to date in relation to the fauna fence performance measures are provided in Table 5.

Table 5: Indicators of success for fauna fencing

Performance measure	Discussion
No records of Giant Barred Frog or Green-thighed Frog road kill on the main carriageways directly adjacent to installed frog fencing in any monitoring event during Years 4, 6 & 8.	This performance measure has been met. No Giant Barred Frog or Green-thighed Frog road kill have been recorded to date.
Lower rates of road kill in proximity to fauna fencing than in sections of the upgrade not near fauna fencing during all monitoring events (Year 4, 6 & 8).	This performance measure has been met. Of the 30 road kill records (excluding birds) from the 2022/2023 monitoring period, nine (30%) records were within and 21 (70%) records were outside fenced areas. Considering the data with regard to the extent of fencing along the highway, calculation of a <i>road kill per kilometre</i> rate (excluding birds) showed the rate of road kill in unfenced areas (6.4 kilometres; 3.28 records/kilometre) to be substantially higher than the rate in fenced areas (30.6 kilometres; 0.29 records/kilometre).
Reduced incidence of road kill from baseline conditions.	This performance measure has been met. The overall average weekly road kill rate for the same three seasons has decreased from baseline values (8.0) to 2018/2019 (7.7), 2019/2020 (3.8), 2020/2021 (5.8) and 2022/2023 (3.6).
Fauna fence is installed at a minimum in areas identified in Schedule 3 of the EPBC approval at Year 4.	This performance measure has been met. TfNSW have advised that all fauna fencing as identified in Schedule 3 of the EPBC approval has been installed.

4.1.2 Road kill

A summary of survey results in relation to the road kill performance measures are provided in Table 6.

Table 6: Performance measures for road kill monitoring

Performance measure	Discussion
Lower rates of road kill in proximity (i.e. areas of the main carriageways within areas adjacent to installed fauna fencing, and within 200 m of rope bridges and fauna underpasses) to fauna fencing, rope bridges and fauna underpasses than in sections of the upgrade not near wildlife crossing structures or fauna fences in Year 1 – 6 & 8 monitoring events.	This performance measure has been met. <i>Fauna fence:</i> Of the 30 road kill records (excluding birds) from the 2022/2023 monitoring period, nine (30%) records were within and 21 (70%) records were outside fenced areas. Considering the data with regard to the extent of fencing along the highway, calculation of a road kill per kilometre rate (excluding birds) showed the rate of road kill in unfenced areas (6.4 kilometres; 3.28 records/kilometre) to be substantially higher than the rate in fenced areas (30.6 kilometres; 0.29 records/kilometre). <i>Aerial crossing 200 metre boundary:</i> Of the 43 road kill records, only one arboreal mammal was recorded. The single arboreal mammal was recorded within 200 metres of an aerial crossing. Considering all road kill records, six were recorded within 200 m of an aerial crossing. Calculation of a <i>road kill per kilometre</i> rate therefore showed the rate of road kill within 200 metres of aerial crossings (5.2

Performance measure	Discussion
	<p>kilometres; 1.15 records/kilometre) to be similar to outside this boundary (31.8 kilometres; 1.16 records/kilometre).</p> <p><i>Underpass 200 metre boundary:</i> Of the 30 road kill records (excluding birds) eight occurred within 200 metres of underpasses. The rate of road kill within 200 metres of fauna underpasses/bridges (19.2 kilometres; 0.42 records/kilometre) was lower than the rate outside this boundary (17.8 kilometres; 1.23 records/kilometre).</p>
<p>Reduced incidence of road kill from baseline conditions during monitoring events in Years 1- 6 & 8 and when all monitoring events are considered at Year 8.</p>	<p>This performance measure has been met.</p> <p>The overall average weekly road kill rate for the same three seasons has decreased from baseline values (8.0) to 2018/2019 (7.7), 2019/2020 (3.8), 2020/2021 (5.8) and 2022/2023 (3.6).</p>
<p>Fauna exclusion fencing is installed at a minimum in the locations identified in Schedule 3 of the EPBC approval at Year 4.</p>	<p>This performance measure has been met.</p> <p>TfNSW have advised that all fauna fencing as identified in Schedule 3 of the EPBC approval has been installed.</p>

5. Recommendations

5.1 Contingency Measures and Recommendations

The EMP lists potential problems and contingency measures for the Project's mitigation measures. Those that are related to the fauna fence monitoring program are listed and discussed in Table 7.

Given that all performance measures were met there are no recommendations based on the outcomes of the 2022/2023 monitoring period specifically relating to contingency measures.

However, it is recommended that maintenance be undertaken as required to maintain the integrity of the fauna fence and minimise the opportunity for fence breaches.

Table 7: Contingency measures for fauna fencing

Potential problems	Contingency measure	Discussion of proposed measure
Breach in fauna fencing. High rates of fauna road strike mortality within 200 metres of fauna underpasses.	Commence review/modification of fauna exclusion fencing design, location or extent depending on species struck by vehicles within two weeks of results reported by ecologist.	Road kill rates were lower in proximity to underpasses. This contingency measure is not considered relevant.
	Inspect fence for breaches and inform maintenance as necessary within two weeks of results reported by ecologist. Any damage to fauna fencing will be temporarily repaired within one week of a breach being identified.	This contingency measure is not considered relevant.
	Permanent repair to occur as soon as possible and within two months of the breach being identified.	This contingency measure is not considered relevant.

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Annex 1 – 2022/2023 road kill survey data

Season	Date	Latitude	Longitude	Species	Native/ introduced	Assigned vertebrate group
Autumn	6/04/2022	-31.459523	152.820815	Bandicoot	Native	Medium Mammal
Autumn	6/04/2022	-31.358491	152.805425	Echidna	Native	Medium Mammal
Autumn	6/04/2022	-31.354691	152.806495	Turtle	Native	Reptile
Autumn	6/04/2022	-31.328217	152.817041	Rabbit	Introduced	Introduced Mammal
Autumn	6/04/2022	-31.313958	152.820254	Bird	Unknown	Bird
Autumn	6/04/2022	-31.300945	152.82175	Bandicoot	Native	Medium Mammal
Autumn	6/04/2022	-31.289992	152.818595	Bird of Prey	Native	Bird
Autumn	6/04/2022	-31.252752	152.819177	Snake	Native	Reptile
Autumn	6/04/2022	-31.219131	152.82385	Kookaburra	Native	Bird
Autumn	6/04/2022	-31.323139	152.818427	Unidentified	Unknown	Unknown
Autumn	6/04/2022	-31.34273	152.809903	Skink	Native	Reptile
Autumn	6/04/2022	-31.406938	152.81738	Water Bird	Native	Bird
Autumn	13/04/2022	-31.357943	152.805527	Small mammal	Unknown	Small Mammal
Autumn	13/04/2022	-31.353729	152.80665	Reptile	Native	Reptile
Autumn	13/04/2022	-31.327434	152.817231	Water Dragon	Native	Reptile
Autumn	13/04/2022	-31.28939	152.818243	Bird	Unknown	Bird
Autumn	20/04/2022	-31.3577	152.805666	Unknown mammal	Unknown	Unknown
Autumn	20/04/2022	-31.208052	152.823002	Pigeon	Introduced	Bird
Autumn	20/04/2022	-31.428192	152.822905	Echidna	Native	Medium Mammal
Autumn	27/04/2022	-31.332619	152.815317	Bird	Native	Bird
Spring	5/10/2022	-31.442803	152.823585	Magpie	Native	Bird
Spring	5/10/2022	-31.280917	152.677786	Kangaroo	Native	Large ground-dwelling Mammal
Spring	5/10/2022	-31.263002	152.814062	Unidentified small mammal	Unknown	Small Mammal
Spring	5/10/2022	-31.199035	152.823307	Unidentified	Unknown	Unknown
Spring	5/10/2022	-31.357836	152.805898	Possum	Native	Arboreal Mammal
Spring	5/10/2022	-31.439535	152.823416	Magpie	Native	Bird
Spring	5/10/2022	-31.346608	152.808197	Bird	Unknown	Bird
Spring	12/10/2022	-31.337854	152.812223	Turtle	Unknown	Reptile
Spring	12/10/2022	-31.189743	152.823668	Medium mammal	Unknown	Medium Mammal
Spring	12/10/2022	-31.407626	152.817528	Bird of Prey	Native	Bird
Spring	21/10/2022	-31.43316	152.822711	Small mammal	Unknown	Small Mammal
Summer	16/01/2023	-31.255024	152.817704	Lace Monitor	Native	Reptile
Summer	16/01/2023	-31.203983	152.823013	Bird	Native	Bird

Season	Date	Latitude	Longitude	Species	Native/ introduced	Assigned vertebrate group
Summer	16/01/2023	-31.173147	152.823079	Bandicoot	Native	Small Mammal
Summer	16/01/2023	-31.134517	152.824111	Kookaburra	Native	Bird
Summer	16/01/2023	-31.212283	152.823563	Unidentified	Unknown	Unknown
Summer	16/01/2023	-31.290984	152.819451	Diamond Python	Native	Reptile
Summer	1/02/2023	-31.394962	152.812064	Echidna	Native	Medium Mammal
Summer	7/02/2023	-31.413537	152.820571	Small mammal	Unknown	Small Mammal
Summer	7/02/2023	-31.182048	152.823602	Small mammal	Unknown	Small Mammal
Summer	7/02/2023	-31.208481	152.823281	Small mammal	Unknown	Small Mammal
Summer	7/02/2023	-31.211288	152.823443	Small mammal	Unknown	Small Mammal
Summer	7/02/2023	-31.291354	152.819597	Wallaby	Native	Large ground-dwelling Mammal

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Appendix H – Fauna Underpass



Fauna Underpass Monitoring 2022/2023

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

May 2023

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Cover photograph: Red-necked Wallaby in F26.40 (left), Echidna in F22.32 (middle) and two Short-eared Brushtail Possum recorded using fauna furniture in C4.46 (right) during late spring/summer surveys.

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Executive summary

Context

This report documents findings of the 2022/2023 monitoring period, the final of three monitoring periods for the fauna underpasses, as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project), and specified in the Oxley Highway to Kempsey Ecological Monitoring Program (EMP, TfNSW 2022).

Aims

The aim of the fauna underpass monitoring program is to determine whether fauna are using the underpass structures to complete crossings under the Pacific Highway. The aim of this report is to determine if the Project is meeting the performance indicators of success for the mitigation measures, and provide corrective actions where required.

Methods

Fourteen underpasses were surveyed in accordance with the monitoring method specified in the EMP, specifically:

- Two remote cameras were placed within each underpass and left to record for a minimum of 60 consecutive days
- Ten hair tube traps were placed in and around the entrance to each underpass for 14 consecutive nights
- Sand plots were established in combined fauna underpasses and monitored for eight consecutive nights
- Scat searches were conducted within underpasses and adjoining habitat during sand plot surveys and camera deployment and retrieval.

Key Results

The key results of the 2022/2023 fauna underpass monitoring were as follows:

- A minimum of two of the fauna groups were recorded at all underpasses. Small ground-dwelling mammals were the most frequently recorded group at all underpasses, followed by macropods, arboreal mammals and reptiles (12 underpasses). Frogs were recorded using one underpass (C36.40).
- The three target threatened species listed on the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Koala, the Giant Barred Frog and Spotted-tail Quoll, were not recorded using the underpasses in 2022/2023.
- One of the two non-EPBC Act target species, the Brush-tailed Phascogale was recorded using two of the underpasses (F20.54 and F22.32). Species identified as indicator species for the Brush-tailed Phascogale were recorded at all underpasses. Indicator species for the Green-thighed Frog (i.e. other frog species) were not recorded.
- Non-native predators including cats, dogs and foxes, were detected at 13 of 14 monitored underpasses (excluding C36.40). Three of the 14 monitored underpasses showed high use by non-native predators.
- To date, EPBC Act listed species, the Koala and Spotted-tailed Quoll, have been recorded at four and one underpass respectively.
- The 2022/2023 average weekly road kill decreased from that recorded during baseline monitoring from 8.0 to 3.6. Two road kill records were within 200 metres of monitored underpasses. There has not been an increase in road kill in proximity to monitored underpasses from baseline.

Conclusions

Performance measures are considered to have been met to date. The use of the underpasses by fauna, as measured and monitored according to the EMP, indicates that the underpasses allow fauna the opportunity for movement within home ranges, for dispersal and/or re-colonisation. The performance measure regarding use of underpasses by the Koala has been met at four underpasses and one underpass for the Spotted-tailed Quoll. Results indicate successful use by Indicator species for the Brush-tailed Phascogale. The performance indicator requiring a reduced incidence of road kill from baseline monitoring was met.

Management Implications

This report presents the results of the final of three monitoring events. Given the successful use by a range of native fauna from different fauna groups it is considered that the underpasses have been a successful mitigation measure allowing species to cross safely under the carriageway and maintain connectivity for adjacent habitat. Therefore, there are no further monitoring measures recommended beyond requirements of the EMP. However, maintenance of fauna fencing particularly within 200 m of underpasses is considered important in continued successful crossing by native fauna.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved by the NSW Department of Environment and Planning in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the then Commonwealth Department of Environment (DoE) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project.

Fauna underpasses were installed to reduce the impact, facilitate movement and maintain habitat connectivity for native fauna. These structures are to be monitored to assess their effectiveness in facilitating fauna movement, as required by the EMP.

1.1.1 Monitoring framework

The design, methods and performance indicators that define the fauna underpass monitoring program are specified in the EMP. The EMP specifies that monitoring be undertaken at 14 underpasses, including 10 dedicated fauna underpasses and four combined drainage/fauna culverts.

The EMP requires monitoring to occur in autumn and late spring/early summer in Years 4, 6 and 8 (operational phase) of the Project. The EMP specifies that additional monitoring may be required if underpasses are determined to be ineffective.

To date, these monitoring events have been conducted and reported as follows:

- Autumn 2018 and spring/summer 2018/2019: Year 4 surveys (Niche 2019a)
- Autumn 2020 and spring/summer 2020/2021: Year 6 surveys (Niche 2021a)
- Autumn 2022 and spring/summer 2022/2023: Year 8 surveys (current report).

This report represents the final of three reports required for the underpass monitoring – Year 8 autumn 2022 and spring/summer 2022/2023.

1.1.2 Background data

Underpass selection

The Project includes over 50 underpasses that may facilitate the passage of fauna, including bridges, dedicated fauna underpasses and combined drainage/fauna culverts. The EMP specifies that 14 underpasses be monitored based on the following criteria:

- All dedicated fauna underpasses will be monitored.
- Combined underpasses that are 50 metres or more in length, and located in proximity to intact native vegetation (fauna habitat) will be monitored.
- No combined culverts that are located in cleared, disturbed or modified areas will be monitored.
- No combined culverts that are located within 600 metres of another monitored underpass will be monitored.

- No incidental underpasses will be monitored (small culverts that are not intended to allow for the passage of fauna but may be used incidentally by small fauna).

Indicator species

The EMP provides a list of indicator and target (threatened) species to determine the successful use of fauna crossing structures. These species are those that have been previously recorded in proximity to the Project or are known to occur in the Project area and were considered as being potentially adversely affected by the Project. Section 2.2.4 of the EMP states: *“The effectiveness of wildlife crossings will be based on their use by fauna groups previously recorded in proximity to the Project (<one kilometre). It is assumed that the Project bisects the habitat of at least some individuals from each of the nominated fauna groups (Table 4). Fauna species known to occur within the Project area that may be potentially adversely affected by the upgrade are listed in Table 5. These species will indicate the successful usage of crossing structures.”* Table 1 lists the five fauna groups that are to be used to assess the effectiveness of the underpasses, as well as the indicator and target species for each of the five groups. It should be noted that while this report discusses the target and indicator species nominated for each underpass, all performance indicators do not directly relate to the use of the underpasses by these fauna groups.

Table 1: Indicator species for fauna crossings (from Table 5 of the EMP)

Fauna group	Indicator species (known from area)	Target (threatened) species
Frogs	<i>Litoria</i> sp., <i>Limnodynastes</i> sp., <i>Crinia</i> sp., Giant Barred Frog	Green-thighed Frog, Giant Barred Frog
Small ground-dwelling mammals	Antechinus, rodents and bandicoots, Echidna, Spotted-tailed Quoll	Spotted-tailed Quoll, Brush-tailed Phascogale
Arboreal mammals	Brush-tail Possum, Ringtail Possum	Brush-tailed Phascogale
Koala	Koala	Koala
Macropods	Swamp Wallaby, Red-necked Wallaby, Eastern Grey Kangaroo	N/A

1.1.3 Purpose of this report

This report details the findings obtained from the third operational monitoring event for the fauna underpasses. The aims of this report are to summarise the methods and results of the 2022/2023 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for fauna underpasses:

- *Complete safe crossing by the targeted EPBC species, the Spotted-tailed quoll and Koala, at a sufficient frequency as defined in Section 1.5 of the EMP. This would ensure that the underpass performance measure would trigger the contingency measures in section 5 for underpass performance after each koala monitoring event to review / modify underpass furniture, habitat, monitoring and if required, agency discussions.*
- *For non-EPBC species (Brush-tailed Phascogale), the complete safe crossing of the nominated underpass by the target species or their indicator species on at least one occasion in order to demonstrate opportunity for dispersal and re-colonisation (excluding frogs which are unlikely to be detected using camera monitoring).*
- *For fauna groups, the complete safe crossing of the nominated underpass by one or more individuals on at least once occasion from each of the relevant fauna groups (small ground-dwelling mammals, arboreal mammals and macropods) to demonstrate opportunity for dispersal and re-colonisation*
- *Reduced incidence of road kill from baseline conditions.*

1.3 Monitoring Timing

Monitoring is to be undertaken in Years 4, 6 and 8 of the Project’s operational phase in late autumn and late spring/early summer each monitoring year for a minimum of 60 days. The timing of monitoring coincides with breeding seasons and dispersal periods for target species, shown in Table 2.

Table 2: Breeding seasons and likely dispersal periods of threatened target species (from Table 13 of the EMP)

Scientific name	Common name	Breeding season	Likely dispersal period
<i>Dasyurus maculatus</i>	Spotted-tail Quoll	April to July	Spring and summer
<i>Litoria brevipalmata</i>	Green-thighed Frog	Late spring and summer	In association with rainfall events
<i>Mixophyes iteratus</i>	Giant Barred Frog	Late spring to early summer	In association with rainfall events
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	May to July	Mid-summer
<i>Phascolarctos cinereus</i>	Koala	Spring and summer	Spring and summer

1.4 Reporting

Annual reporting of monitoring results will include:

- Detailed description of monitoring methodology
- Results of the monitoring period
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA).

1.5 Limitations

Limitations relevant to the survey methodology that potentially impact on efficacy of the program include:

- Due to their small size and cryptic nature, frogs and smaller reptiles are difficult to detect within the underpasses using the current survey methods and thus if present, may have gone undetected.
- The EMP requires installation of sand plots at combined underpasses, which serve as combined drainage/fauna culverts. It was considered that sand plots established across the active drainage channel of the culvert would likely wash away. In consultation with Transport for NSW (TfNSW) it was therefore determined that sand plots would be established across the entire width of the underpass only if the drainage channel was not inundated with water.
- The EMP requires an assessment of the effectiveness of the underpasses for species listed under the Commonwealth EPBC Act, with ‘effective’ defined in Section 1.5 of the EMP as “*Result in the complete, safe crossing of the crossing by the targeted EPBC species at a sufficient frequency to ensure that habitat connectivity is maintained or improved from baseline conditions (determined by surveys condition 4a and information provided in the preliminary documentation), and ongoing population viability by providing opportunities for species dispersal and re-colonisation; and result in reduced incidence of road kill from baseline conditions (determined by surveys condition 4a and information provided in the preliminary Documentation)*”. The EMP does not define what “sufficient frequency” would be and baseline crossing frequencies are unknown and therefore cannot be used to assess the success of the underpasses. In addition, this monitoring program does not provide a means of

measuring dispersal and re-colonisation of species or population viability. The limitations of the EMP with regards to this performance measure are discussed in detail in Table 14.

2. Methods

2.1 Monitoring Sites

Monitoring was undertaken at 14 underpasses, including 10 dedicated fauna underpasses and four combined drainage/fauna culverts. Table 3 lists the fauna groups nominated in Table 12 of the EMP and shows the relevance of each of these groups at each of the underpasses (as specified in Table 12 of EMP). Target species (non-EPBC and EPBC listed species) have also been considered separately to their related fauna group as Table 12 of the EMP specifically nominates individual target species at certain underpasses. While the Brush-tailed Phascogale (*Phascogale tapoatafa*) was not specifically nominated within Table 12 of the EMP, it is listed in Table 13 of the EMP as a species targeted by underpasses and has therefore been included separately as a non-EPBC target species. Underpass F34.72 was erroneously omitted from Table 12 in the EMP; the text states all dedicated underpasses are to be monitored, therefore, after consultation with TfNSW, F34.72 was included in the monitoring. Fauna groups were therefore not nominated for F34.72 within the EMP. For the purpose of assessment, fauna groups/species nominated for the two closest underpasses (F33.40 and C36.4) have been included here as a guide for F34.72. The location of each monitored underpass is shown in Figure 1 and Figure 2. It should be noted that while this report discusses the target and indicator species nominated for each underpass, the performance indicators do not directly relate to the use of the underpasses as specified in Table 3 below. As such, the performance indicators are addressed as presented in the EMP.

Table 3: Monitored fauna underpasses and target species (adapted from Table 12 of the EMP).

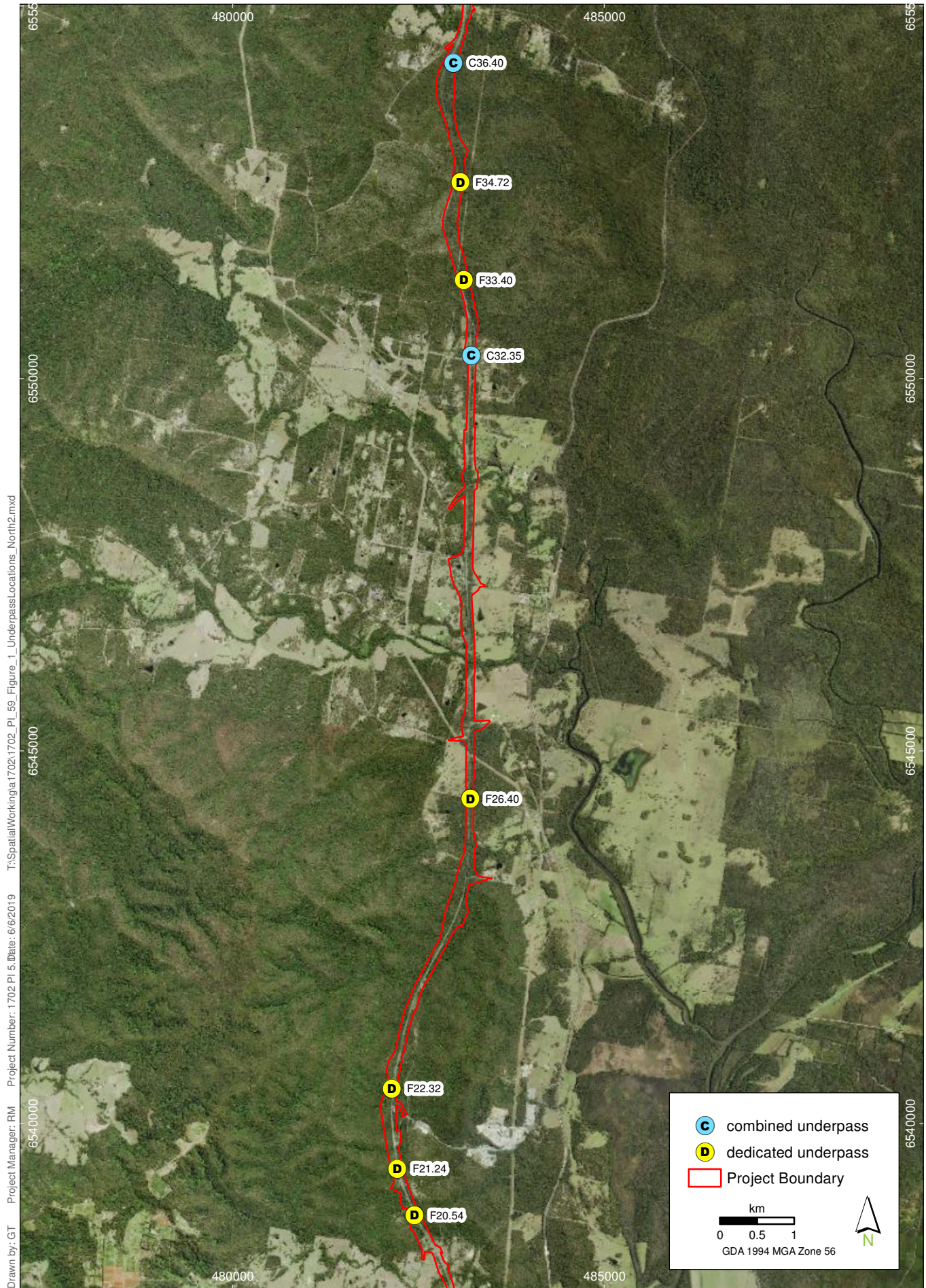
Target fauna group/species	Indicator species	Underpass number													
		F1.04	F1.62	C4.46	C7.26	F9.70	F11.67	F20.54	F21.24	F22.32	F26.40	C32.35	F33.40	F34.72*	C36.40
Fauna group/species (target threatened species)															
Frogs (Green-thighed Frog)	<i>Litoria</i> sp., <i>Limnodynastes</i> sp., <i>Crinia</i> sp., Giant Barred Frog	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Small ground-dwelling mammals (Brush-tailed Phascogale)	<i>Antechinus</i> spp, rodents and bandicoots, Echidna, Spotted-tail Quoll	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Arboreal mammals (Brush-tailed Phascogale)	Brush-tail Possum, Ringtail Possum		✓	✓	✓	✓	✓			✓			✓	✓	✓
Macropods	Swamp Wallaby, Red-necked Wallaby, Eastern Grey Kangaroo	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reptiles		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Non-EPBC target species															
Green-thighed Frog	<i>Litoria</i> sp., <i>Limnodynastes</i> sp., <i>Crinia</i> sp., Giant Barred Frog													✓	✓
Brush-tailed Phascogale*	<i>Antechinus</i> spp, rodents and bandicoots, Echidna, Spotted-tail Quoll, Brush-tail Possum, Ringtail Possum														
EPBC target species															
Giant Barred Frog	Giant Barred Frog														✓
Koala	Koala	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spotted-tail Quoll	Spotted-tail Quoll				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

+ The Brush-tailed Phascogale was not previously nominated at any underpass in Table 12 of the EMP but has been included based on Table 13 of EMP. *Nominated fauna groups/species are based on the two closest underpasses and proximity of recorded Green-thighed Frog habitat.

2.2 Survey Method

Surveys were undertaken in accordance with the EMP. At each underpass the following survey techniques were used:

- Two motion-detecting cameras were installed in the middle of each underpass, one facing along the fauna furniture and one facing along the ground, where possible. Cameras were left operating for a minimum of 60 days in autumn and late spring/early summer.
- Sand plots at least one metre wide were established across the entire width of the raised cement footpath at each end of combined underpasses as drainage channels were inundated at the time of monitoring. Sand plots were monitored for eight nights in each monitoring period. Each morning, sand plots were checked, any tracks recorded and plots raked clean.
- Ten hair-tubes were attached to fauna furniture (where possible) or placed along the ground within each underpass and in adjoining habitat. Hair tubes were baited with a mixture of peanut butter, honey and oats and left for a minimum of 14 consecutive nights in each monitoring period. Hair samples were sent to Robyn Carter for analysis, and were identified to species level where possible.
- Scat searches were undertaken within underpasses and adjoining habitat during sand plot surveys and camera deployment and retrieval.



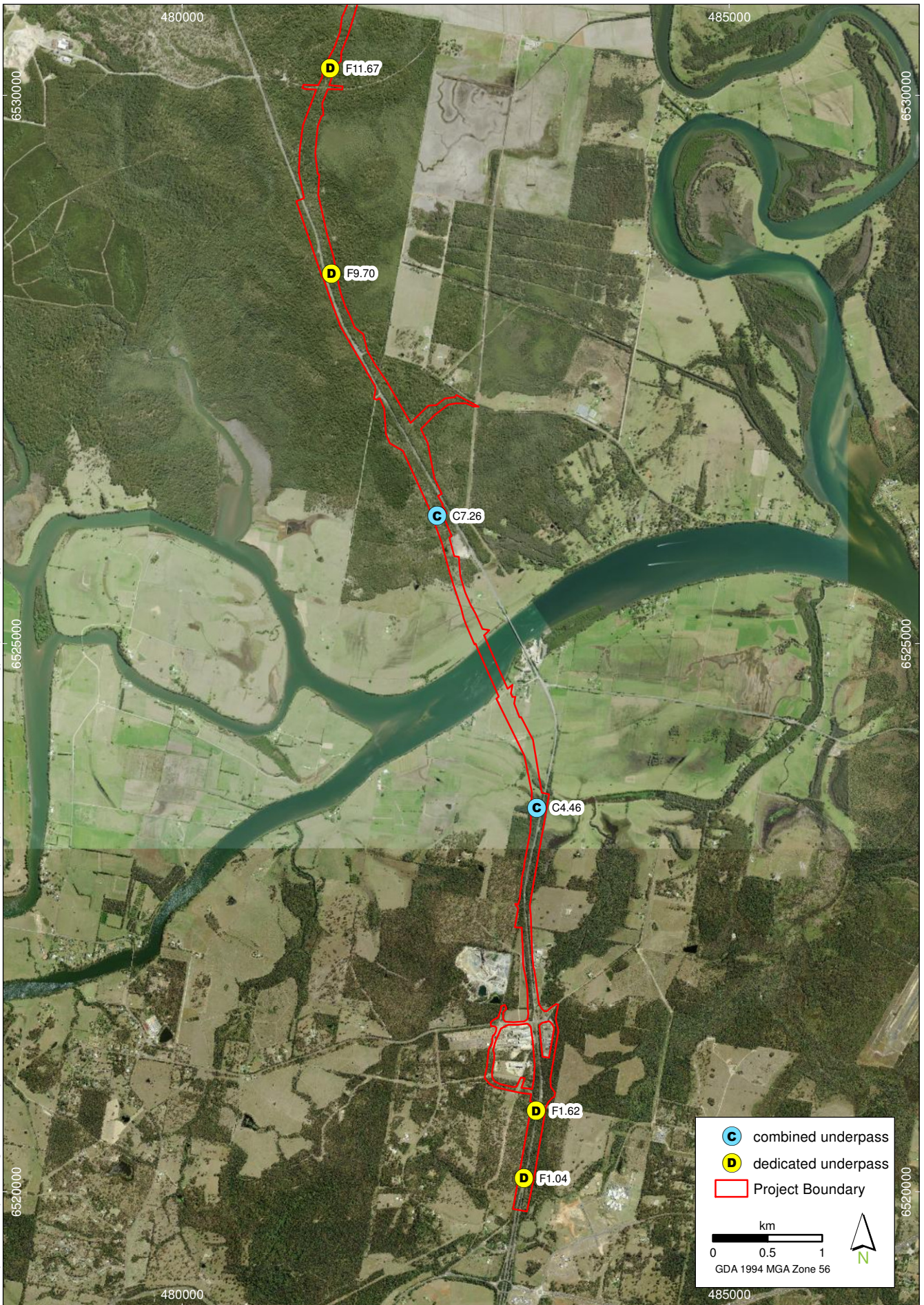
Fauna Underpass Locations - North

Oxley Highway to Kempsey - PI 5.9 Fauna Underpass Monitoring

FIGURE 1

Imagery: (c) LPI 2013

Drawn by: GT Project Manager: RM Project Number: 1702 PI 5 Date: 6/6/2019 T:\spatial\projects\at1700\at1702_OH2K_Ecology\Maps\PI_5_Ecology_OH2K\PI_59_Figure_2_UnderpassLocations_South.mxd



Fauna Underpass Locations - South

Oxley Highway to Kempsey - PI 5.9 Fauna Underpass Monitoring

FIGURE 2

Imagery: (c) LPI 2013

3. Results

3.1 2022/2023 Monitoring Summary

Detailed field data are provided in Annex 1 and Annex 2. Results of the different survey methods were combined to provide an overall assessment of the use of the monitored underpasses.

3.1.1 Monitoring periods

The 2022/2023 monitoring periods were as follows:

- Autumn 2022: 30 March 2022 – 1 and 7 June May 2022
- Late spring/early summer 2022/2023: 3-4 November 2022 – 4 January 2023.

Hair tube surveys were undertaken in the first two weeks of the monitoring period. Sand plots were monitored for eight nights in autumn (10 – 19 May 2022) and late spring/summer (8 – 16 December 2022). As the deployment periods were longer than the minimum 60 days, any species recorded outside of the 60 day monitoring period were considered as value adding data and included in the assessment of underpass use by fauna groups.

Camera details, including monitoring dates and durations, for autumn and spring/summer surveys are provided in Annex 1.

3.1.2 Remote cameras

Table 4 provides a summary of the fauna records for the monitored underpasses. Cameras captured a total of 1708 fauna records over the two monitoring periods. A proportion (12.1%) of records were unidentified, which consisting of partial and/or unclear images and could not be identified as either native or introduced fauna, including unidentified small mammals recorded as rodents. Of those records that were identified, 57.0% were identified as native fauna.

Table 4: 2022/2023 camera fauna record summary

Underpass	# fauna records	# natives	# non native	# unidentified	# introduced predator	% native	% introduced predator
F1.04	50	15	34	1	34	30.0	68.0
F1.62	120	83	35	2	34	69.2	28.3
C4.46	236	163	70	3	46	69.1	19.5
C7.26	16	2	12	2	5	12.5	31.3
F9.70	64	5	37	22	16	7.8	25.0
F11.67	88	23	49	16	16	26.1	18.2
F20.54	212	151	38	23	4	71.2	1.9
F21.24	279	172	45	62	4	61.6	1.4
F22.32	226	110	68	49	1	48.7	0.4
F26.40	165	114	45	6	1	69.1	0.6
C32.35	75	56	16	3	6	74.7	8.0
F33.40	115	58	49	8	2	50.4	1.7
F34.72	61	21	31	9	4	34.4	6.6
C36.40	1	0	0	1	0	0.0	0.0
TOTALS	1708	973	529	206	173	57.0	10.1

3.1.3 2022/2023 native fauna use of underpasses

Results of the different survey methods were combined to provide an overall assessment of the use of monitored underpasses by the nominated fauna groups, however only the small ground-dwelling mammals, arboreal mammals and macropods, i.e. not frogs or reptiles, factor into the determination of performance measure outcomes. While a specific means of determining a “complete safe crossing” by targeted EPBC species is not specified in the EMP, it is considered that animals captured on remote cameras within the underpass are using the underpass to complete successful crossings. Table 5 shows the use of underpasses by fauna groups and target species. Shaded squares indicate the underpasses where fauna groups/target species were nominated (Table 3). A summary of the use of underpasses by the respective fauna groups is as follows:

- Frogs: Scat recorded at one of the 14 nominated underpasses (C36.40).
- Small ground-dwelling mammals: recorded at all 14 nominated underpasses represented by rodents, antechinus, bandicoots and the Echidna.
- Arboreal mammals: recorded at seven of the nine nominated underpasses, and at five additional underpasses; represented by the Brushtail Possum.
- Macropods: recorded at 12 of the 14 nominated underpasses (excluding F1.04 and C36.40); represented by the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*) and Swamp Wallaby (*Wallabia bicolor*).
- Reptiles: recorded at 12 of the 14 nominated underpasses; represented predominantly by the Eastern Water Dragon (*Intellagama lesueurii*) and Lace Monitor (*Varanus varius*).

Table 5: 2022/2023 native fauna use of underpasses

Target fauna group/species	Indicator species	Underpass number													
		F1.04	F1.62	C4.46	C7.26	F9.70	F11.67	F20.54	F21.24	F22.32	F26.40	C32.35	F33.40	F34.72*	C36.40
Fauna group/species (target threatened species)															
Frogs (Green-thighed Frog)	<i>Litoria</i> sp., <i>Limnodynastes</i> sp., <i>Crinia</i> sp., Giant Barred Frog														Y (1)
Small ground-dwelling mammals (Brush-tailed Phascogale)	<i>Antechinus</i> spp, rodents and bandicoots, Echidna, Spotted-tail Quoll	Y (1)	Y (2)	Y (1)	Y (1)	Y (1)	Y (1)	Y (3)	Y (2)	Y (4)	Y (3)	Y (2)	Y (3)	Y (1)	Y (2)
Arboreal mammals (Brush-tailed Phascogale)	Brush-tail Possum, Ringtail Possum	Y (2)	Y (2)	Y (2)	Y (1)		Y (1)	Y (1)	Y (2)	Y (2)	Y (2)	Y (1)		Y (1)	Y (1)
Macropods	Swamp Wallaby, Red-necked Wallaby, Eastern Grey Kangaroo		Y (3)	Y (2)	Y (1)	Y (1)	Y (2)	Y (2)	Y (1)	Y (2)	Y (3)	Y (1)	Y (2)	Y (1)	
Reptiles			Y (1)	Y (2)	Y (1)		Y (1)	Y (1)	Y (1)	Y (1)	Y (1)	Y (1)	Y (1)	Y (1)	Y (1)
Non-EPBC target species															
Green-thighed Frog	<i>Litoria</i> spp., <i>Limnodynastes</i> spp., <i>Crinia</i> spp., Giant Barred Frog														
Brush-tailed Phascogale*	<i>Antechinus</i> spp, rodents and bandicoots, Echidna, Spotted-tail Quoll, Brush-tail Possum, Ringtail Possum							Y (1)		Y (1)					
EPBC target species															
Giant Barred Frog	Giant Barred Frog														
Koala (Koala)	Koala														
Spotted-tail Quoll	Spotted-tail Quoll														

* The Brush-tailed Phascogale was not previously nominated at any underpass in Table 12 of the EMP. Shaded cells are the nominated underpasses *Nominated fauna groups/species are based on the two closest underpasses. (#) = number of different species detected.

3.1.4 2022/2023 EPBC target species

Three of the five target threatened species (Table 1) are listed under the EPBC Act, including the Koala (*Phascolarctos cinereus*), Giant Barred Frog (*Mixophyes iteratus*) and Spotted-tailed Quoll (*Dasyurus maculatus*). These species were specifically nominated as target species at all, one and 10 of the underpasses respectively, however only the Koala and Spotted-tailed Quoll factor into the determination of performance measure outcomes.

The Koala was not recorded using any underpass during the 2022/2023 monitoring period. Neither the Giant Barred Frog or the Spotted-tailed Quoll were recorded within the underpasses during the 2022/2023 monitoring.

3.1.1 2022/2023 non-EPBC target species and presence of indicator species

Non-EPBC target threatened species include the Green-thighed Frog (*Litoria brevipalmata*) and Brush-tailed Phascogale, however only the Brush-tailed Phascogale factors into the determination of performance measure outcomes. The Brush-tailed Phascogale was recorded at two of the 14 underpasses (F20.54 and F22.32) during the 2022/2023 monitoring period, once in autumn and once in spring/summer.

Indicator species for the Brush-tailed Phascogale include those species included in the small ground-dwelling mammal fauna group and the arboreal mammal fauna group. While the Brush-tailed Phascogale

was not specifically nominated at individual underpasses, for the purpose of assessment, it is assumed that this species is a general target at all underpasses where the small ground-dwelling mammals and/or arboreal mammal fauna groups have been nominated, i.e. at all underpasses. Representatives of the small ground-dwelling fauna group were detected at all of the 14 underpasses with at least one indicator species at any underpass and representatives of the arboreal mammal group were recorded at seven of the nine nominated underpasses.

The Green-thighed Frog was specifically nominated as a species that may ‘possibly’ (TfNSW 2022) use F33.40 and C36.40. Indicator species for this target species include those species listed within the frog fauna group, however only amphibian scats were recorded at one underpass (C36.40) during the 2022/2023 monitoring periods. F33.40 is located approximately 150 metres (western side of carriageway) and 250 metres (eastern side of carriageway) south of Green-thighed Frog ponds constructed as part of the Project’s mitigation requirements for this species, in proximity to a site where the species was recorded during targeted surveys (Site 16, Lewis 2013). However, no Green-thighed Frogs have been recorded at these ponds during the two monitoring events undertaken by Niche as part of the Project’s Green-thighed Frog pond monitoring in 2016/2017 and 2018/2019 (Niche 2017a; Niche 2018a). It should be noted that it is unlikely that, if present, individuals from the identified Site 16 population would travel the required distance to F33.40 (Lemckert and Slatyer 2002). C36.40 is within 400 metres of a targeted survey site (Site 17, exact location not provided; Lewis 2013) identified as a likely location for the species and visited during targeted surveys. However, no Green-thighed Frogs were recorded at this site during the targeted surveys.

3.1.2 2022/2023 use of underpasses by non-native predators

Non-native predators including cats, dogs and foxes, were detected at 13 of the 14 monitored underpasses. Table 6 shows the non-native predators recorded using each underpass and the percentage of all identified fauna records that were non-native predators.

Based on previous underpass monitoring outcomes (Sandpiper Ecological 2015, Sandpiper Ecological 2017) and in consultation with North Coast Local Land Services (Biosecurity Manager, *pers. comm.* 2017), it was considered that visitation by non-native predators equating to greater than 25 per cent of visitations to the underpass or visitations by non-native predators on more than 25 per cent of the days monitored, constitutes high use by non-native predators.

Three of the 14 monitored underpasses showed high use by non-native predators, notably cats and foxes. The highest use was recorded at the following four underpasses: F1.04, F1.62, and C7.26 with visitation by non-native predators accounting for 68.0%, 28.3% and 31.1% of visitations respectively. Visitation by dogs was low in comparison.

Table 6: 2022/2023 exotic predator use of underpasses

Species	Underpass number													
	F1.04	F1.62	C4.46	C7.26	F9.70	F11.67	F20.54	F21.24	F22.32	F26.40	C32.35	F33.40	F34.72	C36.40
Fox (<i>Vulpes vulpes</i>)	30	21	46	0	2	4	3	1	1	1	6	1	2	0
Cat (<i>Felis catus</i>)	4	13	0	0	0	0	0	1	0	0	0	1	0	0
Dog (<i>Canis familiaris/dingo</i>)	0	0	0	5	14	12	1	2	0	0	0	0	2	0
Percentage of visitations	68.0	28.3	19.5	31.1	25.0	18.2	1.9	1.4	0.4	0.6	8.0	1.7	6.6	0.0

Bold indicates visitation rate by exotic predators > 25% of all visitations.

3.2 Cumulative Use

Combined results from the 2018/2019, 2020/2021 and 2022/2023 monitoring events are presented below.

3.2.1 Cumulative native fauna use of underpasses

Table 7 shows the cumulative use of underpasses by fauna groups and target species to date. All but one of the fauna groups (frogs), have been recorded using all of fourteen underpasses. A summary of the use of underpasses by the respective fauna groups is as follows:

- Frogs: Scat recorded at one of the 14 nominated underpasses (C36.40).
- Small ground-dwelling mammals: recorded at all nominated underpasses; represented by rodents, antechinus, bandicoots, the Echidna and the Spotted-tailed Quoll.
- Arboreal mammals: recorded at all nine nominated underpasses, and at five additional underpasses; represented by the Brushtail Possum and the Koala.
- Macropods: recorded at all 14 nominated underpasses; represented by the Eastern Grey Kangaroo, Red-necked Wallaby and Swamp Wallaby.
- Reptiles: recorded at all 14 nominated underpasses; represented predominantly by the Eastern Water Dragon and Lace Monitor.

Table 7: Cumulative fauna use of underpasses - 2018/2019, 2020/2021 and 2022/2023

Target fauna group/species	Indicator species	Underpass number													
		F1.04	F1.62	C4.46	C7.26	F9.70	F11.67	F20.54	F21.24	F22.32	F26.40	C32.35	F33.40	F34.72*	C36.40
Fauna group/species (target threatened species)															
Frogs (Green-thighed Frog)	<i>Litoria</i> sp., <i>Limnodynastes</i> sp., <i>Crinia</i> sp., Giant Barred Frog														Y
Small ground-dwelling mammals (Brush-tailed Phascogale)	<i>Antechinus</i> spp, rodents and bandicoots, Echidna, Spotted-tail Quoll	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Arboreal mammals (Brush-tailed Phascogale)	Brushtail Possum, Ringtail Possum	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Macropods	Swamp Wallaby, Red-necked Wallaby, Eastern Grey Kangaroo	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Reptiles		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Non-EPBC target species															
Green-thighed Frog	<i>Litoria</i> spp., <i>Limnodynastes</i> spp., <i>Crinia</i> spp., Giant Barred Frog														
Brush-tailed Phascogale*	<i>Antechinus</i> spp, rodents and bandicoots, Echidna, Spotted-tail Quoll, Brushtail Possum, Ringtail Possum							Y		Y					
EPBC target species															
Giant Barred Frog	Giant Barred Frog														
Koala (Koala)	Koala					Y	Y					Y	Y		
Spotted-tail Quoll	Spotted-tail Quoll														Y

* The Brush-tailed Phascogale was not specifically nominated at any underpass in Table 12 of the EMP. Shaded cells are the nominated underpasses *Nominated fauna groups/species are based on the two closest underpasses.

3.2.2 Cumulative EPBC Act listed target species

As outlined in section 3.3, three target species are listed under the EPBC Act including the Koala, Giant Barred Frog and Spotted-tailed Quoll, however only the Koala and Spotted-tailed Quoll factor into the determination of performance measure outcomes. To date, the Koala and the Spotted-tailed Quoll have been recorded using five underpasses during the 2018/2019 and 2020/2021 monitoring periods; the Koala has been detected using F9.70, F11.67, C32.35 and F33.40, and the Spotted-tailed Quoll has been detected using C36.40. Details of these records are provided in Table 8 and discussed below. The Giant Barred Frog has not been detected using any underpasses.

Three of the four underpasses used by the Koala are dedicated fauna underpasses with installed fauna furniture. The fourth underpass used by the Koala (C32.35) is a combined drainage/fauna culvert without installed fauna furniture. All Koalas were recorded on the ground. The Spotted-tailed Quoll was detected using a nominated combined drainage/fauna culvert heading in a westerly direction on the raised fauna footpath.

The Giant Barred Frog was specifically nominated as a species that may ‘possibly’ (TfNSW 2022) use C36.40. Given the constructed state of C36.40, the intermittent water flow within the underpass and in the drainage line connecting to the underpass, and the absence of habitat within the underpass to facilitate movement (including shelter such as leaf litter, vegetation, rocks and logs), it is considered unlikely that this species would use this underpass. The nearest baseline record is from Maria River, approximately 500 metres to the north (Lewis 2014). Giant Barred Frog monitoring for the Project has shown that this species is traversing the Pacific Highway within the monitored waterways under bridges (Niche 2018b).

As mentioned, it is considered that animals captured on remote cameras within the underpass are using the underpass to complete successful crossings. Koalas have therefore been recorded completing safe crossings at four of the 14 underpasses for which it is a target species, and the Spotted-tail Quoll has been recorded completing a safe crossing at one of 10 underpasses for which it is a target species.

Table 8: Cumulative EPBC Act listed species recorded in underpasses

Season	Underpass	Date	Time	Species	Position	Direction
Autumn	C36.40	28/05/2018	2:43:37	Spotted-tailed Quoll	Ground	West
Spring/summer	F33.40	23/11/2018	5:41:47	Koala	Ground	East
Spring/summer	F11.67	24/11/2018	23:16:54	Koala	Ground	East
Spring/summer	F9.70	16/12/2018	11:06:19	Koala	Ground	East
Spring/summer	C32.35	29/11/2020	7:13:29	Koala	Ground	West

3.2.3 Cumulative non-EPBC Act listed target species and presence of indicator species

Non-EPBC target threatened species include the Green-thighed Frog and Brush-tailed Phascogale, however only the Brush-tailed Phascogale factors into the determination of performance measure outcomes.

Indicator species for the Brush-tailed Phascogale include those species within the small ground-dwelling mammal fauna group and the arboreal mammal fauna group. Representatives of the small ground-dwelling fauna group were detected at all underpasses with at least two indicator species at any underpass. Representatives of the arboreal mammal group were recorded at eight of the nine nominated underpasses indicating relatively high use of the underpasses by these fauna groups.

Indicator species for the Green-thighed Frog include those species listed within the frog fauna group, however no amphibians were detected at any of the underpasses during the 2018/2019 and 2020/2021. During the 2022/2023 monitoring periods the presence of amphibians at C36.40 was recorded based on scat detected.

3.2.4 Cumulative use of underpasses by non-native predators

Non-native predators including cats, dogs and foxes, have been detected at all of the fourteen monitored underpasses. Table 9 shows the non-native predators recorded using each underpass and Table 10 shows the percentage of all identified fauna records that were non-native predators. The majority (11 of 14) of the monitored underpasses showed high use by non-native predators during at least one monitoring period. At least two of the three different non-native predators have been recorded at each underpass, with all three recorded at 12 of 14 underpasses. Non-native predator use at underpasses has increased at five of the monitored underpasses since 2018/2019 monitoring and at two of the underpasses since 2020/2021.

Table 9: Cumulative frequency of exotic predator use of underpasses (number of records)

Species	Underpass number													
	F1.04	F1.62	C4.46	C7.26	F9.70	F11.67	F20.54	F21.24	F22.32	F26.40	C32.35	F33.40	F34.72	C36.40
Fox (<i>Vulpes vulpes</i>)	84	54	57	56	30	12	9	4	18	31	7	54	6	4
Cat (<i>Felis catus</i>)	9	18	9	9	10	1	9	6	4	5	33	27	26	25
Dog (<i>Canis familiaris/dingo</i>)	1	0	1	10	15	19	10	4	3	13	0	2	28	2

Bold indicates exotic predator which occurs most frequently at each underpass.

Table 10: Cumulative exotic predator use of underpasses to (percentage of all fauna recorded)

Species	Underpass number													
	F1.04	F1.62	C4.46	C7.26	F9.70	F11.67	F20.54	F21.24	F22.32	F26.40	C32.35	F33.40	F34.72	C36.40
2018/2019	53.1	43.3	14.5	12.7	21.0	1.8	20.8	20.0	8.0	36.6	30.0	35.2	34.7	27.8
2020/2021	28.6	46.2	7.6	79.7	31.6	29.4	17.0	5.3	75.0	20.0	54.9	41.9	35.9	39.4
2022/2023	68.0	28.3	19.5	31.1	25.0	18.2	1.9	1.4	0.4	0.6	8.0	1.7	6.6	0.0

Bold indicates visitation rate by exotic predators > 25% of all visitations.

3.3 Road Kill

3.3.1 Weekly road kill rate

As part of the road kill monitoring component of the Project, road kill surveys were undertaken in April 2022 (autumn), October 2022 (spring) and January 2023 (summer), involving weekly surveys of the entire length of the Project for four weeks in each season. Detailed reporting of these surveys is presented in Niche (2023).

There were a total of 43 road kill records for the spring, summer and autumn 2022/2023 road kill monitoring events, including 20 in autumn, 11 in spring and 12 in summer. Baseline surveys were undertaken prior to the commencement of construction for 12 weeks in spring 2013, summer 2014 and autumn 2014. Monitoring took place weekly for four weeks in each of the seasons as required by the EMP. Baseline surveys recorded 96 animals as road kill during the three monitoring events, representing 33 species and an average weekly road kill for spring, summer and autumn of 9.5, 11.8 and 3.3 respectively. Table 11 shows the average weekly road kill for across all years, stages of the Project and seasons to date.

Spring and summer weekly road kill rates were lower in the 2022/2023 monitoring period than during baseline surveys (2.8 cf 9.5 and 3.0 cf 11.8 respectively), while autumn 2023 was higher than baseline for the same period (5.0 cf 3.3). The overall average weekly road kill rate (calculated for the same three seasons) was similar during the baseline surveys and for the first year of operation (8.0 and 7.7 respectively), however the road kill rate for the last three years of operational monitoring has been lower (3.8 in 2019/2020, 5.8 in 2020/2021 and 3.6 in 2022/2023).

3.3.2 Road kill within 200 metres of monitored fauna underpasses

Table 12 shows the road kill records within 200 metres of monitored underpasses during 2022/2023, 2020/2021, 2018/2019 and baseline monitoring events. There were a total of two road kill records within 200 metres of monitored underpasses during 2022/2023 monitoring (F33.40 and C32.35), decreased from the three road kill records during the 2021/2022, 2020/2021 and 2018/2019 surveys respectively. Baseline road kill surveys included five road kill within 200 metres of monitored underpasses including F1.04, F34.72, F22.32 and C7.26.

3.3.3 Threatened species road kill

Table 13 lists the threatened species identified as road kill throughout the Project to date. One Koala was identified in October 2020, within a partially fenced area of the highway on the northbound left lane near Barry’s Creek. TfNSW inspected the area of the Koala road strike within days to review the fencing integrity. Minor tree limbs were removed from fauna fencing in the general area, but it was considered unlikely that these provided a potential access point. No holes or issues with the fencing were identified during the inspection. The individual likely entered the motorway from the unfenced intersection at Mingaletta Road or fallen tree limbs on the fauna fence near the U-turn bay at Barry’s Creek, crossed from the southbound lane to the northbound land where it was hit.

The baseline monitoring report (Lewis 2014) states that, based on baseline Koala road kill records, “the baseline count for road kill should be set at 1 individual per 8 weeks”. Koala road kill has therefore not increased from the baseline count.

There have been no threatened species road kill recorded since the 2020/2021 monitoring period.

Table 11: Average weekly road kill rate for all monitoring to date

Monitoring period		Spring (n)	Summer (n)	Autumn (n)	Winter (n)	Annual (n)
Baseline	2013/2014	9.5 (4)	11.8 (4)	3.3 (4)	No surveys	8.0 (12)
Construction phase	2015/2016 (all surveys)	4.2 (13)	5.8 (14)	6.7 (13)	4.1 (12)	5.0 (52)
	2015/2016 (4 weeks)	2.75 (4)	6.5 (4)	6.5 (4)	3.0 (4)	
	2016/2017 (all surveys)	3.3 (13)	2.6 (13)	2.0 (12)	2.2 (14)	2.3 (52)
	2016/2017 (4 weeks)	4.0 (4)	1.5 (4)	1.5 (4)	2.5 (4)	
	2017/2018 (all surveys)	2.9 (9)	No surveys*	No surveys*	3.3 (4)	3.0 (13)
	2017/2018 (4 weeks)	1.5 (4)	No surveys*	No surveys*	3.3 (4)	
12-week post-opening	2017/2018 (all sections combined)					4.5 (12)
Operational	2018/2019	11.3 (4)	6.8 (4)	5.0 (4)	No surveys	7.7 (12)
Operational	2019/2020	5.3 (4)	3.8 (4)	2.5 (4)	No surveys	3.8 (12)
Operational	2020/2021	5.8 (4)	6.0 (4)	5.5 (4)	No surveys	5.8 (12)
Operational	2022/2023	2.8 (4)	3.0 (4)	5.0 (4)	No surveys	3.6 (12)

n = number of survey weeks; * = construction partially complete

Table 12: Road kill within 200 metres of monitored fauna underpasses and distance from underpass

Monitoring event	Season	Species	Native/ introduced	Fauna category	Underpass	Distance (metres)
2022/2023	Summer	Bandicoot	Native	Small Mammal	F33.40	135
2022/2023	Summer	Small mammal	Unknown	Small Mammal	C32.35	98
2020/2021	Autumn	Bandicoot	Native	Medium mammal	C32.35	14.6
2020/2021I	Autumn	Snake	Native	Reptile	F11.67	34.6
2020/2021I	Autumn	Snake	Native	Reptile	F11.67	35.4
2020/2021I	Summer	Kookaburra	Native	Bird	C7.26	57.1
2018/2019	Spring	Medium Mammal	unknown	Medium ground dwelling mammal	C32.35	136.8
2018/2019	Summer	Medium Mammal	unknown	Medium ground dwelling mammal	F21.24	31.9
2018/2019	Summer	Kangaroo	native	Large ground dwelling mammal	C32.35	54.3
Baseline	Autumn	Brushtail Possum	native	Arboreal Mammal	F1.04	67.0
Baseline	Spring	Lace Monitor	native	Reptile	F34.72	77.8
Baseline	Spring	Koala	native	Arboreal Mammal	F22.32	117.3
Baseline	Summer	Eastern Grey Kangaroo	native	Large ground dwelling mammal	C7.26	150.4
Baseline	Summer	Red-necked Wallaby	native	Large ground dwelling mammal	F22.32	150.5

Table 13: Threatened species road kill to date

Monitoring type (report)	Monitoring period	Threatened species identified as road kill (number recorded)
Baseline (Lewis 2014)	2013-2014	<ul style="list-style-type: none"> • Koala (1*) • Grey-headed Flying Fox (2)
Clearing (Niche 2015)	2014-2015	<ul style="list-style-type: none"> • Koala (4) • Grey-headed Flying Fox (1) • Masked Owl (2) • Spotted-tail Quoll (1)
Construction (Niche 2016)	2015-2016	<ul style="list-style-type: none"> • Koala (1)
Construction (Niche 2017b)	2016-2017	<ul style="list-style-type: none"> • Koala (2)
Construction (Niche 2018c)	2017-2018	Nil
Operational (Niche 2019b)	2018-2019	<ul style="list-style-type: none"> • Koala (1)
Operational (Niche 2020)	2020-2021	<ul style="list-style-type: none"> • Brush-tail Phascogale (1)
Operational (Niche 2021b)	2020-2021	<ul style="list-style-type: none"> • Koala (1)

* = An additional three Koala road kill were recorded between August 2013 and February 2014, outside of the monitoring period.

4. Discussion

4.1 Performance Measures

A summary and discussion of the 2022/2023 fauna underpass monitoring results in relation to the performance measures is provided in Table 14.

Table 14: Performance measures

Performance measure	Discussion
<p><i>Complete safe crossing by the targeted EPBC species, the Spotted-tailed quoll and Koala, at a sufficient frequency as defined in Section 1.5 of the EMP. This would ensure that the underpass performance measure would trigger the contingency measures in section 5 for underpass performance after each koala monitoring event to review / modify underpass furniture, habitat, monitoring and if required, agency discussions.</i></p>	<p>This performance measure is considered to have been met.</p> <p>Section 1.5 of the EMP defines an ‘effective’ crossing as: <i>“Result in the complete, safe crossing of the crossing by the targeted EPBC species at a sufficient frequency to ensure that habitat connectivity is maintained or improved from baseline conditions (determined by surveys condition 4a and information provided in the preliminary documentation), and ongoing population viability by providing opportunities for species dispersal and re-colonisation; and result in reduced incidence of road kill from baseline conditions (determined by surveys condition 4a and information provided in the preliminary Documentation”.</i></p> <p>The crossing frequency required to determine effective habitat connectivity for each EPBC species and baseline crossing frequencies are unknown. As such, it is not possible to determine if fauna are crossing with ‘sufficient frequency’ and therefore it is not possible to use this metric to assess the success of the underpasses. In addition, the monitoring program does not provide a means of measuring dispersal and re-colonisation of species. However, it is considered that the monitoring scope permits comment on the use of underpasses as demonstrating <i>opportunity</i> for dispersal and reduction in road kill. This performance measure has therefore been assessed in this manner for each of the three EPBC Act listed species.</p> <p>To date, the Koala and Spotted-tailed Quoll have been recorded during the monitoring. The Koala was recorded in both the 2018/2019 and 2020/2021 monitoring periods whilst the Spotted-tailed Quoll has only been recorded on one occasion in 2018/2019.</p> <p>The Koala was recorded using one underpass in 2020/2021 and three underpasses in 2018/2019, each on a single occasion. These events all occurred within the spring/summer monitoring event, which may reflect seasonal movement patterns of the species. The detection of this species within a number of underpasses may be considered as demonstration of ‘successful crossing at a sufficient frequency’ as the records demonstrates that the underpasses provide opportunity for dispersal. In addition, the baseline road kill monitoring report (Lewis 2014) states that, based on baseline Koala road kill records, <i>“the baseline count for road kill should be set at 1 individual per 8 weeks”.</i> Koala road kill has therefore not increased from the baseline count.</p> <p>The Spotted-tailed Quoll has only been recorded on one occasion in 2018/2019 within a single underpass. Given the low densities and cryptic nature of this species, it is considered unlikely that this species would be detected at all of the nominated underpasses. Spotted-tailed Quoll monitoring (two events of 21 consecutive nights using 36 cameras over 2,700 ha and repeated within three different areas) within the Project Area has not resulted in the detection of this species. In addition, one event during 2022/2023 monitored 14 fauna crossing locations within three broad monitoring areas for not less than three months from 1 June to 14 September 2022, also resulting in no detection of the species. The detection of this species within an underpass may be considered as demonstration of ‘successful crossing at a sufficient frequency’ as the record demonstrates that the underpass provides opportunity for dispersal, and there have been no incidences of road kill recorded for this species since construction.</p>
<p><i>For non-EPBC species (Brush-tailed Phascogale), the complete safe crossing of the nominated underpass by the target species or their indicator species on at least one occasion in order to demonstrate opportunity for dispersal and re-colonisation (excluding frogs which are unlikely to be detected using camera monitoring).</i></p>	<p>This performance measure has been met.</p> <p>The Brush-tailed Phascogale was recorded using two of the 14 underpasses during 2022/2023 monitoring periods. The species was recorded on one occasion in underpasses F20.54 and F22.32, in autumn and summer, respectively.</p> <p>Indicator species (small ground-dwelling mammals and/or arboreal mammals) for the Brush-tailed Phascogale were recorded using all 14 underpasses in 2022/2023.</p>

Performance measure	Discussion
<p><i>For fauna groups, the complete safe crossing of the nominated underpass by one or more individuals on at least once occasion from each of the relevant fauna groups (small ground-dwelling mammals, arboreal mammals and macropods) to demonstrate opportunity for dispersal and re-colonisation.</i></p>	<p>This performance measure has been met.</p> <p>All underpasses have records of crossings by representatives from all of the three specified fauna groups, as follows:</p> <ul style="list-style-type: none"> • Small ground-dwelling mammals: recorded at all nominated underpasses; represented by rodents, antechinus, bandicoots, the Echidna and the Spotted-tailed Quoll. • Arboreal mammals: recorded at all nine nominated underpasses, and at five additional underpasses; represented by the Brushtail Possum and the Koala. • Macropods: recorded at all 14 nominated underpasses; represented by the Eastern Grey Kangaroo, Red-necked Wallaby and Swamp Wallaby.
<p><i>Reduced incidence of road kill from baseline conditions.</i></p>	<p>This performance measure has been met.</p> <p>The annual average weekly road kill rate has decreased from baseline to 2022/2023 operational monitoring (8.0 in baseline <i>cf.</i> 3.6 in 2022/2023).</p>

5. Recommendations

5.1 Contingency Measures

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are related to the underpass monitoring program are listed and discussed in Table 15.

Table 15: Contingency measures

Potential problem	EMP contingency measure	Discussion of proposed measure
No recorded presence of indicator species from the nominated classes in underpasses.	Commence review/modification of fauna furniture associated with underpasses within two weeks of results reported by ecologist.	Four of the five fauna groups have been detected at all monitored underpasses. Frogs have been detected using only one underpass during monitoring events, however monitoring methods do not favour their detection. This contingency measure is not considered relevant.
No recorded presence of cover- dependent species or fauna species with low mobility in underpasses.	Commence review/modification of habitat (i.e. vegetation composition and structure; type and abundance of natural habitat features) adjoining the underpass within two weeks of results reported by ecologist.	All three relevant fauna groups have been detected using all 14 underpasses. Frogs have been detected using only one underpass during monitoring events, however monitoring methods do not favour their detection. This contingency measure is not considered relevant.
Increased incidence of road kill from baseline conditions, in proximity to underpasses, particularly target species.	Commence review/modification of frequency and/or timing of monitoring periods within two weeks of results reported by ecologist.	Overall annual weekly road kill rates have decreased compared to baseline monitoring. Two road kill fauna were recorded during 2022/2023 monitoring within 200 metres of monitored underpasses (F33.40 and C32.35) and five road kill fauna were recorded within 200 metres of four different underpasses during baseline monitoring (F1.04, F34.72, F22.32 and C7.26). There has not been an increase in road kill in proximity to monitored underpasses. No target species (the Koala) was recorded as road kill during the 2022/2023 monitoring period. The baseline monitoring report (Lewis 2014) states that, based on baseline Koala road kill records, “the baseline count for road kill should be set at 1 individual per 8 weeks”. Koala road kill has not increased from the baseline count. This contingency measure is not considered relevant.
Inferior results compared to baseline surveys for the EPBC species, relevant to reference site monitoring.	If it is not reasonable or feasible to redesign/modify the underpass, discussions with EPA, DP&I and DoTE will be undertaken to determine if additional biodiversity offsets are required within 1 month of above reviews being completed.	Comparison of underpass records with EPBC species reference site monitoring may be undertaken only at a superficial level due to the different means of data collection of the different monitoring components. Koalas were recorded along the entire length of the Project during baseline surveys (Lewis 2014). The Koala was recorded using four underpasses in areas where the Koala was recorded during the baseline surveys (Niche 2019c). The Spotted-tailed Quoll was not recorded during baseline surveys (Niche 2018d) but was recorded using one nominated underpass during the 2018/2019 fauna underpass monitoring. The Giant Barred Frog has been recorded traversing the Project under constructed bridges at locations where it was recorded during baseline surveys (Niche 2018b), but not using the nominated underpass, which is considered unlikely to provide suitable habitat for this species. This contingency measure is not considered relevant.

5.2 Recommendations

Given the successful use by a range of native fauna from different fauna groups it is considered that the underpasses have been a successful mitigation measure allowing species to cross safely under the carriageway and maintain connectivity for adjacent habitat. Underpasses are a key mitigation measure in reducing the impact of the highway as a major barrier to native fauna. Therefore, there are no further monitoring measures recommended beyond requirements of the EMP. However, maintenance of fauna fencing particularly within 200 m of underpasses is considered important in continued successful crossing by native fauna.

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Annex 1 – 2022/2023 camera results

Table 16: 2022/2023 remote camera records – F1.04, F1.62, C4.46, C7.26, F9.70, F11.67 and F20.54

Underpass	F1.04		F1.62		C4.46		C7.26		F9.70		F11.67		F20.54	
Fauna group / Species	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer
Small ground-dwelling mammals														
<i>Antechinus</i> sp.					Y (3)	Y (2)			Y (1)					Y (1)
Bandicoot				Y (4)										Y (6)
Northern Brown Bandicoot (<i>Isodon macrourus</i>)				Y (1)										
Long-nosed Bandicoot (<i>Perameles nasuta</i>)				Y (3)										Y (2)
Echidna (<i>Tachyglossus aculeatus</i>)														Y (1)
Spotted-tailed Quoll (<i>Dasyurus maculatus</i>)*														
<i>Rattus fuscipes</i>														
<i>Rattus rattus</i>					Y (10)	Y (12)		Y (7)	Y (15)	Y (6)	Y (4)	Y (29)	Y (29)	Y (5)
<i>Rattus</i> spp.														
Rodent/Marsupial	Y (1)		Y (1)			Y (2)		Y (2)	Y (18)	Y (4)	Y (4)	Y (12)	Y (19)	Y (4)
Arboreal mammals														
Brush-tail Possum			Y (7)	Y (1)	Y (36)	Y (36)	Y (2)						Y (27)	Y (21)
Common Brush-tail Possum (<i>Trichosurus vulpecula</i>)		Y (15)	Y (2)		Y (5)	Y (44)								
Short-eared Brush-tail Possum (<i>Trichosurus caninus</i>)			Y (16)	Y (1)	Y (8)	Y (9)							Y (31)	Y (17)
Brush-tailed Phascogale (<i>Phascogale tapoatafa</i>)													Y (1)	
Koala														
Koala (<i>Phascolarctos cinereus</i>)*														

Underpass	F1.04		F1.62		C4.46		C7.26		F9.70		F11.67		F20.54	
Fauna group / Species	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer
Macropods														
Eastern Grey Kangaroo (<i>Macropus giganteus</i>)			Y (2)	Y (22)		Y (1)			Y (1)	Y (2)	Y (1)	Y (5)	Y (2)	Y (9)
Macropod sp.			Y (1)	Y (14)								Y (2)		Y (1)
Swamp Wallaby (<i>Wallabia bicolor</i>)				Y (1)										
Red-necked Wallaby (<i>Macropus rufogriseus</i>)				Y (2)										Y (7)
Wallaby			Y (2)	Y (2)							Y (4)		Y (1)	
Reptiles														
Blue-tongue Lizard (<i>Tiliqua scincoides</i>)														
Eastern Water Dragon (<i>Intellagama lesueurii</i>)					Y (5)									
Lace Monitor (<i>Varanus varius</i>)				Y (2)	Y (1)	Y (13)						Y (6)		Y (23)
Snake														
Other														
Microbat										Y (1)				Y (1)
Unk Mammal				Y (1)										
<i>Rattus rattus</i>														
Raven (<i>Corvus</i> sp.)														
Wood Duck (<i>Chenonetta jubata</i>)														
Fox (<i>Vulpes vulpes</i>)	Y (30)		Y (7)	Y (14)		Y (46)			Y (2)		Y (4)		Y (3)	
Deer				Y (1)		Y (2)								
Cat (<i>Felis catus</i>)	Y (3)	Y (1)	Y (9)	Y (4)										
Wild Dog (<i>Canis lupus</i>)							Y (5)		Y (14)		Y (1)	Y (11)		Y (1)
Swallow														

Y = detected; (n) = number of records; * = EPBC target species

Table 17: 2022/2023 remote camera records – F21.24, F22.32, F26.40, C32.35, F33.40, F34.72 and C36.40

Underpass	F21.24		F22.32		F26.40		C32.35		F33.40		F34.72		C36.40	
Fauna group / Species	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer
Small ground-dwelling mammals														
<i>Antechinus</i> sp.	Y (2)	Y (29)	Y (3)	Y (5)		Y (7)								
Bandicoot	Y (4)		Y (2)	Y (1)		Y (5)		Y (2)	Y (10)	Y (2)				
Northern Brown Bandicoot (<i>Isoodon macrourus</i>)				Y (1)										
Long-nosed Bandicoot (<i>Perameles nasuta</i>)	Y (1)								Y (2)	Y (3)				
Echidna (<i>Tachyglossus aculeatus</i>)				Y (1)		Y (1)				Y (1)				
Spotted-tailed Quoll (<i>Dasyurus maculatus</i>)*														
Black Rat (<i>Rattus rattus</i>)	Y (1)	Y (40)	Y (9)	Y (58)	Y (21)	Y (23)	Y (10)		Y (18)	Y (29)	Y (5)	Y (22)		
<i>Rattus</i> sp.	Y (7)	Y (19)	Y (17)	Y (25)						Y (6)		Y (4)		
Rodent/Marsupial	Y (11)	Y (23)	Y (1)	Y (6)		Y (6)	Y (3)			Y (2)		Y (3)		
Arboreal mammals														
Brushtail Possum	Y (46)	Y (26)	Y (14)	Y (27)	Y (13)	Y (4)		Y (1)			Y (4)			
Common Brushtail Possum (<i>Trichosurus vulpecula</i>)	Y (10)	Y (12)	Y (14)	Y (1)		Y (10)					Y (3)	Y (4)		
Short-eared Brushtail Possum (<i>Trichosurus caninus</i>)	Y (30)	Y (5)	Y (1)	Y (1)	Y (2)									
Brush-tailed Phascogale (<i>Phascogale tapoatafa</i>)				Y (1)										
Koala														
Koala (<i>Phascolarctos cinereus</i>)*														
Macropods														
Grey Kangaroo (<i>Macropus giganteus</i>)	Y (1)				Y (1)	Y (11)								
Macropod sp.		Y (1)	Y (3)		Y (3)				Y (3)	Y (1)	Y (1)			
Swamp Wallaby (<i>Wallabia bicolor</i>)			Y (3)	Y (2)		Y (16)			Y (11)	Y (16)				

Underpass	F21.24		F22.32		F26.40		C32.35		F33.40		F34.72		C36.40	
Fauna group / Species	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer	autumn	spring/ summer
Wallaby			Y (3)	Y (1)	Y (1)	Y (1)				Y (4)	Y (6)			
Red-necked Wallaby (<i>Macropus rufogriseus</i>)				Y (1)		Y (5)				Y (1)			Y (1)	
Reptiles														
Blue-tongue Lizard (<i>Tiliqua scincoides</i>)														
Eastern Water Dragon (<i>Intellagama lesueurii</i>)					Y (2)									
Lace Monitor (<i>Varanus varius</i>)		Y (3)		Y (24)		Y (25)				Y (1)		Y (1)		
Unk Skink														
Other														
Microbat	Y (1)		Y (1)			Y (1)	Y (1)					Y (1)		
<i>Rattus rattus</i>														
Unk Mammal														
Raven (<i>Corvus</i> sp.)														
Wood Duck (<i>Chenonetta jubata</i>)														
Fox (<i>Vulpes vulpes</i>)	Y (1)		Y (1)			Y (1)	Y (6)		Y (1)		Y (2)			
Hare (<i>Lepus 27uropaeus</i>) / Rabbit (<i>Oryctolagus cuniculus</i>)														
Cat (<i>Felis catus</i>)	Y (1)								Y (1)					
Wild Dog (<i>Canis lupus</i>)		Y (2)										Y (2)		
Unk Bird					Y (5)		Y (13)					Y (1)		
Lewin's Honeyeater														
Superb Fairy Wren														
Welcome Swallow							Y (39)							

Y = detected; (n) = number of records; * = EPBC target species

Table 18: Autumn 2022 camera details

Underpass	Camera	Operating for entire period (Y/N)	Install date	Retrieve date	Operational days	Location	Direction facing (E/W)	Number of fauna records	Notes
F1.04	156	Y	30/03/2022	7/06/2022	67	Top	W	4	
F1.04	162	Y	30/03/2022	7/06/2022	67	Bottom	W	29	
F1.62	399	Y	30/03/2022	7/06/2022	67	Top	E	34	
F1.62	422	Y	30/03/2022	7/06/2022	67	Bottom	W	20	
C4.46	443	Y	30/03/2022	7/06/2022	67	Top	E	69	
C4.46	870	Y	30/03/2022	7/06/2022	67	Bottom	E	0	
C7.26	127	Y	30/03/2022	1/06/2022	61	Bottom	E	5	
C7.26	380	Y	30/03/2022	1/06/2022	61	Top	E	2	
F9.7	383	Y	30/03/2022	1/06/2022	61	Bottom	E	17	
F9.7	423	Y	30/03/2022	1/06/2022	61	Top	W	34	
F11.67	387	Y	30/03/2022	1/06/2022	61	Top	E	8	
F11.67	425	Y	30/03/2022	1/06/2022	61	Bottom	E	23	
F20.54	120	Y	30/03/2022	1/06/2022	61	Top	E	68	
F20.54	415	Y	30/03/2022	1/06/2022	61	Bottom	E	6	
F21.24	125	Y	30/03/2022	1/06/2022	61	Top	W	1	
F21.24	442	Y	30/03/2022	1/06/2022	61	Bottom	E	117	
F22.32	175	Y	30/03/2022	1/06/2022	61	Bottom	E	11	
F22.32	431	Y	30/03/2022	1/06/2022	61	Top	E	59	
F26.4	194	Y	31/03/2022	1/06/2022	60	Bottom	E	5	
F26.4	373	Y	31/03/2022	1/06/2022	60	Top	E	36	
C32.35	80	Y	31/03/2022	1/06/2022	60	Bottom	W	33	
C32.35	435	N	31/03/2022	1/06/2022	48	Bottom	E	0	19/5/2022 last photo
F33.4	72	Y	31/03/2022	1/06/2022	60	Bottom	E	28	
F33.4	432	N	31/03/2022	1/06/2022	22	Top	E	19	Camera 427 replaced after found not to be triggering on 11/5

F34.72	134	Y	31/03/2022	1/06/2022	60	Bottom	E	11	
F34.72	377	Y	31/03/2022	7/06/2022	66	Top	E	10	
C36.4	65	Y	31/03/2022	1/06/2022	60	Bottom	W	1	
C36.4	378	N	31/03/2022	1/06/2022	60	Bottom	E	0	Camera error taking videos.

Table 19: Spring/summer 2022/2023 camera details

Underpass	Camera #	Operating for entire period (Y/N)	Install date	Retrieve date	Operational days	Location	Direction facing (E/W)	Number of fauna records	Notes
F1.04	433	N	4/11/2022	3/01/2023	40	Bottom	W	17	
F1.04	447	N	4/11/2022	3/01/2023	35	Top	W	0	
F1.62	430	Y	4/11/2022	3/01/2023	60	Top	W	62	
F1.62	178	Y	4/11/2022	3/01/2023	60	Bottom	W	4	
C4.46	424	Y	4/11/2022	3/01/2023	60	Bottom	W	107	
C4.46	870	Y	4/11/2022	3/01/2023	60	Top	W	60	
C7.26	432	Y	3/11/2022	3/01/2023	60	Bottom	E	0	
C7.26	426	Y	3/11/2022	3/01/2023	60	Top	W	9	
F9.7	194	Y	3/11/2022	3/01/2023	60	Bottom	W	2	
F9.7	167	Y	3/11/2022	3/01/2023	60	Top	W	11	
F11.67	85	Y	3/11/2022	3/01/2023	60	Bottom	W	10	
F11.67	423	Y	3/11/2022	3/01/2023	60	Top	E	47	
F20.54	156	Y	3/11/2022	3/01/2023	60	Bottom	E	49	
F20.54	174	Y	3/11/2022	3/01/2023	60	Top	W	89	
F21.24	443	Y	3/11/2022	3/01/2023	60	Top	E	158	
F21.24	127	Y	3/11/2022	3/01/2023	60	Bottom	E	3	
F22.32	125	Y	3/11/2022	3/01/2023	60	Bottom	E	33	
F22.32	382	Y	3/11/2022	3/01/2023	60	Top	W	123	
F26.4	65	Y	3/11/2022	3/01/2023	60	Bottom	E	64	

Underpass	Camera #	Operating for entire period (Y/N)	Install date	Retrieve date	Operational days	Location	Direction facing (E/W)	Number of fauna records	Notes
F26.4	369	Y	3/11/2022	3/01/2023	60	Top	E	60	
C32.35	397	Y	3/11/2022	3/01/2023	60	Bottom	E	42	
F33.4	72	Y	3/11/2022	3/01/2023	60	Bottom	E	22	
F33.4	374	Y	3/11/2022	3/01/2023	60	Top	E	46	
F34.72	134	Y	3/11/2022	3/01/2023	60	Bottom	E	6	
F34.72	422	Y	3/11/2022	3/01/2023	60	Top	E	34	
C36.4	141	Y	3/11/2022	3/01/2023	60	Bottom	W	0	
C36.4	378	N	3/11/2022	3/01/2023	43	Top	E	0	

Annex 2 – 2022/2023 scat, track and hair-tube results

Table 20: 2022/2023 sand plot survey results

Species	C4.46	C7.26	C32.35	C36.40
Fox		Y	Y	
Rodent	Y	Y	Y	Y
Echidna				
Cat		Y	Y	Y
Dog		Y	Y	
Brush-tail Possum				Y
Koala				
Bandicoot	Y		Y	Y
Lace Monitor		Y		
Water Dragon			Y	
Macropod		Y		
Reptile	Y	Y		Y
Mammal				

Y = detected

Table 21: 2022/2023 tracks and scats results

Species	F1.04	F1.62	C4.46	C7.26	F9.70	F11.67	F20.54	F21.24	F22.32	F26.40	C32.35	F36.4
Bird				T	T				T			
Macropod		Y				T	T	T	T			
Possum						T						
Microbat								I		I	I/C	I
Rodent			C/T		T	T/C	T			C	C	C
Frog												C
Cat/Fox		T		T					T			
Dog					T	T			T		C	
Deer	T											

I = observed, C = scat, T = track

Table 22: 2022/2023 hair tube results

Season	Monitoring year	Underpass	Location	number of tubes	Hair tube deploy date	Hair tube retrieve date	Tubes with hair (samples sent for ID)	Species identified
Autumn	2022	F1.04	OH2K	10	30/03/2022	12/05/2022	1	<i>Rattus</i> sp.
Autumn	2022	F1.62	OH2K	10	30/03/2022	12/05/2022	1	Human
Autumn	2022	C4.46	OH2K	10	30/03/2022	12/05/2022	11	<i>Trichosurus</i> sp.
Autumn	2022	C7.26	OH2K	10	30/03/2022	11/05/2022	3	<i>Rattus rattus</i> , <i>Rattus</i> sp.
Autumn	2022	F9.70	OH2K	10	30/03/2022	10/05/2022	0	NA
Autumn	2022	F11.67	OH2K	10	30/03/2022	10/05/2022	8	<i>Rattus rattus</i>
Autumn	2022	F20.54	OH2K	10	30/03/2022	10/05/2022	2	<i>Rattus rattus</i> , <i>Trichosurus</i> sp.
Autumn	2022	F21.24	OH2K	10	30/03/2022	11/05/2022	9	<i>Trichosurus</i> sp.
Autumn	2022	F22.32	OH2K	10	30/03/2022	11/05/2022	5	<i>Rattus rattus</i> , <i>Trichosurus</i> sp.
Autumn	2022	F26.40	K2K	10	30/03/2022	10/05/2022	2	<i>Rattus</i> sp., <i>Trichosurus</i> sp.
Autumn	2022	C32.35	K2K	10	30/03/2022	10/05/2022	3	<i>Rattus rattus</i> , <i>Rattus</i> sp.
Autumn	2022	F33.40	K2K	10	30/03/2022	11/05/2022	7	<i>Rattus rattus</i> , <i>Rattus</i> sp.
Autumn	2022	F34.72	K2K	10	30/03/2022	10/05/2022	12	<i>Trichosurus</i> sp.
Autumn	2022	C36.40	K2K	10	30/03/2022	11/05/2022	3	Human, <i>Rattus</i> sp., <i>Trichosurus</i> sp.
Summer	2022	F1.04	OH2K	10	4/11/2022	9/12/2022	2	<i>Trichosurus</i> sp.
Summer	2022	F1.62	OH2K	10	4/11/2022	9/12/2022	1	<i>Trichosurus</i> sp.
Summer	2022	C4.46	OH2K	10	4/11/2022	9/12/2022	8	<i>Rattus rattus</i> , <i>Trichosurus</i> sp.
Summer	2022	C7.26	OH2K	10	3/11/2022	7/12/2022	0	NA
Summer	2022	F9.70	OH2K	10	3/11/2022	7/12/2022	2	Macopod
Summer	2022	F11.67	OH2K	10	3/11/2022	7/12/2022	7	<i>Rattus rattus</i> , <i>Rattus</i> sp.
Summer	2022	F20.54	OH2K	10	3/11/2022	7/12/2022	1	<i>Trichosurus</i> sp.
Summer	2022	F21.24	OH2K	10	3/11/2022	7/12/2022	7	<i>Trichosurus</i> sp.
Summer	2022	F22.32	OH2K	10	3/11/2022	7/12/2022	6	<i>Rattus rattus</i> , <i>Rattus</i> sp.
Summer	2022	F26.40	K2K	10	3/11/2022	7/12/2022	0	NA
Summer	2022	C32.35	K2K	10	3/11/2022	7/12/2022	3	<i>Trichosurus</i> sp., <i>Perameles nasuta</i>
Summer	2022	F33.40	K2K	10	3/11/2022	7/12/2022	1	<i>Wallabia bicolor</i>
Summer	2022	F34.72	K2K	10	3/11/2022	7/12/2022	7	<i>Rattus</i> sp., <i>Trichosurus</i> sp.
Summer	2022	C36.40	K2K	10	3/11/2022	7/12/2022	0	NA

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Appendix I – Aerial Crossings



Aerial Crossing Monitoring 2022/2023

Oxley Highway to Kempsey, Pacific Highway Upgrade

Transport for NSW

May 2023

Document control

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Cover photograph: Brushtail Possum on Rope Bridge 1 (left) and Feathertail Glider on Glider Pole 3 (right).

Executive Summary

Context

This report documents findings for the 2022/2023 monitoring period, the final of three monitoring periods for the aerial crossings, as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project) and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022).

Aims

The aim of the aerial crossing monitoring program is to determine whether the aerial crossings, rope bridges and gliders poles, are being used by the nominated target arboreal fauna species. The aims of this report are to summarise the methods and results of the 2022/2023 monitoring period and determine if performance measures are being met, as per the EMP.

Methods

In accordance with the EMP, three rope bridges (RB1, RB2 and RB3) and three glider pole crossings (GP1, GP2 and GP3) in the northern Kundabung to Kempsey (Ku2K) section of the Project were monitored in autumn 2022 and late spring/early summer of 2022/2023. Monitoring involved the use of automated cameras for a period of 60 consecutive days, hair tube deployment on rope bridge poles and 50 metre radius searches around crossing poles for dead animals or road kill.

Key Results

A successful crossing was considered to have occurred if an individual animal was detected using the median glider pole or was detected in rapid succession at both the western and eastern ends of the rope bridge. In summary, for the 2022/2023 monitoring period:

- All rope bridge poles were used by at least one indicator species, including the Feathertail Glider, Sugar Glider and Brushtail Possum.
- Successful crossings were recorded on RB3.
- Glider crossing GP3 has been successfully used by indicator glider species including the Feathertail Glider and Sugar Glider. No fauna were detected using GP1 or GP2. GP2 provided no signal during summer monitoring download.
- No targeted threatened species were detected during the 2022/2023 monitoring.
- No dead animals were recorded during the 50 metre perimeter searches around each pole or during analogous road kill surveys that were undertaken as part of the ecological monitoring for the Project.

Conclusions

Performance measures to date have been met for the rope bridge crossings. Rapid succession observations of indicator species (Brushtail Possum and Ringtail Possum) were recorded at RB1 and RB3. A possible rapid succession observation of an indicator species (Brushtail Possum) occurred in 2017 at RB2. Indicator glider species (Sugar Glider, Feathertail Glider) have also been recorded at RB1 and RB2. It is therefore considered that the monitoring has demonstrated that all three rope bridges are providing opportunity for dispersal and re-colonisation.

Performance measures to date have been met for two of the three glider pole crossings (GP2 and GP3), with indicator species, Feathertail Gliders and Sugar Gliders being recorded using the median glider poles at both these locations, indicating a successful crossing. No gliders have been recorded at GP1 during any

monitoring period. A previous review of the glider pole connectivity concluded that according to recorded glide distance of glider species the poles are within an achievable glide distance for pole to pole glides and pole to canopy glides (Niche 2021).

Management Implications

No further monitoring is required to be undertaken for the following reasons:

- Cameras may not always be triggered by gliders utilising glider poles due to technical and design limitations, for example the trigger requires passage of the gliding individual through the collar, any arrivals/departures from above or below this point would not be captured.
- GP2 is within 100 m of GP1 and has recorded Feathertail and Sugar Gliders using the median glider pole at GP2, thus confirming connectivity in the vicinity of GP1 and GP2 demonstrating opportunity for dispersal and recolonisation in the area.
- A review of pole connectivity and glide distances at GP1 in comparison to those at GP2 and GP3 has been undertaken. According to recorded glide distance of glider species all poles are within an achievable glide distance for pole to pole glides and pole to canopy glides.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the then Commonwealth Department of Environment (DoE) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project.

Aerial crossings have been installed to reduce the impacts on fauna, facilitate movement and maintain habitat connectivity for existing glider/arboreal mammal populations. These structures are to be monitored to assess their effectiveness in maintaining habitat connectivity, as required by the EMP.

1.1.1 Monitoring framework

The design, methods and performance indicators that define the aerial crossing monitoring program are specified in the EMP.

The EMP requires monitoring to occur in autumn and late spring/early summer in Years 4, 6 and 8 (operational phase) of the Project. The EMP specifies that additional monitoring may be required if the aerial crossings are found to be ineffective and require modification.

This report represents the final of three reports required for the aerial crossing monitoring – Year 8 autumn 2022 and spring/summer 2022/2023.

1.1.2 Background data

The installation of aerial crossings was employed as a means of mitigating the barrier effects of roads on gliders and arboreal mammals. Section 2.2.4 of the EMP states:

“The effectiveness of wildlife crossings will be based on their use by fauna groups previously recorded in proximity to the Project (<one kilometre). It is assumed that the Project bisects the habitat of at least some individuals from each of the nominated fauna groups (Table 4). Fauna species known to occur within the Project area that may be potentially adversely affected by the upgrade are listed in Table 5. These species will indicate the successful usage of crossing structures.”

Gliding and arboreal fauna potentially impacted by habitat fragmentation and the barrier effect of the Project are provided in Table 1. The EMP states that *“some of these species will be used as indicator species to measure the success of fauna crossings”*. Table 2 lists the target gliders and arboreal mammals and the indicator species to be used to assess crossing use. The use of aerial crossings by indicator and target species from Table 2 will be discussed.

Table 1: Species that are known or likely to occur in the Project area potentially impacted by habitat fragmentation (from Table 4 of the EMP)

Fauna group	Species	Occurrence in Project area
Gliders	Feathertail Glider (<i>Acrobates pygmaeus</i>)	Known
	Yellow-bellied Glider (<i>Petaurus australis</i>)	Known
	Sugar Glider (<i>Petaurus breviceps</i>)	Known
	Squirrel Glider (<i>Petaurus norfolcensis</i>)	Moderate likelihood
Arboreal mammals	Koala (<i>Phascolarctos cinereus</i>)	Known
	Common Brushtail Possum (<i>Trichosurus vulpecula</i>)	Known
	Common Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	Known
	Brush-tailed Phascogale (<i>Phascogale tapoatafa</i>)	High likelihood

Table 2: Indicator and target species to assess usage of crossings (from Table 5 of the EMP)

Fauna group	Indicator species (known from Project area)	Target (threatened) species
Arboreal mammals	Brushtail Possum, Ringtail Possum	Brush-tailed Phascogale
Koala	Koala	Koala
Gliders	Sugar Glider, Feathertail Glider	Squirrel Glider, Yellow-bellied Glider

1.1.3 Purpose of this report

This report details the findings of the final of three monitoring periods for the aerial crossings. The aims of this report are to summarise the methods and results of the 2022/2023 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for the rope bridges:

- *Complete crossing of the rope bridge, (through camera monitoring or other evidence of complete crossings), by native arboreal fauna species known to occur in the Project area, (see Table 1) or other indicator species (see Table 2) on at least one occasion in order to demonstrate opportunity for dispersal and re-colonisation. This performance measure would also be considered to be met where gliders are not detected at both ends of the rope bridge due to the likelihood of gliders to leave the bridge once within gliding distance of habitat.*
- *For target non-EPBC listed species (Brush-tailed Phascogale, Squirrel Glider and (at the time) Yellow-bellied Glider), complete crossing of the rope bridge, (through camera monitoring or other evidence of complete crossings), by the arboreal target species or their nominated indicator species on at least one occasion in order to demonstrate opportunity for dispersal and re-colonisation. This performance measure would also be considered to be met where gliders are not detected at both ends of the rope bridge due to the likelihood of gliders to leave the bridge once within gliding distance of habitat*
- *Lower rates of road kill arboreal species in proximity to rope bridges than in sections of the upgrade away from crossing structures.*

The EMP specifies the following performance measures for the glider poles:

- *Evidence of use of glider poles by native gliders known to occur in the Project area (see Table 1).*
- *For target non-EPBC listed species (Squirrel Glider and (at the time) Yellow-bellied Glider), the complete passage of the target species or their nominated indicator species (see Table 2) on at least one occasion in order to demonstrate opportunity for dispersal and recolonisation).*
- *Lower rates of road kill gliders in proximity to glider poles than in sections of the upgrade away from crossing structures.*

1.3 Monitoring Timing

Monitoring is to be undertaken in Years 4, 6 and 8 of the Project’s operational phase. Monitoring is to occur in late autumn and late spring/early summer each year for a minimum of 60 days. The timing of monitoring coincides with breeding seasons and dispersal periods for target and other gliding or arboreal species known from the Project area. Arboreal species’ movements increase in autumn as individuals seek flowering resources and in spring as individuals disperse post-breeding.

1.4 Reporting

Annual reporting of monitoring results will include:

- Detailed description of monitoring methodology
- Results of the monitoring period
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA).

1.5 Limitations

The following limitations to the monitoring procedure were encountered:

- The camera detection system is designed to maximise the likelihood that any animal using the structures is photographed, i.e. the cameras are fitted with motion detectors triggered to take photographs as animals pass by and the glider poles also have collars to force the animals through a single gap where the camera lens is trained. However, the highly mobile nature of gliders may result in their arrival on the structures at a variety of locations, all of which cannot be captured by the cameras. As a result, complete passage across the structure/road may not always be captured. This limitation applies to both glider poles and rope bridges.

2. Survey Methods

2.1 Monitoring Sites

The Project involved the installation of eleven rope bridge and seven glider pole crossings. Of these, three rope bridge crossings and three glider pole crossings in the northern Kundabung to Kempsey (Ku2K) section of the Project were monitored. Details of the monitored crossings, including nominated target and indicator species, are provided in Table 3 and their location is provided in Figure 1.

Rope bridge crossings consist of a single rope crossing between two poles, each located on either side of the carriageway. Glider crossings consist of three poles, one on the eastern and western sides of the carriageway and one in the median, allowing gliders to traverse the highway.

Table 3: Monitored aerial crossings (adopted from Tables 4, 5, 14, 15 and 16 of the EMP)

Site	Crossing type	Target species	Indicator species
RB1	Rope bridge	Yellow-bellied Glider, Squirrel Glider, Brush-tailed Phascogale*	Brushtail Possum, Ringtail Possum, Sugar Glider, Feathertail Glider
RB2	Rope bridge	Yellow-bellied Glider, Squirrel Glider, Brush-tailed Phascogale*	Brushtail Possum, Ringtail Possum, Sugar Glider, Feathertail Glider
RB3	Rope bridge	Yellow-bellied Glider, Squirrel Glider, Brush-tailed Phascogale*	Brushtail Possum, Ringtail Possum, Sugar Glider, Feathertail Glider
GP1	Glider pole	Yellow-bellied Glider, Squirrel Glider	Sugar Glider, Feathertail Glider
GP2	Glider pole	Yellow-bellied Glider, Squirrel Glider	Sugar Glider, Feathertail Glider
GP3	Glider pole	Yellow-bellied Glider, Squirrel Glider	Sugar Glider, Feathertail Glider

*The Brush-tailed Phascogale was excluded from the target species in Table 14 of the EMP but included as a target species in Table 15, and has therefore been considered a target species for all rope bridge crossings.

2.2 Survey Methods

2.2.1 Remote cameras

Automated cameras were installed at each crossing structure. A single camera was installed on each median glider pole and at each end of the rope bridge crossing. Customised surveillance systems were installed at rope bridge and glider crossings using BuckEye Cam X7D Covert IR wireless surveillance cameras (minimum response time 200 milliseconds) and standard antennae. Cameras were mounted on a customised adjustable camera mount or strut. Power was provided via a solar panel and extension power cable connected to a battery housing near ground level, which is mounted on each pole. Each median glider pole was fitted with a collar to direct animals toward the camera lens in order to capture their image. Rope bridge poles were fitted with an external dual active infra-red sensor to trigger cameras. All cameras were calibrated for short focus and reduced infrared output to maximise species identification. These devices were specifically designed by Faunatech Pty Ltd for these crossing structures. Images were downloaded wirelessly to ground level via X-Manager software installed on a laptop. Images were downloaded from two 60-day periods; one in late autumn and one in late spring/early summer. However, where possible, downloaded images that occurred outside of the specified monitoring periods were retained and used as value adding data.

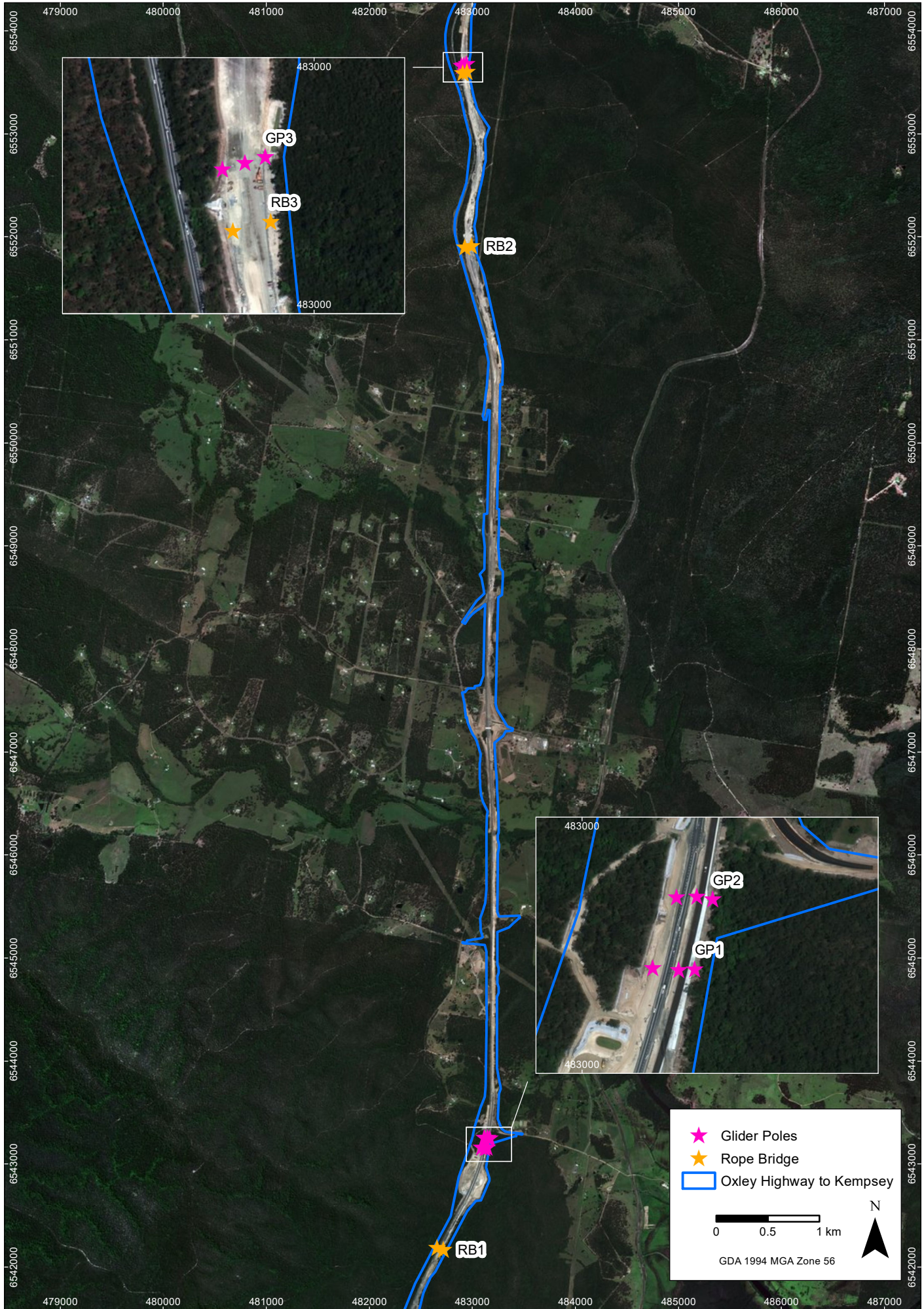
2.2.2 Hair tubes

Hair tubes were installed on the pole at each end of the rope bridge structures only and left in place for 14 consecutive nights during both monitoring periods. Each hair tube was baited with a mixture of oats and peanut butter. Hair samples were sent to Robyn Carter Hair ID for analysis, and were identified to species level where possible.

2.2.3 Terrestrial perimeter search

At each download, the ground within a 50 metre radius of both rope bridge poles and glider poles was inspected for any dead animals or road kill. Data collected during the road kill surveys as part of the broader ecological monitoring for the Project was also reviewed for road kill within 50 metres of the crossing poles.

Drawn by: MH Project Manager: RM Project Number: 1702 5.10 Date: 4/11/2019



Location of monitored aerial crossings

Aerial Crossing Monitoring: Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1

Imagery: (c) LPI 2009-04-17

3. Results

Raw data and camera details for the autumn and spring/summer 2022/2023 monitoring periods are presented in Annex 1.

3.1 2022/2023 Remote Cameras

Combined results from autumn and spring/summer 2022/2023 monitoring for the rope bridge and glider pole crossings are presented in Table 4 and Table 5 respectively.

The sixty day monitoring periods were 12 March – 12 May 2022 (autumn) and 1 November – 31 December 2022 (late spring/early summer). Image downloads occurred in June 2022 (for the autumn data set) and February/March 2023 (for the spring/summer data set). As such, fauna records obtained outside the nominated 60-day monitoring period were included in the results as they are considered to provide potentially valuable data. It should be noted that 139 of the 142 arboreal fauna records (98%) on aerial crossing structures occurred outside of the specified monitoring periods.

3.1.1 Rope bridge crossings

All six cameras provided a signal for the 2022/2023 autumn monitoring period, however two cameras did not provide a signal for the summer monitoring period (Camera 2 of RB1 and Camera 5 of RB2).

Photographic data was analysed for the detection of the same species in rapid succession between the western and eastern ends of the rope bridge crossings as an indication of a successful crossing. Successful crossings by a Brushtail Possum on 31 separate occasions at RB3. One of these successful crossings occurred inside the 60 day Autumn 2022 monitoring period.

All rope bridge poles were used by at least one nominated indicator species including the Feathertail Glider, Sugar Glider and Brushtail Possum. No target threatened species were recorded using the rope bridges.

Table 4: 2022/2023 fauna use of rope bridge crossings

Species	RB1		Crossings	RB2		Crossings	RB3		Crossings
	East (Cam 2)	West (Cam 1)		East (Cam 6)	West (Cam 5)		East (Cam 8)	West (Cam 7)	
Feathertail Glider		Y (11)	Y*		Y (2)	Y*			
Brushtail Possum		Y (1)					Y (39)	Y (48)	31
Sugar Glider		Y (3)	Y*	Y (7)		Y*			
<i>Antechinus</i> sp.				Y (3)					

(n) = number of separate occasion the species was detected. * = as per the EMP “performance measure would also be considered to be met where gliders are not detected at both ends of the rope bridge due to the likelihood of gliders to leave the bridge once within gliding distance of habitat”.

3.1.2 Glider crossings

Two of the three cameras on median glider poles provided a signal during both autumn and summer 2022/2023 monitoring periods, Camera 4 GP2 provided no signal during the summer 2022/2023.

A successful crossing is considered to have occurred if an individual animal is detected using the median pole. Feathertail Gliders and Sugar Gliders were detected using the median pole at GP3 on at least one occasion during the 2022/2023 monitoring, and therefore are considered to have successfully used the

poles to cross the carriageway. Target threatened species were not detected using any of the glider crossings. All records occurred outside of the 60 day monitoring period.

Table 5: 2022/2023 fauna use of glider crossings

Species	GP1 (Cam 3)	GP2 (Cam 4)	GP3 (Cam 9)
Feathertail Glider			Y (7)
Sugar Glider			Y (3)

(n) = number of separate occasions the species was detected.

3.1.3 Camera maintenance

Camera 2, 4 and 5 could would not connect to the laptop during the spring/summer 2022/2023 monitoring period. Maintenance was previously conducted prior to autumn 2020 by TfNSW following connection issues experienced in January 2019 (Niche 2019).

3.2 2022/2023 Hair Tubes

Hair samples were obtained at the eastern pole of RB3 only during the 2022/2023 monitoring period. One hair sample was identified as Brushtail Possum during spring/summer.

3.3 2022/2023 Road Kill and 50 metre Perimeter Search

No dead animals were recorded during the 50 metre perimeter searches around each pole or during road kill surveys undertaken as part of the broader ecological monitoring for the Project.

3.4 Cumulative Analysis

3.4.1 Rope bridge crossings and glider poles

The use of rope bridges to date by arboreal species is provided in Table 6 and the use of glider poles to date by various glider species is provided in Table 7. A summary of the results in relation to target and indicator species is provided in Table 8.

Successful crossings have been observed at both RB1 and RB3. Non-gliding arboreal fauna have been detected at RB2 on the eastern pole.(single occasion, a Brushtail Possum and Antechinus on three occasions). As reported in Niche (2019), a possible successful crossing of RB2 occurred in November 2017 prior to the first official autumn 2018 monitoring event, whereby a Brushtail Possum was recorded heading west from the eastern RB2 pole, a second Brushtail Possum was then recorded by the same camera approximately 14 minutes later heading east back towards the eastern RB2 pole. It is considered likely that this was the same individual. The lack of image at the western pole of RB2 (camera 5) may indicate an incomplete crossing, or failure of camera 5 to capture the image.

Both the Sugar Glider and Feathertail Glider have been recorded using GP2 and GP3. However, there have been no glider species recorded using GP1. GP2 is located approximately 100 metres north of GP1 and has demonstrated, albeit limited, use. GP3 has the highest recorded use of the three glider pole crossing structures.

None of the target threatened species have been recorded using either the rope bridges or the glider poles.

Table 6: Rope bridge records to date

Species	RB1		Crossings	RB2		Crossings	RB3		Crossings
	East (Cam 2)	West (Cam 1)		East (Cam 6)	West (Cam 5)		East (Cam 8)	West (Cam 7)	
Feathertail Glider	Y (19)	Y (11)	Y*	Y (20)	Y (5)	Y*			
Brushtail Possum	Y (2)	Y (1)		Y (1)			Y (70)	Y (105)	55
Ringtail Possum	Y (17)	Y (16)	16						
Sugar Glider	Y (7)	Y (3)	Y*	Y (7)		Y*			
<i>Antechinus</i> sp.				Y (3)					

(n) = number of separate occasions the species was detected. * = as per the EMP “performance measure would also be considered to be met where gliders are not detected at both ends of the rope bridge due to the likelihood of gliders to leave the bridge once within gliding distance of habitat”.

Table 7: Glider pole records to date

Species	GP1 (Cam 3)	GP2 (Cam 4)	GP3 (Cam 9)
Feathertail Glider		Y (1)	Y (19)
Sugar Glider		Y (1)	Y (5)

Table 8: Summary of outcomes

Site	Crossing type	Target species	Indicator species	Successful non-gliding arboreal species crossings	Observed indicator glider species
RB1	Rope bridge	Yellow-bellied Glider, Squirrel Glider, Brush-tailed Phascogale*	Brushtail Possum, Ringtail Possum, Sugar Glider, Feathertail Glider	Ringtail Possum (2020/2021)	Sugar Glider, Feathertail Glider
RB2	Rope bridge	Yellow-bellied Glider, Squirrel Glider, Brush-tailed Phascogale*	Brushtail Possum, Ringtail Possum, Sugar Glider, Feathertail Glider	Possible Brushtail Possum (2017)	Feathertail Glider, Sugar Glider
RB3	Rope bridge	Yellow-bellied Glider, Squirrel Glider, Brush-tailed Phascogale*	Brushtail Possum, Ringtail Possum, Sugar Glider, Feathertail Glider	Brushtail Possum (2020/2021, 2022/2023)	
GP1	Glider pole	Yellow-bellied Glider, Squirrel Glider	Sugar Glider, Feathertail Glider	Not applicable to glider poles	No records
GP2	Glider pole	Yellow-bellied Glider, Squirrel Glider	Sugar Glider, Feathertail Glider	Not applicable to glider poles	Sugar Glider, Feathertail Glider
GP3	Glider pole	Yellow-bellied Glider, Squirrel Glider	Sugar Glider, Feathertail Glider	Not applicable to glider poles	Sugar Glider, Feathertail Glider

*The Brush-tailed Phascogale was excluded from the target species in Table 14 of the EMP but included as a target species in Table 15, and has therefore been considered a target species for all rope bridge crossings.

4. Discussion

4.1 Performance Measures

A summary of the survey results to date in relation to the performance measures is provided in Table 9 and Table 10.

Table 9: Indicators of success for rope bridge crossings

Performance measure	Discussion
<i>Complete crossing of the rope bridge, (through camera monitoring or other evidence of complete crossings), by native arboreal fauna species known to occur in the Project area, (see Table 1) or other indicator species (see Table 2) on at least one occasion in order to demonstrate opportunity for dispersal and re-colonisation. This performance measure would also be considered to be met where gliders are not detected at both ends of the rope bridge due to the likelihood of gliders to leave the bridge once within gliding distance of habitat.</i>	This performance measure has been met. Rapid succession records of native fauna species (Brushtail Possum and Ringtail Possum) have been recorded at RB1 and RB3. A possible rapid succession record (Brushtail Possum) occurred in 2017 at RB2. Indicator glider species (Sugar Glider, Feathertail Glider) have been recorded at RB1 and RB2.
<i>For target non-EPBC listed species (Brush-tailed Phascogale, Squirrel Glider and (at the time) Yellow-bellied Glider), complete crossing of the rope bridge, (through camera monitoring or other evidence of complete crossings), by the arboreal target species or their nominated indicator species on at least one occasion in order to demonstrate opportunity for dispersal and re-colonisation. This performance measure would also be considered to be met where gliders are not detected at both ends of the rope bridge due to the likelihood of gliders to leave the bridge once within gliding distance of habitat</i>	This performance measure has been met. Rapid succession records of indicator species (Brushtail Possum and Ringtail Possum) have been recorded at RB1 and RB3. A possible rapid succession record of an indicator species (Brushtail Possum) occurred in 2017 at RB2. Indicator glider species (Sugar Glider, Feathertail Glider) have been recorded at RB1 and RB2.
<i>Lower rates of road kill arboreal species in proximity to rope bridges than in sections of the upgrade away from crossing structures.</i>	This performance measure has been met. No dead animals were recorded during the 50 metre perimeter searches around each pole or during road kill surveys that were undertaken as part of the broader ecological monitoring for the Project.

Table 10: Indicators of success for glider poles

Performance measure	Discussion
<i>Evidence of use of glider poles by native gliders known to occur in the Project area (see Table 1).</i>	This performance measure has been met at GP2 and GP3. Feathertail Gliders and Sugar Gliders have been recorded using median glider poles at GP2 and GP3, indicating a successful crossing. No gliders have been recorded at GP1.
<i>For target non-EPBC listed species (Squirrel Glider and (at the time) Yellow-bellied Glider), the complete passage of the target species or their nominated indicator species (see Table 2) on at least one occasion in order to demonstrate opportunity for dispersal and recolonisation).</i>	This performance measure has been met at GP2 and GP3. Indicator species, Feathertail Gliders and Sugar Gliders, have been recorded using median glider poles at GP2 and GP3, indicating a successful crossing. No gliders have been recorded at GP1.
<i>Lower rates of road kill arboreal species in proximity to rope bridges than in sections of the upgrade away from crossing structures.</i>	This performance measure has been met. No dead animals were recorded during the 50 metre perimeter searches around each pole or during road kill surveys that were undertaken as part of the ecological monitoring for the Project.

5. Recommendations

5.1 Contingency Measures

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered to be relevant to the aerial crossing monitoring program are listed and discussed in Table 11.

Table 11: Contingency measures

Potential problems	Contingency measure (EMP)	Discussion of proposed measure
<ul style="list-style-type: none"> No use of rope bridge by arboreal native fauna. No use of glider poles by gliding species. Arboreal vehicle strike in proximity to rope bridges. 	<ul style="list-style-type: none"> Review/modify frequency and/or timing of monitoring periods. Review/modify habitat (i.e. canopy species adjoining rope bridge and connectivity to rope bridge). 	<p>RB1, RB2, RB3, GP2, and GP3 have all demonstrated use by native arboreal fauna. GP1 has no recorded use to date. These contingency measures have therefore been considered for GP1.</p> <p><i>Monitoring frequency:</i> recommendations are discussed below in Table 12.</p> <p><i>Review of crossing structure:</i> A previous review of the glider pole connectivity concluded that according to recorded glide distance of glider species the poles are within an achievable glide distance for pole to pole glides and pole to canopy glides (Niche 2021). It should be acknowledged that, given GP2 is 100 metres north of GP1 and that GP2 has demonstrated use by gliding species, connectivity for animals that occur in the vicinity of GP1 and GP2 is not necessarily compromised.</p>

5.2 Recommendations

The recommendations provided in Table 12 aim to address proposed contingency measures and to meet performance criteria. The recommendation has been provided to maximise the opportunity to capture records at GP1.

Table 12: Recommendations

Relevant contingency measure proposed in EMP	Discussion	Recommendation
Review/modify frequency and/or timing of monitoring periods.	The majority of fauna records have occurred outside the specified monitoring period. It was previously recommended that camera monitoring should be increased from the two 60-day monitoring events to continual monitoring/downloading at GP1. This recommendation was adopted by TFNSW for the 2022/2023 monitoring period.	Further monitoring is not considered necessary – see below.
Review/modify habitat (i.e. canopy species adjoining rope bridge and connectivity to rope bridge).	According to recorded glide distance of glider species the poles are within an achievable glide distance for pole to pole glides and pole to canopy glides. Previous recommendation stated that if fauna records remain absent from GP1 at the completion of Year 8 monitoring, these	<p>Despite continual monitoring of GP1 during year 8 to maximise the likelihood of confirming use of the structure no fauna was recorded.</p> <p>No further monitoring is required to be undertaken for the following reasons:</p> <ul style="list-style-type: none"> Cameras may not always be triggered by gliders utilising glider poles due to technical and design limitations, for example the trigger requires passage

Relevant contingency measure proposed in EMP	Discussion	Recommendation
	<p>outcomes and the need for further action should be discussed with the EPA.</p>	<p>of the gliding individual through the collar, any arrivals/departures from above or below this point would not be captured.</p> <ul style="list-style-type: none"> • GP2 is within 100 m of GP1 and has recorded Feathertail and Sugar Gliders using the median glider pole at GP2, thus confirming connectivity in the vicinity of GP1 and GP2 demonstrating opportunity for dispersal and recolonisation in the area. • A review of pole connectivity and glide distances at GP1 in comparison to those at GP2 and GP3 has been undertaken. According to recorded glide distance of glider species all poles are within an achievable glide distance for pole to pole glides and pole to canopy glides (Niche 2021).

References

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Niche (2019). Aerial Crossing Monitoring 2018. Oxley highway to Kempsey, Pacific Highway Upgrade. Prepared by Niche Environment and Heritage Pty Ltd for Transport for NSW.

Niche (2021). Aerial Crossing Monitoring 2020/2021. Oxley highway to Kempsey, Pacific Highway Upgrade. Prepared by Niche Environment and Heritage Pty Ltd for Transport for NSW.

TfNSW (2022). Oxley Highway to Kempsey Pacific Highway Upgrade Ecological Monitoring Program. Transport for NSW Update to report prepared by SMEC Hyder Joint Venture, February 2022.

Annex 1 – Field Data

Table 13: 2022/2023 aerial crossing camera results

Results presented below are all fauna records downloaded from aerial cameras since the previous download i.e. between July 2020 and March 2023.

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022 autumn	GP3	Glider	9	Mid	22/01/2021 0:24	Feathertail Glider	Y	OUT	D	Unk	Yes
2022 autumn	GP3	Glider	9	Mid	25/01/2021 0:39	Feathertail Glider	Y	OUT	D	Unk	Yes
2022 autumn	GP3	Glider	9	Mid	26/01/2021 23:56	Feathertail Glider	Y	OUT	D	Unk	Yes
2022 autumn	GP3	Glider	9	Mid	27/01/2021 0:57	Feathertail Glider	Y	OUT	D	Unk	Yes
2022 autumn	GP3	Glider	9	Mid	5/02/2021 23:52	Sugar Glider	Y	OUT	P	Unk	Yes
2022 autumn	GP3	Glider	9	Mid	8/02/2021 22:47	Feathertail Glider	Y	OUT	D	Unk	Yes
2022 autumn	GP3	Glider	9	Mid	3/03/2021 22:20	Feathertail Glider	Y	OUT	D	Unk	Yes
2022 autumn	RB1	Rope	1	W	20/03/2021 20:32	Brushtail Possum	Y	OUT	P	Unk	Unknown
2022 autumn	RB2	Rope	5	W	5/08/2020 11:44	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	5	W	26/10/2020 10:33	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	5	W	29/10/2020 10:17	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	5	W	30/10/2020 10:58	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	5	W	3/11/2020 14:59	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	5	W	6/12/2020 23:38	Feathertail Glider	Y	OUT	D	Unk	Unknown
2022 autumn	RB2	Rope	5	W	16/12/2020 11:02	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	5	W	30/12/2020 8:24	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	5	W	11/01/2021 2:32	Feathertail Glider	Y	OUT	D	Unk	Unknown
2022 autumn	RB2	Rope	5	W	19/01/2021 0:43	Feathertail Glider	Y	OUT	D	Unk	Unknown
2022 autumn	RB2	Rope	6	E	4/03/2021 23:05	Sugar Glider	Y	OUT	P	West	Unknown
2022 autumn	RB2	Rope	6	E	4/03/2021 23:06	Sugar Glider	Y	OUT	P	East	Unknown
2022 autumn	RB2	Rope	6	E	8/03/2021 5:15	Sugar Glider	Y	OUT	P	West	Unknown
2022 autumn	RB2	Rope	6	E	8/03/2021 5:15	Sugar Glider	Y	OUT	P	East	Unknown

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022 autumn	RB2	Rope	6	E	24/03/2021 8:50	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	6	E	4/04/2021 0:23	Sugar Glider	Y	OUT	P	West	Unknown
2022 autumn	RB2	Rope	6	E	4/04/2021 0:23	Sugar Glider	Y	OUT	P	East	Unknown
2022 autumn	RB2	Rope	6	E	11/04/2021 1:40	Sugar Glider	Y	OUT	D	West	Unknown
2022 autumn	RB2	Rope	6	E	11/04/2021 1:42	Sugar Glider	Y	OUT	D	West	Unknown
2022 autumn	RB2	Rope	6	E	3/10/2021 13:35	Butcher Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	6	E	26/10/2021 21:45	<i>Antechinus</i> sp.	Y	OUT	P	East	Unknown
2022 autumn	RB2	Rope	6	E	23/11/2021 22:56	Sugar Glider	Y	OUT	P	East	Unknown
2022 autumn	RB2	Rope	6	E	9/12/2021 7:44	Bird	N	OUT	D	Unk	NA
2022 autumn	RB2	Rope	6	E	18/12/2021 9:08	Magpie	N	OUT	D	NA	NA
2022 autumn	RB2	Rope	6	E	19/12/2021 14:04	Magpie	N	OUT	D	NA	NA
2022 autumn	RB2	Rope	6	E	25/12/2021 3:28	Sugar Glider	Y	OUT	P	West	Unknown
2022 autumn	RB2	Rope	6	E	25/12/2021 3:28	Sugar Glider	Y	OUT	P	West	Unknown
2022 autumn	RB2	Rope	6	E	25/12/2021 3:29	Sugar Glider	Y	OUT	P	East	Unknown
2022 autumn	RB2	Rope	6	E	25/12/2021 3:29	Sugar Glider	Y	OUT	P	West	Unknown
2022 autumn	RB3	Rope	7	W	27/08/2020 21:44	Brushtail Possum	Y	OUT	D	West	Unknown
2022 autumn	RB3	Rope	7	W	27/08/2020 22:27	Brushtail Possum	Y	OUT	D	East	Unknown
2022 autumn	RB3	Rope	7	W	14/09/2020 9:07	Kookaburra	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	7	W	26/09/2020 21:01	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	26/09/2020 22:34	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	5/10/2020 2:31	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	5/10/2020 2:43	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	6/10/2020 19:23	Common Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	7	W	14/10/2020 0:42	Brushtail Possum	Y	OUT	D	East	No
2022 autumn	RB3	Rope	7	W	14/10/2020 23:24	Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	7	W	14/10/2020 23:32	Brushtail Possum	Y	OUT	D	East	No
2022 autumn	RB3	Rope	7	W	31/10/2020 6:10	Bird	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	7	W	31/10/2020 18:00	<i>Corvus</i> sp.	N	OUT	D	NA	NA

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022 autumn	RB3	Rope	7	W	1/11/2020 5:38	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	7	W	2/11/2020 4:42	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	7	W	5/11/2020 22:49	Common Brushtail Possum	Y	OUT	D	East	No
2022 autumn	RB3	Rope	7	W	5/11/2020 22:55	Common Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	7	W	9/11/2020 16:51	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	7	W	14/11/2020 3:09	Common Brushtail Possum	Y	OUT	D	East	No
2022 autumn	RB3	Rope	7	W	4/03/2021 3:49	Common Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	5/03/2021 6:50	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	7	W	10/03/2021 0:07	Short-eared Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	10/03/2021 0:53	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	10/03/2021 18:09	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	7	W	11/03/2021 22:45	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	12/03/2021 0:59	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	12/03/2021 21:42	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	13/03/2021 2:40	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	13/03/2021 20:23	Brushtail Possum	Y	OUT	D	East	No
2022 autumn	RB3	Rope	7	W	13/03/2021 20:24	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	14/03/2021 4:06	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	14/03/2021 23:23	Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	7	W	15/03/2021 1:31	Brushtail Possum	Y	OUT	D	East	No
2022 autumn	RB3	Rope	7	W	15/03/2021 23:26	Common Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	7	W	8/04/2021 18:57	Common Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	12/05/2022 21:33	Brushtail Possum	Y	IN	D	East	Yes
2022 autumn	RB3	Rope	7	W	8/06/2022 17:39	Common Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	8/06/2022 19:52	Common Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	8/06/2022 20:03	Common Brushtail Possum	Y	OUT	D	East	No
2022 autumn	RB3	Rope	7	W	8/06/2022 20:21	Common Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	8/06/2022 20:23	Common Brushtail Possum	Y	OUT	D	East	Yes

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022 autumn	RB3	Rope	7	W	8/06/2022 20:46	Common Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	7	W	9/06/2022 17:47	Common Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	7	W	10/06/2022 1:02	Common Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	30/07/2020 12:49	Magpie	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	27/08/2020 21:43	Common Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	27/08/2020 22:29	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	5/10/2020 2:31	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	5/10/2020 2:45	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	13/10/2020 17:23	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	14/10/2020 0:44	Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	14/10/2020 5:38	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	14/10/2020 23:34	Common Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	17/10/2020 5:39	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	27/10/2020 16:33	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	1/11/2020 4:35	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	2/11/2020 5:39	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	3/11/2020 5:32	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	4/03/2021 3:52	Short-eared Brushtail Possum	Y	OUT	D	Unk	Yes
2022 autumn	RB3	Rope	8	E	7/03/2021 8:52	<i>Corvus</i> sp.	N	OUT	D	NA	NA
2022 autumn	RB3	Rope	8	E	9/03/2021 23:14	Common Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	8	E	9/03/2021 23:15	Common Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	8	E	9/03/2021 23:48	Common Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	8	E	10/03/2021 0:05	Brushtail Possum	Y	OUT	P	West	Yes
2022 autumn	RB3	Rope	8	E	10/03/2021 0:57	Short-eared Brushtail Possum	Y	OUT	P	East	Yes
2022 autumn	RB3	Rope	8	E	11/03/2021 22:42	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	12/03/2021 1:03	Short-eared Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	12/03/2021 21:41	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	13/03/2021 2:45	Common Brushtail Possum	Y	OUT	D	East	Yes

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022 autumn	RB3	Rope	8	E	13/03/2021 20:26	Short-eared Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	13/03/2021 20:27	Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	8	E	13/03/2021 20:28	Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	8	E	14/03/2021 4:01	Short-eared Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	8/04/2021 18:54	Short-eared Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	12/05/2022 21:35	Common Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	8/06/2022 17:36	Common Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	8/06/2022 19:49	Common Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	8/06/2022 20:06	Common Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	8/06/2022 20:24	Common Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	8/06/2022 20:26	Short-eared Brushtail Possum	Y	OUT	D	East	Yes
2022 autumn	RB3	Rope	8	E	8/06/2022 20:43	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	9/06/2022 17:44	Brushtail Possum	Y	OUT	D	West	No
2022 autumn	RB3	Rope	8	E	9/06/2022 17:45	Brushtail Possum	Y	OUT	D	West	Yes
2022 autumn	RB3	Rope	8	E	10/06/2022 1:04	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB1	Rope	1	W	28/01/2023 2:26	Feathertail Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	28/01/2023 2:26	Feathertail Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	29/01/2023 2:59	Feathertail Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	29/01/2023 3:55	Feathertail Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	15/02/2023 21:27	Feathertail Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	16/02/2023 0:28	Feathertail Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	17/02/2023 19:44	Feathertail Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	19/02/2023 1:27	Feathertail Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	19/02/2023 1:27	Feathertail Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	22/02/2023 3:39	Feathertail Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	22/02/2023 3:39	Feathertail Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	24/02/2023 23:35	Feathertail Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	24/02/2023 23:35	Feathertail Glider	Y	OUT	D	West	No

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022/23 summer	RB1	Rope	1	W	25/02/2023 0:53	Sugar Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	25/02/2023 0:53	Sugar Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	25/02/2023 3:50	Feathertail Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	25/02/2023 3:50	Feathertail Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	25/02/2023 20:38	Feathertail Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	25/02/2023 20:38	Feathertail Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	26/02/2023 1:09	Sugar Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	26/02/2023 1:09	Sugar Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	26/02/2023 1:09	Sugar Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	26/02/2023 1:09	Sugar Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	26/02/2023 1:09	Sugar Glider	Y	OUT	D	West	No
2022/23 summer	RB1	Rope	1	W	6/03/2023 1:05	Sugar Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	6/03/2023 1:05	Sugar Glider	Y	OUT	D	East	No
2022/23 summer	RB1	Rope	1	W	6/03/2023 1:06	Sugar Glider		OUT	D	West	No
2022/23 summer	RB2	Rope	6	E	30/10/2022 1:57	<i>Antechinus</i> sp.	Y	OUT	D	West	No
2022/23 summer	RB2	Rope	6	E	30/10/2022 1:57	<i>Antechinus</i> sp.	Y	OUT	D	West	No
2022/23 summer	RB2	Rope	6	E	30/10/2022 1:57	<i>Antechinus</i> sp.	Y	OUT	D	East	No
2022/23 summer	RB2	Rope	6	E	30/10/2022 1:57	<i>Antechinus</i> sp.	Y	OUT	D	West	No
2022/23 summer	RB2	Rope	6	E	30/10/2022 1:57	<i>Antechinus</i> sp.	Y	OUT	D	East	No
2022/23 summer	RB2	Rope	6	E	4/11/2022 2:59	<i>Antechinus</i> sp.	Y	IN	D	East	No
2022/23 summer	RB2	Rope	6	E	29/11/2022 11:24	Noisy Friarbird	N	IN	D		No
2022/23 summer	RB3	Rope	7	W	11/06/2022 3:09	Common Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	7	W	11/06/2022 3:59	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	7	W	11/06/2022 3:59	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	7	W	11/06/2022 3:59	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	7	W	11/06/2022 18:09	Common Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	7	W	11/06/2022 18:09	Common Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	7	W	11/06/2022 18:09	Common Brushtail Possum	Y	OUT	D	West	Yes

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022/23 summer	RB3	Rope	7	W	12/06/2022 1:01	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	7	W	12/06/2022 1:01	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	7	W	13/06/2022 2:06	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	16/06/2022 20:08	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	17/06/2022 22:49	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	17/06/2022 22:49	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	17/06/2022 22:49	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	17/06/2022 22:49	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	17/06/2022 23:51	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	17/06/2022 23:51	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	18/06/2022 2:19	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	18/06/2022 2:19	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	18/06/2022 2:19	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	18/06/2022 2:19	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	20/06/2022 18:05	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	21/06/2022 1:43	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	22/06/2022 21:23	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	22/06/2022 21:23	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	22/06/2022 21:23	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	24/06/2022 0:58	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	24/06/2022 0:58	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	24/06/2022 0:58	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	25/06/2022 21:23	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	25/06/2022 21:23	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	26/06/2022 1:08	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	26/06/2022 1:08	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	26/06/2022 1:08	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	26/06/2022 1:23	Common Brushtail Possum	Y	OUT	D	West	No

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022/23 summer	RB3	Rope	7	W	26/06/2022 23:38	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	26/06/2022 23:38	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	26/06/2022 23:38	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	29/06/2022 18:27	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	29/06/2022 18:27	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	30/06/2022 2:22	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	30/06/2022 2:22	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	30/06/2022 12:53	Raven	N	OUT	D		No
2022/23 summer	RB3	Rope	7	W	3/07/2022 18:41	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	3/07/2022 18:41	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	4/07/2022 23:55	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	4/07/2022 23:55	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	7/07/2022 17:58	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	7/07/2022 17:58	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	7/07/2022 17:58	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	8/07/2022 21:39	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	8/07/2022 21:39	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	9/07/2022 19:30	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	9/07/2022 19:30	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	9/07/2022 19:30	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	9/07/2022 19:30	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	9/07/2022 19:30	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	9/07/2022 19:30	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	28/02/2023 23:21	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	7	W	3/03/2023 3:09	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	7	W	3/03/2023 3:09	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	11/06/2022 3:07	Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	8	E	11/06/2022 3:07	Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	8	E	11/06/2022 4:01	Common Brushtail Possum	Y	OUT	D	East	Yes

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022/23 summer	RB3	Rope	8	E	11/06/2022 4:01	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	8	E	11/06/2022 4:01	Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	8	E	11/06/2022 18:04	Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	8	E	11/06/2022 18:04	Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	8	E	11/06/2022 18:04	Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	8	E	11/06/2022 18:04	Brushtail Possum	Y	OUT	D	West	Yes
2022/23 summer	RB3	Rope	8	E	12/06/2022 1:03	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	8	E	12/06/2022 1:03	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	8	E	12/06/2022 1:03	Common Brushtail Possum	Y	OUT	D	East	Yes
2022/23 summer	RB3	Rope	8	E	13/06/2022 2:03	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	13/06/2022 2:03	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	16/06/2022 20:11	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	16/06/2022 20:11	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	16/06/2022 20:11	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 22:45	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 22:45	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 22:45	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 22:45	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 22:46	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 22:46	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 22:46	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	17/06/2022 23:54	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	18/06/2022 2:15	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	18/06/2022 2:15	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	18/06/2022 2:15	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	18/06/2022 2:15	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	20/06/2022 18:07	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	20/06/2022 18:07	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	21/06/2022 1:40	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	21/06/2022 1:40	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	21/06/2022 1:40	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	22/06/2022 21:25	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	22/06/2022 21:25	Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	22/06/2022 21:25	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	24/06/2022 0:56	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	24/06/2022 0:56	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	25/06/2022 21:26	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	25/06/2022 21:26	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	25/06/2022 21:26	Common Brushtail Possum	Y	OUT	D	East	No
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	Unk	No
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	Unk	No
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	Unk	No
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	Unk	No
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	Unk	No

Season	Site	Crossing	Camera	Pole	Date and Time	Species	Arboreal	IN/OUT	Certainty	Direction	Evidence complete crossing
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	Unk	No
2022/23 summer	RB3	Rope	8	E	26/06/2022 1:12	Common Brushtail Possum	Y	OUT	D	Unk	No
2022/23 summer	RB3	Rope	8	E	3/03/2023 3:06	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	3/03/2023 3:06	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	3/03/2023 3:06	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	RB3	Rope	8	E	3/03/2023 3:06	Brushtail Possum	Y	OUT	D	West	No
2022/23 summer	GP3	Glider	9	Mid	14/03/2021 2:28	Feathertail Glider	Y	OUT	D	NA	No
2022/23 summer	GP3	Glider	9	Mid	16/11/2021 7:49	Bird	N	OUT	D	NA	No
2022/23 summer	GP3	Glider	9	Mid	23/12/2021 6:31	Raven	N	OUT	D	NA	No
2022/23 summer	GP3	Glider	9	Mid	8/07/2022 1:55	Sugar Glider	Y	OUT	D	NA	No
2022/23 summer	GP3	Glider	9	Mid	8/07/2022 1:55	Sugar Glider	Y	OUT	D	NA	No
2022/23 summer	GP3	Glider	9	Mid	8/07/2022 1:55	Sugar Glider	Y	OUT	D	NA	No
2022/23 summer	GP3	Glider	9	Mid	3/03/2023 3:25	Feathertail Glider	Y	OUT	D	NA	No

E = east; W = west; M = median; NA = not applicable; N = No; Y = Yes; Unk = unknown, P=Probable, D= Definite

Table 14: Camera details

Camera	Crossing	Loc	Season	start 60 days	end 60 days	TOTAL photos	TOTAL fauna	TOTAL arboreal	60 day photos	60 day fauna	60 day arboreal	Notes
1	RB1	W	Autumn 2022	12/03/2022	12/05/2022	15	1	1	0	0	0	
2	RB1	E	Autumn 2022	12/03/2022	12/05/2022	1	0	0	0	0	0	
3	GP1	M	Autumn 2022	12/03/2022	12/05/2022	42	0	0	0	0	0	
4	GP2	M	Autumn 2022	12/03/2022	12/05/2022	3	0	0	0	0	0	
5	RB2	W	Autumn 2022	12/03/2022	12/05/2022	100	2	2	0	0	0	
6	RB2	E	Autumn 2022	12/03/2022	12/05/2022	119	65	59	0	0	0	
7	RB3	W	Autumn 2022	12/03/2022	12/05/2022	166	92	90	3	3	3	
8	RB3	E	Autumn 2022	12/03/2022	12/05/2022	219	80	79	1	1	1	
9	GP3	M	Autumn 2022	12/03/2022	12/05/2022	37	13	13	0	0	0	
1	RB1	W	Summer 2022/23	1/11/2022	31/12/2022	34	27	27	0	0	0	

Camera	Crossing	Loc	Season	start 60 days	end 60 days	TOTAL photos	TOTAL fauna	TOTAL arboreal	60 day photos	60 day fauna	60 day arboreal	Notes
2	RB1	E	Summer 2022/23	1/11/2022	31/12/2022	0	0	0	0	0	0	No signal or connection
3	GP1	M	Summer 2022/23	1/11/2022	31/12/2022	47	0	0	32	0	0	
4	GP2	M	Summer 2022/23	1/11/2022	31/12/2022	0	0	0	0	0	0	No signal or connection
5	RB2	W	Summer 2022/23	1/11/2022	31/12/2022	0	0	0	0	0	0	No signal or connection
6	RB2	E	Summer 2022/23	1/11/2022	31/12/2022	137	7	6	22	2	1	
7	RB3	W	Summer 2022/23	1/11/2022	31/12/2022	60	60	59	0	0	0	
8	RB3	E	Summer 2022/23	1/11/2022	31/12/2022	66	65	65	0	0	0	
9	GP3	M	Summer 2022/23	1/11/2022	31/12/2022	62	7	5	6	0	0	

Loc = location; E = east; W = west; M = median; NA = not applicable

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Appendix J – Widened Median



Widened Median Monitoring 2022

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

May 2023

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Cover photograph: Widened median and aerial crossings photographed from Bill Hill Rd (left), Common Brushtail Possum recorded on remote camera East of widened median and Sugar Glider recorded on remote camera within the median.

Executive Summary

Context

This report documents findings from the 2022 monitoring period, the final of three monitoring periods for the widened median, as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project) and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022). Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project.

Aims

The aim of the widened median monitoring program is to determine whether the widened median is being used by glider species, specifically the threatened Yellow-bellied Glider and Squirrel Glider. The aims of this report are to summarise the methods and results of the 2022 monitoring period and determine if performance measures are being met, as per the EMP.

Methods

In response to recommendations within the 2020 Widened Median Monitoring Report and endorsement by Transport for NSW (TfNSW) and the NSW Environment Protection Authority (EPA), monitoring was undertaken in accordance with changes to the methods provided within the approved EMP. The changes resulted in the discontinuation of hair tube sampling and spotlighting surveys, replaced with baited arboreal motion-detecting camera monitoring.

A total of 18 arboreal motion-detecting cameras were deployed, including six within the median and another six within adjacent habitat on either side of the carriageway. Cameras were deployed on prominent trees and baited with a honey, oat and peanut butter mixture left in a bait canister on an opposing tree.

Nest boxes within the median and adjacent habitat each side of the carriageway were monitored as part of the Nest Box Monitoring Program for the Project and data was used to supplement the assessment of the widened median.

Key Results

The key results can be summarised as follows:

- Yellow-bellied Gliders have not been recorded within the median.
- Squirrel Gliders have not been definitively recorded.
- Three glider species were detected during surveys including, the Sugar Glider, Feathertail Glider and Sugar/Squirrel Glider.
- All glider species were detected in adjacent habitat as well as within the Median.

Conclusions

The performance indicator requiring evidence of use of median vegetation by the target glider species (Yellow-bellied Glider and Squirrel Glider) has not been met. Two potential Squirrel Gliders in 2022/2023 on arboreal cameras and one observation of an individual during spotlighting surveys in 2020 were recorded within the median. The Yellow-bellied Glider was not recorded within the median.

The performance indicator requiring evidence of use by dispersing individuals and different age cohorts cannot be assessed using the prescribed survey methods.

The performance indicator requiring use by glider species other than threatened species, e.g. Sugar Glider, has been met. The Sugar Glider has been recorded using the median during spotlighting surveys and arboreal camera monitoring.

Management Implications

Despite the change in methodology and use of arboreal baited cameras within the median use by target species could not be confirmed. However, further monitoring is not recommended for the following reasons:

- The target species were not recorded within the adjacent vegetation, east and west of the widened median, as such the absence of records from the median should not be considered as an indication of the performance of the mitigation.
- The widened median has been successfully used by other glider species (Feathertail Glider and Sugar Glider) a substantial number of times throughout the monitoring program, demonstrating the effectiveness of the mitigation measure to provide safe crossing opportunities.
- These glider species have been used as indicator species for the target glider species when considering the performance of other mitigation measures for the Project (rope bridges and glider poles).

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW, previously the Department of Environment (DoE)) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project.

1.1.1 Monitoring framework

The design, methods and performance indicators that define the widened median monitoring program are specified in the EMP. Monitoring of the widened median was to commence during the first optimal season, that is, during breeding and dispersal periods (June – September) for target species, following the completion of the Project. As the final stage of the Project was opened in March 2018, monitoring commenced in June 2018, year 4 of the Project. Monitoring was scheduled to be undertaken for a minimum of three years: in years 4, 6 and 8 of the Project. Additional years may be required if the widened median is found to be ineffective and require modification.

To date, these monitoring events have been undertaken and reported as follows:

- Winter/spring 2018 (Year 4): Niche 2019a
- Winter/spring 2020 (Year 6): Niche 2021
- Winter/spring 2022 (Year 8): Current report

This report presents the results of the final of the three monitoring periods – year 8, winter/spring 2022.

1.1.2 Background data

The retention of trees within a median that separates the northbound and southbound carriageways has been employed as a means of mitigating the barrier effect of roads on gliders by providing safe crossing opportunities. The median is approximately 50 metres at its widest and is supplemented by three sets of glider poles and one canopy rope bridge (see Figure 1). Vegetation communities in the widened median and either side of the carriageway include Moist Gully Forest, Paperbark Swamp Forest, Swamp Mahogany/Forest Red Gum Swamp Forest, Moist Floodplain Forest and Dry Ridgetop Forest (TfNSW 2022). The target species and their breeding and dispersal periods are provided in Table 1.

Table 1: Target species (from Table 18 of the EMP)

Target species	Breeding season	Likely dispersal
Yellow-bellied Glider (<i>Petaurus australis</i>)	Between July and September (variable depending on habitat characteristics)	Winter to spring (when young 12-24 months of age)
Squirrel Glider (<i>Petaurus norfolcensis</i>)	Between April and November (peak during winter)	Autumn to spring

1.1.3 Purpose of this report

This report details the findings obtained from the third and final monitoring period for the widened median. The aims of this report are to summarise the methods and results of the 2022 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for the widened median:

- *Evidence of use of median vegetation by the target glider species*
- *Evidence of use by dispersing individuals and different age cohorts*
- *Use by glider species other than threatened species e.g. sugar glider.*

Target glider species identified in the EMP include the Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*).

1.3 Monitoring Timing

Monitoring is to be undertaken over 16 weeks from June to September in years 4, 6 and 8 of the Project.

1.4 Reporting

As per the EMP, the annual reporting of monitoring results will include:

- Detailed description of monitoring methodology employed
- Results of the monitoring period
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations
- If contingency measures should be implemented.

This report prepared under the EMP will be submitted to NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA).

1.5 Limitations

The transition from spotlighting and hair tube sampling utilised as monitoring methods in Year 4 and Year 6 to baited arboreal motion-detecting camera monitoring and ongoing nest box monitoring in Year 8 presents a limitation in the comparability of data throughout all monitoring periods. However, the use of motion-detecting cameras was adopted in order to provide additional fauna observations and increased chance of detection of the target species.

Where possible, individuals were identified to species, however accurate identification of Squirrel Gliders through camera trap imagery was not always possible due to distinguishing features being hidden from view.

2. Methods

In response to recommendations within the 2020 Widened Median Monitoring Report (Niche 2020) and endorsement by Transport for NSW (TfNSW) and the NSW Environment Protection Authority (EPA), monitoring was undertaken in accordance with changes to the methods provided within the approved EMP. The changes resulted in the discontinuation of hair tube sampling and spotlighting surveys, replaced with baited arboreal motion-detecting camera monitoring.

2.1 Monitoring Sites

There have been no changes to the area of monitoring. Monitoring was undertaken in accordance the EMP, within the widened median and retained habitat either side of the highway corridor (Figure 1).

2.2 Survey Methods

Year 8 surveys were undertaken in accordance with the new methodology using the following techniques:

- Arboreal camera monitoring
- Nest box monitoring.

Year 4-6 surveys were undertaken in accordance with the original EMP using the following techniques:

- Hair tube sampling
- Spotlighting transects
- Nest box monitoring.

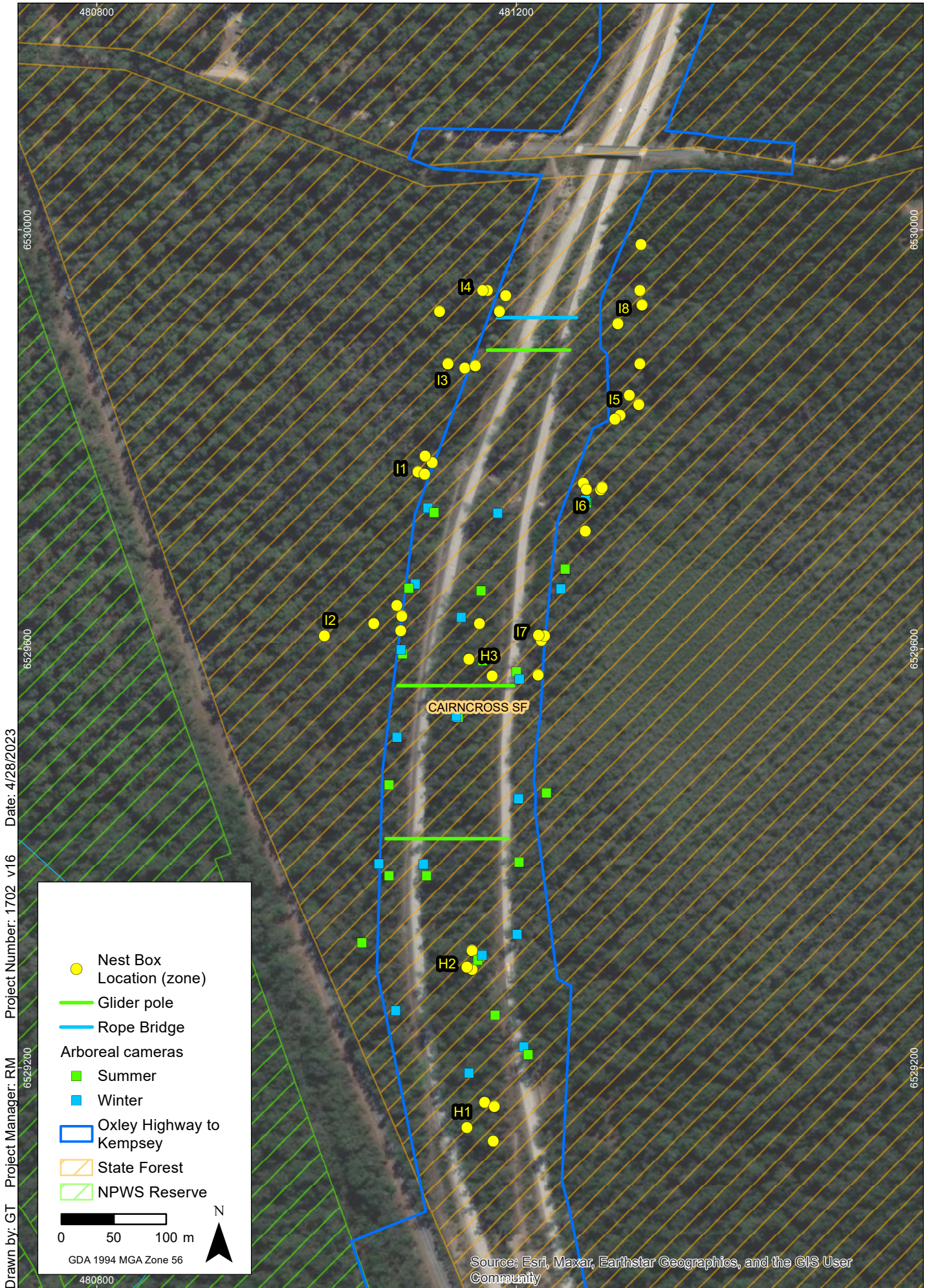
2.2.1 Arboreal camera monitoring

Commencing in Year 8, a total of 18 arboreal motion-detecting cameras were deployed, including six within the median and another six within adjacent habitat on either side of the carriageway. Cameras were deployed on prominent trees and baited with a honey, oat and peanut butter mixture left in a bait canister on an opposing tree. An arborist was employed to mount each camera between four and six metres above-ground. Arboreal camera monitoring was carried out over two, two-month sample periods, with bait changed after four weeks. Monitoring occurred during winter 2022 and in late spring/early summer 2022/2023.

2.2.2 Nest box monitoring

Nest boxes within the median and adjacent habitat each side of the carriageway were monitored as part of the Nest Box Monitoring Program for the Project. There are 11 nest boxes located within the median and a further 18 boxes on the eastern side and 18 boxes on the western side of the carriageway immediately adjacent to the median.

Each nest box was visually inspected using a wireless camera attached to the end of an extendable pole, or by a tree climber when inspection from the ground was not possible. Details recorded for each box included: occupation by fauna, species if present, signs of use by fauna, box condition, maintenance required, changes to surrounding landscape and daily weather conditions.



Widened median monitoring 2022/2023

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 1

3. Results

Figure 2 shows the location of cameras where gliding species were detected along with the relevant nest box monitoring results for the 2022 monitoring period.

3.1 Arboreal camera monitoring

A total of 18 cameras were deployed, including six within the widened median, and six on either side of the of the carriageway. Results of the arboreal camera monitoring are provided in Table 2.

The 2022/2023 monitoring periods were as follows:

- Winter 2022: 20 June 2022 – 13 September 2022
- Late spring/early summer: 9 November – 9 March 2023.

A total of 653 and 237 records of fauna were captured during winter and summer, respectively. Of the 653 and 237 records from winter and summer, 312 were recorded within the median. Sugar Gliders were the most commonly recorded fauna recorded during monitoring, followed by *Antechinus* sp. and Black Rat (*Rattus rattus*). Gliders, including the Sugar Glider and Feathertail Glider, were recorded within the median as well as in adjacent habitat to the east and west of the widened median.

Monitoring did not reveal use by the target species; the Yellow-bellied Glider was not recorded, and three potential records of the Squirrel Glider occurred within the median.

Table 2: Arboreal camera monitoring results.

Species	West		Median		East	
	Winter	Summer	Winter	Summer	Winter	Summer
Sugar Glider (<i>Petaurus breviceps</i>)	Y (125)	Y (43)	Y (205)	Y (40)	Y (93)	Y (17)
Sugar/Squirrel glider (<i>Petaurus breviceps</i> / <i>Petaurus norfolcensis</i>)			Y (2)	Y (1)		
Feathertail Glider (<i>Acrobates pygmaeus</i>)		Y (3)	Y (2)		Y (1)	
<i>Antechinus</i> sp.	Y (17)	Y (23)	Y (42)	Y (1)	Y (109)	Y (17)
Black Rat (<i>Rattus rattus</i>)	Y (8)	Y (39)	Y (6)			Y (38)
Common Brushtail Possum (<i>Trichosurus vulpecula</i>)					Y (11)	Y (6)
Rodent/Marsupial	Y (2)	Y (5)		Y (1)	Y (2)	Y (1)
Bird		Y (2)				
Unknown Glider			Y (3)		Y (2)	
Unidentified (partial)	Y (5)		Y (9)		Y (10)	

Y = recorded, (#) = number of records.

3.2 Nest Box Monitoring

Eighteen nest boxes were installed on either side of the carriageway and 12 nest boxes within the widened median as part of the *Nest Box Plan of Management* (NBPoM, Lewis 2013). The results of inspections to

date are provided in Annex 2 and have been extracted from the 2022 Nest Box Monitoring report (Niche 2023). Table 3 summarises the species recorded using these nest boxes during the 2022 survey period as well as all inspections to date.

3.2.1 Occupation

The Sugar Glider was recorded occupying nest boxes on two occasions within the median during 2022 nest box monitoring. Sugar Gliders were recorded in two different small glider nest boxes (H2_390 and H3_395) during the winter monitoring period. Other species previously identified using nest boxes within the median include *Antechinus* sp. on one occasion and a Lace Monitor on one occasion. Comparably, there was one records of occupation by Sugar Gliders to the east and one record to the west during 2022 nest box monitoring.

3.2.2 Signs of use

During the 2022 nest box monitoring, 50% of nest boxes within the median showed signs of use, while 22% and 38% of nest boxes to the east and west respectively showed signs of use.

Considering all nest box monitoring events, 42% of the boxes (five boxes) within the median have been found to be occupied on at least one occasion and 83% of the boxes (ten boxes) within the median have been found to be occupied or have shown signs of use on at least one occasion. The rate of occupancy/use of boxes within the median is similar to the rate of occupancy/use of nest boxes in adjacent forested habitat.

The Yellow-bellied Glider has been recorded previously on six occasions using nest boxes along the alignment (Niche 2020) in locations 10-15 kilometres north of the widened median. Similarly, the Squirrel Glider has been previously recorded on three occasions in nest boxes from 1.5 to 10 kilometres from the median (Niche 2018). These species have not been recorded occupying nest boxes within the median.

Table 3: Nest box occupancy and species recorded in nest boxes within the median and adjacent to the highway

Species	Summer/winter 2021/2022			All inspections		
	East	Median	West	East	Median	West
Number of boxes occupied at least once (%)	1 (6%)	2 (17%)	2 (11%)	5 (28%)	5 (42%)	5 (28%)
Number of boxes occupied or showing signs of use at least once (%)	4 (22%)	6 (50%)	7 (38%)	17 (94%)	10 (83%)	16 (88%)
Sugar Glider	✓ (1)	✓ (2)	✓ (1)	✓ (1)	✓ (5)	✓ (6)
Common Brushtail Possums (<i>Trichosurus vulpecula</i>)	✓ (1)		✓ (1)	✓ (6)		
<i>Antechinus</i> sp.					✓ (1)	
Lace monitor (<i>Varanus varius</i>)				✓ (2)	✓ (1)	✓ (1)

(#) number of occasions found occupying nest boxes

3.3 Summary of Results

The results of the three monitoring periods to date (2018, 2020 and 2022) have been combined to show the cumulative use of the median by target fauna. Table 4 provides a cumulative summary of fauna recorded within the median and adjacent habitat east and west of the carriageway. Methods of detection have included arboreal camera monitoring, spotlighting, hair tubes and nest box monitoring.

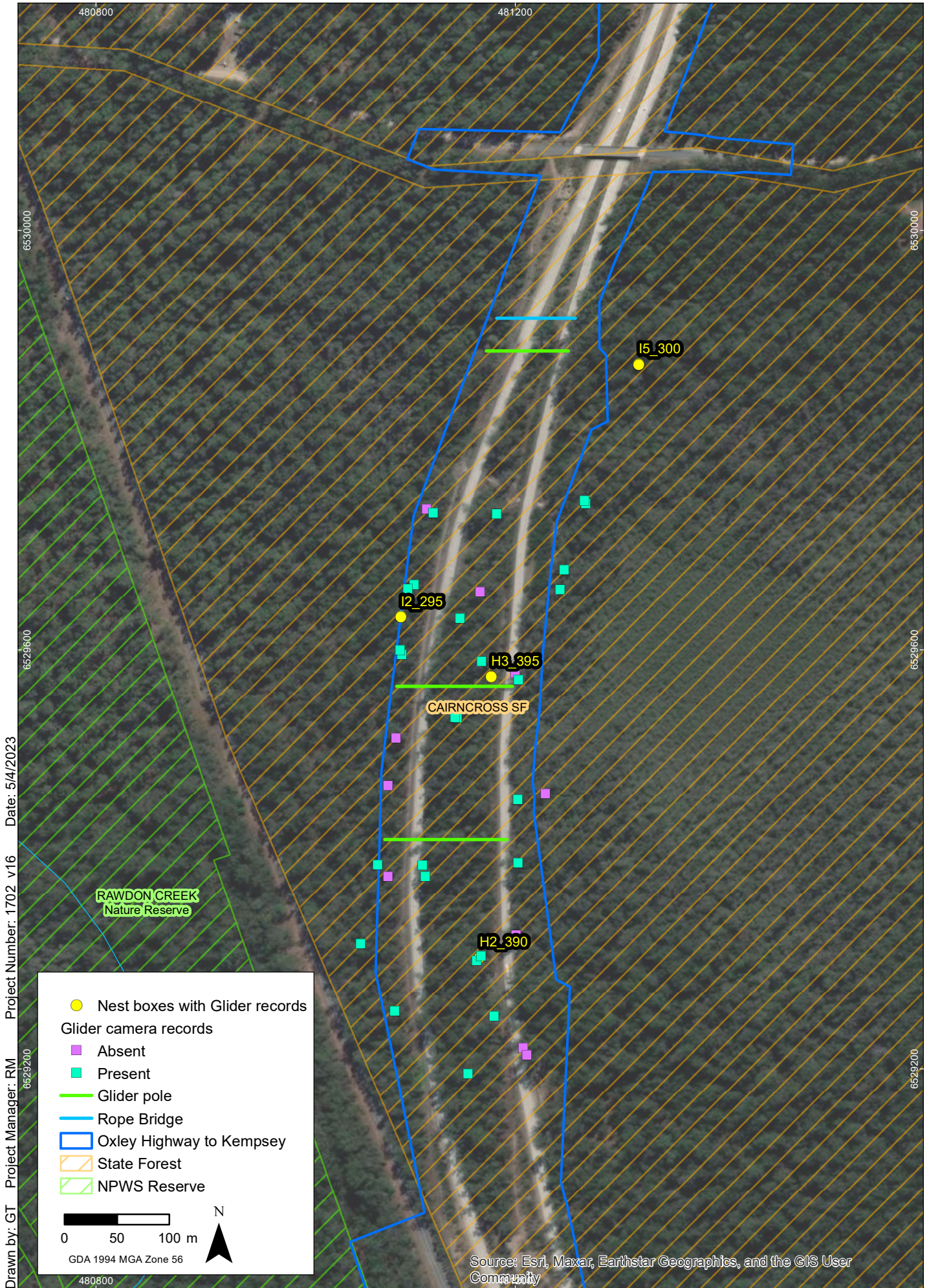
A total of 14 species were detected during surveys, including two (possibly three) glider species (Sugar Glider, Feathertail Glider and Sugar/Squirrel Glider). All glider species were detected in adjacent habitat as well as within the median.

The Yellow-bellied Glider was not recorded whilst five potential records of the Squirrel Glider occurred within the median throughout the monitoring program.

Table 4: Cumulative use of median, eastern and western roadside habitat

Species	Transect		
	East	Median	West
Feathertail Glider	✓ (2s, 1c)	✓ (2s, 2c)	✓ (3c)
Sugar/Squirrel Glider *	✓ (6s)	✓ (2s, 3c)	✓ (1s)
Sugar Glider	✓ (3s, 110c)	✓ (7s, 3n, 245c)	✓ (1s, 5n, 168c)
Common Brushtail Possum	✓ (4s)		✓ (2s)
Brushtail Possum (<i>Trichosurus</i> spp.)	✓ (5n, 2h)		✓ (1h)
Cat (<i>Felis catus</i>)	✓ (1s, 17c)		
Bat (Microbat and Flying Fox)	✓ (1s)	✓ (1s)	
Bird		✓ (1s)	✓ (2c)
<i>Rattus</i> sp.	✓ (6h)	✓ (14h)	✓ (1s, 3h)
Black Rat	✓ (11h, 38c)	✓ (35h, 6c)	✓ (2h, 47c)
Bush Rat (<i>Rattus fuscipes</i>)	✓ (1h)		
Rodent	✓ (1h, 3c)	✓ (6c)	✓ (3h, 7c)
<i>Antechinus</i> sp.	✓ (116c)	✓ (1n, 43c)	✓ (40c)
Lace Monitor (<i>Varanus varius</i>)	✓ (2n)	✓ (1n)	✓ (1n)

#- number of records, * - denotes possible Squirrel Glider record, s-spotlighting, n-nest boxes, h-hair tubes, c-remote camera.



Widened median monitoring results

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 2

4. Discussion

4.1 Performance Measures

A summary of the monitoring results to date in relation to the performance measures is provided in Table 5.

Table 5: Summary of performance measures

Performance measure	Discussion
Evidence of use of median vegetation by the target glider species (Yellow-bellied Glider and Squirrel Glider).	This performance measure has not been met. Five possible Squirrel Glider observations have been made over the course of the three monitoring periods undertaken to date, during spotlighting surveys and arboreal camera monitoring within the median. The Yellow-bellied Glider has not been recorded within the median.
Evidence of use by dispersing individuals and different age cohorts.	This performance measure cannot be assessed. Surveys completed do not permit the determination of dispersal (they provide information on presence/absence and behaviour only in this instance) and offer limited opportunity to determine age of individuals.
Use by glider species other than threatened species e.g. Sugar Glider	This performance measure has been met. The Sugar Glider and Feathertail Glider have been recorded using the median during spotlighting surveys and arboreal camera monitoring.

5. Recommendations

5.1 Contingency Measures

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered relevant to the widened median monitoring are listed and discussed in Table 6.

Table 6: Contingency measures

Potential problem	Contingency measure	Discussion of proposed measure
No evidence of use of the median vegetation by the target glider species.	Investigate alternative crossing structures (e.g. glider poles and/or rope bridges) in consultation with EPA.	<p>Yellow-bellied Gliders have not been recorded within the median.</p> <p>Squirrel Gliders have not been definitively recorded.</p> <p>Sugar Gliders were recorded actively foraging within the median vegetation. This species is listed in the EMP as an indicator species for the target species, to be used to assess the success of road crossing structures (glider poles and rope bridges). However, the use of indicator species to assess the success of the widened median as a mitigation measure is not provided for within the EMP.</p> <p>It is however considered that the median is providing roosting and foraging habitat for small gliders and that, if present, would provide habitat and connectivity for Squirrel Gliders.</p> <p>Yellow-bellied Gliders were identified during baseline surveys undertaken in 2013 within Cairncross State Forest, directly to the south west of the median (one individual during two out of three surveys, one month apart (Lewis 2014)), however current surveys of the same area have not recorded this species. Yellow-bellied Glider records from nest box monitoring and other incidental records (Niche 2019b) occur from approximately 10 kilometres north of the median. There have been no records of this species in closer proximity to the median during any operational monitoring. Given the absence of records in adjacent habitat, the absence of records from the median should not be considered as an indication of the performance of the mitigation measure.</p> <p>The widened median is already supplemented by three sets of glider poles and one rope bridge. However, as the aerial crossings are not being monitored it is not possible to confirm traverses, however the presence of gliders within the median and occupation of the installed nest boxes would indicate traverses of the highway on at least a number of occasions, via the glider crossings or <i>in situ</i> trees. Yellow-bellied Gliders were not detected within the median or in adjacent habitat during the monitoring program. Foraging and roosting habitat is present within the median, however it is not abundant. It is possible that the median may provide transitory habitat only for this species, in which case the likelihood of detection of this species may be expected to be lower than small gliders, which have demonstrated use of the habitat within the widened median for roosting and foraging.</p> <p>Given that the widened median is already supplemented by crossing structures and small gliders are demonstrating use of the widened median, this contingency measure is not considered relevant.</p>
Evidence of use by dispersing individuals and different age cohorts.	Not applicable	<p>Surveys completed do not permit the determination of dispersal (they provide information on presence/absence and behaviour only in this instance) and offer limited opportunity to determine age of individuals. Given the purpose of the monitoring program is to determine use of the mitigation measure by glider species, the nature of the movement and age of individuals is of no consequence and is beyond the scope of the monitoring program.</p>

5.2 Recommendations

Despite the change in methodology and use of arboreal baited cameras within the median use by target species could not be confirmed. However, further monitoring is not recommended for the following reasons:

- The target species were not recorded within the adjacent vegetation, east and west of the widened median, as such the absence of records from the median should not be considered as an indication of the performance of the mitigation.
- The widened median has been successfully used by other glider species (Feathertail Glider and Sugar Glider) a substantial number of times throughout the monitoring program, demonstrating the effectiveness of the mitigation measure to provide safe crossing opportunities.
- These glider species have been used as indicator species for the target glider species when considering the performance of other mitigation measures for the Project (rope bridges and glider poles).

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Annex 1 – Nest box results

Table 7: Nest box monitoring results (extracted from Niche 2023)

Zone	Location	Box #	Box type	Height (m)	Tree species	Summer 2022 species	Summer 2022 signs of use	Winter 2022 species	Winter 2022 signs of use
H1	Median	385	LG	10	Blackbutt		Nil		
H1	Median	386	SG	7	Blackbutt		Nil		
H1	Median	387	Parr	8	Blackbutt		Nil		
H1	Median	388	Poss.	8	Blackbutt		Old leaves		Latrine
H2	Median	389	MB	7	Tallowwood		Nil		Nil
H2	Median	390	SG	6	Tallowwood		Old leaves	Sugar Gliders	Occupied
H2	Median	391	LG	10	Blackbutt		Old leaves		Euc leaf
H2	Median	392	SG	6	Blackbutt		Old leaves		Fresh euc nest
H3	Median	393	Cock	12	Blackbutt		Nil		Nil
H3	Median	394	Poss.	6	Blackbutt		Nil		Nil
H3	Median	395	SG	6	Turpentine		Nil	Sugar Gliders	Occupied
H3	Median	396	LG	10	Blackbutt		Old leaves		Old leaves
I1	West	290	Scan	6	Swamp Mahogany	Ants	Nil	Ants	Nil
I1	West	292	SG	8	Pink Bloodwood	Insect	Nil	Termites	Old leaf
I1	West	293	SG	8	Swamp Mahogany	Ants	Old leaves		Conical Euc Nest
I1	West	294	Poss.	7	Swamp Mahogany		Nil		Nil
I2	West	288	LG	10	White Stringybark		Nil		Nil
I2	West	289	Parr	8	Blackbutt		Nil		Nil
I2	West	291	MB	7	White Stringybark		Nil		Nil
I2	West	295	SG	8	Blackbutt	Sugar Glider x4	Occupied		Fresh euc nest
I2	West	296	Scan	6	White Stringybark		Euc leaf	Insects	Nil
I3	West	283	SO	10	Tallowwood		Nil		Nil
I3	West	284	Poss.	7	Tallowwood		Old leaves		Nil
I3	West	285	LG	10	Blackbutt		Old leaves		Bark and leaf
I3	West	286	SG	8	White Stringybark		Nil		Nil
I3	West	287	Scan	8	Mahogany		Euc leaf		Nil
I4	West	279	LG	10	Mahogany		Nil	Common Brushtail Possum	Occupied
I4	West	280	MB	8	Blackbutt		Nil		Fresh euc
I4	West	281	Parr	8	Mahogany		Nil		Nil
I4	West	282	Poss.	8	Turpentine		Nil		Nil
I5	East	297	SG	6	White Mahogany		Nil		Nil
I5	East	298	Poss.	8	Tallowwood		Nil		Nil
I5	East	299	Add. Poss.	8	Tallowwood		Nil		Old leaves
I5	East	300	SO	10	Mahogany	Common Brushtail Possum	Nil	Sugar Glider	Occupied
I5	East	301	LG	10	Tallowwood		Nil		Nil

Zone	Location	Box #	Box type	Height (m)	Tree species	Summer 2022 species	Summer 2022 signs of use	Winter 2022 species	Winter 2022 signs of use
I6	East	307	Poss.	6	Mahogany		Nil		Old leaf
I6	East	308	SG	7	Bloodwood		old leaves, latrine		Euc leaf
I6	East	309	Parr	9	Mahogany		Nil		Nil
I6	East	310	Scan	5	Mahogany		Nil		Nil
I6	East	311	LG	9	Mahogany		Nil		Nil
I7	East	312	Parr	7	Mahogany		Nil		Nil
I7	East	313	LG	9	Mahogany		Euc leaf		Old leaf
I7	East	314	LG	10	Swamp Mahogany		Nil	Termites	Nil
I7	East	315	MB	6	White Stringybark		Nil		Nil
I8	East	316	LG	10	White Stringybark		Old leaves		Old leaf
I8	East	317	Poss.	7	Turpentine		Nil		Nil
I8	East	318	Parr	8	Blackbutt		Nil		Nil
I8	East	319	Cockatoo	10	Blackbutt		Nil		Unk

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Appendix K – Nest Boxes



Nest Box Monitoring 2022

Oxley Highway to Kempsey, Pacific Highway Upgrade

Transport for NSW

August 2023

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Cover photograph: Common Brushtail Possum in large glider nest box (left) and Sugar Gliders in scansorial nest box (right) recorded during summer 2022 surveys.

Executive Summary

Context

This report documents findings for the 2022 monitoring period, the third of three operational monitoring periods for nest boxes, as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project) and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022). Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project.

Aims

The aim of this report is to summarise the methods and results of the summer 2021/2022 and winter 2022 monitoring and determine if performance measures have been met, as per the EMP.

Methods

Monitoring was undertaken in accordance with the EMP, in summer from 11 January 2022- 17 March 2022 and in winter from 29 June - 12 September 2022. Each nest box was visually inspected using a wireless camera attached to the end of an extendable pole, or by a tree climber when inspection from the ground was not possible. Details recorded for each box included: occupation by fauna, species if present, signs of use by fauna, box condition, any maintenance required, changes to surrounding landscape and daily weather conditions.

Key Results

A total of 516 nest boxes were inspected in summer 2021/2022 and 518 in winter 2022 during the monitoring period. A total of 189 nest boxes in summer (37.8%) and 207 (44.0%) in winter were occupied or showed signs of use by native vertebrate fauna.

Twenty species of native fauna have been identified using nest boxes to date, including three threatened species; the Yellow-bellied Glider (*Petaurus australis*), Greater Glider (*Petauroides volans*) and Squirrel Glider (*Petaurus norfolcensis*).

A total of 110 boxes (20.9% of the 527 installed boxes) require maintenance after Event 9, including 76 replacements.

Conclusions

Outcomes of the performance measures can be summarised as follows:

- *Use of nest boxes by a wide range of native fauna species: This performance indicator has been met.* Twenty native vertebrate fauna species, including three threatened species, have been recorded occupying boxes to date.
- *Use of nest boxes designed for specific species by those same species: This performance indicator has been met by 5 of the 9 nest box types to date.* Nest box types Scan, SG, LG, Poss and MB boxes have all recorded use by target species. Nest box types Parr, Co, SO and LFO have not shown signs of use by target fauna. Given the low likelihood of use of artificial hollows by these birds and the absence of impacts to known roosting/breeding sites, the installation of additional nest boxes or other constructed hollows is not recommended.
- *Low rate of use of nest boxes by introduced fauna species: This performance indicator has been met.* Exotic birds were recorded using two nest boxes and 2.4% of nest boxes in summer and 1.3% in winter showed signs of use by European Bees.

- *Low level of maintenance of nest boxes: This performance indicator has not been met.* 20.9% of boxes required maintenance/replacement after Event 9. The nest box program has successfully delivered habitat during the time of the program.

Management Implications

Given the uptake and occupation of nest boxes to date, recommendations are limited to the replacement/repair of lost or damaged boxes.

The NBPoM requires a total of 524 nest boxes be installed and available to fauna. In order to meet this requirement, maintenance actions and replacements are to be completed. TfNSW are currently working with relevant landholders to discuss ongoing presence of nest boxes and any relocations required.

All actions required to ensure the requisite numbers of nest boxes will be completed in 2023, pending landowner agreement.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the then Commonwealth Department of Environment (DoE) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project.

1.1.1 Monitoring framework

The EMP specifies that nest boxes were to be installed in Year 1 (2015) and Year 2 (2016) (construction phase), with monitoring to commence in summer and winter shortly after the installation period (2016) and continue in Year 4 (2018), Year 6 (2020) and Year 8 (2022). For the Nest Box Monitoring, the Project has been divided into two sections:

- Oxley Highway to Kundabung (Ch. 0 - 24040), hereafter referred to as OH2Ku.
- Kundabung to Kempsey (Ch. 24040 - 37850), hereafter referred to as Ku2K.

To date, nine monitoring events have been undertaken and reported on as follows:

- Construction monitoring:
 - *Event 1-winter 2016*: Niche 2017 (and see Lewis 2017a and Sandpiper 2017a).
 - *Event 2-summer 2017*: Niche 2017 (and see Lewis 2017a and Sandpiper 2017b).
 - *Event 3-winter 2017*: Niche 2018a (and see Lewis 2017b and Sandpiper 2017c).
- Operational monitoring:
 - *Event 4-summer 2018*: Niche (2018b).
 - *Event 5-winter 2018*: Niche (2018b).
 - *Event 6-summer 2020*: Niche (2021).
 - *Event 7-winter 2020*: Niche (2021).
 - *Event 8-summer 2022*: current report.
 - *Event 9-winter 2022*: current report.

Events 1 and 2 were the first biannual inspections after installation. Event 3 (winter 2017) was an additional monitoring event due to the installation of nest boxes occurring six months ahead of the scheduled first monitoring event, and was the final construction monitoring event.

Events 4 and 5 were the first operational monitoring events (undertaken in Year 4). Event 6 and Event 7 were the second of three years (Years 4, 6 and 8) of biannual operational monitoring. The final monitoring events (8 and 9) occurred in summer 2021/2022 and winter 2022.

A pre-handover maintenance inspection was undertaken at Year 8 during the 2022 operational monitoring (Events 8 and 9).

1.1.2 Purpose of this report

This report complies with the monitoring requirements described within the EMP and details the findings obtained from the third of three operational monitoring events.

The aim of this report is to summarise the methods and results of the summer and winter 2022 monitoring and determine if performance measures are being met, as per the EMP.

1.1.3 Performance measures

The EMP specifies the performance measures for nest boxes as follows:

Indicators of success of nest boxes include:

- *Use of nest boxes by a wide range of native fauna species.*
- *Use of nest boxes designed for specific species by those same species.*
- *Low rate of use of nest boxes by introduced fauna species.*
- *Low level of maintenance of nest boxes.*

1.1.4 Monitoring timing

As per the EMP, monitoring is to be undertaken in summer and winter of 2018, 2020 and 2022. The EMP states the following regarding monitoring timing:

“Nest boxes will be installed in Year 1 and 2 (construction phase). Monitoring will commence in summer and winter shortly after the installation period (Year 2) and will continue in summer and winter of Year 4, Year 6, Year 8. A pre-handover maintenance inspection will be undertaken at Year 8.”

1.1.5 Reporting

As per the EMP, annual reporting of monitoring results is to include:

- Detailed description of monitoring methodology employed.
- Results of the monitoring period.
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations.
- If contingency measures should be implemented.

All reports prepared under the EMP will be submitted to the NSW Department of Planning and Environment (DPE) and the NSW Environment Protection Authority (EPA).

2. Survey Methods

2.1 Nest Boxes Monitored

The *Nest Box Plan of Management* (NBPoM, Lewis 2013) describes the number, type and distribution of nest boxes required to mitigate the loss of hollows from the landscape as a result of the Project, and the ongoing management of the nest boxes. The boxes were installed in two phases: 60% prior to or during clearing to provide temporal refuge habitat and the remaining 40% once a final count of functional tree hollows was made during clearing supervision. Phase 2 calculations required an additional four boxes for OH2Ku and 101 for Ku2K. The number of nest boxes installed and available to fauna is provided in Table 1.

During the operational monitoring, wildfires and other issues have resulted in fluctuations in the number of nest boxes available to fauna. Nest boxes have been consistently replaced when required to ensure the minimum required number be available to fauna at the completion of each monitoring period.

A total of 516 and 518 nest boxes were monitored during Event 8 and 9 respectively, which excluded those boxes that were not able to be opened/accessed. A total of 19 and 56 boxes were found to be no longer available to fauna following the completion of Event 8 and Event 9 respectively, due to the condition of the box. A number of additional boxes were found to be partly broken or deteriorated; however these were included as they may still be used by fauna during the current monitoring periods.

The nest boxes were installed in zones to provide clusters of nest boxes in areas requiring mitigation for the loss of hollows. Figure 1 shows the location of nest boxes.

Table 1: Nest boxes available to fauna

	NBPoM	Phase 1 Event 1	Phase 2	Boxes required	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8	Event 9
OH2Ku	469	263	4	267	269	269	269	269	261	262	253	222
Ku2K	254	156	101	257	156	205	245	245	254	254	253	248
Total available to fauna	723	419		524	425	474	514	514	515	516	506	470

2.2 Methods

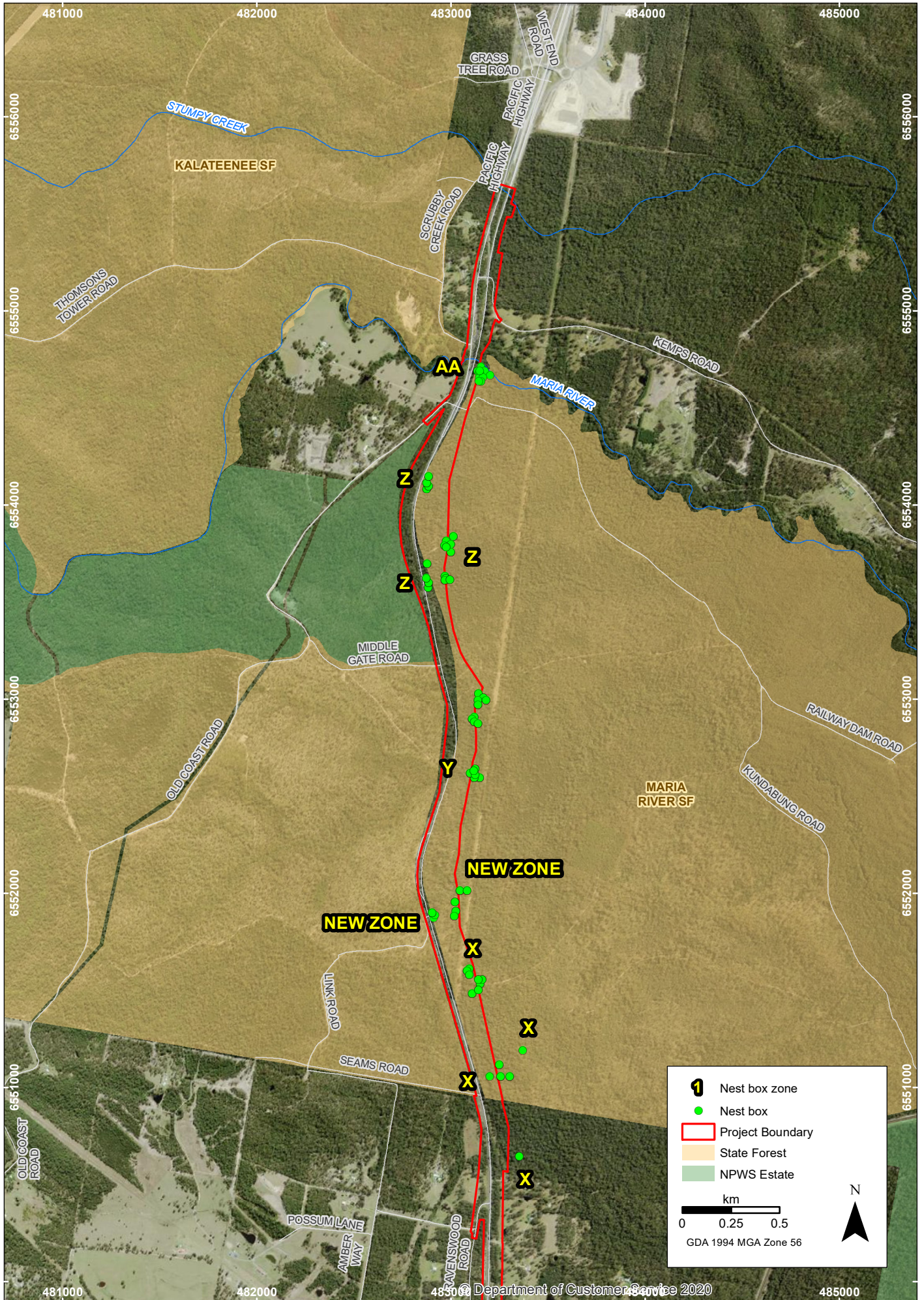
The EMP, in accordance with the NBPoM, states that monitoring will involve a visual inspection of each nest box, and at each monitoring period, the following information will be collected:

- *Inspection date, weather conditions (rain, wind, cloud cover, ambient temperature) and time each nest box was inspected.*
- *Nest box identification number.*
- *If the nest box is occupied by native fauna, and if so, the species. If the nest box is not occupied by a native species, record any signs of use by native species, such as feathers, droppings, scats, hair or nesting material.*
- *If the nest box is occupied by a pest species such as European bees, or Common Myna.*
- *Is there any deterioration of the nest box and is any maintenance required.*
- *Any changes to the surrounding habitats, such as clearing or installation of wildlife crossing structures.*

The maintenance regime will involve:

- *The removal of pest species such as Common Myna, Common Starlings and European Bees.*
- *The replacement of fallen, damaged or deteriorated nest boxes.*
- *The repositioning or relocation of nest boxes that show no sign of use after several successive monitoring periods*
- *The removal of excess nesting material that may block access to the nest box over time.*

Drawn by: MH Project Manager: RM Project Number: 1702.PI.5.14 Date: 3/30/2023



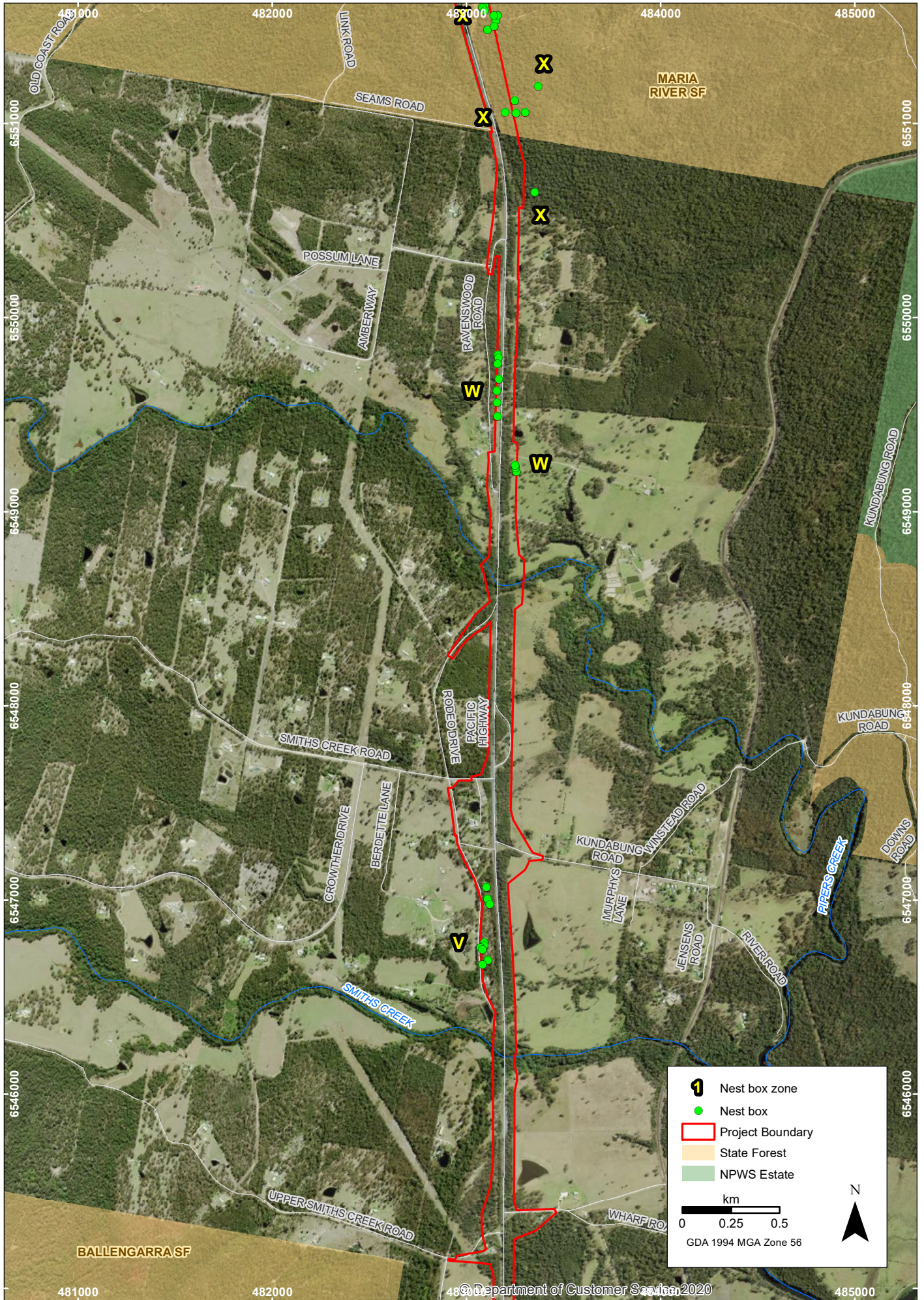
Nest Box Locations

Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1.1

Imagery: (c) LPI 2014-6-10

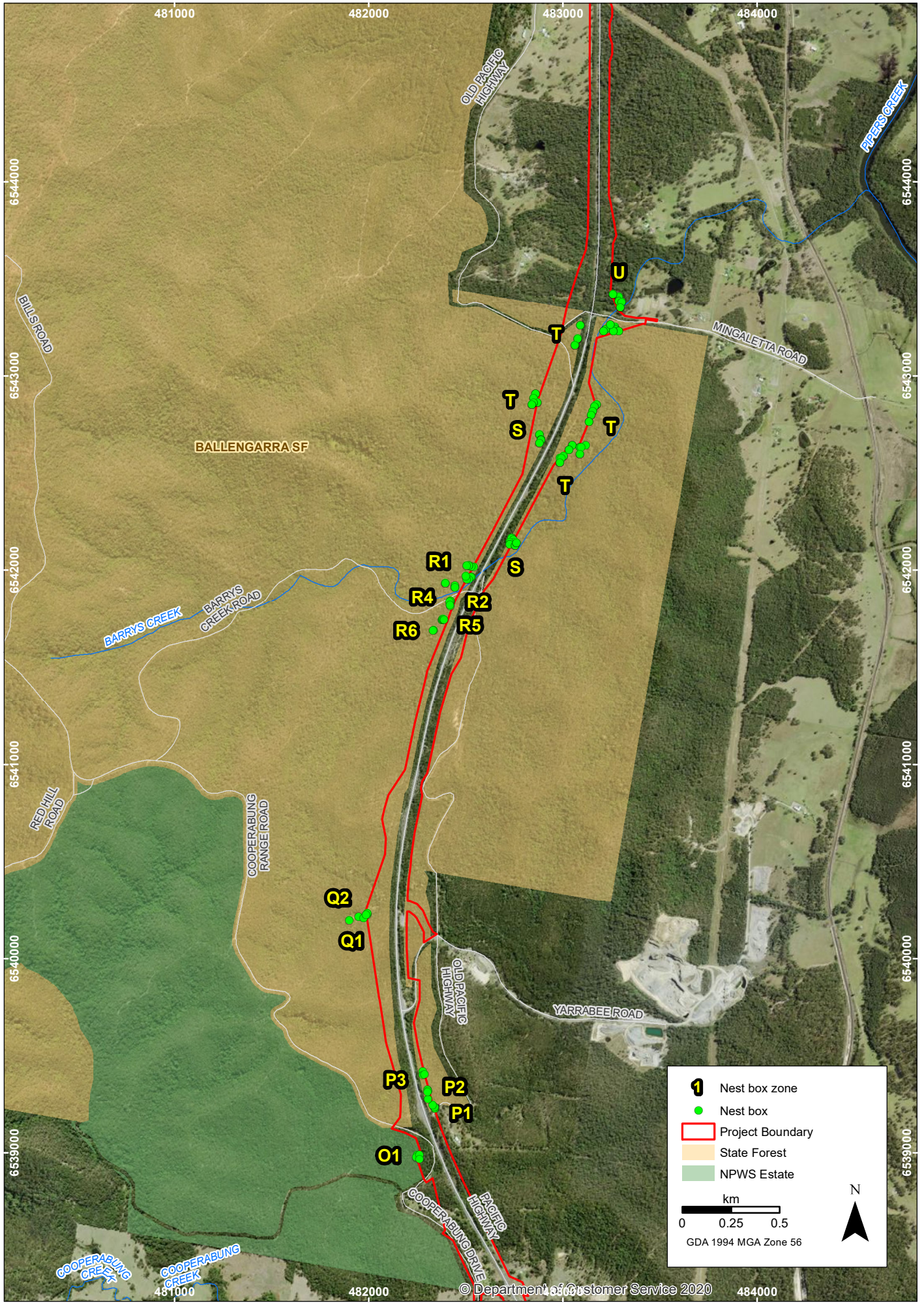
Drawn by: MH Project Manager: RM Project Number: 1702.PI.5.14 Date: 3/30/2023



Nest Box Locations
Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1.2
Imagery: (c) LPI 2014-6-10

Drawn by: MH Project Manager: RM Project Number: 1702.PI.5.14 Date: 3/30/2023



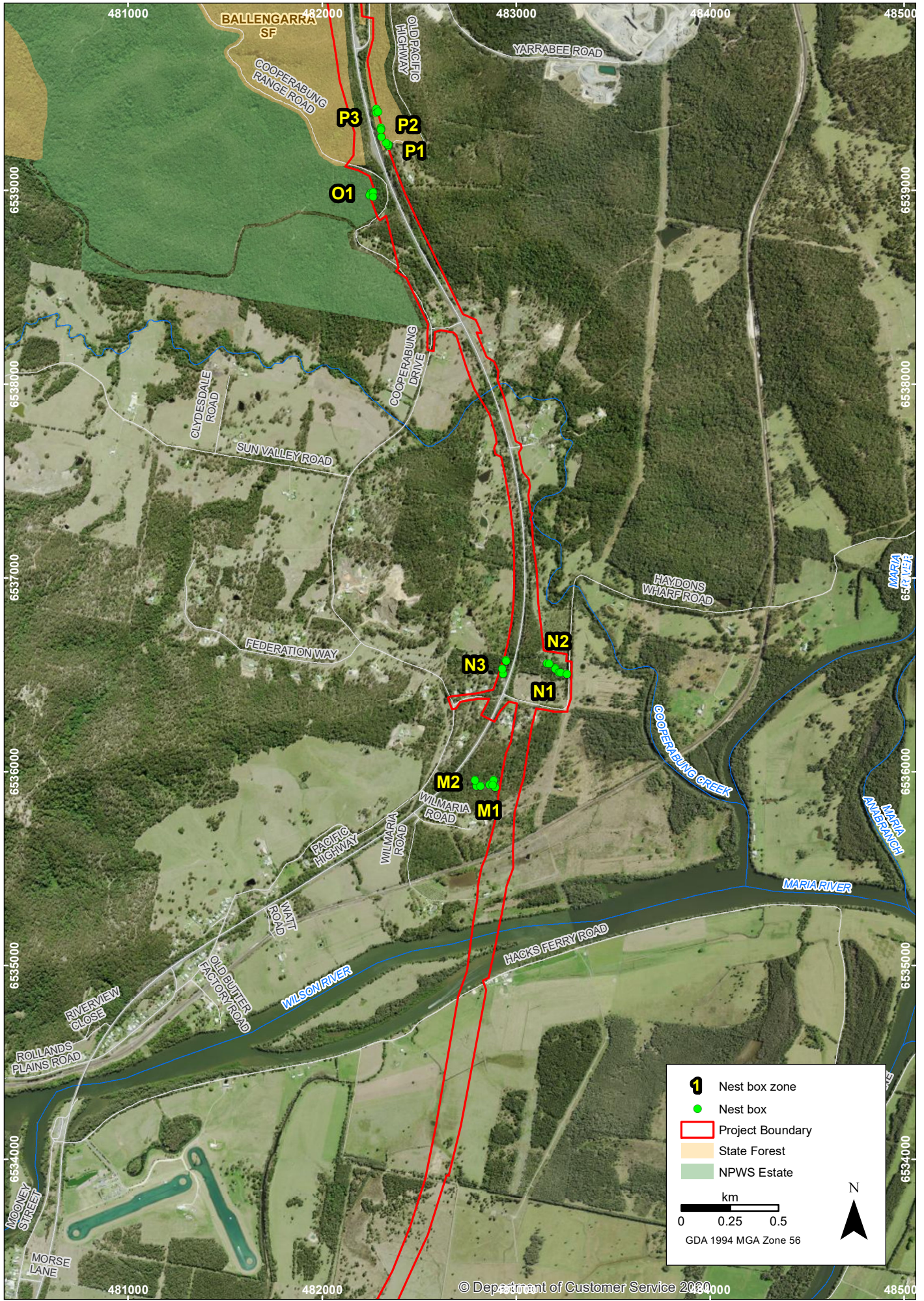
Nest Box Locations

Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1.3

Imagery: (c) LPI 2014-6-10

Drawn by: MH Project Manager: RM Project Number: 1702 PI 5.14 Date: 3/30/2023

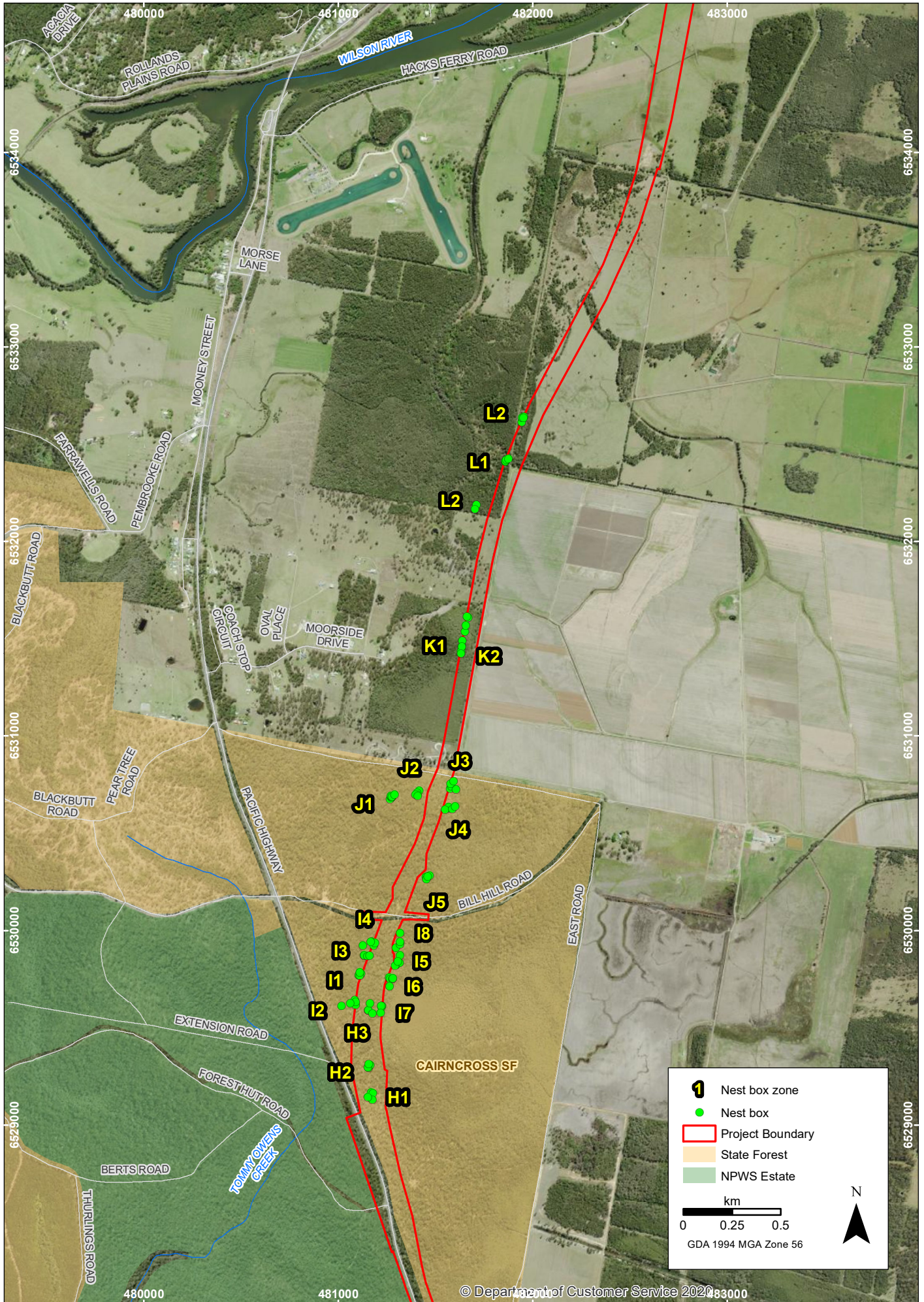


Nest Box Locations

Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1.4

Imagery: (c) LPI 2014-6-10

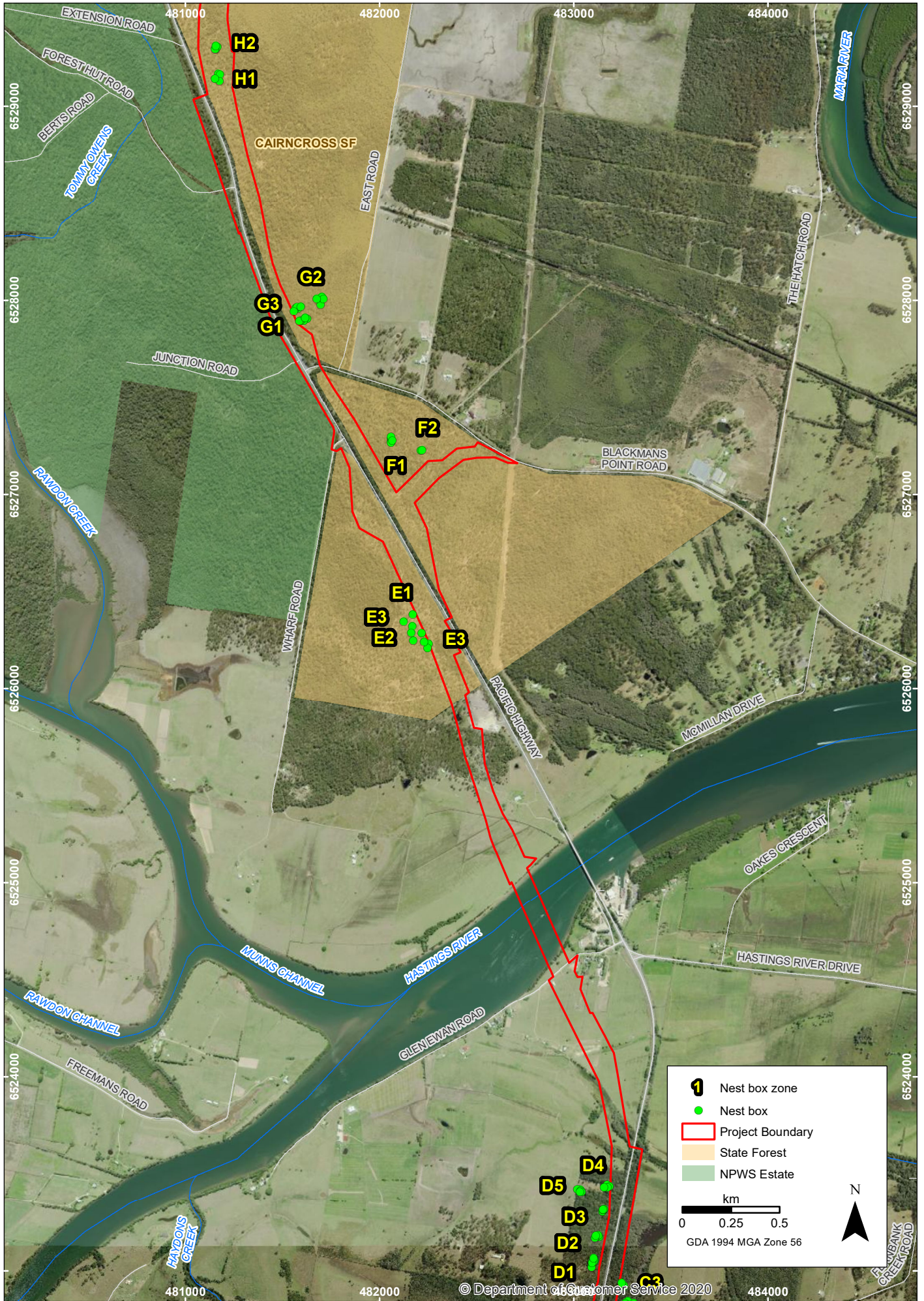


Nest Box Locations

Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1.5

Imagery: (c) LPI 2014-6-10



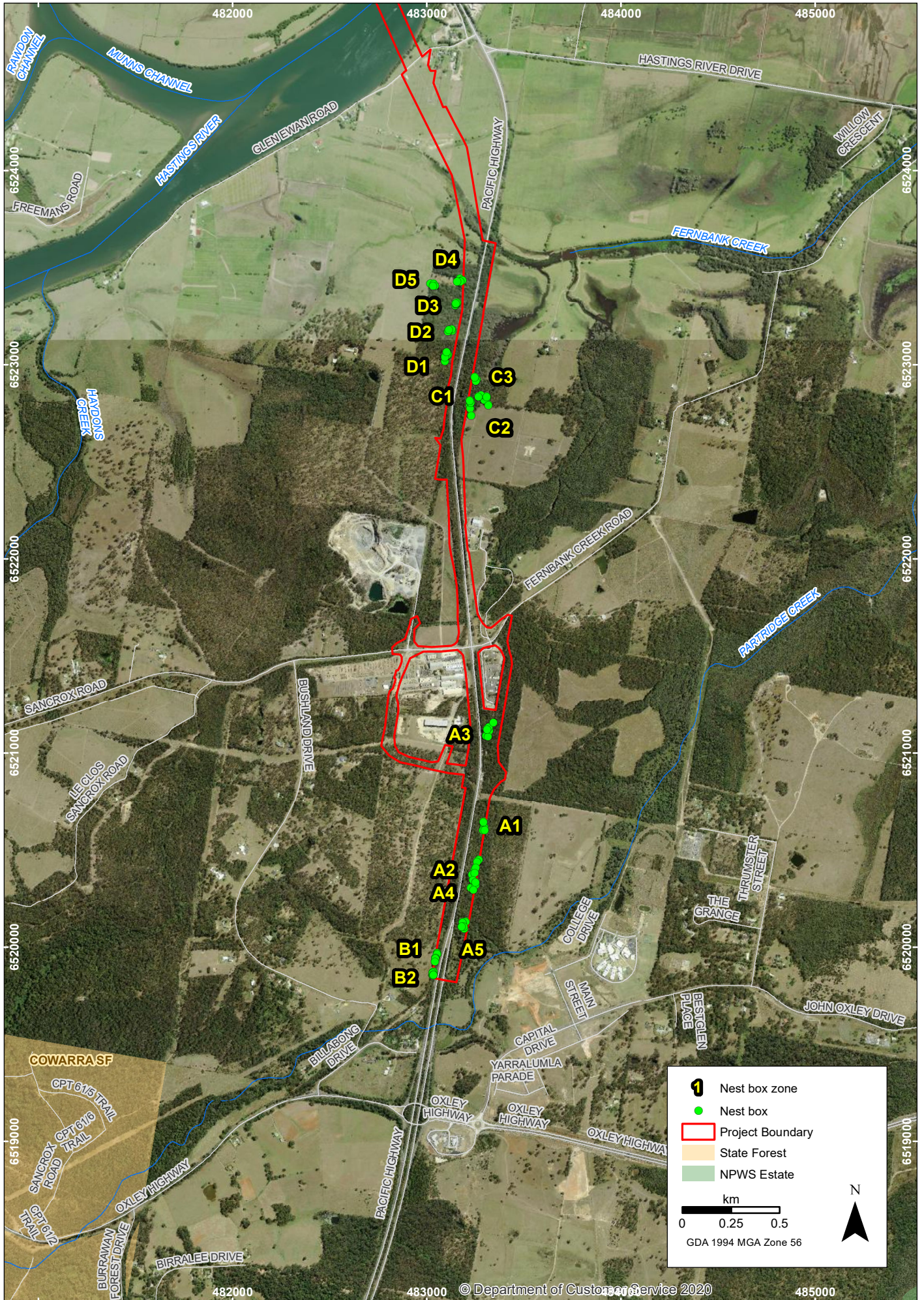
Nest Box Locations

Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1.6

Imagery: (c) LPI 2014-6-10

Drawn by: MH Project Manager: RM Project Number: 1702.PI.5.14 Date: 3/30/2023



Nest Box Locations

Pacific Highway Upgrade – Oxley Highway to Kempsey

FIGURE 1.7

Imagery: (c) LPI 2014-6-10

3. Results

3.1 2022 Seasonal Results

Summer and winter inspection results and survey weather conditions are provided in Annex 1, Annex 2 and Annex 3, respectively. To provide an overall representation of nest box results for the entire Project, OH2Ku and Ku2K results have been combined.

3.1.1 Event 8 – summer 2021/2022

Summer surveys were undertaken between 11 January and 17 March 2022. A total of 527 nest boxes were installed and due to be checked. Of these, 11 boxes were unable to be inspected at the time of monitoring (could not be located, inaccessible or could not be opened), resulting in the inspection of a total of 516 nest boxes. A total of 506 nest boxes were known to be available to fauna (excluding those that could not be found or were fallen/broken). Of these, 39 (7.7%) were occupied by native vertebrate fauna and a further 150 (29.6%) showed signs of use by native vertebrate fauna. A total of 189 nest boxes (37.4%) were therefore either occupied or showed signs of use by native vertebrate fauna during the 2021/2022 summer surveys.

3.1.2 Event 9 – winter 2022

Winter surveys were undertaken between 29 June and 12 September 2022. A total of 527 nest boxes were installed and due to be checked. Of these, nine boxes were unable to be inspected at the time of monitoring (could not be located, inaccessible or could not be opened), resulting in the inspection of a total of 518 nest boxes. A total of 470 nest boxes were known to be available to fauna (excluding those that could not be found or were fallen/broken). Of these, 45 (9.6%) were occupied by native vertebrate fauna and a further 162 (34.5%) showed signs of use by native vertebrate fauna. A total of 207 nest boxes (44.0%) were therefore either occupied or showed signs of use by native vertebrate fauna during the 2022 winter surveys.

3.2 2022 Native Fauna Use

Thirteen species from three fauna groups were recorded occupying nest boxes during Event 8 and Event 9. These included:

- Mammals:
 - Arboreal mammals: Common Brushtail Possum (*Trichosurus vulpecula*), Short-eared Brushtail Possum (*Trichosurus caninus*), Yellow-bellied Glider (*Petaurus australis*), Sugar Glider (*Petaurus breviceps*), possible Squirrel Glider (*Petaurus norfolcensis*), Feathertail Glider (*Acrobates pygmaeus*) and Common Ringtail Possum (*Pseudocheirus peregrinus*).
 - Scansorial mammals: Brown Antechinus (*Antechinus stuartii*).
- Birds: Lorikeet (*Trichoglossus* sp.) and Australian Owlet Nightjar (*Aegotheles christoptus*).
- Reptiles: Lace Monitor (*Varanus varius*) and Carpet Python (*Morelia spilota*).

Of particular note was the detection of the Yellow-bellied Glider recorded on one occasion in winter in a small glider type box within zone V. Possible Squirrel Glider were noted occupying small glider and scansorial type boxes. Both of these species are listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Yellow-bellied Glider is listed as vulnerable under the EPBC Act (2 March 2022). Use of nest boxes by native fauna is further discussed in Section 3.6.2.

3.3 2021/2022 Design Specific Use

The NBPoM proposed the installation of the following types of species-specific nest boxes:

- Scansorial fauna (Antechinus) (Scan)
- Small gliders (Feathertail Glider and Sugar Glider) (SG)
- Larger gliders (Squirrel Glider, Yellow-bellied Glider, Greater Glider) (LG)
- Possums (Common Brushtail Possum, Short-eared Possum and Common Ringtail Possum) (Poss)
- Microchiropteran bats (fluttering and direct flying species that utilise tree hollows) (MB)
- Medium sized parrots/lorikeets (Parr)
- Cockatoo (Black Cockatoos) (Co)
- Small Owls (Southern Boobook and Barn Owl) (SO)
- Large Forest Owls (Masked Owl, Sooty Owl, Powerful Owl) (LFO).

Fauna observed to be occupying nest boxes at the time of monitoring have been grouped into the above target groups and their nest box use is provided in Table 2.

Possoms and reptiles were recorded in a variety of nest box types and sizes. The majority of small gliders (Sugar Gliders) were found in Scan and SG boxes. Large gliders (Yellow-bellied Gliders and potential Squirrel Glider) were recorded in SG and Scan boxes. Large Glider, microbat, parrot, cockatoo, small owl and large forest owl nest boxes were not used by their target fauna in Event 8 or Event 9. Microbats, Cockatoo and Owl fauna groups were not recorded using nest boxes during the current monitoring events. Cumulative design-specific use is discussed in Section 3.8.4.

Table 2: 2021/2022 nest box use by target species

Fauna group	Nest box type								
	Scansorial Fauna (Scan)	Small Glider (SG)	Large Glider (LG)	Possum (Poss)	Microbat (MB)	Parrot/Lorikeet (Parr)	Cockatoo (Co)	Small Owl (SO)	Large Forest Owl (LFO)
Scansorial fauna	1	5	1						1
Small gliders	7	7			1	1		1	
Large gliders*	1	1							
Possums		4	12	20		3	4	2	4
Microbats									
Parrots/lorikeets		1							
Cockatoos									
Small owls									
Large forest owls									
Other birds								1	
Reptiles	1		1			1		1	

*includes possible Squirrel Glider records

3.4 2021/2022 Use by Invasive/Exotic Species

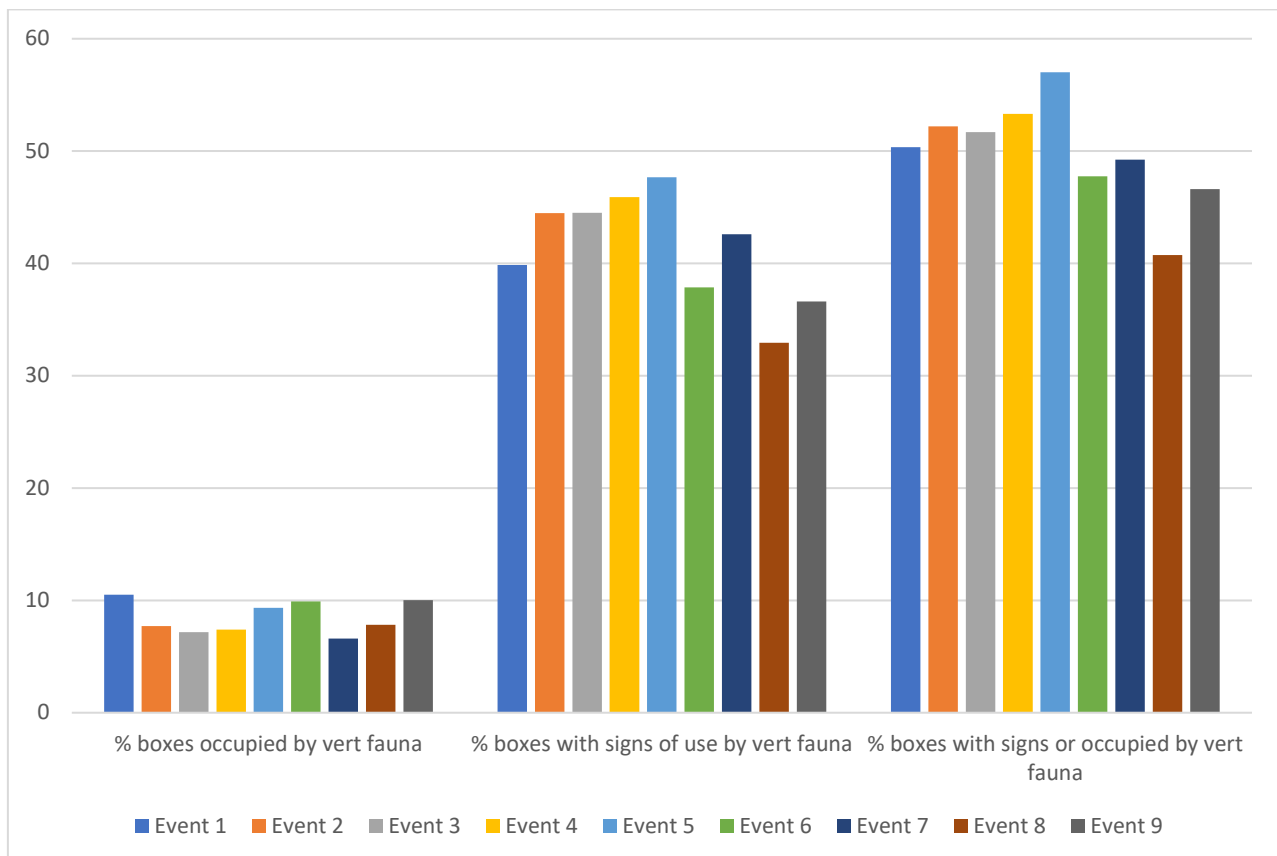
The NBPoM identifies native and non-native pest species with the potential to utilise nest boxes including the European Bee (*Apis mellifera*), exotic birds including Common Myna (*Acridotheres tristis*) and Common Starling (*Sturnus vulgaris*), and termites and ants. These fauna are considered pests for the nest box program as they compete with native/target fauna for nesting resources, create nests/hives that exclude target fauna, and introduce maintenance and longevity issues.

Evidence of exotic bird use was recorded in Zone W, within two adjacent possum boxes (Box 129 and 131). Boxes contained an untidy nest with rubbish, considered likely to be a nest of the Common Myna. European Bees were recorded in 12 boxes (2.5%) in Event 8 and 6 boxes (1.3%) in Event 9. Including ants, termites, insects and wasps, a total of 45 boxes (of 506 available to fauna; 8.9%) in Event 8 and 44 boxes (of 470 available to fauna; 9.4%) in Event 9 were occupied by pest species.

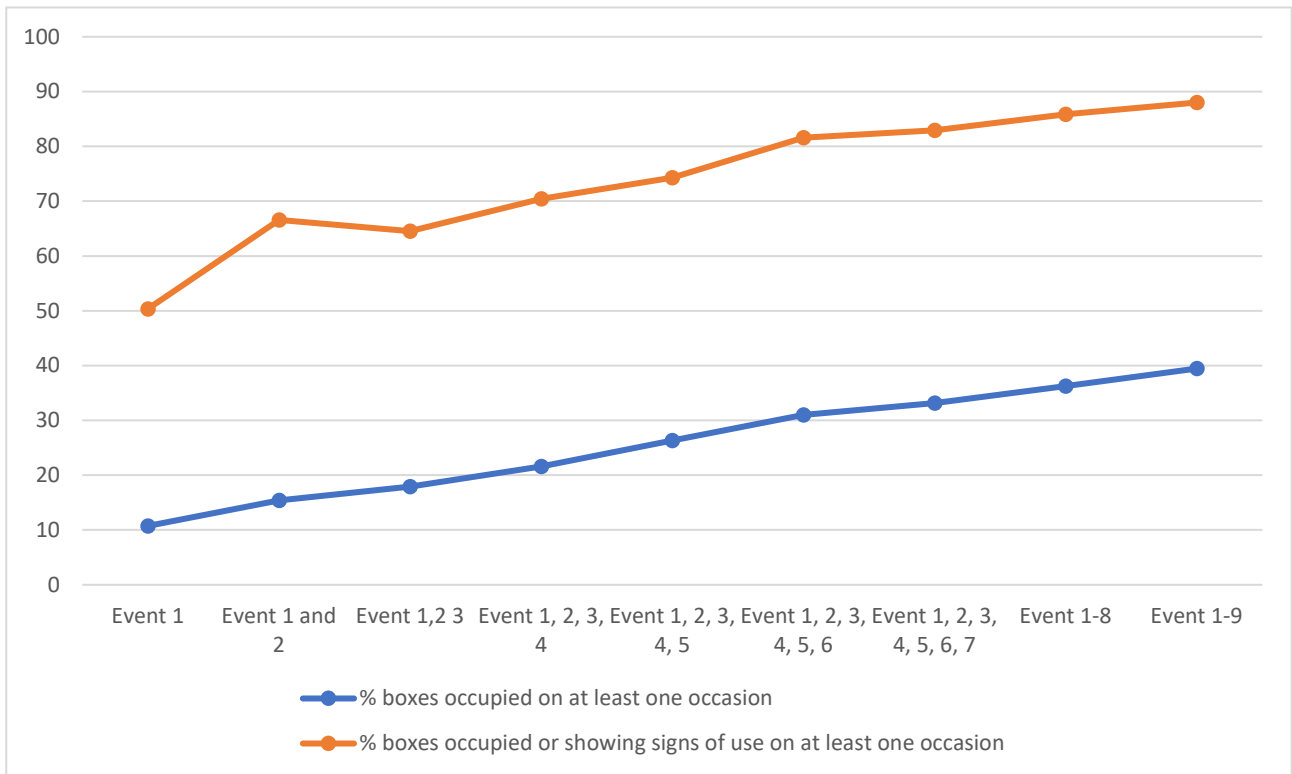
3.5 All Monitoring Events

3.5.1 Occupation rate

Graph 1 shows the rate of occupation and signs of use by native vertebrate fauna for all individual monitoring events to date, while Graph 2 shows the cumulative occupation for all monitoring events, i.e. the percent of all boxes available to fauna that had been occupied or showed signs of use during at least one monitoring event. While the recorded occupancy during any one monitoring event appears to fluctuate between 6% and 10%, Graph 2 shows that over 39% of boxes have been occupied on at least one occasion during inspections and that over 88% of boxes have been occupied or have shown signs of use on at least one occasion during inspections and that the percent of boxes used continues to increase each monitoring.



Graph 1: Nest box occupation and signs of use by native fauna



Graph 2: Cumulative occupation and signs of use of nest boxes by native fauna

3.5.2 Native fauna use

Table 3 lists the native vertebrate fauna recorded during the current and previous surveys, with threatened species highlighted in bold. One threatened species was definitively recorded during Event 9: the Yellow-bellied Glider, listed as vulnerable under the BC Act and EPBC Act.

The Yellow-bellied Glider was recorded in zone AA NBT03 (small owl box) in Event 3 and Event 4; zone AA NBT08 (large glider box) in Event 2 and in zone R3 NBT330 (large glider box) in Event 4 and Event 6, zone R3 NBT332 (cockatoo box) in Event 6 and in zone V in a NBT32 (small glider box) in Event 9.

The Squirrel Glider was detected during Event 3 in zone NEW ZONE NBT96 (possum box) and Event 4 in zone C2 NBT219 (small glider box) and G3 NBT209 (scansorial box). A number of additional glider records during Event 4, 5, 6, 7 and 9 were recorded as possible Squirrel Gliders, however identification could not be confirmed.

The threatened Greater Glider (listed as vulnerable under the EPBC Act) has not been detected since Event 2 (zone R1 box 322, large forest owl box, and zone R3 box 334, large glider box).

Table 3: Nest box fauna

Fauna group	Species	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8	Event 9
Arboreal mammals	Short-eared Possum (<i>Trichosurus caninus</i>)		✓					✓	✓	
	Common Brushtail Possum (<i>Trichosurus vulpecula</i>)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Yellow-bellied Glider (<i>Petaurus australis</i>)		✓	✓	✓		✓			✓
	Sugar Glider (<i>Petaurus breviceps</i>)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Greater Glider (<i>Petauroides volans</i>)		✓							
	Common Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	✓	✓			✓	✓	✓	✓	
	Feathertail Glider (<i>Acrobates pygmaeus</i>)	✓	✓	✓			✓	✓		✓
	Squirrel Glider (<i>Petaurus norfolcensis</i>)			✓	✓			*		*
Scansorial mammals	Brown Antechinus (<i>Antechinus stuartii</i>)	✓	✓	✓	✓	✓	✓		✓	✓
Flying mammals	Gould's Long-eared Bat (<i>Nyctophilus gouldi</i>)	✓	✓	✓						
	Chocolate Wattled Bat (<i>Chalinolobus morio</i>)		✓							
	Lesser Long-eared Bat (<i>Nyctophilus geoffroyi</i>)			✓						
	Unknown Microbat						✓			
Birds	Australian Owlet Nightjar (<i>Aegotheles chrisoptus</i>)	✓	✓	✓	✓	✓	✓			✓

Fauna group	Species	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8	Event 9
	Scaly-breasted Lorikeet (<i>Trichoglossus chlorolepidotus</i>)		✓	✓	✓	✓				✓
	Rainbow Lorikeet (<i>Trichoglossus moluccanus</i>)							✓		
	Eastern Rosella (<i>Platycercus eximius</i>)			✓						
	White-throated Treecreeper (<i>Cormobates leucophaea</i>)			✓		✓				
Reptiles	Lace Monitor (<i>Varanus varius</i>)	✓	✓	✓	✓	✓	✓	✓		✓
	Carpet Python (<i>Morelia spilota</i>)		✓		✓	✓	✓			✓

* possible record but identification not confirmed.

3.5.3 Cumulative design-specific use

The total number of fauna recorded in each nest box type for all monitoring events to date is provided in Table 4.

Scansorial fauna have been recorded occupying more frequently the smaller Scan, SG and MB boxes, however on two occasions were found in Owl boxes. Small gliders have been found occupying all box types except for the largest cockatoo and large forest owl boxes. The large gliders (Squirrel Gliders and Yellow-bellied Gliders) have been recorded in Scan, SG, Poss, LG, cockatoo, SO and LFO boxes. Possums have been recorded occupying all but the smallest nest boxes. Lorikeet records were from SG boxes, and other birds (White-throated Treecreeper and Owlet Nightjars) have been found occupying a range of box types. Similarly, reptiles have been found occupying a range of nest box types.

Overall, box types Scan, SG, LG, Poss and MB have all recorded occupancy by their target fauna group. Parr type boxes were used by non-target fauna, with the Lorikeet records occurring in SG boxes, which are similar in dimensions to, but with a smaller entrance and shallower, than the Parr boxes. Box types Co, SO and LFO were not used by their target fauna, and as mentioned previously, these bird groups have not been recorded using nest boxes.

Table 4: Total nest box use by target species across all monitoring events to date

Fauna group	Nest box type								
	Scansorial Fauna (Scan)	Small Glider (SG)	Large Glider (LG)	Possum (Poss)	Microbat (MB)	Parrot/Lorikeet (Parr)	Cockatoo (Co)	Small Owl (SO)	Large Forest Owl (LFO)
Scansorial fauna	3	13			1			1	1
Small gliders	40	37	1	1	5	8		1	
Large gliders	5	4	4	1			1	2	1
Possums		4	44	73		8	10	4	11
Microbats					7				
Parrots/lorikeets		6							
Cockatoos									
Small owls									
Large forest owls									
Other birds	1		1	3		4		7	1
Reptiles	5	2	5	3		10	1	8	
Total	54	66	55	81	13	30	12	23	14

3.6 Final maintenance actions

A total of 110 boxes (20.9% of the 527 installed boxes) require maintenance after Event 9, including 76 replacements. Maintenance actions required include fixing broken lids and replacing damaged, broken or substantially deteriorated boxes. Annex 4 lists the structural maintenance issues encountered at the close of Event 9.

The NBPoM requires a total of 524 nest boxes be installed and available to fauna. In order to meet this requirement, maintenance actions and replacements are to be completed. TfNSW are currently working with relevant landholders to discuss ongoing presence of nest boxes and any relocations required.

All actions required to ensure the requisite numbers of nest boxes will be completed in 2023, pending landowner agreement.

4. Discussion

4.1 Performance Measures

A summary of Event 8 and Event 9 monitoring results in relation to the performance indicators is provided in Table 5. Results from all monitoring undertaken to date have also been used in the assessment of results against performance indicators due to the expected gradual uptake of nest boxes by fauna.

Table 5: Performance measures and discussion

Performance indicators of success	Discussion
Use of nest boxes by a wide range of native fauna species.	This performance indicator has been met. Twenty native vertebrate fauna species, including three threatened species, have been recorded occupying boxes to date. Notable absentees are larger forest birds. Hollow-dependant hylid tree frogs were not observed, however some of these species may prefer hollows that retain water, which nest boxes are designed not to do.
Use of nest boxes designed for specific species by those same species.	This performance indicator has been met by 5 of the 9 nest box types to date. Nest box types Scan, SG, LG, Poss and MB boxes have all recorded use by target species. Nest box types Parr, Co, SO and LFO have not shown signs of use by target fauna (however these nest box types were used by other vertebrate fauna groups). The target fauna of these boxes were not recorded using any nest box type, with the exception of Lorikeet records from SG boxes. This is discussed further in Table 8.
Low rate of use of nest boxes by introduced fauna species.*	This performance indicator has been met. Exotic birds were recorded using two nest boxes and 2.4% of nest boxes in summer and 1.3% in winter showed signs of use by European Bees.
Low level of maintenance of nest boxes.*	This performance indicator has not been met. 20.9% of boxes required maintenance/replacement after Event 9.

*= as per the bat roost boxes (Niche 2015), these levels/rates were not specified in the EMP, as such an arbitrary level/rate of $\leq 10\%$ has been assigned.

5. Recommendations

5.1 Contingency Measures and Recommendations

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered to be relevant to the nest box monitoring program are listed and discussed in Table 6 and recommendations are discussed in Table 7.

Table 6: Contingency measures

Potential problem	Contingency measure proposed in EMP	Discussion of proposed measure
Nest box being used by non-target species.	Review number and design of next boxes.	All nest box types showed use by non-target vertebrate fauna. As generalists, reptiles were expected, and observed to use a range of nest box types. Smaller arboreal fauna were recorded more frequently in smaller SG and Scan boxes than non-target species. Possums were the highest recorded fauna group frequently occupying larger boxes. The level of use by non-target native vertebrate fauna is not considered to warrant contingency measures. This contingency measure is not considered relevant.
Nest boxes become occupied by exotic or invasive fauna such as European Bees.	Review/modify nest box design to exclude undesirable species, treat nest boxes to deter/eradicate pest species, or relocate nest boxes.	Exotic birds were recorded using two adjacent nest boxes and less than 3% of nest boxes currently show signs of use by European Bees. The use of nest boxes by non-target pests is not considered to warrant contingency measures. This contingency measure is not considered relevant.
Poor uptake or usage by native fauna species.	Review the types and numbers of nest box designs, their location or positioning within the tree.	Nest boxes have been installed and monitored since 2017. The NBPoM (Lewis 2013) assessed hollow suitability for fauna and considered that 61 of the hollows recorded within the Project Area were suitable for the Glossy Black-cockatoo and 14 were suitable for large forest owls. However, the NBPoM notes that there is limited evidence to suggest that black cockatoos will use artificial nest boxes and that evidence of artificial nest box use by owl species is also limited. Anecdotal observations and literature, such as Goldingay and Stevens (2009), indicates that research regarding artificial hollow use by native bat and bird species is limited. In addition, nest box monitoring of nearby sections of the Pacific Highway Upgrade have not recorded use of nest boxes by cockatoos or owls (Niche 2018b, Sandpiper 2017d). In order to better understand the role/intention of the installed large nest boxes, a review of the Flora and Fauna Working Paper (RTA 2010) and the pre-clearing reports (Sandpiper 2017e, Sandpiper 2017f, Lewis 2018) for the Project was completed. RTA (2010) reported that the Masked Owl, Sooty Owl and Glossy Black-cockatoo were recorded during surveys and the Powerful Owl was considered highly likely to occur (and later recorded, Lewis 2013). The records were not nesting records (road kill and call playback, respectively). Pre-clearing surveys did not record evidence of roosting/nesting by these species during hollow clearing (Sandpiper 2017e, Sandpiper 2017f, Lewis 2018), i.e. there were no known roosting/breeding hollows of these species removed for the Project. This would indicate that the installation of nest boxes targeting these species was for general habitat resource provision as opposed to compensating for known roosting/breeding sites. Goldingay (2019) undertook a review of nest box projects for the (then) NSW Roads and Maritime Services and concluded that parrot/large owl boxes were almost five times less likely to be used and that no large owls/parrots were observed using nest boxes. Goldingay (2019) recommended that nest boxes no longer be installed for birds. Consideration of the movement/ranging of these species would indicate that, while the availability of suitable roosting/nesting hollows is a constraint for these species, the availability of foraging resources and prey availability, and therefore the availability of prey hollows, is thought to be more important (e.g. Soderquist and Gibbons 2007) to

		<p>persistence in an area and the range of the individuals. Glossy Black-cockatoos have been observed on a number of occasions continuing to forage over the Project Area (<i>pers. obs.</i>) and the existing nest box program is providing suitable roosting/nesting opportunities for prey species. There are approximately 387 scansorial, possum, small glider and large glider boxes available. Of these, 350 (90.4%) have shown signs of use on a least one occasion and 150 (38.8%) have been occupied during any one monitoring event.</p> <p>Given the low likelihood of use of artificial hollows by these birds and the absence of impacts to known roosting/breeding sites, the installation of additional nest boxes or other constructed hollows is not recommended. In addition, the current nest box program and uptake is supporting an occupancy of up to 10% of nest boxes suitable to potential prey species, a level of occupancy consistent with the reported hollow-bearing tree occupancy by mammals (Goldingay 2019) and therefore it is not considered necessary to augment the existing nest box installation with additional boxes beyond replacing those lost. This contingency measure is not considered relevant.</p>
Nest boxes deteriorating rapidly and requiring maintenance.	Identify causes of nest box failure, modify design and construct accordingly.	<p>20.9% of boxes required maintenance/replacement. Nest boxes have been installed and monitored since 2017 and have therefore provided habitat for over six years. The nest box program has successfully delivered habitat during the time of the program. Maintenance actions will be undertaken to ensure the minimum requisite number of nest boxes are available to fauna at the close of the program.</p> <p>This contingency measure is not considered relevant.</p>

Table 7: Recommendations

Issue to be addressed	Recommendation
Number of nest boxes	The NBPoM requires a total of 524 nest boxes be installed and available to fauna. In order to meet this requirement, maintenance actions and replacements are to be completed. TfNSW are currently working with relevant landholders to discuss ongoing presence of nest boxes and any relocations required.
In accordance with the EMP's maintenance regime:	
The removal of pest species such as Common Myna, Common Starlings and European Bees.	Less than 3% of boxes have shown use by pest species. Removal of pest species from this small number of boxes is not considered necessary.
The replacement of fallen, damaged or deteriorated nest boxes	<p>The NBPoM requires a total of 524 nest boxes be installed and available to fauna. In order to meet this requirement, maintenance actions and replacements are to be completed. TfNSW are currently working with relevant landholders to discuss ongoing presence of nest boxes and any relocations required.</p> <p>All actions required to ensure the requisite numbers of nest boxes will be completed in 2023, pending landowner agreement.</p>
The repositioning or relocation of nest boxes that show no sign of use after several successive monitoring periods	To date over 88% of boxes have shown signs of use on at least one occasion. Given the increasing rate of use of nest boxes, and that this rate is expected to further increase with time since installation, relocation of unused nest boxes is not recommended.
The removal of excess nesting material that may block access to the nest box over time	There are no nest boxes requiring removal of nest material.

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Annex 1 – Summer 2021/2022 (Event 8) nest box monitoring

Section	Zone/ cluster	Box # / NBT	Box type	Orientati on (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/ Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	AA	1	MB	W	9	Turpentine	11/01/2022	NA		Unk			Unk	Unk	No	Increase in Lantana	Inaccessib le
Ku2K	AA	1	Scan	E	14	Turpentine	11/01/2022	NA		Unk			Unk	Unk	No	Increase in Lantana	Inaccessib le
Ku2K	AA	2	Pa	E	8	Tallowwood	11/01/2022	10:58	Go Pro	N			old leaf nest	Good	No		
Ku2K	AA	2	SG	NE	11	Tallowwood	11/01/2022	10:58	Go Pro	N			Nil	Good	No		
Ku2K	AA	3	Poss.	E	10	Coastal Blackbutt	11/01/2022	11:03	Go Pro	N			Nil		No		
Ku2K	AA	3	SO	E	15	Coastal Blackbutt	11/01/2022	11:09	Visual	N	Bees	Pest	Nil	Good	No		
Ku2K	AA	4	Poss.	W	7	Brush Box	11/01/2022	10:55	Go Pro	N	Ants	Pest	old leaves	Good	No		
Ku2K	AA	4	Scan	N	5	Brush Box	11/01/2022	10:55	Go Pro	N			Nil	Good	No		
Ku2K	AA	5	LFO	NW	14	Coastal Blackbutt	21/02/2022	9:50	Tree Climber	N			old leaves	Good	No		
Ku2K	AA	5	Poss.	E	9	Coastal Blackbutt	21/02/2022	9:50	Tree Climber	N			Nil	Good	No		
Ku2K	AA	6	MB	NE	8	Brush Box	11/01/2022	10:51	Go Pro	N			Nil	Good	No		dead tree
Ku2K	AA	6	Pa	NE	6	Brush Box	11/01/2022	10:40	Go Pro	N			Nil	Good	No		dead tree
Ku2K	AA	6	Pa	W	7	Brush Box	11/01/2022	10:51	Go Pro	N			Nil	Good	No		dead tree
Ku2K	AA	6	Scan	NE	5	Turpentine	11/01/2022	10:40	Go Pro	N			Nil	Good	No		new Pa
Ku2K	AA	7	Poss.	E	10	Tallowwood	11/01/2022	10:45	Go Pro	N	Bees	Pest	Nil	Good	No		
Ku2K	AA	7	SG	S	8	Tallowwood	11/01/2022	10:45	Go Pro	N			old leaves	Good	No		
Ku2K	AA	8	LG	N	15	Coastal Blackbutt	21/02/2022	9:50	Tree Climber	N			old leaves	Good	No		old honeyco mb
Ku2K	AA	9	Poss.			Coastal Blackbutt											
Ku2K	AA	9	Poss.		9	Coastal Blackbutt	11/01/2022	10:38	Go Pro	N			Nil	Good	No		
Ku2K	AA	9	Scan			Coastal Blackbutt											
Ku2K	AA	9	Scan		6	Coastal Blackbutt	11/01/2022	10:38	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	AA	94	Scan	SE	15	Coastal Blackbutt	21/02/2022	9:52	Tree Climber	N			old euc leaves	Good	No		
Ku2K	AA	94	SG	SE	12	Coastal Blackbutt	21/02/2022	9:52	Tree Climber	N			leaves and bark	Good	No		
Ku2K	AA	95	Scan			Coastal Blackbutt			DNE/Replaced								
Ku2K	AA	95	Scan			Coastal Blackbutt			DNE/Replaced								
Ku2K	AA	95	Scan		7	Turpentine	11/01/2022	11:16	Go Pro	N			Nil	Good	No		
Ku2K	NEW ZONE	90	Poss.	NW	10	Red Mahogany	11/01/2022	9:29	Go Pro	N			euc leaf nest	Good	No		
Ku2K	NEW ZONE	90	Scan	S	10	Red Mahogany	11/01/2022	9:31	Go Pro	N			Nil	Good	No		
Ku2K	NEW ZONE	91	Poss.			White Mahogany	11/01/2022	9:33	Go Pro	N			euc leaf nest	Good	No		
Ku2K	NEW ZONE	91	Scan			White Mahogany	11/01/2022	9:32	Go Pro	N			Nil	Good	No		
Ku2K	NEW ZONE	92	LG	NE		Coastal Blackbutt	9/03/2022	12:40	Tree Climber	N			old leaves	Good	No		
Ku2K	NEW ZONE	92	Scan			Coastal Blackbutt	11/01/2022	9:36	Go Pro	N			stripped bark nest	Good	No		
Ku2K	NEW ZONE	96	Co	E	18	Coastal Blackbutt	21/02/2022	15:22	Tree Climber	Y	Common Brushtail Possum	Native	Occupied	Good	No		
Ku2K	NEW ZONE	96	Poss.	SW	14	Coastal Blackbutt	21/02/2022	15:22	Tree Climber	N			Euc leaf nest	Good	No		
Ku2K	NEW ZONE	97	LFO	N	15	Coastal Blackbutt	21/02/2022	15:40	Tree Climber	N			Old leaves and eg shell	Good	No		
Ku2K	NEW ZONE	97	Poss.	N	11	Coastal Blackbutt	21/02/2022	15:40	Tree Climber	N			Old euc leaves	Good	No		
Ku2K	NEW ZONE	98	LG	NE	14	Coastal Blackbutt	21/02/2022	14:57	Tree Climber	N			Nil	Good	No		Old honeycomb

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	NEW ZONE	98	Scan	E	10	Coastal Blackbutt	21/02/2022	14:57	Tree Climber	N			Fresh euc leaves	Good	No		
Ku2K	NEW ZONE	99	Poss.	W	9	White Mahogany	21/02/2022	16:00	Tree Climber	N			Nil	Good	No		
Ku2K	NEW ZONE	99	SG	N	5	White Mahogany	21/02/2022	16:00	Tree Climber	N			Euc leaf nest	Good	No		
Ku2K	NEW ZONE	100	LG	SE	12	Coastal Blackbutt	21/02/2022	15:45	Tree Climber	N			old leaves	Good	No		old honeycomb
Ku2K	NEW ZONE	100	Poss.	SE	10	Coastal Blackbutt	21/02/2022	15:45	Tree Climber	N			Nil	Good	No		
Ku2K	S	58	LG	NE	8	Brush Box	9/03/2022	10:34	Tree Climber	N	Bees	Pest	Fresh hive	Good	No		
Ku2K	S	58	Scan	NE	5	Brush Box	12/01/2022	11:08	Go Pro	N			Conical euc leaf nest	Good	No		
Ku2K	S	59	Poss.	NE	5	Tallowwood	12/01/2022	10:56	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	S	59	SG	NE	8	Tallowwood	12/01/2022	10:57	Go Pro	N			Nil	Good	No		
Ku2K	S	60	LG	NE	8	White Mahogany	9/03/2022	9:58	Tree Climber	N	Ants	Pest	Nil	Good	No		
Ku2K	S	60	Poss.	NE	5	White Mahogany	12/01/2022	10:58	Go Pro	N			Nil	Good	No		
Ku2K	S	61	Poss.	NE	12	Pink Bloodwood	12/01/2022	11:06	Go Pro	N			Nil	Good	No		
Ku2K	S	61	SO	NE	13	Pink Bloodwood	12/01/2022	11:05	Go Pro	N			Nil	Good	No		
Ku2K	S	72	LG	NW	7	Turpentine	12/01/2022	14:22	Go Pro	N			Old leaves	Good	No		Lid almost broken. Checked also with Tree climber.
Ku2K	S	72	Poss.	SE	5	Turpentine	12/01/2022	14:23	Go Pro	N			Nil	Good	No		
Ku2K	S	73	LG	S	7	Pink Bloodwood	8/03/2022	10:04	Tree Climber	N			Nil	Moderate	No		Slight det. check next

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
																	inspection
Ku2K	S	73	Poss.	SE	9	Pink Bloodwood	8/03/2022	10:04	Tree Climber	N			Nil	Good	No		
Ku2K	S	74	Co	NE	13	Grey Ironbark	8/03/2022	9:40	Tree Climber	N	Wasps	Pest	Nil	Good	No		
Ku2K	S	75	Pa	E	10	Pink Bloodwood	12/01/2022	14:26	Go Pro	N			Nil	Good	No		
Ku2K	S	75	Scan	E	7	Pink Bloodwood	12/01/2022	14:25	Go Pro	N			old leaf	Good	No		
Ku2K	S	76	Poss.	S	10	Brush Box	12/01/2022	14:35	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	S	76	Scan	S	8	Brush Box	12/01/2022	14:34	Go Pro	N			old euc leaf	Good	No		
Ku2K	S	77	LFO	SE	14	Grey Ironbark	8/03/2022	9:57	Tree Climber	N			Nil	Good	No		
Ku2K	S	77	Poss.	SE	6	Grey Ironbark	8/03/2022	9:59	Tree Climber	N			Nil	Good	No		
Ku2K	S	78	Pa	E	7	Brush Box	12/01/2022	14:32	Go Pro	N			old euc leaf	good	No		
Ku2K	S	78	SG	W	5	Brush Box	12/01/2022	14:33	Go Pro	N			Nil	good	No		
Ku2K	S	79	Scan	E	6	Turpentine	12/01/2022	14:28	Go Pro	Not avail			Not avail	Poor - no bottom	Replace		no bottom
Ku2K	S	79	SG	N	6	Turpentine	12/01/2022	14:29	Go Pro	N			leaf	Good	No		
Ku2K	S	80	SG		8	Turpentine	12/01/2022	14:39	Go Pro	N	Ants	Pest	Nil	Good	No		Required to meet nest box numbers for K2K - New box installed 28/06/21
Ku2K	S	81	SG		7	Tallowwood	12/01/2022	14:40	Go Pro	N			Nil	Good	No		Required to meet nest box numbers for K2K - New box installed 28/06/21

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	S	82	SG		7	Turpentine	12/01/2022	14:42	Go Pro	N	Ants	Pest	Nil	Good	No		Required to meet nest box numbers for K2K - New box installed 28/06/21
Ku2K	T	48	MB	SE	4	White Mahogany	12/01/2022	11:38	Go Pro	N			Nil	Good	No		
Ku2K	T	48	Poss.	N	7	White Mahogany	12/01/2022	11:37	Go Pro	N			Nil	Good	No		
Ku2K	T	49	LG	NE	9	Pink Bloodwood	12/01/2022	11:32	Go Pro	N			Nil	Poor	Replace		lid fell off
Ku2K	T	49	MB	SE	7	Pink Bloodwood	12/01/2022	11:35	Go Pro	N			Nil	Good	No		
Ku2K	T	50	Poss.	NE	9	Tallowwood	12/01/2022	11:25	Go Pro	N			Feather and grass litter in what appear to be a nest	Good	No		
Ku2K	T	50	Scan	NE	5	Tallowwood	12/01/2022	11:23	Go Pro	N			Nil	Good	No		
Ku2K	T	51	LG	NE	8	Tallowwood	12/01/2022	11:20	Go Pro	N			Nil	Good	No		
Ku2K	T	51	Poss.	NE	5	Tallowwood	12/01/2022	11:21	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	52	Pa	E	10	White Stringybark	12/01/2022	11:18	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	52	SG	NE	4	White Stringybark	12/01/2022	11:13	Go Pro	N			Stripped stringybark	Good	No		
Ku2K	T	53	Scan	SE	5	Tallowwood	12/01/2022	13:07	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	53	SG	SE	8	Tallowwood	12/01/2022	13:06	Go Pro	N	Ants	Pest	Conical euc leaf nest	Good	No		
Ku2K	T	54	LG	SE	9	Red Mahogany	22/02/2022	10:57	Tree Climber	N	Bees	Pest	Nil	Good	No		active hive
Ku2K	T	54	SG	SE	6	Red Mahogany	12-Jan	13:04	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	55	Pa	E	6	Pink Bloodwood	12/01/2022	13:02	Go Pro	N			Conical euc leaf nest	Good	No		
Ku2K	T	55	Scan	E	5	Pink Bloodwood	12-Jan	13:01	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	T	56	Scan	E	8	Brush Box	12/01/2022	12:58	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	56	SG	N	8	Brush Box	12-Jan	12:59	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	57	LG	E	8	Brush Box	12/01/2022	13:11	Go Pro	N			Nil	Good	No		
Ku2K	T	57	MB	N	3	Brush Box	12-Jan	13:13	Go Pro	N			Full of euc leaf	Good	No		
Ku2K	T	62	Co	N	14	Tallowwood	8/03/2022			Not located			Unk				Not found
Ku2K	T	63	LG	NE	10	Small-fruited Grey Gum	8/03/2022	8:30	Tree climber	Y	Common Brushtail Possum	Native	Occupied	Moderate	Replace		Lid hinge broken and det./damp inside.
Ku2K	T	63	SG	E	7	Small-fruited Grey Gum	12/01/2022	13:59	Go Pro	N			Conical euc leaf nest	Good	No		
Ku2K	T	64	LG	N	6	Grey Ironbark	12/01/2022	13:21	Go Pro	N			Nil	Good	No		
Ku2K	T	64	SG	E	10	Grey Ironbark	12/01/2022	13:22	Go Pro	N			Euc leaf	no lid	Replace		
Ku2K	T	65	SO			Tallowwood	12/01/2022	13:25	Go Pro	N			Euc leaf	Good	No		
Ku2K	T	66	SG	N	6	Small-fruited Grey Gum	12/01/2022	13:58	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	66	SO	SE	9	Small-fruited Grey Gum	12/01/2022	13:57	Go Pro	N			Nil	Good	No		
Ku2K	T	67	LFO	E	10	Tallowwood	12/01/2022	13:55	Go Pro	Y	CBT Poss	Native	Occupied	Good	No		
Ku2K	T	67	Poss.	N		Tallowwood	12/01/2022	13:56	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	68	LG	E	12	Tallowwood	8/03/2022	7:50	Tree Climber	N			Nil	Good	No		
Ku2K	T	68	SG	E		Tallowwood	12/01/2022	13:51	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	T	69	MB	N		Pink Bloodwood	12/01/2022	13:46	Go Pro	N			Euc leaf and latrine	Good	No		
Ku2K	T	70	SO	E	13	Tallowwood	12/01/2022	13:49	Go Pro	N			Nil	Good	No		
Ku2K	T	71	LG	E	12	Flooded Gum	8/03/2022	8:14	Tree Climber	N	Ants	Pest	Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	T	71	MB	E		Flooded Gum	12/01/2022	13:41	Go Pro	Not avail			Not avail	broken on ground	Replace		
Ku2K	T	119	LG	N	14	Grey Ironbark	9/03/2022	11:21	Tree Climber	N	Bees	Pest	Nil	Good	No		
Ku2K	T	119	Poss.	SW	8	Grey Ironbark	9/03/2022	11:21	Tree Climber	N			Nil	Good	No		
Ku2K	T	120	Poss.	W	9	Tallowwood	12/01/2022	12:09	Go Pro	N			Nil	Good	No		
Ku2K	T	120	Scan	N	7	Tallowwood	12/01/2022	12:10	Go Pro	Y	Sugar Glider	Native	Occupied	Good	No		
Ku2K	T	121	LG	E	7	Tallowwood	12/01/2022	12:05	Go Pro	N			Euc leaf	Good	No		
Ku2K	T	121	Scan	N	5	Tallowwood	12/01/2022	12:07	Go Pro	N			Nil	Good	No		
Ku2K	T	134	Co	SE	12	Tallowwood	12/01/2022	12:02	Go Pro	N			Nil	Good	No		
Ku2K	T	134	Poss.	W	9	Tallowwood	12/01/2022	12:03	Go Pro	N			Euc leaf	Good	No		
Ku2K	U	37	LFO	NE	15	Flooded Gum	22/02/2022	9:09	Tree Climber	N			Nil	good	No		
Ku2K	U	37	Poss.	E	10	Flooded Gum	22/02/2022	9:08	Tree Climber	Y	Mountain Brushtail Possum	Native	Occupied	Good	Consider rewire - check next inspection.		
Ku2K	U	38	Scan	E	6	Grey Ironbark	17/03/2022	10:19	Go Pro	N			Old leaves	Good	No		
Ku2K	U	38	SG	W	10	Grey Ironbark	17/03/2022	10:18	Go Pro	N			Old leaves	Good	No		
Ku2K	U	39	LG	NE	8	Tallowwood	22/02/2022	9:13	Tree Climber	N			Nil	Good	No		
Ku2K	U	39	Poss.	N	10	Tallowwood	22/02/2022	9:13	Tree Climber	N			Nil	Good	No		
Ku2K	U	40	Pa	NE	6	Grey Ironbark	17/03/2022	10:23	Go Pro	N			Euc leaves	Good	No		
Ku2K	U	40	SG	W	8	Grey Ironbark	17/03/2022	10:23	Go Pro	N			Nil	Good	No		
Ku2K	U	41	MB	N	11	Brush Box	17/03/2022	10:31	Go Pro	N			Nil	Good	No		
Ku2K	U	41	Poss.	E	8	Brush Box	17/03/2022	10:29	Go Pro	Y	Short-eared Brushtail Possum		Occupied	Good	No		
Ku2K	U	42	MB	NE	5	White Mahogany	17/03/2022	9:53	Go Pro	N			Nil	Good	No		
Ku2K	U	42	SO	NE	11	White Mahogany	17/03/2022	9:52	Go Pro	N			Nil	Good	No		
Ku2K	U	43	MB	N	5	Grey Ironbark	17/03/2022	9:48	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	U	43	Pa	SW	8	Grey Ironbark	17/03/2022	9:48	Go Pro	N			Leaves	Good	No		
Ku2K	U	44	Scan	NE	5	White Mahogany	17/03/2022	10:22	Go Pro	N			old leaf	Moderate	Replace		Det. Inside. Check next inspection .
Ku2K	U	44	SG	NE	5	White Mahogany	17/03/2022	10:02	Go Pro	N			Nil	Poor - no lid	Replace		
Ku2K	U	45	LG	E	8	Pink Bloodwood	22/02/2022	10:13	Tree Climber	N			Nil	Good	No		old honeycomb
Ku2K	U	45	SG	N	5	Pink Bloodwood	22/02/2022	10:13	Tree Climber	N	Ants	Pest	Nil	Good	No		
Ku2K	U	46	LG	NE	8	White Mahogany	22/02/2022	10:01	Tree Climber	N			Nil	Poor - lid broken	Fix lid		
Ku2K	U	46	Scan	NE	5	White Mahogany	22/02/2022	10:02	Tree Climber	N			old leaf	Good	No		old honeycomb
Ku2K	U	47	Poss.	SE	8	White Mahogany	17/03/2022	9:44	Go Pro	N			Nil	Good	No		
Ku2K	U	47	Scan	N	5	White Mahogany	17/03/2022	9:46	Go Pro	N			Nil	Good	No		
Ku2K	U	93	Poss.	S	10	White Mahogany	17/03/2022	9:56	Go Pro	N			Bark and leaves	Good	No		
Ku2K	U	93	Scan	NE	5	White Mahogany	17/03/2022	9:57	Go Pro	N			Nil	Good	No		
Ku2K	V	31	Scan	N	6	Tallowwood	17/03/2022	8:25	Go Pro	N			Nil	Good	No		Branch making inspection difficult
Ku2K	V	31	SG	N	10	Tallowwood	17/03/2022	8:26	Go Pro	N			Nil	Good	No		
Ku2K	V	32	Pa	N	9	Small-fruited Grey Gum	17/03/2022	8:28	Go Pro	N			Nil	Good	No		
Ku2K	V	32	SG	S	7	Small-fruited Grey Gum	17/03/2022	8:27	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	V	33	MB	W	5	Grey Ironbark	17/03/2022	8:33	Go Pro	N			Nil	Good	No		
Ku2K	V	33	Scan	E	6	Grey Ironbark	17/03/2022	8:31	Go Pro	N			Conical euc nest	Good	No		
Ku2K	V	34	Poss.	N	6	Tallowwood	17/03/2022	8:41	Go Pro	N			leaf	Good	No		
Ku2K	V	34	SG	NE	10	Tallowwood	17/03/2022	8:42	Go Pro	Not avail			old bird nest- feathers/egg shell	Poor - no lid	Replace		
Ku2K	V	35	MB	W	5	Scribbly Gum	17/03/2022	8:45	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	V	35	Pa	N	9	Scribbly Gum	17/03/2022	8:46	Go Pro	N			Nil	Good	No		
Ku2K	V	36	Poss.	N	8	Pink Bloodwood	17/03/2022	8:50	Go Pro	N			Nil	Good	No		
Ku2K	V	36	Scan	E	6	Pink Bloodwood	17/03/2022	8:49	Go Pro	N			Euc leaf	Good	No		
Ku2K	V	126	LG	NW	9	White Stringybark	9/03/2022	11:37	Tree Climber	N	Bees	Pest	Nil	Good	No		
Ku2K	V	126	Poss.	E	6	White Stringybark	9/03/2022	11:37	Tree Climber	N			Nil	Good	No		
Ku2K	V	127	LG	SW	9	Small-fruited Grey Gum	17/03/2022	8:17	Not inspected	Unk			Unk	Good	No		
Ku2K	V	127	Scan	SW	7	Small-fruited Grey Gum	17/03/2022	8:16	Go Pro	N			Euc nest	Good	No		
Ku2K	V	128	Poss.	W	12	Small-fruited Grey Gum	17/03/2022	8:13	Go Pro	N			conical euc nest	Good	No		
Ku2K	V	128	Scan	N	5	Small-fruited Grey Gum	17/03/2022	8:13	Go Pro	N			Nil	Good	No		
Ku2K	V	133	LFO	N	12	Grey Ironbark	17/03/2022	8:53	Go Pro	N			Nil	Good	No		
Ku2K	V	133	SG	N	8	Grey Ironbark	17/03/2022	8:52	Go Pro	N			euc leaves	Good	No		
Ku2K	W	112	MB	E	10	Bancrofts Red Gum	11/01/2022	9:09	Go Pro	N			Nil	Good	No		
Ku2K	W	112	Scan	NW	4	Bancroft's Red Gum	11/01/2022	9:10	Go Pro	N			euc leaf and honeycomb	Good	No		
Ku2K	W	113	LG	W	10	Bancrofts Red Gum	9/3/12:16	12:16	Tree Climber	N			Nil	Good	No		Old beehive

Section	Zone/cluster	Box # / NBT	Box type	Orientati on (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/ Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	W	113	Scan	W	6	Bancrofts Red Gum	11/01/2022	9:06	Go Pro	N			Euc leaf	Good	No		
Ku2K	W	114	Poss.	W	10	Grey Ironbark	11/01/2022	9:03	Go Pro	N			leaf and bark	Good	No		
Ku2K	W	114	Scan	NW	6	Grey Ironbark	11/01/2022	9:01	Go Pro	N			Nil	Good	No		
Ku2K	W	115	Pa	NW	6	White Mahogany	11/01/2022	8:57	Go Pro	N			Nil	Good	No		
Ku2K	W	115	Poss.	W	8	White Mahogany	11/01/2022	8:58	Go Pro	Y	CBT Poss	Native	Occupied	Good	No		
Ku2K	W	116	Poss.	W	14	Grey Ironbark	11/01/2022	8:40	Go Pro	N			Nil	Good	No		
Ku2K	W	116	Scan	S	8	Grey Ironbark	11/01/2022	8:50	Go Pro	N			Conical euc nest	Good	No		
Ku2K	W	117	Poss.	SW	13	Small-fruited Grey Gum	11/01/2022	8:32	Go Pro	Y	Starling	Pest	Occupied	Good	No		
Ku2K	W	117	SG	SW	10	Small-fruited Grey Gum	11/01/2022	8:34	Go Pro	Y	Sugar Glider	Native	Occupied	Good	No		
Ku2K	W	118	MB	S	8	Bancrofts Red Gum	11/01/2022	8:27	Go Pro	N			Nil	Good	No		
Ku2K	W	118	Scan	S	10	Bancrofts Red Gum	11/01/2022	8:22	Go Pro	Y	Sugar Glider	Native	Occupied	Good	No		
Ku2K	W	129	MB	SW	8	Tallowwood	17/03/2022	9:26	Go Pro	N			Nest	Good	No		
Ku2K	W	129	Poss.	NE	9	Tallowwood	17/03/2022	9:27	Go Pro	N			Stick nest	Good	No		
Ku2K	W	130	MB	SW	10	White Mahogany	17/03/2022	9:23	Go Pro	N			Euc leaf nest	Good	No		
Ku2K	W	130	Poss.	E	6	White Mahogany	17/03/2022	9:24	Go Pro	N			stick nest and rubbish	Good	No		
Ku2K	W	131	MB	S	8	Small-fruited Grey Gum	17/03/2022	9:19	Go Pro	N			Conical euc nest	Good	No		
Ku2K	W	131	Poss.	E	9	Small-fruited Grey Gum	17/03/2022	9:19	Go Pro	N			Stick nest	Good	No		
Ku2K	X	26	Pa	S	8	White Mahogany	11/01/2022	14:47	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	X	26	SG	S	6	White Mahogany	11/01/2022	14:47	Go Pro	N			Nil	Good	No		
Ku2K	X	27	Pa	NE	7	Pink Bloodwood	11/01/2022	14:45	Go Pro	N			Nil	Good	No		Wasp nest
Ku2K	X	27	Scan	NE	5	Pink Bloodwood	11/01/2022	14:45	Go Pro	N	Ants	Pest	Old leaf	Good	No		
Ku2K	X	28	MB	N	5	White Stringybark	11/01/2022	14:42	Go Pro	N			Euc nest	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	X	28	Poss.	E	6	White Stringybark	11/01/2022	14:42	Go Pro	N			Nil	Good	No		
Ku2K	X	29	Co			Coastal Blackbutt			DNE								
Ku2K	X	30	LFO			Small-fruited Grey Gum			DNE								
Ku2K	X	30	Poss.			Small-fruited Grey Gum			DNE								
Ku2K	X	80	LG	SE	10	Coastal Blackbutt	11/01/2022	14:31	Visual	Unk			Unk	Good	No		Not checked rear facing box.
Ku2K	X	80	SG	E	8	Coastal Blackbutt	11/01/2022	14:31	Go Pro	N			Euc nest	Good	No		
Ku2K	X	81	MB	S	8	Pink Bloodwood	11/01/2022	14:27	Go Pro	N			Nil	Good	No		
Ku2K	X	81	Pa	SE	10	Pink Bloodwood	11/01/2022	14:27	Go Pro	N			Nil	Good	No		
Ku2K	X	82	Poss.	NW	11	Turpentine	11/01/2022	14:20	Go Pro	N			Nil	Good	No		
Ku2K	X	82	SG	NE	9	Turpentine	11/01/2022	14:40	Go Pro	N			Euc leaf	Good	No		
Ku2K	X	83	LG	S	12	Coastal Blackbutt	22/02/2022	7:30	Tree Climber	N			Nil	Good	No		Honeycomb
Ku2K	X	83	Pa	N	10	Coastal Blackbutt	11/01/2022	14:37	Go Pro	N			Nil	Good	No		
Ku2K	X	84	Pa	W	10	White Stringybark	11/01/2022	14:33	Go Pro	N			old leaf	Good	No		
Ku2K	X	84	Scan	N	7	White Stringybark	11/01/2022	14:33	Go Pro	N			Nil	Good	No		Insect nest
Ku2K	X	101	Co	E		Coastal Blackbutt	22/02/2022	8:05	Tree Climber	N			Nil	Poor- bottom fallen out	Replace		
Ku2K	X	101	Poss.	E	14	Coastal Blackbutt	17/03/2022	9:09	Go Pro	N			Euc nest	Good	No		
Ku2K	X	102	LFO	S		Coastal Blackbutt	22/02/2022	8:01	Tree Climber	N			Nil	Good	No		
Ku2K	X	102	Poss.	W		Coastal Blackbutt	22/02/2022	8:00	Tree Climber	N			Euc nest	Good	No		
Ku2K	X	103	Co	N	15	Coastal Blackbutt	22/02/2022	8:22	Tree Climber	Y	Common Brushtail Possum	Native	Occupied	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	X	103	Poss.	N	12	Coastal Blackbutt	22/02/2022	8:21	Tree Climber	N			Nil	Poor - Wire double wrapped on tree and broken lid.	No - fixed in winter.		
Ku2K	X	132	Co		DNE?	Turpentine			DNE								
Ku2K	Y	16	MB	S	10	Coastal Blackbutt	11/01/2022	13:11	Go Pro	N			Nil	Good	No		
Ku2K	Y	16	Pa	E	13	Coastal Blackbutt	11/01/2022	13:10	Go Pro	N			Nil	Good	No		
Ku2K	Y	17	Pa	NW	10	Grey Ironbark	11/01/2022	12:54	Go Pro	N			Nil	Good	No		
Ku2K	Y	17	Scan	SW	6	Grey Ironbark	11/01/2022	12:51	Go Pro	N			Nil	Good	No		
Ku2K	Y	18	LG	SE	10	Tallowwood	11/01/2022	13:04	Go Pro	N	Bees	Pest	Nil	Good	No		
Ku2K	Y	18	Scan	E	7	Tallowwood	11/01/2022	13:03	Go Pro	N			Nil	Good	No		
Ku2K	Y	19	Scan	W	6	Pink Bloodwood	11/01/2022	13:00	Go Pro	N			Nil	Good	No		
Ku2K	Y	19	SO	N	13	Pink Bloodwood	11/01/2022	12:59	Go Pro	N			Nil	Good	No		
Ku2K	Y	20	Scan	SW	8	White Mahogany	11/01/2022	13:18	Go Pro	N			euc leaf nest	Good	No		
Ku2K	Y	20	SG	N	10.5	White Mahogany	11/01/2022	13:19	Go Pro	N	Ants	Pest	Nil	Good	No		
Ku2K	Y	21	Poss.			White Mahogany			DNE								
Ku2K	Y	21	SG			White Mahogany			DNE								
Ku2K	Y	22	Pa	SE	11	Grey Ironbark	11/01/2022	13:25	Go Pro	N			Nil	Good	No		
Ku2K	Y	22	Scan	S	8	Grey Ironbark	11/01/2022	13:23	Go Pro	N			euc leaf	Good	No		
Ku2K	Y	23	LG			White Mahogany			DNE								
Ku2K	Y	23	Poss.			White Mahogany			DNE								
Ku2K	Y	24	Co	NE	14	Coastal Blackbutt	21/02/2022	13:59	Tree Climber	N			Nil	Good	No		
Ku2K	Y	24	Poss.	E	10	Coastal Blackbutt	21/02/2022	13:59	Tree Climber	N			Nil	Good	No		
Ku2K	Y	25	LFO	NE	13	Scribbly Gum	11/01/2022	13:58	Go Pro	N			Nil	Good	No		
Ku2K	Y	25	Poss.	S	8	Scribbly Gum	11/01/2022	13:54	Go Pro	N			Nil	Good	No		
Ku2K	Y	85	Poss.			Coastal Blackbutt	11/01/2022	12:42	Go Pro	N			Scattered euc leaf	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientati on (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/ Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	Y	85	Scan			Coastal Blackbutt	11/01/2022	12:46	Go Pro	N			bark	Good	No		
Ku2K	Y	86	LG			Red Mahogany	21/02/2022	12:50	Tree Climber	N			Nil	Good	No		
Ku2K	Y	86	MB			Red Mahogany	21/02/2022	12:50	Tree Climber	N			Nil	Good	No		
Ku2K	Y	87	MB	S	12	Grey Ironbark	11/01/2022	13:45	Go Pro	N			Nil	Good	No		
Ku2K	Y	87	SG	SW	9	Grey Ironbark	11/01/2022	13:45	Go Pro	N			Old euc leaf nest	Good	No		
Ku2K	Y	88	LG	N	12	Red Mahogany	21/02/2022	13:28	Tree Climber	N			Nil	Good	No		Honeycomb
Ku2K	Y	88	SG	N	9	Red Mahogany	21/02/2022	13:28	Tree Climber	N			Old leaves mouldy	Good	No		
Ku2K	Y	89	LG	SE	17	Red Mahogany			Not accessible	Unk			Unk				Dead Tree
Ku2K	Y	89	Poss.	SE	10	Red Mahogany	11/01/2022	13:40	Go Pro	N			Nil	Good	No		Dead Tree
Ku2K	Z	10	LG	SW	14	Coastal Blackbutt	21/02/2022	10:18	Tree Climber	N			Euc leaves	Good	No		
Ku2K	Z	10	Pa	SW	12	Coastal Blackbutt	21/02/2022	10:19	Tree Climber	N			Nil	Good	No		
Ku2K	Z	11	MB	E	8	White Stringybark	11/01/2022	11:41	Go Pro	N			Nil	Good	No		Dead Tree
Ku2K	Z	11	Poss.	E	10	White Stringybark	11/01/2022	11:42	Go Pro	N			Nil	Good	No		Dead Tree
Ku2K	Z	12	Pa	NW	11	White Mahogany	11/01/2022	12:05	Go Pro	N			Nil	Good	No		
Ku2K	Z	12	Scan	NE	9	White Mahogany	11/01/2022	12:06	Go Pro	N			Nil	Good	No		
Ku2K	Z	13	Poss.	E	12	White Mahogany	11/01/2022	11:50	Go Pro	N			Nil	Good	No		
Ku2K	Z	13	SG	SW	10	White Mahogany	11/01/2022	11:51	Go Pro	N			Euc leaf nest	Good	No		
Ku2K	Z	14	LG	N	8	Pink Bloodwood	11/01/2022	11:44	Go Pro	N			Nil	Good	No		Dead Tree
Ku2K	Z	14	MB	S	6	Pink Bloodwood	11/01/2022	11:45	Go Pro	N			Nil	Good	No		Dead Tree
Ku2K	Z	15	Pa	E	10	Pink Bloodwood	11/01/2022	11:47	Go Pro	N			Nil	Good	No		
Ku2K	Z	15	Scan	E	5	Pink Bloodwood	11/01/2022	11:46	Go Pro	N			Nil	Good	No		
Ku2K	Z	104	LG	NE	11	Red Mahogany	9/03/2022	13:05	Tree Climber	N			Nil	Moderate	No		Mouldy inside.
Ku2K	Z	104	Scan	S	7	Red Mahogany	11/01/2022	9:56	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	Z	105	Poss.	S	11	White Mahogany	11/01/2022	9:58	Go Pro	N			old leaf	Good	No		
Ku2K	Z	105	Scan	E	6	White Mahogany	11/01/2022	9:58	Go Pro	N			Nil	Good	No		
Ku2K	Z	106	Poss.	NW	9	Coastal Blackbutt	11/01/2022	10:03	Go Pro	N			Nil	Good	No		
Ku2K	Z	106	SG	E	7	Coastal Blackbutt	11/01/2022	10:03	Go Pro	N			Nil	Good	No		
Ku2K	Z	107	LG	N	18	White Mahogany	11/01/2022	10:03	Visual	Unk			Unk	Good	No		Not checked dead tree.
Ku2K	Z	107	Poss.	E	15	White Mahogany	11/01/2022	10:03	Visual	Unk			Unk	Good	No		Not checked dead tree.
Ku2K	Z	108	Poss.	NW	13	Coastal Blackbutt	21/02/2022	11:14	Tree Climber	N			Nil	Good	No		
Ku2K	Z	108	SG	N	8	Coastal Blackbutt	21/02/2022	11:41	Tree Climber	N			Nil	Good	No		
Ku2K	Z	109	LG		15	Coastal Blackbutt	21/02/2022	10:56	Tree Climber	N			Nil	Good	No		Old beehive
Ku2K	Z	109	Scan			Coastal Blackbutt	21/02/2022	10:56	Tree Climber	N			Fresh euc leaf nest	Good	No		
Ku2K	Z	110	Poss.	SE	10	Red Mahogany	21/02/2022	11:05	Tree Climber	N			Leaf litter	Good	No		
Ku2K	Z	110	SG	SE	8	Red Mahogany	21/02/2022	11:04	Tree Climber	N			Conical leaf nest	Good	No		
Ku2K	Z	111	LG	SW	18	Red Mahogany	21/02/2022	11:50	Tree Climber	N			Nil	Good	No		
Ku2K	Z	111	SG	SW	12	Red Mahogany	21/22/22	11:50	Tree Climber	N			Conical euc nest	Good	No		
Ku2K	Z	122	Poss.			Tallowwood	11/01/2022	10:19	Go Pro	N			Nil	Good			
Ku2K	Z	122	Scan			Tallowwood	11/01/2022	10:19	Go Pro	N			Nil	Good			
Ku2K	Z	123	LG	SE	15	White Stringybark	9/03/2022	13:14	Tree Climber	N			Nil	Good	No		Old beehive. No hose on wire/tree.
Ku2K	Z	123	SG	W	9	White Stringybark	11-Jan	10:17	Go Pro	N			Nil	Good			No hose.

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
Ku2K	Z	124	LG	W	12	Small Fruited Grey Gum	9/03/2022	13:33	Tree Climber	N			Nil	Good	No		No hose on wire/tree.
Ku2K	Z	124	Scan	W	10	Small Fruited Grey Gum	9/03/2022	13:33	Tree Climber	Y	Sugar Glider-check photo	Native	Occupied	Good	No		No hose on wire. Box approx. 20x20cm size.
Ku2K	Z	125	Scan	W	12	Coastal Blackbutt	9/03/2022	14:29	Tree Climber	N			Nil	Good	No		No hose on wire/tree.
Ku2K	Z	125	SG	S	16	Coastal Blackbutt	9/03/2022	14:29	Tree Climber	N			Nil	Good	No		No hose on wire/tree.
Ku2K	z	132	Co	E	12	Tallowood	9/03/2022	14:29	Tree Climber	N			Nil	Moderate	No		Heavy box only heald by 1 wire. Wire cutting into tree.
OH2Ku	A1	165	Scan	E	5	Mahog spp	10/03/2022	8:10	Go Pro	N			Nil	Good	No	Post fire	New Box
OH2Ku	A1	180	SG	N	7	Tallow	10/03/2022	8:10	Go Pro	N			Nil	Good	No	Post fire	New Box
OH2Ku	A1	181	Poss.	NE	7	Mele spp.	10/03/2022	8:12	Go Pro	N			Nil	Good	No	Post fire	New Box
OH2Ku	A1	182	Poss.	E	7	P. Bloodwood	10/03/2022	8:08	Go Pro	N			Nil	Good	No	Post fire	New Box
OH2Ku	A1	380	LG	NE	10	Blackbutt	10/03/2022	8:12	Go Pro	N			Nil	Good	No	Post fire	New Box
OH2Ku	A2	172	Scan	E	5	Tallow	10/03/2022	8:22	Go Pro	N			Euc conical leaf nest	Good	No	Post fire	
OH2Ku	A2	173	SG	NE	7	Mahog spp	10/03/2022	8:18	Go Pro	N			Nil	Good	No	Post fire	
OH2Ku	A2	174	LG	E	10	Red Mahog	8/03/2022	14:30	Tree Climber	N			Nil	Lid broken	Replace	Post fire	
OH2Ku	A2	176	Parr	NE	8	Blackbutt	10/03/2022	8:25	Go Pro	N			Nil	Good	No	Post fire	New Box
OH2Ku	A2	178	SO	E	10	Red Mahog	10/03/2022	8:22	Go Pro	N			Nil	Good	No	Post fire	

Section	Zone/cluster	Box # / NBT	Box type	Orientati on (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/ Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	A2	186	Poss.	N	8	Red Mahog	10/03/2022	8:26	Go Pro	N			Nil	Good	No	Post fire	New Box
OH2Ku	A3	179	Scan	NE	5	Stringybark	10/03/2022	9:23	Go Pro	N			Old leaves	Good	No		
OH2Ku	A3	380	Scan	NE	5	Stringybark	10/03/2022	9:19	Go Pro	N			Euc conical leaf nest	Moderate	No		
OH2Ku	A3	381	SG	NE	6	Blackbutt	10/03/2022	9:27	Go Pro	Y	Sugar Glider		Occupied	Good	No		
OH2Ku	A3	382	Parrot	NE	8	Blackbutt	10/03/2022	9:28	Go Pro	Y	Common Brushtail Possum		Occupied	Good	No		
OH2Ku	A3	383	Poss.	E	6	Blackbutt	10/03/2022	9:20	Go Pro	N			Nil	Poor	Replace		Damp and rotting inside.
OH2Ku	A3	384	Cockatoo	NE	12	Blackbutt	8/03/2022	14:12	Tree Climber	Y	Common Brushtail Possum	Native	Occupied	Good	No		
OH2Ku	A4	183	Scan	NE	5	Turpentine	10/03/2022	8:28	Go Pro	N	Ants	Pest	Leaves	Good	No		
OH2Ku	A4	184	SG	ENE	6	Tallowwood	10/03/2022	8:35	Go Pro	N			Old leaves	Good	No		
OH2Ku	A4	185	Poss.	NE	8	Stringybark	10/03/2022	8:32	Go Pro	N			Nil	Poor	Replace		Lid damaged. Deteriorated inside.
OH2Ku	A4	186	LG	NE	8	Stringybark	10/03/2022	8:31	Go Pro	N			Nil	Poor	Replace		Deteriorated inside. Damp/mouldy
OH2Ku	A4	187	Parr	NE	8	Tallowwood	10/03/2022	8:36	Go Pro	N			Nil	Good	No		
OH2Ku	A5	168	LG	NE	8	Blackbutt	8/03/2022	15:30	Tree Climber	N	Bees	Pest	Nil	Good	No		Recent inactive beehive
OH2Ku	A5	171	Small owl	NE	12	Blackbutt	8/03/2022	15:00	Tree Climber	N			Nil	Poor	Replace		Lid broken, wire cutting

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
																	into tree. Old honeycomb.
OH2Ku	A5	188	Scan	NE	5	Tallowwood	10/03/2022	8:45	Go Pro	N			Conical nest	Good	No		
OH2Ku	A5	189	SG	E	8	Bloodwood	10/03/2022	8:52	Go Pro	N			Euc leaf	Moderate	Slight det. Check next inspection.		
OH2Ku	A5	190	SG	E	9	Bloodwood	10/03/2022	8:59	Go Pro	N			Nil	Good	No		
OH2Ku	A5	191	Poss.	NE	7	Tallowwood	10/03/2022	8:46	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No		
OH2Ku	B1	397	SG	NE	7	Tallowwood	17/02/2022	9:33	Go Pro	N			Euc leaf	Good	No		
OH2Ku	B1	398	Poss.	N	8	Tallowwood	17/02/2022	9:32	Go Pro	N			Euc leaf	Good	No		
OH2Ku	B1	399	Scan	NE	5	Tallowwood	17/02/2022	9:30	Go Pro	N			euc leaf nest	Good	No		
OH2Ku	B1	400	Parr	NE	7	Grey gum	17/02/2022	9:22	Go Pro	N			Nil	Good	No		
OH2Ku	B1	401	Scan	N	6	Red mahogany	17/02/2022	9:24	Go Pro	Y	Sugar Glider x3	Native	Occupied	Good	No		
OH2Ku	B1	402	Poss.	NE	7	Wh stringy	17/02/2022	9:19	Go Pro	N			Nil	Good	No		
OH2Ku	B1	403	MB	NE	5	Tallowwood	17/02/2022	9:13	Go Pro	N			Nil	Good	No		
OH2Ku	B2	167	SG			Blackbutt	17/02/2022	9:03	Go Pro	N	Bees	Pest	Nil	Good	No		Lid stuck
OH2Ku	B2	404	SG	N	6	P. Bloodwood	17/02/2022	9:09	Go Pro	N			Old Euc nest	Good	No		
OH2Ku	B2	405	Scan	N	5	Blackbutt	17/02/2022	8:56	Go Pro	N			Euc leaf	Poor	Replace		Lid broken
OH2Ku	B2	406	LG	E	8	Tallowwood	17/02/2022	9:07	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No		
OH2Ku	B2	407	Cock	NNW	13	P. Bloodwood	9/03/2022	8:30	Tree Climber	Y	Common Brushtail Possum	Native	Occupied	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientati on (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/ Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	B2	408	Poss. Add	N	7	P. Bloodwood	17/02/2022	9:02	Go Pro	N			Nil	Good	No		
OH2Ku	C1	222	SG	NE	7	Sw mahog	10/03/2022	11:38	Go Pro	N			Euc nest	Good	No		
OH2Ku	C1	223	Poss.	NE	8	Sw mahog	10/03/2022	11:42	Go Pro	N			Nil	Moderate	No		Damp inside
OH2Ku	C1	224	Scan	E	7	Melaleuca sp.	10/03/2022	11:35	Go Pro	N			Nil	Good	No		
OH2Ku	C1	225	LG	E	8	Sw mahog	10/03/2022	11:30	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No		
OH2Ku	C1	226	Parr	E	6	Sw mahog	10/03/2022	11:48	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	C2	216	LG	E	9	Sw mahog	10/03/2022	11:56	Go Pro	N			Nil	Poor	Replace		Det. Inside
OH2Ku	C2	217	Parr	E	7	Sw mahog	10/03/2022	11:52	Go Pro	N	Bees	Pest	Nil	Moderate	No		
OH2Ku	C2	218	Poss.	E	6	Melaleuca quinquenervia	10/03/2022	12:02	Go Pro	N			Nil	Moderate	No		
OH2Ku	C2	219	SG	NE	7	Sw mahog	10/03/2022	11:58	Go Pro	N			Euc leaf	Poor	Replace		Lid broken
OH2Ku	C2	220	Scan	N	5	Melaleuca spp.	10/03/2022	12:05	Go Pro	Y	Sugar Glider	Native	Occupied	Good	No		
OH2Ku	C2	221	LG	N	9	Blackbutt	10/03/2022	11:51	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No		
OH2Ku	C3	227	Poss.	NE	8	Melaleuca quinquenervia	10/03/2022	11:23	Go Pro	N			Nil	Good	No		
OH2Ku	C3	228	SG	NE	7	Melaleuca quinquenervia	10/03/2022	11:24	Go Pro	Y	Ringtail Possum	Native	Occupied	Good	No		
OH2Ku	C3	229	Scan	E	6	Melaleuca quinquenervia	10/03/2022	12:17	Go Pro	N			Old leaf	Good	No		
OH2Ku	D1	355	LG	NE	10	Blackbutt	10/03/2022	10:45	Go Pro	N			Nil	Poor - no lid	Replace		
OH2Ku	D1	356	Poss.	NE	8	Stringybark?	10/03/2022	10:40	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	D1	357	SG	N	7	Stringybark?	10/03/2022	10:42	Go Pro	Y	Antechinus	Native	Occupied	Good	No		
OH2Ku	D1	358	PARR	NE	8	Tallow	10/03/2022	10:44	Go Pro	N			Nil	Poor - no lid	Replace		
OH2Ku	D1	359	Scan	E	5	Melaleuca. quinn.	10/03/2022	10:39	Go Pro	N			Leaf nest	Moderate	No		
OH2Ku	D2	360	SG	NE	5	Bloodwood	10/03/2022	10:36	Go Pro	N			Euc nest	Good	No		
OH2Ku	D2	361	Poss.	E	8	Stringybark	10/03/2022	10:31	Go Pro	Y	Common Brushtail Possum	Native	Leaf nest	Moderate	No		Ageing box
OH2Ku	D2	362	Scan	N	6	Bloodwood	10/03/2022	10:30	Go Pro	N			Nil	Poor - no lid	Replace		
OH2Ku	D2	363	MB	NW	5	Stringybark	10/03/2022	10:34	Go Pro	N			Nil	Good	No		
OH2Ku	D2	364	SG	NE	8	Red Mahog	10/03/2022	10:32	Go Pro	Y	Antechinus	Native	Occupied	Moderate	No		
OH2Ku	D3	365	SG	NE	7	Blackbutt	10/03/2022	10:26	Go Pro	Y	Antechinus	Native	Occupied	Moderate	No		Box ageing
OH2Ku	D3	366	Scan	NE	5	Bloodwood	10/03/2022	10:24	Go Pro	N			Old leaves	Deteriorated inside. Damp/mouldy	No		Mouldy inside
OH2Ku	D3	367	Parr	N	8	Bloodwood?	10/03/2022	10:21	Go Pro	N			Nil	Deteriorated inside. Damp/mouldy	No		
OH2Ku	D3	368	Pos	NE	8	Bloodwood	10/03/2022	10:22	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No		
OH2Ku	D3	378	SG	NE	8	Wh stringy?	10/03/2022	10:20	Go Pro	N			Old euc leaf	Moderate	No		
OH2Ku	D4	369	Parr	NE	8	Bloodwood	10/03/2022	9:53	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No		
OH2Ku	D4	371	Scan	NE	5	Blackbutt	10/03/2022	9:52	Go Pro	N			Euc nest	Moderate	No		
OH2Ku	D4	372	LG	N	10	Blackbutt	10/03/2022	9:55	Go Pro	Not avail			Not avail	Poor	Replace		No lid of bottom left.

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	D4	373	Poss.	N	8	Blackbutt	10/03/2022	9:57	Go Pro	N			Nil	Moderate	Det. Check next inspection.		Det./damp/mouldy inside
OH2Ku	D4	376	SG	NE	7	Blackbutt	10/03/2022	10:00	Go Pro	N			Old euc nest	Moderate	Det. Check next inspection.		Det./damp/mouldy inside
OH2Ku	D5	374	Poss.	NW	7	Bloodwood	10/03/2022	10:11	Go Pro	N			Nil	Moderate	Det. Check next inspection.		Det./damp/mouldy inside
OH2Ku	D5	375	Scan	E	5	Swamp Mahog	10/03/2022	10:14	Go Pro	N			Nil	Poor	Replace		Det./damp/mouldy inside
OH2Ku	D5	377	LG	E	10	Blackbutt	10/03/2022	10:07	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No		Det./damp/mouldy inside
OH2Ku	D5	378	MB	NW	7	Blackbutt	10/03/2022	10:06	Go Pro	N			Nil	Good	No		
OH2Ku	D5	379	Parr	NE	8	Blackbutt	10/03/2022	10:10	Go Pro	Y	Brushtail Possum	Native	Occupied	Good	No		Possible short-eared BP.
OH2Ku	E1	200	SO	NE	9	Blackbutt	17/02/2022	10:49	Go Pro	N			Nil	Good	No		
OH2Ku	E1	201	SG	N	7	Blackbutt	17/02/2022	10:44	Go Pro	N	Bees	Pest	Nil	Poor	Replace		
OH2Ku	E2	198	Parr	NE	9	Blackbutt	17/02/2022	10:57	Go Pro	N			Nil	Good	No		
OH2Ku	E2	199	Poss.	N	8	Blackbutt	17/02/2022	10:54	Go Pro	N			Euc nest	Good	No		
OH2Ku	E3	193	SG	NE	7	Bloodwood	17/02/2022	11:13	Go Pro	N			Euc nest	Good	No		
OH2Ku	E3	194	MB	N	8	Ironbark	17/02/2022	11:17	Go Pro	N			Nil	Good	No		
OH2Ku	E3	195	Poss. add	NE	8	Tallow	17/02/2022	11:07	Go Pro	N			Nil	Good	No		
OH2Ku	E3	196	Scan	N	5.5	Bloodwood	17/02/2022	11:05	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	E3	274	Cockatoo	NE	10	Blackbutt	8/03/2022	12:57	Tree Climber	N			Nil	Moderate	No		Lid wedged

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
																	against tree.
OH2Ku	F1	160	SO	N	7	Blackbutt	17/03/2022	14:00	Go Pro	N			Nil	Good	No		
OH2Ku	F1	161	Poss.	E	8	Bloodwood	17/03/2022	14:00	Go Pro	N			Old leaf	Good	No		
OH2Ku	F1	162	LFO	ESE	15	Blackbutt	8/03/2022	13:40	Tree Climber	N			Nil	Good	No		
OH2Ku	F1	166	Scan	NE	7	Turpentine	17/03/2022	14:30	Go Pro	N			euc leaf	Good	No		
OH2Ku	F1	504	SG	NE	6	P. Bloodwood	17/03/2022	14:30	Go Pro	N			euc nest	Good	No		
OH2Ku	F2	163	Poss.	N	7	Tallowwood	17/03/2022	14:30	Go Pro	N			Nil	Good	No		
OH2Ku	F2	164	SG	NE	7	Pink Bloodwood	17/03/2022	14:30	Go Pro	N			old leaf	Good	No		
OH2Ku	G1	197	LG	NE	10	Blackbutt	17/03/2022	13:13	Go Pro	N			old leaf	Moderate	No		Old beehive
OH2Ku	G1	202	MB	N	6	Tallow	17/03/2022	13:22	Go Pro	N			Nil	Good	No		
OH2Ku	G1	203	Poss.	N	8	Bloodwood	17/03/2022	13:23	Go Pro	N			old leaf	Good	Repostion		
OH2Ku	G1	204	Scan	NE	5	Sw mahog	17/03/2022	13:25	Go Pro	N			old leaf	Good	No		
OH2Ku	G1	206	SG	N	6	Sw Mahog	17/03/2022	13:19	Go Pro	N			old leaf	Moderate	No	Det. Inside	
OH2Ku	G2	211	LG	NE	10	Blackbutt	17/03/2022	13:07	Go Pro	N			old leaf	Good	No		
OH2Ku	G2	212	Poss.	NE	8	Blackbutt	17/03/2022	12:57	Go Pro	N			old leaf	Moderate	No		
OH2Ku	G2	213	Parr	N	8	White Stringybark	17/03/2022	13:04	Go Pro	N			Nil	Good	No		
OH2Ku	G2	214	SG	N	8	White Stringybark	17/03/2022	12:59	Go Pro	N			Nil	Moderate	No		old ant nest
OH2Ku	G2	215	Scan	N	5	White Stringybark	17/03/2022	13:08	Go Pro	N			Nil	Poor - lid broken	Replace		
OH2Ku	G3	206	Poss.	E	8	Stringybark sp.	17/03/2022	13:36	Go Pro	N			Nil	Good	No		
OH2Ku	G3	207	SG	NE	6	Mahog sp	17/03/2022	13:31	Go Pro	N			old leaf	Poor - lid broken	Replace		
OH2Ku	G3	208	LG	NE	8	Stringybark sp.	17/03/2022	13:33	Go Pro	N			Nil	Poor - lid broken	Replace		
OH2Ku	G3	209	Scan	E	5	Mahog sp	17/03/2022	13:30	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	G3	210	SO	E	10	Blackbutt	17/03/2022	13:39	Go Pro	N			Nil	Poor - lid broken	Replace		
OH2Ku	H1	385	LG	NE	10	Blackbutt	17/02/2022	13:38	Go Pro	N			Nil	Poor	Replace		
OH2Ku	H1	386	SG	E	7	Blackbutt	17/02/2022	13:43	Go Pro	N			Nil	Poor	Replace		
OH2Ku	H1	387	Parr	NE	8	Blackbutt	17/02/2022	13:44	Go Pro	N			Nil	Poor	Replace		
OH2Ku	H1	388	Poss.	NE	8	Blackbutt	17/02/2022	13:40	Go Pro	N			Old leaves	Good	No		
OH2Ku	H2	389	MB	NW	7	Tallowwood	17/02/2022	13:34	Go Pro	N			Nil	Good	No		
OH2Ku	H2	390	SG	NE	6	Tallowwood	17/02/2022	13:31	Go Pro	N			Old leaves	Good	No		
OH2Ku	H2	391	LG	NE	10	Blackbutt	17/02/2022	13:34	Go Pro	N			Old leaves	Good	No		
OH2Ku	H2	392	SG	NE	6	Blackbutt	17/02/2022	13:33	Go Pro	N			Old leaves	Good	No		
OH2Ku	H3	393	Cock	NE	12	Blackbutt	8/03/2022	11:30	Tree Climber	N			Nil	Poor	Replace		Lid broken
OH2Ku	H3	394	Poss.	NE	6	Blackbutt	17/02/2022	13:54	Go Pro	N			Nil	Good	No		
OH2Ku	H3	395	SG	NE	6	Turpentine	17/02/2022	13:19	Go Pro	N			Nil	Good	No		
OH2Ku	H3	396	LG	NE	10	Blackbutt	17/02/2022	13:16	Go Pro	N			Old leaves	Good	No		
OH2Ku	I1	290	Scan	N	6	Sw. Mahog	17/02/2022	12:22	Go Pro	N	Ants	Pest	Nil	Good	No		
OH2Ku	I1	292	SG	N	8	P. Bloodwood	17/02/2022	12:14	Go Pro	N	Insect	Pest	Nil	Good	No		
OH2Ku	I1	293	SG	E	8	Sw. Mahog	17/02/2022	12:21	Go Pro	N	Ants	Pest	Old leaves	Good	No		
OH2Ku	I1	294	Poss.	NE	7	Sw. Mahog	17/02/2022	12:16	Go Pro	N			Nil	Good	No		
OH2Ku	I2	288	LG	NE	10	Wh. Stringybark	17/02/2022	12:54	Go Pro	N			Nil	Good	No		
OH2Ku	I2	289	Parr	E	8	Blackbutt	17/02/2022	13:02	Go Pro	N			Nil	Poor	Replace		
OH2Ku	I2	291	MB	NW	7	Wh. Stringybark	17/02/2022	12:40	Go Pro	N			Nil	Good	No		
OH2Ku	I2	295	SG	E	8	Blackbutt	17/02/2022	12:42	Go Pro	Y	Sugar Glider x4	Native	Occupied	Good	No		
OH2Ku	I2	296	Scan	NE	6	Wh. Stringybark	17/02/2022	12:57	Go Pro	N			Euc leaf	Good	No		
OH2Ku	I3	283	SO	E	10	Tallowwood	17/02/2022	12:06	Go Pro	N			Nil	Moderate	Box det. Check next inspection.		Box deteriorating.

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	I3	284	Poss.	N	7	Tallowwood	17/02/2022	12:07	Go Pro	N			Old leaves	Good	No		
OH2Ku	I3	285	LG	NE	10	Blackbutt	17/02/2022	12:03	Go Pro	N			Old leaves	Good	No		
OH2Ku	I3	286	SG	NE	8	White Stringybark	17/02/2022	12:08	Go Pro	Not avail			Not avail	Poor	Replace		No lid, box damaged
OH2Ku	I3	287	Scan	N	8	Mahog spp	17/02/2022	12:08	Go Pro	N			Euc leaf	Good	No		
OH2Ku	I4	279	LG	NE	10	Mahog spp.	17/02/2022	11:57	Go Pro	N			Nil	Good	No		
OH2Ku	I4	280	MB	W	8	Blackbutt	17/02/2022	11:53	Go Pro	N			Nil	Good	No		
OH2Ku	I4	281	Parr	NE	8	Mahog spp.	17/02/2022	11:52	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	I4	282	Poss.	N	8	Turp	17/02/2022	11:58	Go Pro	N			Nil	Good	No		
OH2Ku	I5	297	SG	E	6	Wh. Mahog	17/02/2022	14:52	Go Pro	N			Nil	Poor	Replace		No lid
OH2Ku	I5	298	Poss.	NE	8	Tallowwood	17/02/2022	14:53	Go Pro	N			Nil	Good	No		
OH2Ku	I5	299	Add. Poss.	N	8	Tallowwood	17/02/2022	14:50	Go Pro	N			Nil	Good	No		
OH2Ku	I5	300	SO	N	10	Mahog. spp.	17/02/2022	14:58	Go Pro	Y	Common Brushtail Possum	Native	Nil	Good	No		
OH2Ku	I5	301	LG	NE	10	Tallowwood	17/02/2022	14:55	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	I6	307	Poss.	E	6	Mahog spp	17/02/2022	14:44	Go Pro	N			Nil	Good	No		
OH2Ku	I6	308	SG	N	7	Bloodwood spp.	17/02/2022	14:41	Go Pro	N			old leaves, latrine	Good	No		Vine growing around box
OH2Ku	I6	309	Parr	E	9	Mahog spp	17/02/2022	14:46	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	I6	310	Scan	NE	5	Mahog spp	17/02/2022	14:46	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	I6	311	LG	NE	9	Mahog spp	17/02/2022	14:30	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	I7	312	Parr	N	7	Mahog spp	17/02/2022	14:20	Go Pro	N			Nil	Poor	Replace	Overgrown gahnia	
OH2Ku	I7	313	LG	NE	9	Mahog spp	17/02/2022	14:25	Go Pro	N			Euc leaf	Moderate	Check next inspection		
OH2Ku	I7	314	LG	NE	10	Sw. Mahog	17/02/2022	14:24	Go Pro	N			Nil	Poor	Replace		Box det.
OH2Ku	I7	315	MB	NW	6	White Stringybark	17/02/2022	14:19	Go Pro	N			Nil	Good	No		
OH2Ku	I8	316	LG	NE	10	White Stringybark	17/02/2022	15:05	Go Pro	N			Old leaves	Good	No		
OH2Ku	I8	317	Poss.	NE	7	Turp	17/02/2022	15:09	Go Pro	N			Nil	Good	No		
OH2Ku	I8	318	Parr	N	8	Blackbutt	17/02/2022	15:10	Go Pro	N			Nil	Good	No		
OH2Ku	I8	319	Cockatoo	NE	10	Blackbutt				Unk			Unk				Lid screwed shut.
OH2Ku	J1	253	Poss. add	NE	8	Red Mahog	18/02/2022	9:35	Go Pro	N			Old leaves	Good	No		
OH2Ku	J1	254	Mb	NW	6	Melaleuca sp.	18/02/2022	9:30	Go Pro	N			Nil	Good	No		
OH2Ku	J1	255	SO	N	12	Red Mahog	18/02/2022	9:32	Go Pro	N			Old leaves	Good	No		
OH2Ku	J1	256	LG	NE	10	Tallowwood	18/02/2022	9:40	Go Pro	N			Fresh euc nest	Good	No		
OH2Ku	J1	257	Scan	NE	5	Melaleuca sp.	18/02/2022	9:39	Go Pro	N			Nil	Good	No		
OH2Ku	J1	258	Poss.	N	8	Tallowwood	18/02/2022	9:46	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No		
OH2Ku	J2	259	LG	E	9	Red. Mahog	18/02/2022	10:06	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	J2	260	Poss.	NE	8	Red. Mahog	18/02/2022	10:04	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No		
OH2Ku	J2	261	Scan	N	6	Red Mahog	18/02/2022	10:02	Go Pro	N			Nil	Moderate	No		Termite nest

Section	Zone/cluster	Box # / NBT	Box type	Orientalion (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	J2	262	SG	NE	8	Sw. Mahog	18/02/2022	9:59	Go Pro	N			Nil	Poor	Replace		Degraded and exposed to sun.
OH2Ku	J2	263	Parr	E	8	Blackbutt	18/02/2022	9:57	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	J3	264	LG	E	10	Mahog sp.	18/02/2022	8:16	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	J3	265	SG	N	7	Red Mahog	18/02/2022	8:10	Go Pro	N			Old leaves	Good	No		
OH2Ku	J3	266	SG	E	8	Sw. Mahog	18/02/2022	8:13	Go Pro	N			Old conical leaf nest	Good	No		
OH2Ku	J3	267	Scan	E	6	Melaleuca sp.	18/02/2022	8:12	Go Pro	N			Nil	Poor	Replace		Lid loose
OH2Ku	J3	268	Poss.	NE	8	Red Mahog	18/02/2022	8:06	Go Pro	N			Nil	Good	No		
OH2Ku	J4	269	LG	N	9	Sw. Mahog	18/02/2022	8:22	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	J4	270	Poss.	NE	8	Mahog sp.	18/02/2022	8:22	Go Pro	N			Nil	Moderate	No		Box degrading still operational
OH2Ku	J4	271	Parr	NE	7	Blackbutt	18/02/2022	8:24	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	J4	272	SG	NE	8	Sw. Mahog	18/02/2022	8:25	Go Pro	N			Old leaves	Good	No		Box aged
OH2Ku	J4	273	Scan	NE	7	Blackbutt	18/02/2022	8:28	Go Pro	Not avail			Not avail	Poor	Replace		No lid
OH2Ku	J5	275	LG	NE	10	Sw. Mahog	18/02/2022	9:01	Go Pro	N			Nil	Good	No		
OH2Ku	J5	276	LG	E	10	Sw. Mahog	18/02/2022	8:56	Go Pro	N			Nil	Good	No		
OH2Ku	J5	277	Scan	E	7	Melaleuca sp.	18/02/2022	8:53	Go Pro	N			Nil	Good	No		
OH2Ku	J5	276B	MB	NW	8	P. Bloodwood	18/02/2022	8:49	Go Pro	N			Nil	Good	No		
OH2Ku	K1	302	SG	NE	6	Melaleuca	17/03/2022	11:06	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	K1	303	Scan	NW	4	Melaleuca sp.	17/03/2022	11:09	Go Pro	N	Bees	Pest	Nil	Good	No		
OH2Ku	K1	304	Scan	N	4	Melaleuca sp.	17/03/2022	11:02	Go Pro	N			euc nest	Good	No		
OH2Ku	K1	305	Poss.	N	5	Melaleuca	17/03/2022	11:01	Go Pro	N			Nil	Good	No		
OH2Ku	K1	306	SG	E	4	Melaleuca	17/03/2022	11:04	Go Pro	N			euc leaves	Good	No		
OH2Ku	K2	502	Scan	E	5	Red Mahog	17/03/2022	11:13	Go Pro	N	Ants	Pest	Nil	Poor - Det. Inside	No		
OH2Ku	K2	503	Scan	NE	5	Red Mahog	17/03/2022	11:11	Go Pro	N	Ants	Pest	Nil	Good	No		
OH2Ku	K2	505	Poss.	NE	7m	Red Mahog	17/03/2022	11:14	Go Pro	N			Nil	Good	No		
OH2Ku	L1	347	SG	N	7	Swamp Oak	17/03/2022	11:41	Go Pro	N			euc leaves	Good	No		
OH2Ku	L1	348	MB	W	7	Casuarina	17/03/2022	11:42	Go Pro	N			Nil	Good	No		
OH2Ku	L1	349	Poss.	E	6	Melaleuca quinn.	17/03/2022	11:43	Go Pro	N			Nil	Good	No		
OH2Ku	L1	350	Scan	NE	5	Melaleuca quinn.	17/03/2022	11:45	Go Pro	N			euc leaves	Good	No		
OH2Ku	L2	351	LG	N	10	Melaleuca quinn.	17/03/2022	12:03	Go Pro	N			Old leaves	Good	No		
OH2Ku	L2	352	Parr	N	8	Melaleuca quinn.	17/03/2022	11:59	Go Pro	N			Nil	Poor - lid broken	Replace		
OH2Ku	L2	353	SG	NE	7	Melaleuca quinn.	17/03/2022	12:00	Go Pro	N			Nil	Poor - no lid	Replace		
OH2Ku	L2	354	Poss.	NE	8	Melaleuca quinn.	17/03/2022	12:00	Go Pro	N			leaves and eggs shell	Good	No		
OH2Ku	L2	500	LFO	E	10	Swamp Mahog				Unk			Unk				No access
OH2Ku	L2	501	Poss.	E	6	Swamp mahog				Not located			Not located				No access
OH2Ku	M1	246	LG	E	9	Ironbark	18/02/2022	10:38	Go Pro	N			Nil	Good	No		
OH2Ku	M1	248	Scan	E	6	P. Bloodwood	18/02/2022	10:42	Go Pro	N	Native Bees	Pest	Nil	Good	No		
OH2Ku	M1	249	SG	E	7	P. Bloodwood	18/02/2022	10:48	Go Pro	N			Old leaves	Good	No		Old honeycomb
OH2Ku	M1	251	Poss.	N	8	Ironbark	18/02/2022	10:40	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	M2	247	SG	NE	8	P. Bloodwood	18/02/2022	10:52	Go Pro	N			Nil	Poor	Replace		Box deteriorating.
OH2Ku	M2	250	Poss.	N	7	Tallowwood	18/02/2022	10:55	Go Pro	N			Nil	Moderate	Replace		Box deteriorating.
OH2Ku	M2	252	MB	NW	5	P. Bloodwood	18/02/2022	10:51	Go Pro	N			Nil	Good			
OH2Ku	N1	355b	Scan	NE	5	Red gum	10/03/2022	11:16	Go Pro	N			Nil	Poor	Replace		Box deteriorating.
OH2Ku	N1	356b	Poss.	NE	7	Red gum	10/03/2022	12:56	Go Pro	N			Old leaves	Moderate	Check next inspection		Box damp and deteriorating.
OH2Ku	N1	357b	Parr	NE	8	Red gum	10/03/2022	12:44	Go Pro	N			Old leaves	Poor	Replace		Box damaged.
OH2Ku	N1	358b	SG	NE	7	Red gum	10/03/2022	12:48	Go Pro	Not avail			Not avail	Poor	Replace		No lid.
OH2Ku	N1	361b	Poss. ad	ENE	9	FRG	10/03/2022	12:43	Go Pro	N			Old leaves	Good	No		
OH2Ku	N1	362b	SO	NE	10	FRG	10/03/2022	12:59	Go Pro	N			Nil	Good	No		
OH2Ku	N2	359b	Scan	E	5	Red gum	10/03/2022	13:00	Go Pro	N			Old leaves	Poor	Replace		Termites, Box damaged.
OH2Ku	N2	360b	LG	ENE	6	Red gum	10/03/2022	13:00	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No		
OH2Ku	N3	363	Scan	NE	6	Casuarina	18/02/2022	11:24	Go Pro	N			Nil	Good	No		
OH2Ku	N3	364	Poss.	N	5	Casuarina	18/02/2022	11:22	Go Pro	N			Nil	Good	No		
OH2Ku	N3	366	Sg	NE	6	Tallowwood	18/02/2022	11:19	Go Pro	N			Old leaf	Good	No		Boxes starting to det.
OH2Ku	N3	365b	Lg	E	8	Tallowwood	18/02/2022	11:16	Go Pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	O1	230	SG	N	7	Tallowwood	12/01/2022	8:17	Go Pro	N			Conical euc leaf nest	Good	No		
OH2Ku	O1	231	LG	N	9	Tallowwood	12/01/2022	8:15	Go Pro	N			Small leaf and bark	Good	No		
OH2Ku	O1	232	SG	E	8	Ironbark	12/01/2022	8:19	Go Pro	N			Nil	Good	No		Full old honeycomb
OH2Ku	O1	233	Poss.	N	9	Pink bloodwood	12/01/2022	8:12	Go Pro	N			Scattered euc leaf	Good	No		
OH2Ku	O1	234	Scan	N	6	Tallowwood	12/01/2022	8:22:00 AM	Go Pro	N	Ants	Pest	Nil	Good	No		
OH2Ku	P1	235	Poss.	NE	7	Tallowwood	18/02/2022	12:02	Go Pro	N			Nil	Good	No		
OH2Ku	P1	236	Parr	E	8	Spotted gum	18/02/2022	12:08	Go Pro	N			Nil	Good	No		Old honeycomb
OH2Ku	P1	237	SG	NE	8	Tallowwood	18/02/2022	12:05	Go Pro	N			Nil	Good	No		
OH2Ku	P1	238	Scan	N	8	Tallowwood	18/02/2022	12:11	Go Pro	N			Conical euc nest	Good	No		
OH2Ku	P2	239	LG	NE	10	Tallowwood	18/02/2022	12:22	Go Pro	N			Old leaves	Good	No		
OH2Ku	P2	240	SG	E	8	Tallowwood	18/02/2022	12:29	Go Pro	N			Nil	Good	No		
OH2Ku	P2	242	Parr	N	8	Spotted gum	18/02/2022	12:28	Go Pro	N			Old leaves	Good	No		
OH2Ku	P2	243	Scan	NE	8	Tallowwood	18/02/2022	12:27	Go Pro	N			Nil	Good	No		
OH2Ku	P3	241	Scan	N	5	Stringybark spp.	18/02/2022	12:42	Go Pro	N			Euc nest	Poor	Replace		Lid broken
OH2Ku	P3	244	Poss.	NE	8	Bloodwood spp.	18/02/2022	12:36	Go Pro	N			Nil	Good			
OH2Ku	P3	245	Scan	N	5	Bloodwood spp.	18/02/2022	12:40	Go Pro	N			Old leaves	Moderate	No		Lid almost broken
OH2Ku	Q1	367	LG	N	8	Bloodwood	12/01/2022	8:42	Go pro	Y	CBT Poss	Native	Occupied	Good	No		
OH2Ku	Q1	368	Scan	E	5	Tallowwood	12/01/2022	8:38	Go pro	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	Q1	369	Po	NE	7	Tallowwood	12/01/2022	8:51	Go pro	N			Shredded bark	Good	No		
OH2Ku	Q1	370	LFO	NNE	18-20	SF grey gum	12/01/2022	8:48	Go pro	Not avail			Not avail	Poor	Replace-broken		Large limb fallen and hit box. Box destroyed.
OH2Ku	Q1	371	Poss	NE	8	Bloodwood	12/01/2022	8:45	Go pro	Y	CBT Poss	Native	Occupied	Good			
OH2Ku	Q2	372	LG	NE	8	Ironbark	12/01/2022	8:57	Go pro	Y	CBT Poss	Native	Occupied	Poor	Replace - no lid		No lid
OH2Ku	R1	320	Poss.	N	8	Turp	12/01/2022	10:13	Go pro	N			Nil	Good	No		
OH2Ku	R1	321	MB	NW	6	Tallow?	12/01/2022	10:12	Go pro	N			Nil	Good	No		
OH2Ku	R1	322	LFO	N	12	Bloodwood	12/01/2022	10:08	Go pro	N			Nil	Good	No		
OH2Ku	R1	323	Add poss.	E	7	Flooded Gum	12/01/2022	10:03	Go pro	N			Nil	Good	No		
OH2Ku	R1	324	Scan	NE	5	Rainforest spp	12/01/2022	10:10	Go pro	N			Old euc leaf	Good	No		
OH2Ku	R2	325	SG	NE	8	Tallow	12/01/2022	10:21	Go pro	N			leaves	Poor - lid hanging	Replace		lid hanging off
OH2Ku	R2	326	Scan	E	6	Bloodwood	12/01/2022	10:21	Go pro	N			euc leaf	Good	No		
OH2Ku	R2	327	MB	W	6	Mahogany	12/01/2022	10:23	Go pro	N			Nil	Good	No		
OH2Ku	R2	328	Parr	NE	8	Mahogany	12/01/2022	10:25	Go pro	N			Nil	Good	No		
OH2Ku	R2	329	Poss.	NE	8	Turp	12/01/2022	10:24	Go pro	N			euc leaf	Good	No		
OH2Ku	R3	330	LG	N	10	Grey gum	12/01/2022	9:46	Go pro	N			Nil	Good	No		
OH2Ku	R3	331	Poss.	NE	8	Turp	12/01/2022	9:50	Go pro	N			Nil	Good	No		
OH2Ku	R3	332	Co	N	14	Grey gum	9/03/2022	9:30	Tree climber	N			Nil	Moderate - lid broken	Fix lid		
OH2Ku	R3	333	add Poss.	NE	6	Same tree as Co/SO	9/03/2022	9:30	Tree climber	N			Nil	Good	No		

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check Date	Time	Inspect type	Vert Fauna Y/N	Species	Native/Pest	Vert Signs of use	Box Cond	Maintenance required	Changes in surrounds	Notes
OH2Ku	R3	334	LG	N	10	Tallowwood	12/01/2022	9:49	Go pro	N			Nil	Good	No		
OH2Ku	R4	335	Scan	N	6	Turp	12/01/2022	9:39	Go pro	N			Old leaf	Good	No		
OH2Ku	R4	336	SG	NE	8	Turp	12/01/2022	9:38	Go pro	N			Old euc nest	Good	No		
OH2Ku	R4	337	Parr	NE	12	Mahogany	12/01/2022	9:42	Go pro	N			Nil	Good	No		
OH2Ku	R4	338	LG	N	10	Bloodwood	12/01/2022	9:34	Go pro	N			Nil	Good	No		
OH2Ku	R4	339	Poss.	NE	8	Tallow	12/01/2022	9:35	Go pro	N			Nil	Good	No		
OH2Ku	R5	340	LG	NE	10	Bloodwood	12/01/2022	9:26	Go pro	N			Nil	Good	No		
OH2Ku	R5	341	Poss.	NE	6	Same tree as LG	12/01/2022	9:28	Go pro	N			Nil	Good	No		
OH2Ku	R5	342	Parr	NE	8	Tallowwood	12/01/2022	9:27	Go pro	N	Ants	Pest	Nil	Good	No		
OH2Ku	R5	343	MB	W	6	Mahogany	12/01/2022	9:28	Go pro	N			Nil	Good	No		
OH2Ku	R5	344	SG	NE	8	Tallowwood	12/01/2022	9:29	Go pro	N			Nil	Poor	Replace		
OH2Ku	R6	345	Scan	NE	10	Tallowwood	12/01/2022	9:20	Go pro	N	Ants	Pest	Nil	Good	No		
OH2Ku	R6	346	LG	N	10	Grey gum	12/01/2022	9:19	Go pro	N			Old leaf	Good	No		

Annex 2 – Winter 2022 (Event 9) nest box monitoring

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	AA	1	MB	W	9	Turpentine	13/07/2022	14:36	Go Pro	N			Nil	Good	No	
Ku2K	AA	1	Scan	E	14	Turpentine	13/07/2022	14:36	Go Pro	N			Nil	Good	No	
Ku2K	AA	2	Pa	E	8	Tallowood	13/07/2022	14:30	Go Pro	N			Nil	Good	No	
Ku2K	AA	2	SG	NE	11	Tallowood	13/07/2022	14:29	Go Pro	N			Euc leaf	Good	No	Lantana growth
Ku2K	AA	3	Poss.	E	10	Coastal Blackbutt	5/09/2022	10:01	Tree climber	N			Nil	Good	No	
Ku2K	AA	3	SO	E	15	Coastal Blackbutt	5/09/2022	10:01	Tree climber	N			Conical Euc nest	Good	No	
Ku2K	AA	4	Poss.	W	7	Brush Box	13/07/2022	14:27	Go Pro	N			Nil	Good	No	
Ku2K	AA	4	Scan	N	5	Brush Box	13/07/2022	14:26	Go Pro	N			Leaf	Good	No	
Ku2K	AA	5	LFO	NW	14	Coastal Blackbutt	5/09/2022	9:22	Tree climber	Y	Antechinus	Native	Occupied	Good	No	
Ku2K	AA	5	Poss.	E	9	Coastal Blackbutt	5/09/2022	9:22	Tree climber	N			Nil	Good	No	
Ku2K	AA	6	MB	NE	8	Brush Box	13/07/2022	14:23	Go Pro	N			Nil	Good	No	
Ku2K	AA	6	Pa	NE	6	Brush Box	13/07/2022	14:22	Go Pro	N			Nil	Good	No	
Ku2K	AA	6	Pa	W	7	Brush Box	13/07/2022	14:23	Go Pro	N			Conical euc nest	Good	No	
Ku2K	AA	6	Scan	NE	5	Turpentine	13/07/2022	14:13	Go Pro	N			Nil	Good	No	
Ku2K	AA	7	Poss.	E	10	Tallowood	13/07/2022	14:19	Go Pro	N			Nil	Good	No	
Ku2K	AA	7	SG	S	8	Tallowood	13/07/2022	14:19	Go Pro	N			Nil	Good	No	
Ku2K	AA	8	LG	N	15	Coastal Blackbutt	5/09/2022	9:10	Visual	Not avail			Not avail	Poor - no lid	Replace	
Ku2K	AA	9	Poss.			Coastal Blackbutt										
Ku2K	AA	9	Poss.		9	Coastal Blackbutt	13/07/2022	14:13	Go Pro	N			Nil	Good	No	
Ku2K	AA	9	Scan			Coastal Blackbutt										
Ku2K	AA	9	Scan		6	Coastal Blackbutt	13/07/2022	14:11	Go Pro	N			Nil	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	AA	94	Scan	SE	15	Coastal Blackbutt	5/09/2022	8:58	Tree Climber	Y	Sugar Glider	Native	Occupied	Good	No	
Ku2K	AA	94	SG	SE	12	Coastal Blackbutt	5/09/2022	8:58	Tree Climber	N			Euc nest, bark and feathers	Good	No	
Ku2K	AA	95	Scan			Coastal Blackbutt										
Ku2K	AA	95	Scan			Coastal Blackbutt										
Ku2K	AA	95	Scan		7	Turpentine	13/07/2022	14:15	Go Pro	N			Nil	Moderate	No	
Ku2K	NEW ZONE	90	Poss.	NW	10	Red Mahogany	29/07/2022	14:35	Go Pro	N			Nil	Good	No	
Ku2K	NEW ZONE	90	Scan	S	10	Red Mahogany	29/07/2022	14:36	Go Pro	N			Euc leaf	Good	Replace lid and rewire	
Ku2K	NEW ZONE	91	Poss.			White Mahogany	29/07/2022	14:37	Go Pro	N			Nil	Moderate	No	
Ku2K	NEW ZONE	91	Scan			White Mahogany	29/07/2022	14:38	Go Pro	N			Conical euc leaf	Good	No	
Ku2K	NEW ZONE	92	LG	NE		Coastal Blackbutt	12/09/2022	14:48	Tree Climber	N			Old euc nest	Good	No	
Ku2K	NEW ZONE	92	Scan			Coastal Blackbutt	29/07/2022	14:38	Go Pro	N			Bark nest	Good	No	
Ku2K	NEW ZONE	96	Co	E	18	Coastal Blackbutt	5/09/2022	14:36	Tree Climber	N			Egg shell	Moderate	Screw lid shut	
Ku2K	NEW ZONE	96	Poss.	SW	14	Coastal Blackbutt	5/09/2022	14:36	Tree Climber	N			Old leaf and scat	Good	No	
Ku2K	NEW ZONE	97	LFO	N	15	Coastal Blackbutt	5/09/2022	14:24	Tree Climber	N			Egg shell	Good	No	
Ku2K	NEW ZONE	97	Poss.	N	11	Coastal Blackbutt	5/09/2022	14:24	Tree Climber	N			Euc leaf and egg shell	Good	No	
Ku2K	NEW ZONE	98	LG	NE	14	Coastal Blackbutt	5/09/2022	13:39	Tree Climber	N			Nil	Good	No	
Ku2K	NEW ZONE	98	Scan	E	10	Coastal Blackbutt	5/09/2022	13:39	Tree Climber	Y	Lace Monitor	Native	Occupied	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	NEW ZONE	99	Poss.	W	9	White Mahogany	14/07/2022	12:18	Go Pro	N			Nil	Good	No	
Ku2K	NEW ZONE	99	SG	N	5	White Mahogany	14/07/2022	12:19	Go Pro	N			Euc nest	Good	No	
Ku2K	NEW ZONE	100	LG	SE	12	Coastal Blackbutt	5/09/2022	14:48	Tree Climber	N			Fresh conical euc nest	Good	No	
Ku2K	NEW ZONE	100	Poss.	SE	10	Coastal Blackbutt	5/09/2022	14:48	Tree Climber	N			Nil	Good	No	
Ku2K	S	58	LG	NE	8	Brush Box	6/09/2022	11:57	Tree Climber	N			Nil	Moderate	Drill hole to drain water.	
Ku2K	S	58	Scan	NE	5	Brush Box	30/06/2022	12:11	Go Pro	N			Old leaf	Moderate	No	
Ku2K	S	59	Poss.	NE	5	Tallowwood	30/06/2022	12:06	Go Pro	N			Nil	Good	No	
Ku2K	S	59	SG	NE	8	Tallowwood	30/06/2022	12:06	Go Pro	N			Nil	Good	No	
Ku2K	S	60	LG	NE	8	White Mahogany	6/09/2022	11:39	Tree Climber	N	Ants	Pest	Nil	Good	No	
Ku2K	S	60	Poss.	NE	5	White Mahogany	30/06/2022	12:07	Go Pro	N			Nil	Good	No	
Ku2K	S	61	Poss.	NE	12	Pink Bloodwood	30/06/2022	12:09	Go Pro	N			Nil	Moderate	No	
Ku2K	S	61	SO	NE	13	Pink Bloodwood	30/06/2022	12:09	Go Pro	N			Nil	Good	No	
Ku2K	S	72	LG	NW	7	Turpentine	17/08/2022	14:09	Go Pro	N			Nil	Moderate	Screw on lid	
Ku2K	S	72	Poss.	SE	5	Turpentine	17/08/2022	14:09	Go Pro	N			Nil	Good	No	
Ku2K	S	73	LG	S	7	Pink Bloodwood	12/09/2022	9:59	Tree Climber	N			Leaves	Moderate	No	
Ku2K	S	73	Poss.	SE	9	Pink Bloodwood	17/08/2022	14:12	Go Pro	N			Nil	Good	No	
Ku2K	S	74	Co	NE	13	Grey Ironbark	12/09/2022	10:15	Tree Climber	N			Nil	Good	No	
Ku2K	S	75	Pa	E	10	Pink Bloodwood	17/08/2022	13:58	Go Pro	N			Nil	Good	No	
Ku2K	S	75	Scan	E	7	Pink Bloodwood	17/08/2022	13:59	Go Pro	N			Euc leaf	Moderate	No	
Ku2K	S	76	Poss.	S	10	Brush Box	17/08/2022	13:56	Go Pro	N			Old leaf	Moderate	No	
Ku2K	S	76	Scan	S	8	Brush Box	17/08/2022	13:56	Go Pro	N			Old leaf	Good	No	
Ku2K	S	77	LFO	SE	14	Grey Ironbark	12/09/2022	10:30	Tree Climber	N			Old scattered leaves	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	S	77	Poss.	SE	6	Grey Ironbark	17/08/2022	13:53	Go Pro	N			Nil	Good	No	
Ku2K	S	78	Pa	E	7	Brush Box	17/08/2022	14:02	Go Pro	N			Full euc leaf	Good	No	
Ku2K	S	78	SG	W	5	Brush Box	17/08/2022	14:01	Go Pro	N			Nil	Good	No	
Ku2K	S	79	Scan	E	6	Turpentine	17/08/2022	14:02	Go Pro	N			Nil	Poor - no bottom	Replace	
Ku2K	S	79	SG	N	6	Turpentine	17/08/2022	14:02	Go Pro	N			Euc nest	Good	No	
Ku2K	S	80	SG		8	Turpentine	17/08/2022	14:17	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	S	81	SG		7	Tallowwood	17/08/2022	14:18	Go Pro	N			Nil	Good	No	
Ku2K	S	82	SG		7	Turpentine	17/08/2022	14:20	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	T	48	MB	SE	4	White Mahogany	30/06/2022	12:31	Go Pro	N			Nil	Good	No	
Ku2K	T	48	Poss.	N	7	White Mahogany	30/06/2022	12:30	Go Pro	N			Nil	Good	No	
Ku2K	T	49	LG	NE	9	Pink Bloodwood	30/06/2022	12:23	Go Pro	Not avail			Not avail	Poor	Replace	
Ku2K	T	49	MB	SE	7	Pink Bloodwood	30/06/2022	12:23	Go Pro	Not avail			Not avail	Poor	Replace	
Ku2K	T	50	Poss.	NE	9	Tallowwood	30/06/2022	12:34	Go Pro	N			Nil	Good	No	
Ku2K	T	50	Scan	NE	5	Tallowwood	30/06/2022	12:33	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	T	51	LG	NE	8	Tallowwood	6/09/2022	12:06	Tree Climber	N	Ants	Pest	Nil	Good	No	
Ku2K	T	51	Poss.	NE	5	Tallowwood	30/06/2022	12:20	Go Pro	N			Nil	Good	No	
Ku2K	T	52	Pa	E	10	White Stringybark	30/06/2022	12:19	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	T	52	SG	NE	4	White Stringybark	30/06/2022	12:18	Go Pro	N			Bark nest	Good	No	
Ku2K	T	53	Scan	SE	5	Tallowwood	17/08/2022	12:51	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	T	53	SG	SE	8	Tallowwood	17/08/2022	12:50	Go Pro	N			Conical nest	Good	No	
Ku2K	T	54	LG	SE	9	Red Mahogany	8/09/2022	12:42	Visual	N	Bees	Pest	Beehive	Good	No	
Ku2K	T	54	SG	SE	6	Red Mahogany	17/08/2022	12:47	Go Pro	N	Ants	Pest	Nil	Moderate	No	
Ku2K	T	55	Pa	E	6	Pink Bloodwood	17/08/2022	12:46	Go Pro	N			Nil	Moderate	No	
Ku2K	T	55	Scan	E	5	Pink Bloodwood	17/08/2022	12:40	Go Pro	N			Euc leaf	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	T	56	Scan	E	8	Brush Box	17/08/2022	12:43	Go Pro	N	Ants	Pest	Nil	Poor	Replace	
Ku2K	T	56	SG	N	8	Brush Box	17/08/2022	12:43	Go Pro	N	Ants	Pest	Nil	Poor	Replace	
Ku2K	T	57	LG	E	8	Brush Box	17/08/2022	12:56	Go Pro	N			Nil	Good	No	
Ku2K	T	57	MB	N	3	Brush Box	17/08/2022	12:56	Go Pro	N			Euc leaf	Poor	Replace	
Ku2K	T	62	Co	N	14	Tallowwood	8/09/2022	12:32	Visual	Not avail			Not avail	broken on ground	Replace	
Ku2K	T	63	LG	NE	10	Small-fruited Grey Gum	8/09/2022	12:09	Tree Climber	Y	Lace Monitor	Native	Occupied	Moderate	No	
Ku2K	T	63	SG	E	7	Small-fruited Grey Gum	17/08/2022	13:17	Go Pro	N			Conical euc leaf	Good	No	
Ku2K	T	64	LG	N	6	Grey Ironbark	17/08/2022	13:14	Go Pro	N			Nil	no lid	Replace	
Ku2K	T	64	SG	E	10	Grey Ironbark	17/08/2022	13:14	Go Pro	Not avail			Not avail	no lid	Replace	
Ku2K	T	65	SO			Tallowwood	17/08/2022	13:11	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No	
Ku2K	T	66	SG	N	6	Small-fruited Grey Gum	17/08/2022	13:20	Go Pro	N	Ants	Pest	Nil	Moderate	No	
Ku2K	T	66	SO	SE	9	Small-fruited Grey Gum	17/08/2022	13:20	Go Pro	N			Nil	Good	No	
Ku2K	T	67	LFO	E	10	Tallowwood	8/09/2022	12:22	Tree Climber	N			Nil	Moderate	No	
Ku2K	T	67	Poss.	N		Tallowwood	17/08/2022	13:25	Go Pro	N	Short-eared Brushtail Possum	Native	Occupied	Good	No	
Ku2K	T	68	LG	E	12	Tallowwood	8/09/2022	11:43	Tree Climber	N			Nil	Good	No	
Ku2K	T	68	SG	E		Tallowwood	17/08/2022	13:38	Go Pro	N			Conical euc nest	Good	No	
Ku2K	T	69	MB	N		Pink Bloodwood	17/08/2022	13:33	Go Pro	N			Euc leaf	Poor/Moderate	No	
Ku2K	T	70	SO	E	13	Tallowwood	17/08/2022	13:37	Go Pro	N			Nil	Good	No	
Ku2K	T	71	LG	E	12	Flooded Gum	8/09/2022	11:48	Tree Climber	N	Ants	Pest	Nil	Good	No	

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	T	71	MB	E		Flooded Gum	17/08/2022	13:31	Go Pro	Not avail			Not avail	broken on ground	Replace	
Ku2K	T	119	LG	N	14	Grey Ironbark	12/09/2022	11:23	Tree Climber	N			Old leaves	Good	No	
Ku2K	T	119	Poss.	SW	8	Grey Ironbark	12/09/2022	11:24	Tree Climber	N			Egg	Good	No	
Ku2K	T	120	Poss.	W	9	Tallowwood	30/06/2022	13:23	Go Pro	N			Nil	Good	No	
Ku2K	T	120	Scan	N	7	Tallowwood	30/06/2022	13:22	Go Pro	N			Euc conical nest	Good	No	
Ku2K	T	121	LG	E	7	Tallowwood	30/06/2022	13:26	Go Pro	N			Nil	Good	No	
Ku2K	T	121	Scan	N	5	Tallowwood	30/06/2022	13:27	Go Pro	N			Old leaf	Good	No	
Ku2K	T	134	Co	SE	12	Tallowwood	12/09/2022	11:11	Tree Climber	N			Scattered euc leaf	Good	No	
Ku2K	T	134	Poss.	W	9	Tallowwood	30/06/2022	13:30	Go Pro	N			Old leaf	Good	No	
Ku2K	U	37	LFO	NE	15	Flooded Gum	5/09/2022	15:24	Tree Climber	N			Nil	Good	No	
Ku2K	U	37	Poss.	E	10	Flooded Gum	5/09/2022	15:24	Tree Climber	N			Nil	Good	No	
Ku2K	U	38	Scan	E	6	Grey Ironbark	30/06/2022	14:18	Go Pro	N			Nil	Moderate	No	
Ku2K	U	38	SG	W	10	Grey Ironbark	30/06/2022	14:18	Go Pro	N			Nil	Good/moderate	No	
Ku2K	U	39	LG	NE	8	Tallowwood	5/09/2022	15:54	Tree Climber	N			Nil	Good	No	
Ku2K	U	39	Poss.	N	10	Tallowwood	5/09/2022	15:54	Tree Climber	N			old leaf	Good	No	
Ku2K	U	40	Pa	NE	6	Grey Ironbark	30/06/2022	14:23	Go Pro	N			Nil	Good	No	
Ku2K	U	40	SG	W	8	Grey Ironbark	30/06/2022	14:24	Go Pro	N			Conical euc nest	Good	No	
Ku2K	U	41	MB	N	11	Brush Box	30/06/2022	14:35	Go Pro	N			Nil	Good	No	
Ku2K	U	41	Poss.	E	8	Brush Box	30/06/2022	14:34	Go Pro	N			Nil	Good	No	
Ku2K	U	42	MB	NE	5	White Mahogany	30/06/2022	14:00	Go Pro	N			Nil	Good	No	
Ku2K	U	42	SO	NE	11	White Mahogany	30/06/2022	14:02	Go Pro	N			Nil	Good	No	
Ku2K	U	43	MB	N	5	Grey Ironbark	30/06/2022	13:59	Go Pro	N			Nil	Moderate	No	
Ku2K	U	43	Pa	SW	8	Grey Ironbark	30/06/2022	13:58	Go Pro	N			old leaf	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	U	44	Scan	NE	5	White Mahogany	30/06/2022	14:08	Go Pro	N	Ants	Pest	old leaf	Moderate	No	
Ku2K	U	44	SG	NE	5	White Mahogany	30/06/2022	14:07	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
Ku2K	U	45	LG	E	8	Pink Bloodwood	8/09/2022	11:14	Tree Climber	N	Bees	Pest	Nil	Moderate	No	
Ku2K	U	45	SG	N	5	Pink Bloodwood	30/06/2022	14:08	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	U	46	LG	NE	8	White Mahogany	8/09/2022	10:43	Tree Climber	N	Ants	Pest	Nil	Moderate	No	
Ku2K	U	46	Scan	NE	5	White Mahogany	30/06/2022	13:54	Go Pro	N			Euc nest	Good	No	
Ku2K	U	47	Poss.	SE	8	White Mahogany	30/06/2022	13:56	Go Pro	N			Euc leaf fresh	Good	No	
Ku2K	U	47	Scan	N	5	White Mahogany	30/06/2022	13:55	Go Pro	N			Nil	Good	No	
Ku2K	U	93	Poss.	S	10	White Mahogany	30/06/2022	14:04	Go Pro	N			Nil	Good	No	
Ku2K	U	93	Scan	NE	5	White Mahogany	30/06/2022	14:05	Go Pro	N			Euc leaf	Good	No	
Ku2K	V	31	Scan	N	6	Tallowwood	14/07/2022	13:29	Go Pro	N			Euc leaf	Good	No	
Ku2K	V	31	SG	N	10	Tallowwood	14/07/2022	13:29	Go Pro	Y	Scaly Lorikeet	Native	Occupied	Good	No	
Ku2K	V	32	Pa	N	9	Small-fruited Grey Gum	14/07/2022	13:35	Go Pro	N			Old leaf	Good	No	
Ku2K	V	32	SG	S	7	Small-fruited Grey Gum	14/07/2022	13:33	Go Pro	Y	Yellow-bellied glider	Native	Occupied	Good	No	
Ku2K	V	33	MB	W	5	Grey Ironbark	14/07/2022	13:40	Go Pro	N			Nil	Good	No	
Ku2K	V	33	Scan	E	6	Grey Ironbark	14/07/2022	13:41	Go Pro	N			Conical euc nest	Good	No	
Ku2K	V	34	Poss.	N	6	Tallowwood	14/07/2022	13:42	Go Pro	N			Nil	Good	No	
Ku2K	V	34	SG	NE	10	Tallowwood	14/07/2022	13:42	Go Pro	Not avail			Nil	poor - no lid	Replace	
Ku2K	V	35	MB	W	5	Scribbly Gum	14/07/2022	13:45	Go Pro	Y	Feathertail Glider	Native	Occupied	Poor - box rotting	Replace	
Ku2K	V	35	Pa	N	9	Scribbly Gum	14/07/2022	13:46	Go Pro	N			Nil	Good	No	
Ku2K	V	36	Poss.	N	8	Pink Bloodwood	14/07/2022	13:47	Go Pro	N			Nil	Good	No	
Ku2K	V	36	Scan	E	6	Pink Bloodwood	14/07/2022	13:47	Go Pro	N			Euc nest	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	V	126	LG	NW	9	White Stringybark	6/09/2022	12:36	Tree Climber	N			Nil	Moderate	Drill hole to drain water.	
Ku2K	V	126	Poss.	E	6	White Stringybark	14/07/2022	13:19	Go Pro	N			Nil	Good	No	
Ku2K	V	127	LG	SW	9	Small-fruited Grey Gum	6/09/2022	12:36	Tree Climber	N			Fresh euc nest	Good	No	
Ku2K	V	127	Scan	SW	7	Small-fruited Grey Gum	14/07/2022	13:22	Go Pro	N			Euc leaf	Good	No	
Ku2K	V	128	Poss.	W	12	Small-fruited Grey Gum	14/07/2022	13:23	Go Pro	N			Nil	Good	No	
Ku2K	V	128	Scan	N	5	Small-fruited Grey Gum	14/07/2022	13:24	Go Pro	N			Euc nest	Good	No	
Ku2K	V	133	LFO	N	12	Grey Ironbark	6/09/2022	13:44	Tree Climber	Y	Common Brushtail Possum	Native	Occupied	Good	No	
Ku2K	V	133	SG	N	8	Grey Ironbark	14/07/2022	13:50	Go Pro	N			euc leaf	Good	No	
Ku2K	W	112	MB	E	10	Bancrofts Red Gum	4/08/2022	12:44	Go Pro	N			Nil	Good	No	
Ku2K	W	112	Scan	NW	4	Bancroft's Red Gum	4/08/2022	12:44	Go Pro	N			Conical euc nest	Good	No	
Ku2K	W	113	LG	W	10	Bancrofts Red Gum	6/09/2022	14:04	Tree Climber	N			Nil	Good	No	
Ku2K	W	113	Scan	W	6	Bancrofts Red Gum	4/08/2022	12:41	Go Pro	N			Nil	Good	No	
Ku2K	W	114	Poss.	W	10	Grey Ironbark	4/08/2022	12:38	Go Pro	N			Nil	Good	No	
Ku2K	W	114	Scan	NW	6	Grey Ironbark	4/08/2022	12:38	Go Pro	N			Euc leaf	Good	No	
Ku2K	W	115	Pa	NW	6	White Mahogany	4/08/2022	12:34	Go Pro	N			Nil	Good	No	
Ku2K	W	115	Poss.	W	8	White Mahogany	4/08/2022	12:34	Go Pro	N			Nil	Good	No	
Ku2K	W	116	Poss.	W	14	Grey Ironbark	4/08/2022	12:31	Go Pro	N			Nil	Good	No	
Ku2K	W	116	Scan	S	8	Grey Ironbark	4/08/2022	12:30	Go Pro	N			Conical Euc nest	Good	No	
Ku2K	W	117	Poss.	SW	13	Small-fruited Grey Gum	4/08/2022	12:23	Go Pro	N			Grass/bark nest	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	W	117	SG	SW	10	Small-fruited Grey Gum	4/08/2022	12:24	Go Pro	N			Conical Euc nest	Good	No	
Ku2K	W	118	MB	S	8	Bancrofts Red Gum	4/08/2022	12:20	Go Pro	N			Nil	Good	No	
Ku2K	W	118	Scan	S	10	Bancrofts Red Gum	4/08/2022	12:20	Go Pro	N			Conical Euc nest	Good	No	
Ku2K	W	129	MB	SW	8	Tallowwood	14/07/2022	13:08	Go Pro	N			Conical Euc nest	Good	No	
Ku2K	W	129	Poss.	NE	9	Tallowwood	14/07/2022	13:09	Go Pro	N			Bird nest with rubbish	Good	No	
Ku2K	W	130	MB	SW	10	White Mahogany	14/07/2022	13:06	Go Pro	N			Euc leaf	Good	No	
Ku2K	W	130	Poss.	E	6	White Mahogany	14/07/2022	13:07	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No	
Ku2K	W	131	MB	S	8	Small-fruited Grey Gum	14/07/2022	13:05	Go Pro	N			Leaf	Good	No	
Ku2K	W	131	Poss.	E	9	Small-fruited Grey Gum	14/07/2022	13:05	Go Pro	N			Bird nest with rubbish	Good	No	
Ku2K	X	26	Pa	S	8	White Mahogany	14/07/2022	12:41	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	X	26	SG	S	6	White Mahogany	14/07/2022	12:42	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	X	27	Pa	NE	7	Pink Bloodwood	14/07/2022	12:39	Go Pro	N	Wasp Nest	Pest	Nil	Good	No	
Ku2K	X	27	Scan	NE	5	Pink Bloodwood	14/07/2022	12:40	Go Pro	N			Conical euc nest	Good	No	
Ku2K	X	28	MB	N	5	White Stringybark	14/07/2022	12:38	Go Pro	N			Euc leaf	Good	No	
Ku2K	X	28	Poss.	E	6	White Stringybark	14/07/2022	12:37	Go Pro	N			Nil	Poor - Water in box.	Drainage hole	
Ku2K	X	29	Co			Coastal Blackbutt										
Ku2K	X	30	LFO			Small-fruited Grey Gum										
Ku2K	X	30	Poss.			Small-fruited Grey Gum										

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	X	80	LG	SE	10	Coastal Blackbutt	8/09/2022	8:21	Tree Climber	N			Nil	Good	No	
Ku2K	X	80	SG	E	8	Coastal Blackbutt	14/07/2022	12:49	Go Pro	N			Conival euc nest	Good	No	
Ku2K	X	81	MB	S	8	Pink Bloodwood	14/07/2022	12:47	Go Pro	N			Nil	Good	No	
Ku2K	X	81	Pa	SE	10	Pink Bloodwood	14/07/2022	12:47	Go Pro	N			Nil	Good	No	
Ku2K	X	82	Poss.	NW	11	Turpentine	14/07/2022	12:44	Go Pro	N			Nil	Good	No	
Ku2K	X	82	SG	NE	9	Turpentine	14/07/2022	12:45	Go Pro	N			Leaf and bark	Good	No	
Ku2K	X	83	LG	S	12	Coastal Blackbutt	8/09/2022	8:06	Tree Climber	N			Nil	Good	No	
Ku2K	X	83	Pa	N	10	Coastal Blackbutt	8/09/2022	8:06	Tree Climber	N			Nil	Good	No	
Ku2K	X	84	Pa	W	10	White Stringybark	14/07/2022	12:50	Go Pro	N			old leaf	Good	No	
Ku2K	X	84	Scan	N	7	White Stringybark	14/07/2022	12:51	Go Pro	N			Nil	Moderate	No	
Ku2K	X	101	Co	E		Coastal Blackbutt	8/09/2022	9:23	Tree Climber	Not avail			Not avail	Poor - no bottom	Replace	
Ku2K	X	101	Poss.	E	14	Coastal Blackbutt	8/09/2022	9:23	Tree Climber	Y	Common Brushtail Possum	Native	Occupied		No	
Ku2K	X	102	LFO	S		Coastal Blackbutt	8/09/2022	9:02	Tree Climber	N			Euc nest	Moderate - lid broken should stay on.	No	
Ku2K	X	102	Poss.	W		Coastal Blackbutt	8/09/2022	9:02	Tree Climber	N			Conical euc nest	Good	No	
Ku2K	X	103	Co	N	15	Coastal Blackbutt	8/09/2022	9:45	Tree Climber	N			Nil	Good	No	
Ku2K	X	103	Poss.	N	12	Coastal Blackbutt	8/09/2022	9:45	Tree Climber	N			Nil	Moderate - lid broken have now screwed shut.	No	
Ku2K	X	132	Co		DNE?	Turpentine										
Ku2K	Y	16	MB	S	10	Coastal Blackbutt	13/07/2022	13:09	Go Pro	N			Nil	Good	No	
Ku2K	Y	16	Pa	E	13	Coastal Blackbutt	13/07/2022	13:08	Go Pro	N			Nil	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	Y	17	Pa	NW	10	Grey Ironbark	13/07/2022	13:02	Go Pro	N			Nil	Good	No	
Ku2K	Y	17	Scan	SW	6	Grey Ironbark	13/07/2022	13:01	Go Pro	N			Nil	Good	No	
Ku2K	Y	18	LG	SE	10	Tallowood	5/09/2022	12:49	Tree Climber	N			Fresh Euc leaves	Good	No	
Ku2K	Y	18	Scan	E	7	Tallowood	13/07/2022	13:12	Go Pro	N			Nil	Good	No	
Ku2K	Y	19	Scan	W	6	Pink Bloodwood	13/07/2022	13:15	Go Pro	N			Nil	Good	No	
Ku2K	Y	19	SO	N	13	Pink Bloodwood	13/07/2022	13:15	Go Pro	N			Nil	Good	No	
Ku2K	Y	20	Scan	SW	8	White Mahogany	13/07/2022	13:20	Go Pro	N	Ants	Pest	Nil	Good	No	
Ku2K	Y	20	SG	N	10.5	White Mahogany	13/07/2022	13:21	Go Pro	N			Euc leaf	Good	No	
Ku2K	Y	21	Poss.			White Mahogany										
Ku2K	Y	21	SG			White Mahogany										
Ku2K	Y	22	Pa	SE	11	Grey Ironbark	13/07/2022	13:22	Go Pro	N	Bees	Pest	Nil	Good	No	
Ku2K	Y	22	Scan	S	8	Grey Ironbark	13/07/2022	13:23	Go Pro	N			Old leaf	Good	No	
Ku2K	Y	23	LG			White Mahogany										
Ku2K	Y	23	Poss.			White Mahogany										
Ku2K	Y	24	Co	NE	14	Coastal Blackbutt	5/09/2022	12:30	Tree Climber	N			Nil	Good	No	
Ku2K	Y	24	Poss.	E	10	Coastal Blackbutt	5/09/2022	12:30	Tree Climber	N			Nil	Good	No	
Ku2K	Y	25	LFO	NE	13	Scribbly Gum	13/07/2022	13:47	Go Pro	N			Old leaf	Good	No	
Ku2K	Y	25	Poss.	S	8	Scribbly Gum	13/07/2022	13:49	Go Pro	N			Nil	Good	No	
Ku2K	Y	85	Poss.			Coastal Blackbutt	13/07/2022	12:58	Go Pro	N			Leaf and bark	Good	No	
Ku2K	Y	85	Scan			Coastal Blackbutt	13/07/2022	12:53	Go Pro	N			Nil	Good	No	
Ku2K	Y	86	LG			Red Mahogany	5/09/2022	12:30	Tree Climber	N			Nil	Good	No	
Ku2K	Y	86	MB			Red Mahogany	5/09/2022	11:45	Tree Climber	N			Nil	Good	No	
Ku2K	Y	87	MB	S	12	Grey Ironbark	13/07/2022	13:42	Go Pro	N			Nil	Good	No	
Ku2K	Y	87	SG	SW	9	Grey Ironbark	13/07/2022	13:43	Go Pro	N			Conical euc nest	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	Y	88	LG	N	12	Red Mahogany	5/09/2022	11:50	Tree Climber	N			Nil	Good	No	
Ku2K	Y	88	SG	N	9	Red Mahogany	5/09/2022	11:50	Tree Climber	N	Ants/Termites	Pest	Old leaves	Good	No	
Ku2K	Y	89	LG	SE	17	Red Mahogany	13/07/2022			Unk			Unk		No	
Ku2K	Y	89	Poss.	SE	10	Red Mahogany	13/07/2022	13:38	Go Pro	N			Nil	Good	No	
Ku2K	Z	10	LG	SW	14	Coastal Blackbutt	5/09/2022	10:44	Tree Climber	N			Old nest	Good	No	
Ku2K	Z	10	Pa	SW	12	Coastal Blackbutt	5/09/2022	10:44	Tree Climber	N			Nil	Good	No	
Ku2K	Z	11	MB	E	8	White Stringybark	14/07/2022	11:03	Go Pro	N			Nil	Good	No	
Ku2K	Z	11	Poss.	E	10	White Stringybark	14/07/2022	11:02	Go Pro	N			Nil	Good	No	
Ku2K	Z	12	Pa	NW	11	White Mahogany	14/07/2022	11:06	Go Pro	N			Nil	Good	No	
Ku2K	Z	12	Scan	NE	9	White Mahogany	14/07/2022	11:05	Go Pro	N			Conical euc nest	Good	No	
Ku2K	Z	13	Poss.	E	12	White Mahogany	14/07/2022	11:09	Go Pro	N			Nil	Good	No	
Ku2K	Z	13	SG	SW	10	White Mahogany	14/07/2022	11:10	Go Pro	Y	Sugar Glider	Native	Occupied	Good	No	
Ku2K	Z	14	LG	N	8	Pink Bloodwood	14/07/2022			Unk			Unk	Good	No	
Ku2K	Z	14	MB	S	6	Pink Bloodwood	14/07/2022	11:15	Go Pro	N			Nil	Moderate	No	
Ku2K	Z	15	Pa	E	10	Pink Bloodwood	14/07/2022	11:12	Go Pro	N			Nil	Good	No	
Ku2K	Z	15	Scan	E	5	Pink Bloodwood	14/07/2022	11:13	Go Pro	N			Nil	Good	No	
Ku2K	Z	104	LG	NE	11	Red Mahogany	12/09/2022	12:22	Tree Climber	N			Nil	Moderate - lid missing?	Maybe replacement/screw down lid.	
Ku2K	Z	104	Scan	S	7	Red Mahogany	29/07/2022	14:12	Go Pro	N			Nil	Good	No	
Ku2K	Z	105	Poss.	S	11	White Mahogany	29/07/2022	14:14	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No	
Ku2K	Z	105	Scan	E	6	White Mahogany	29/07/2022	14:15	Go Pro	N			Conical euc nest	Good	No	
Ku2K	Z	106	Poss.	NW	9	Coastal Blackbutt	29/07/2022	14:17	Go Pro	N			Nil	Moderate	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
Ku2K	Z	106	SG	E	7	Coastal Blackbutt	29/07/2022	14:18	Go Pro	N			Nil	Good	No	
Ku2K	Z	107	LG	N	18	White Mahogany	29/07/2022			Unk			Unk	Good	No	
Ku2K	Z	107	Poss.	E	15	White Mahogany	29/07/2022			Unk			Unk	Good	No	
Ku2K	Z	108	Poss.	NW	13	Coastal Blackbutt	12/09/2022	13:00	Tree Climber	Y	Common Brushtail Possum	Native	Occupied	Mod/Poor - Lid broken - may screw on.	Fix lid	
Ku2K	Z	108	SG	N	8	Coastal Blackbutt	12/09/2022	13:00	Tree Climber	N			Nil	Good	No	
Ku2K	Z	109	LG		15	Coastal Blackbutt	12/09/2022	12:44	Tree Climber	N			Nil	Poor - Full of water -	drill drainage hole.	
Ku2K	Z	109	Scan			Coastal Blackbutt	12/09/2022	12:44	Tree Climber	N			Conical euc nest	Good	No	
Ku2K	Z	110	Poss.	SE	10	Red Mahogany	14/07/2022	11:30	Go Pro	N			old leaf	Good	No	
Ku2K	Z	110	SG	SE	8	Red Mahogany	14/07/2022	11:32	Go Pro	N			Euc leaf	Good	No	
Ku2K	Z	111	LG	SW	18	Red Mahogany	12/09/2022	13:24	Tree Climber	N			Nil	Good	No	
Ku2K	Z	111	SG	SW	12	Red Mahogany	12/09/2022	13:25	Tree Climber	N			Conical euc nest	Good	No	
Ku2K	Z	122	Poss.			Tallowwood	29/07/2022	14:03	Go Pro	N			Nil	Good	No	
Ku2K	Z	122	Scan			Tallowwood	29/07/2022	14:03	Go Pro	N			Nil	Good	No	
Ku2K	Z	123	LG	SE	15	White Stringybark	12/09/2022	14:23	Tree Climber	N	Bees	Pest	Nil	Good	No	
Ku2K	Z	123	SG	W	9	White Stringybark	29/07/2022	14:05	Go Pro	N			Nil	Good	No	
Ku2K	Z	124	LG	W	12	Small Fruited Grey Gum	12/09/2022	14:22	Tree Climber	N			Nil	Good	No	
Ku2K	Z	124	Scan	W	10	Small Fruited Grey Gum	12/09/2022	14:22	Tree Climber	Y	Sugar/Squirrel Gliders	Native	Occupied	Good	No	
Ku2K	Z	125	Scan	W	12	Coastal Blackbutt	12/09/2022	14:15	Tree Climber	N			Nil	Good	No	
Ku2K	Z	125	SG	S	16	Coastal Blackbutt	12/09/2022	14:15	Tree Climber	N			Nil	Good	No	
Ku2K	z	132	Co	E	12	Tallowwood	12/09/2022	13:55	Tree Climber	N			Nil	Mod/Poor - Lid broken - may screw on.	Maybe replacement/ screw on.	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
															screw down lid.	
OH2Ku	A1	165	Scan	E	5	Mahog spp	18/08/2022	13:38	Go Pro	N			Nil	Good	No	
OH2Ku	A1	180	SG	N	7	Tallow	18/08/2022	13:38	Go Pro	N			Nil	Good	No	
OH2Ku	A1	181	Poss.	NE	7	Mele spp.	18/08/2022	13:40	Go Pro	N			Nil	Good	No	
OH2Ku	A1	182	Poss.	E	7	P. Bloodwood	18/08/2022	13:36	Go Pro	N			Nil	Good	No	
OH2Ku	A1	380	LG	NE	10	Blackbutt	18/08/2022	13:41	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No	
OH2Ku	A2	172	Scan	E	5	Tallow	18/08/2022	13:51	Go Pro	N			Euc nest	Good	No	
OH2Ku	A2	173	SG	NE	7	Mahog spp	18/08/2022	13:47	Go Pro	N			Nil	Good	No	
OH2Ku	A2	174	LG	E	10	Red Mahog	18/08/2022	13:47	Go Pro	N			Nil	Lid broken	Maybe replacement/ screw down lid.	
OH2Ku	A2	176	Parr	NE	8	Blackbutt	18/08/2022	13:52	Go Pro	N			Nil	Good	No	
OH2Ku	A2	178	SO	E	10	Red Mahog	18/08/2022	13:50	Go Pro	N			Nil	Good	No	
OH2Ku	A2	186	Poss.	N	8	Red Mahog	18/08/2022	13:54	Go Pro	N			Nil	Good	No	
OH2Ku	A3	179	Scan	NE	5	Stringybark	19/08/2022	9:39	Go Pro	N			Euc leaf	Moderate	No	
OH2Ku	A3	380	Scan	NE	5	Stringybark	19/08/2022	8:35	Go Pro	N			old leaf	Moderate	No	
OH2Ku	A3	381	SG	NE	6	Blackbutt	19/08/2022	8:40	Go Pro	N			Conical euc nest	Good	No	
OH2Ku	A3	382	Parrot	NE	8	Blackbutt	19/08/2022	8:42	Go Pro	N			Nil	Moderate	No	
OH2Ku	A3	383	Poss.	E	6	Blackbutt	19/08/2022	8:37	Go Pro	Not avail			Not avail	Poor	Replace	
OH2Ku	A3	384	Cockatoo	NE	12	Blackbutt	6/09/2022	8:02	Tree Climber	N			Old leaf, box chewed	Good	No	
OH2Ku	A4	183	Scan	NE	5	Turpentine	18/08/2022	13:57	Go Pro	N			Conical euc nest	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	A4	184	SG	ENE	6	Tallowwood	18/08/2022	14:00	Go Pro	N			Euc nest	Good	No	
OH2Ku	A4	185	Poss.	NE	8	Stringybark	18/08/2022	13:59	Go Pro	N			Nil	Moderate	Replace	
OH2Ku	A4	186	LG	NE	8	Stringybark	18/08/2022	13:58	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	Replace	
OH2Ku	A4	187	Parr	NE	8	Tallowwood	18/08/2022	14:01	Go Pro	N			Nil	Good	No	
OH2Ku	A5	168	LG	NE	8	Blackbutt	19/08/2022	11:19	Go Pro	N			Nil	Moderate	No	
OH2Ku	A5	171	Small owl	NE	12	Blackbutt	19/08/2022	11:15	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	A5	188	Scan	NE	5	Tallowwood	19/08/2022	11:12	Go Pro	N			Nil	Good	No	
OH2Ku	A5	189	SG	E	8	Bloodwood	19/08/2022	11:17	Go Pro	N	Insects	Pest	Nil	Moderate	No	
OH2Ku	A5	190	SG	E	9	Bloodwood	19/08/2022	11:10	Go Pro	N			Nil	Good	No	
OH2Ku	A5	191	Poss.	NE	7	Tallowwood	19/08/2022	11:10	Go Pro	N			Fresh euc	Good	No	
OH2Ku	B1	397	SG	NE	7	Tallowwood	19/08/2022	8:20	Go Pro	N			Bark & leaf	Moderate	No	
OH2Ku	B1	398	Poss.	N	8	Tallowwood	19/08/2022	8:19	Go Pro	N			Nil	Good	No	
OH2Ku	B1	399	Scan	NE	5	Tallowwood	19/08/2022	8:17	Go Pro	Not avail			leaf	Poor - fallen and broken	Replace	
OH2Ku	B1	400	Parr	NE	7	Grey gum	19/08/2022	8:14	Go Pro	N			Nil	Good	No	
OH2Ku	B1	401	Scan	N	6	Red mahogany	19/08/2022	8:15	Go Pro	N			Conical euc nest	Good	No	
OH2Ku	B1	402	Poss.	NE	7	Wh stringy	19/08/2022	8:13	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	B1	403	MB	NE	5	Tallowwood	19/08/2022	8:12	Go Pro	N			Nil	Good	No	
OH2Ku	B2	167	SG			Blackbutt	19/08/2022	8:05	Go Pro	N			leaf	Poor - broken lid	Maybe replacement/ screw down lid.	
OH2Ku	B2	404	SG	N	6	P. Bloodwood	19/08/2022	8:11	Go Pro	N			Euc leaf	Moderate	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	B2	405	Scan	N	5	Blackbutt	19/08/2022	7:58	Go Pro	N			Euc leaf	Poor - broken lid	Maybe replacement/ screw down lid.	
OH2Ku	B2	406	LG	E	8	Tallowwood	19/08/2022	8:10	Go Pro	N			Bark	Moderate	No	
OH2Ku	B2	407	Cock	NNW	13	P. Bloodwood	6/09/2022	7:24	Tree Climber	N			Dead Bird and Euc lead	Good	No	
OH2Ku	B2	408	Poss. Add	N	7	P. Bloodwood	19/08/2022	8:02	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No	
OH2Ku	C1	222	SG	NE	7	Sw mahog	19/08/2022	10:31	Go Pro	N			Chewed euc leaf	Good	No	
OH2Ku	C1	223	Poss.	NE	8	Sw mahog	19/08/2022	10:33	Go Pro	N			Nil	Moderate	No	
OH2Ku	C1	224	Scan	E	7	Melaleuca sp.	19/08/2022	10:28	Go Pro	Y	Antechinus	Native	Occupied	Good	No	
OH2Ku	C1	225	LG	E	8	Sw mahog	19/08/2022	10:24	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No	
OH2Ku	C1	226	Parr	E	6	Sw mahog	19/08/2022	10:37	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	C2	216	LG	E	9	Sw mahog	19/08/2022	10:45	Go Pro	N			Fresh euc leaf	Moderate	No	
OH2Ku	C2	217	Parr	E	7	Sw mahog	19/08/2022	10:43	Go Pro	N	Beehive	Pest	Nil	Poor	Replace	
OH2Ku	C2	218	Poss.	E	6	Melaleuca quinquenervia	19/08/2022	10:49	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No	
OH2Ku	C2	219	SG	NE	7	Sw mahog	19/08/2022	10:46	Go Pro	N			Euc leaf	Poor	Replace	
OH2Ku	C2	220	Scan	N	5	Melaleuca spp.	19/08/2022	10:53	Go Pro	N			Bark and leaf nest	Good	No	
OH2Ku	C2	221	LG	N	9	Blackbutt	19/08/2022	10:40	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	C3	227	Poss.	NE	8	Melaleuca quinquenervia	19/08/2022	10:17	Go Pro	Not avail			Not avail	Poor - no lid	Replace	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	C3	228	SG	NE	7	Melaleuca quinquenervia	19/08/2022	10:16	Go Pro	N			Bark and leaf nest	Moderate	No	
OH2Ku	C3	229	Scan	E	6	Melaleuca quinquenervia	19/08/2022	10:11	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	D1	355	LG	NE	10	Blackbutt	19/08/2022	9:41	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	D1	356	Poss.	NE	8	Stringybark?	19/08/2022	9:37	Go Pro	N			Nil	Moderate	No	
OH2Ku	D1	357	SG	N	7	Stringybark?	19/08/2022	9:40	Go Pro	Y	Antechinus	Native	Occupied	Moderate	No	
OH2Ku	D1	358	PARR	NE	8	Tallow	19/08/2022	9:41	Go Pro	N			Nil	poor - no lid	Maybe replacement/ screw down lid.	
OH2Ku	D1	359	Scan	E	5	Melaleuca. quinn.	19/08/2022	9:36	Go Pro	N			Euc nest	Moderate	No	
OH2Ku	D2	360	SG	NE	5	Bloodwood	19/08/2022	9:29	Go Pro	Y	Antechinus	Native	Occupied	Poor	Replace	
OH2Ku	D2	361	Poss.	E	8	Stringybark	19/08/2022	9:30	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No	
OH2Ku	D2	362	Scan	N	6	Bloodwood	19/08/2022	9:28	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	D2	363	MB	NW	5	Stringybark	19/08/2022	9:31	Go Pro	N			Nil	Good	No	
OH2Ku	D2	364	SG	NE	8	Red Mahog	19/08/2022	9:23	Go Pro	N			Latrine and euc nest	Moderate	No	
OH2Ku	D3	365	SG	NE	7	Blackbutt	19/08/2022	9:24	Go Pro	N	Ants	Pest	Old euc nest	Moderate	No	
OH2Ku	D3	366	Scan	NE	5	Bloodwood	19/08/2022	9:22	Go Pro	N			Old leaf	Moderate	No	
OH2Ku	D3	367	Parr	N	8	Bloodwood?	19/08/2022	9:20	Go Pro	Not avail			Not avail	poor - no lid	Replace	
OH2Ku	D3	368	Pos	NE	8	Bloodwood	19/08/2022	9:21	Go Pro	N			Euc leaf	Moderate	No	
OH2Ku	D3	378	SG	NE	8	Wh stringy?	19/08/2022	9:19	Go Pro	N			Euc nest	Moderate - aging	No	

Section	Zone/cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	D4	369	Parr	NE	8	Bloodwood	19/08/2022	8:59	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No	
OH2Ku	D4	371	Scan	NE	5	Blackbutt	19/08/2022	8:58	Go Pro	N			Conical euc leaf	Moderate	No	
OH2Ku	D4	372	LG	N	10	Blackbutt	19/08/2022	8:58	Go Pro	Not avail			Not avail	Poor - box broken no lid/bottom	Replace	
OH2Ku	D4	373	Poss.	N	8	Blackbutt	19/08/2022	9:04	Go Pro	N			Euc leaf	Moderate	No	
OH2Ku	D4	376	SG	NE	7	Blackbutt	19/08/2022	9:01	Go Pro	N			Euc leaf	Moderate	No	
OH2Ku	D5	374	Poss.	NW	7	Bloodwood	19/08/2022	9:12	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No	
OH2Ku	D5	375	Scan	E	5	Swamp Mahog	19/08/2022	9:15	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	D5	377	LG	E	10	Blackbutt	19/08/2022	9:11	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	D5	378	MB	NW	7	Blackbutt	19/08/2022	9:09	Go Pro	N			Nil	Good	No	
OH2Ku	D5	379	Parr	NE	8	Blackbutt	19/08/2022	9:10	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No	
OH2Ku	E1	200	SO	NE	9	Blackbutt	29/06/2022	9:11	Go Pro	N			Nil	Moderate	No	
OH2Ku	E1	201	SG	N	7	Blackbutt	29/06/2022	9:15	Go Pro	Not avail			Nil	Poor - no lid	Replace	
OH2Ku	E2	198	Parr	NE	9	Blackbutt	29/06/2022	9:03	Go Pro	N			Nil	Good	No	
OH2Ku	E2	199	Poss.	N	8	Blackbutt	29/06/2022	9:06	Go Pro	N			Nil	Good	No	
OH2Ku	E3	193	SG	NE	7	Bloodwood	29/06/2022	8:55	Go Pro	N			Old euc nest	Good	No	
OH2Ku	E3	194	MB	N	8	Ironbark	29/06/2022	8:54	Go Pro	N			Nil	Moderate	No	
OH2Ku	E3	195	Poss. add	NE	8	Tallow	29/06/2022	8:59	Go Pro	N			Nil	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	E3	196	Scan	N	5.5	Bloodwood	29/06/2022	9:09	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	E3	274	Cockatoo	NE	10	Blackbutt	6/09/2022	9:07	Tree Climber	N			Nil	Moderate	No	
OH2Ku	F1	160	SO	N	7	Blackbutt	29/06/2022	10:09	Go Pro	Y	Owlet Nightjar	Native	Occupied	Moderate	No	
OH2Ku	F1	161	Poss.	E	8	Bloodwood	29/06/2022	10:03	Go Pro	N			Nil	Good	No	
OH2Ku	F1	162	LFO	ESE	15	Blackbutt	6/09/2022	10:03	Tree Climber	N			Old leaf and old honeycomb	Good	No	
OH2Ku	F1	166	Scan	NE	7	Turpentine	29/06/2022	10:09	Go Pro	Y	Sugar Glider	Native	Occupied	Poor	Maybe replacement/ screw down lid.	
OH2Ku	F1	504	SG	NE	6	P. Bloodwood	29/06/2022	10:04	Go Pro	N			Euc nest	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	F2	163	Poss.	N	7	Tallowwood	29/06/2022	9:53	Go Pro	N			Nil	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	F2	164	SG	NE	7	Pink Bloodwood	29/06/2022	9:55	Go Pro	N			Conical Euc Nest	Good	No	
OH2Ku	G1	197	LG	NE	10	Blackbutt	29/06/2022	10:30	Go Pro	Y	Antechinus	Native	Occupied	Moderate	No	
OH2Ku	G1	202	MB	N	6	Tallow	29/06/2022	10:37	Go Pro	N			Nil	Good	No	
OH2Ku	G1	203	Poss.	N	8	Bloodwood	29/06/2022	10:39	Go Pro	N			Old Leaf	Moderate	Reposition	
OH2Ku	G1	204	Scan	NE	5	Sw mahog	29/06/2022	10:42	Go Pro	N			Nil	Good	No	
OH2Ku	G1	206	SG	N	6	Sw Mahog	29/06/2022	10:34	Go Pro	N			Conical Euc Nest	Moderate	No	
OH2Ku	G2	211	LG	NE	10	Blackbutt	29/06/2022	11:01	Go Pro	N			Nil	Good	No	
OH2Ku	G2	212	Poss.	NE	8	Blackbutt	29/06/2022	11:09	Go Pro	N			Nil	Moderate	No	
OH2Ku	G2	213	Parr	N	8	White Stringybark	29/06/2022	10:59	Go Pro	N			Nil	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	G2	214	SG	N	8	White Stringybark	29/06/2022	11:08	Go Pro	N	Insect nest	Pest	Nil	Moderate	No	
OH2Ku	G2	215	Scan	N	5	White Stringybark	29/06/2022	11:04	Go Pro	N			Old leaf	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	G3	206	Poss.	E	8	Stringybark sp.	29/06/2022	10:53	Go Pro	N			Nil	Moderate/poor	No	
OH2Ku	G3	207	SG	NE	6	Mahog sp	29/06/2022	10:49	Go Pro	N			old leaves	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	G3	208	LG	NE	8	Stringybark sp.	29/06/2022	10:51	Go Pro	N			Nil	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	G3	209	Scan	E	5	Mahog sp	29/06/2022	10:46	Go Pro	Y	Sugar Glider	Native	Occupied	Good	No	
OH2Ku	G3	210	SO	E	10	Blackbutt	29/06/2022	10:55	Go Pro	Not avail			Not avail	Poor - lid broken	Replace	
OH2Ku	H1	385	LG	NE	10	Blackbutt	29/06/2022	13:30	Go Pro	Not avail			Not avail	Poor - lid broken	Replace	
OH2Ku	H1	386	SG	E	7	Blackbutt	29/06/2022	13:34	Go Pro	Not avail			Not avail	Poor - lid broken	Replace	
OH2Ku	H1	387	Parr	NE	8	Blackbutt	29/06/2022	13:34	Go Pro	Not avail			Not avail	Poor - lid broken	Replace	
OH2Ku	H1	388	Poss.	NE	8	Blackbutt	29/06/2022	13:32	Go Pro	N			Latrine	Good	No	
OH2Ku	H2	389	MB	NW	7	Tallowwood	29/06/2022	13:24	Go Pro	N			Nil	Good	No	
OH2Ku	H2	390	SG	NE	6	Tallowwood	29/06/2022	13:25	Go Pro	Y	Sugar Gliders	Native	Occupied	Good	No	
OH2Ku	H2	391	LG	NE	10	Blackbutt	29/06/2022	13:25	Go Pro	N			euc leaf	Good	No	
OH2Ku	H2	392	SG	NE	6	Blackbutt	29/06/2022	13:23	Go Pro	N			Fresh euc nest	Poor - lid broken	Maybe replacement/ screw down lid.	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	H3	393	Cock	NE	12	Blackbutt	12/09/2022	14:00	Tree Climber	N			Nil	Poor	Replace	
OH2Ku	H3	394	Poss.	NE	6	Blackbutt	29/06/2022	13:14	Go Pro	N			Nil	Moderate	No	
OH2Ku	H3	395	SG	NE	6	Turpentine	29/06/2022	13:13	Go Pro	Y	Sugar Gliders	Native	Occupied	Good	No	
OH2Ku	H3	396	LG	NE	10	Blackbutt	29/06/2022	13:09	Go Pro	N			Old leaves	Good	No	
OH2Ku	I1	290	Scan	N	6	Sw. Mahog	29/06/2022	12:43	Go Pro	N	Ants	Pest	Nil	Moderate	No	
OH2Ku	I1	292	SG	N	8	P. Bloodwood	29/06/2022	12:44	Go Pro	N	Termites	Pest	Old leaf	Good	No	
OH2Ku	I1	293	SG	E	8	Sw. Mahog	29/06/2022	12:36	Go Pro	N			Conical Euc Nest	Moderate	No	
OH2Ku	I1	294	Poss.	NE	7	Sw. Mahog	29/06/2022	12:39	Go Pro	N			Nil	Good	No	
OH2Ku	I2	288	LG	NE	10	Wh. Stringybark	29/06/2022	12:57	Go Pro	N			Nil	Moderate	No	
OH2Ku	I2	289	Parr	E	8	Blackbutt	29/06/2022	12:53	Go Pro	N			Nil	Poor - hing broken	Maybe replacement/ screw down lid.	
OH2Ku	I2	291	MB	NW	7	Wh. Stringybark	29/06/2022	12:49	Go Pro	N			Nil	Good	No	
OH2Ku	I2	295	SG	E	8	Blackbutt	29/06/2022	12:59	Go Pro	N			Fresh euc nest	Moderate	No	
OH2Ku	I2	296	Scan	NE	6	Wh. Stringybark	29/06/2022	12:51	Go Pro	N	Insects	Pest	Nil	Poor - no lid	Maybe replacement/ screw down lid.	
OH2Ku	I3	283	SO	E	10	Tallowood	29/06/2022	12:25	Go Pro	N			Nil	Moderate	No	
OH2Ku	I3	284	Poss.	N	7	Tallowood	29/06/2022	12:30	Go Pro	Not avail			Not avail	Poor - broken box	Replace	
OH2Ku	I3	285	LG	NE	10	Blackbutt	29/06/2022	12:23	Go Pro	N			Bark and leaf	Good	No	
OH2Ku	I3	286	SG	NE	8	White Stringybark	29/06/2022	12:26	Go Pro	N			Nil	Poor - no lid	Replace	
OH2Ku	I3	287	Scan	N	8	Mahog spp	29/06/2022	12:28	Go Pro	N			Nil	Moderate	No	
OH2Ku	I4	279	LG	NE	10	Mahog spp.	29/06/2022	12:16	Go Pro	Y	Common Brush-tail Possum	Native	Occupied	Poor - no lid	Maybe replacement/ screw down lid.	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	I4	280	MB	W	8	Blackbutt	29/06/2022	12:13	Go Pro	N			Fresh euc	Good	No	
OH2Ku	I4	281	Parr	NE	8	Mahog spp.	29/06/2022	12:12	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	I4	282	Poss.	N	8	Turp	29/06/2022	12:18	Go Pro	N			Nil	Moderate	No	
OH2Ku	I5	297	SG	E	6	Wh. Mahog	29/06/2022	14:21	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	I5	298	Poss.	NE	8	Tallowwood	29/06/2022	14:25	Go Pro	N			Nil	Good	No	
OH2Ku	I5	299	Add. Poss.	N	8	Tallowwood	29/06/2022	14:22	Go Pro	N			Old leaves	Moderate	No	
OH2Ku	I5	300	SO	N	10	Mahog. spp.	29/06/2022	14:28	Go Pro	Y	Sugar Glider	Native	Occupied	Good	No	
OH2Ku	I5	301	LG	NE	10	Tallowwood	29/06/2022	14:24	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	I6	307	Poss.	E	6	Mahog spp	29/06/2022	14:17	Go Pro	N			old leaf	Poor/Mod - deteriorating inside	No	
OH2Ku	I6	308	SG	N	7	Bloodwood spp.	29/06/2022	14:14	Go Pro	N			euc leaf	Good	No	
OH2Ku	I6	309	Parr	E	9	Mahog spp	29/06/2022	14:15	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	I6	310	Scan	NE	5	Mahog spp	29/06/2022	14:09	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	I6	311	LG	NE	9	Mahog spp	29/06/2022	14:10	Go Pro	N			Nil	Good	No	
OH2Ku	I7	312	Parr	N	7	Mahog spp	29/06/2022	13:58	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	I7	313	LG	NE	9	Mahog spp	29/06/2022	13:59	Go Pro	N			Old leaf	Moderate	No	
OH2Ku	I7	314	LG	NE	10	Sw. Mahog	29/06/2022	14:01	Go Pro	N	Termites	Pest	Nil	Poor	Replace	
OH2Ku	I7	315	MB	NW	6	White Stringybark	29/06/2022	13:56	Go Pro	N			Nil	Good	No	
OH2Ku	I8	316	LG	NE	10	White Stringybark	29/06/2022	14:33	Go Pro	N			Old leaf	Good	No	
OH2Ku	I8	317	Poss.	NE	7	Turp	29/06/2022	14:36	Go Pro	N			Nil	Good	No	
OH2Ku	I8	318	Parr	N	8	Blackbutt	29/06/2022	14:37	Go Pro	N			Nil	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	I8	319	Cockatoo	NE	10	Blackbutt	29/06/2022			Unk			Unk	Good	No	
OH2Ku	J1	253	Poss. add	NE	8	Red Mahog	18/08/2022	12:05	Go Pro	N			Euc nest	Good	No	
OH2Ku	J1	254	Mb	NW	6	Melaleuca sp.	18/08/2022	12:09	Go Pro	N			Nil	Good	No	
OH2Ku	J1	255	SO	N	12	Red Mahog	18/08/2022	12:04	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No	
OH2Ku	J1	256	LG	NE	10	Tallowwood	18/08/2022	12:11	Go Pro	N			Conical euc nest	Good	No	
OH2Ku	J1	257	Scan	NE	5	Melaleuca sp.	18/08/2022	12:12	Go Pro	N			Nil	Good	No	
OH2Ku	J1	258	Poss.	N	8	Tallowwood	18/08/2022	12:14	Go Pro	Y	Short-eared Brushtail Possum	Native	Occupied	Good	No	
OH2Ku	J2	259	LG	E	9	Red. Mahog	18/08/2022	12:27	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	J2	260	Poss.	NE	8	Red. Mahog	18/08/2022	12:27	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Moderate	No	
OH2Ku	J2	261	Scan	N	6	Red Mahog	18/08/2022	12:25	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	J2	262	SG	NE	8	Sw. Mahog	18/08/2022	12:23	Go Pro	N			Euc leaf	Poor	Replace	
OH2Ku	J2	263	Parr	E	8	Blackbutt	18/08/2022	12:22	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	J3	264	LG	E	10	Mahog sp.	18/08/2022	12:56	Go Pro	N			Nil	Poor - no lid	Replace	
OH2Ku	J3	265	SG	N	7	Red Mahog	18/08/2022	12:57	Go Pro	Y	Antechinus	Native	Occupied	Moderate	No	
OH2Ku	J3	266	SG	E	8	Sw. Mahog	18/08/2022	12:54	Go Pro	N			Euc leaf	Moderate	No	
OH2Ku	J3	267	Scan	E	6	Melaleuca sp.	18/08/2022	12:53	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	J3	268	Poss.	NE	8	Red Mahog	18/08/2022	12:50	Go Pro	N			Bark	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	J4	269	LG	N	9	Sw. Mahog	18/08/2022	13:02	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	J4	270	Poss.	NE	8	Mahog sp.	18/08/2022	13:02	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	J4	271	Parr	NE	7	Blackbutt	18/08/2022	13:01	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	J4	272	SG	NE	8	Sw. Mahog	18/08/2022	13:04	Go Pro	N			Euc leaf	Good	No	
OH2Ku	J4	273	Scan	NE	7	Blackbutt	18/08/2022	13:07	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	J5	275	LG	NE	10	Sw. Mahog	29/06/2022	15:02	Go Pro	N			Nil	Good	No	
OH2Ku	J5	276	LG	E	10	Sw. Mahog	29/06/2022	14:58	Go Pro	Y	Common Brush-tail Possum	Native	Occupied	Good	No	
OH2Ku	J5	277	Scan	E	7	Melaleuca sp.	29/06/2022	15:00	Go Pro	N	Ants	Pest	Nil	Good	No	
OH2Ku	J5	276B	MB	NW	8	P. Bloodwood	29/06/2022	14:54	Go Pro	N			Nil	Good	No	
OH2Ku	K1	302	SG	NE	6	Melaleuca	18/08/2022	11:05	Go Pro	N	Bee	Pest	Nil	Moderate	No	
OH2Ku	K1	303	Scan	NW	4	Melaleuca sp.	18/08/2022	11:02	Go Pro	N			Nil	Moderate	No	
OH2Ku	K1	304	Scan	N	4	Melaleuca sp.	18/08/2022	10:56	Go Pro	N	Insects	Pest	Old leaf	Poor	Replace	
OH2Ku	K1	305	Poss.	N	5	Melaleuca	18/08/2022	10:53	Go Pro	N			Nil	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	K1	306	SG	E	4	Melaleuca	18/08/2022	10:59	Go Pro	N			Conical paperbark nest	Good	No	
OH2Ku	K2	502	Scan	E	5	Red Mahog	18/08/2022	11:09	Go Pro	N	Termites	Pest	Nil	Poor	Replace	
OH2Ku	K2	503	Scan	NE	5	Red Mahog	18/08/2022	11:07	Go Pro	N	Termites	Pest	Nil	Poor	Replace	
OH2Ku	K2	505	Poss.	NE	7m	Red Mahog	18/08/2022	11:10	Go Pro	N			Nil	Moderate	No	
OH2Ku	L1	347	SG	N	7	Swamp Oak	18/08/2022	10:16	Go Pro	Y	Sugar Gliders	Native	Occupied	Moderate	No	
OH2Ku	L1	348	MB	W	7	Casuarina	18/08/2022	10:19	Go Pro	N			Nil	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	L1	349	Poss.	E	6	Melaleuca quinn.	18/08/2022	10:21	Go Pro	Y	Common Brushtail Possum	Native	Occupied	Good	No	
OH2Ku	L1	350	Scan	NE	5	Melaleuca quinn.	18/08/2022	10:23	Go Pro	N			Paperbark nest	Good	No	
OH2Ku	L2	351	LG	N	10	Melaleuca quinn.	19/08/2022			Unk			Unk		No	
OH2Ku	L2	352	Parr	N	8	Melaleuca quinn.	20/08/2022			Not avail			Not avail	Poor - lid broken	Replace	
OH2Ku	L2	353	SG	NE	7	Melaleuca quinn.	21/08/2022			Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	L2	354	Poss.	NE	8	Melaleuca quinn.	22/08/2022			Unk			Unk		No	
OH2Ku	L2	500	LFO	E	10	Swamp Mahog	23/08/2022			Unk			Unk		No	
OH2Ku	L2	501	Poss.	E	6	Swamp mahog	24/08/2022			Not located			Not located		No	
OH2Ku	M1	246	LG	E	9	Ironbark	18/08/2022	8:33	Go Pro	N			Old euc leaf	Good	No	
OH2Ku	M1	248	Scan	E	6	P. Bloodwood	18/08/2022	8:38	Go Pro	N	Insects	Pest	Nil	Poor	Replace	
OH2Ku	M1	249	SG	E	7	P. Bloodwood	18/08/2022	8:42	Go Pro	N			Old euc leaf	Moderate	No	
OH2Ku	M1	251	Poss.	N	8	Ironbark	18/08/2022	8:35	Go Pro	N			Euc leaf	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	M2	247	SG	NE	8	P. Bloodwood	18/08/2022	8:47	Go Pro	N			Old euc leaf	Poor	Replace	
OH2Ku	M2	250	Poss.	N	7	Tallowwood	18/08/2022	8:51	Go Pro	N			Nil	Poor	Replace	
OH2Ku	M2	252	MB	NW	5	P. Bloodwood	18/08/2022	8:45	Go Pro	N			Nil	Good	No	
OH2Ku	N1	355b	Scan	NE	5	Red gum	18/08/2022	8:12	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	N1	356b	Poss.	NE	7	Red gum	18/08/2022	8:12	Go Pro	N			Bark and leaf	Moderate	No	
OH2Ku	N1	357b	Parr	NE	8	Red gum	18/08/2022	8:10	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	N1	358b	SG	NE	7	Red gum	18/08/2022	8:10	Go Pro	Not avail			Not avail	Poor - no lid	Replace	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	N1	361b	Poss. ad	ENE	9	FRG	18/08/2022	8:05	Go Pro	N			Euc leaf	Good	No	
OH2Ku	N1	362b	SO	NE	10	FRG	18/08/2022	8:05	Go Pro	Y	Diamond Python	Native	Occupied	Good	No	
OH2Ku	N2	359b	Scan	E	5	Red gum	18/08/2022	8:15	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	N2	360b	LG	ENE	6	Red gum	18/08/2022	8:14	Go Pro	Not avail			Not avail	Poor - no bottom	Replace	
OH2Ku	N3	363	Scan	NE	6	Casuarina	18/08/2022	9:09	Go Pro	N			Euc leaf	Poor - no lid	Replace	
OH2Ku	N3	364	Poss.	N	5	Casuarina	18/08/2022	9:12	Go Pro	N			Euc leaf	Moderate	No	
OH2Ku	N3	366	Sg	NE	6	Tallowwood	18/08/2022	9:14	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	N3	365b	Lg	E	8	Tallowwood	18/08/2022	9:14	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	O1	230	SG	N	7	Tallowwood	30/06/2022	8:49	Go Pro	N			Old leaf nest	Good	No	
OH2Ku	O1	231	LG	N	9	Tallowwood	30/06/2022	8:47	Go Pro	N			Nil	Good	No	
OH2Ku	O1	232	SG	E	8	Ironbark	30/06/2022	8:51	Go Pro	N	Old beehive	Pest	Nil	Good	No	
OH2Ku	O1	233	Poss.	N	9	Pink bloodwood	30/06/2022	8:42	Go Pro	N			Nil	Good	No	
OH2Ku	O1	234	Scan	N	6	Tallowwood	30/06/2022	8:55	Go Pro	N	Insect Nest	Pest	Nil	Good	No	
OH2Ku	P1	235	Poss.	NE	7	Tallowwood	29/07/2022	10:31	Go Pro	N			Euc leaf	Good	No	
OH2Ku	P1	236	Parr	E	8	Spotted gum	29/07/2022	10:34	Go Pro	N			Nil	Moderate	No	
OH2Ku	P1	237	SG	NE	8	Tallowwood	29/07/2022	10:35	Go Pro	N			Conical euc nest	Good	No	
OH2Ku	P1	238	Scan	N	8	Tallowwood	29/07/2022	10:38	Go Pro	N			Euc leaf	Good	No	
OH2Ku	P2	239	LG	NE	10	Tallowwood	29/07/2022	10:41	Go Pro	N			Leaf	Good	No	
OH2Ku	P2	240	SG	E	8	Tallowwood	29/07/2022	10:45	Go Pro	N			Nil	Moderate	No	
OH2Ku	P2	242	Parr	N	8	Spotted gum	29/07/2022	10:45	Go Pro	Y	Lace Monitor	Native	Occupied	Good	No	
OH2Ku	P2	243	Scan	NE	8	Tallowwood	29/07/2022	10:46	Go Pro	N			Conical euc nest	Good	No	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
OH2Ku	P3	241	Scan	N	5	Stringybark spp.	29/07/2022	11:00	Go Pro	N			Fresh euc nest	Poor - no lid	Replace	
OH2Ku	P3	244	Poss.	NE	8	Bloodwood spp.	29/07/2022	10:58	Go Pro	N			Nil	Moderate	No	
OH2Ku	P3	245	Scan	N	5	Bloodwood spp.	29/07/2022	11:01	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	Q1	367	LG	N	8	Bloodwood	30/06/2022	9:22	Go Pro	N			Nil	Good	No	
OH2Ku	Q1	368	Scan	E	5	Tallowwood	30/06/2022	9:30	Go Pro	N			Old euc leaf	Good	No	
OH2Ku	Q1	369	Po	NE	7	Tallowwood	30/06/2022	9:27	Go Pro	N			Nil	Good	No	
OH2Ku	Q1	370	LFO	NNE	18-20	SF grey gum	30/06/2022			Not avail			Not avail	Broken on ground.	Replace	
OH2Ku	Q1	371	Poss	NE	8	Bloodwood	30/06/2022	9:24	Go Pro	N			Nil	Good	No	
OH2Ku	Q2	372	LG	NE	8	Ironbark	6/09/2022			Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	R1	320	Poss.	N	8	Turp	30/06/2022	10:34	Go Pro	N			Nil	Moderate	No	
OH2Ku	R1	321	MB	NW	6	Tallow?	30/06/2022	10:20	Go Pro	N			Nil	Good	No	
OH2Ku	R1	322	LFO	N	12	Bloodwood	30/06/2022	10:22	Go Pro	N			Nil	Moderate	No	
OH2Ku	R1	323	Add poss.	E	7	Flooded Gum	30/06/2022	10:21	Go Pro	N			Nil	Moderate	No	
OH2Ku	R1	324	Scan	NE	5	Rainforest spp	30/06/2022	10:28	Go Pro	N			Old leaf	Moderate	No	
OH2Ku	R2	325	SG	NE	8	Tallow	30/06/2022	10:43	Go Pro	Not avail			Not avail	Poor - no lid	Replace	
OH2Ku	R2	326	Scan	E	6	Bloodwood	30/06/2022	10:42	Go Pro	N			Conical nest	Good	No	
OH2Ku	R2	327	MB	W	6	Mahogany	30/06/2022	10:40	Go Pro	N			Nil	Good	No	
OH2Ku	R2	328	Parr	NE	8	Mahogany	30/06/2022	10:39	Go Pro	N			Nil	Moderate	No	
OH2Ku	R2	329	Poss.	NE	8	Turp	30/06/2022	10:38	Go Pro	N			Old leaf	Moderate	No	
OH2Ku	R3	330	LG	N	10	Grey gum	30/06/2022	10:58	Go Pro	N			Nil	Moderate	No	
OH2Ku	R3	331	Poss.	NE	8	Turp	30/06/2022	10:54	Go Pro	N			Nil	Moderate	No	
OH2Ku	R3	332	Co	N	14	Grey gum	6/09/2022	10:51	Tree Climber	N			Nil	Poor - lid broken	Maybe replacement/	

Section	Zone/ cluster	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Check date	Time	Inspect type	Vert fauna Y/N	Species	Native/ Pest	Vert signs of use	Box condition	Maintenance required	Changes in surrounds
															screw down lid.	
OH2Ku	R3	333	add Poss.	NE	6	Same tree as Co/SO	30/06/2022	10:48	Go Pro	N	Termites	Pest	Nil	Moderate/Good	No	
OH2Ku	R3	334	LG	N	10	Tallowwood	30/06/2022	10:56	Go Pro	N			Nil	Moderate	No	
OH2Ku	R4	335	Scan	N	6	Turp	30/06/2022	11:07	Go Pro	N			Old leaf	Moderate	No	
OH2Ku	R4	336	SG	NE	8	Turp	30/06/2022	11:06	Go Pro	N			Old leaf	Good	No	
OH2Ku	R4	337	Parr	NE	12	Mahogany	30/06/2022	11:04	Go Pro	N			Nil	Good	No	
OH2Ku	R4	338	LG	N	10	Bloodwood	30/06/2022	11:10	Go Pro	N			Old leaf	Moderate	No	
OH2Ku	R4	339	Poss.	NE	8	Tallow	30/06/2022	11:09	Go Pro	N			Bark nest	Good	No	
OH2Ku	R5	340	LG	NE	10	Bloodwood	30/06/2022	11:18	Go Pro	N	Termites	Pest	Nil	Moderate	No	
OH2Ku	R5	341	Poss.	NE	6	Same tree as LG	30/06/2022	11:19	Go Pro	N	Termites	Pest	Nil	Moderate	No	
OH2Ku	R5	342	Parr	NE	8	Tallowwood	30/06/2022	11:20	Go Pro	N			Nil	Moderate	No	
OH2Ku	R5	343	MB	W	6	Mahogany	30/06/2022	11:17	Go Pro	N			Nil	Good	No	
OH2Ku	R5	344	SG	NE	8	Tallowwood	30/06/2022	11:15	Go Pro	N	Ants	Pest	Nil	Poor - broken lid	Maybe replacement/ screw down lid.	
OH2Ku	R6	345	Scan	NE	10	Tallowwood	30/06/2022	11:26	Go Pro	N			Fresh euc nest	Good	No	
OH2Ku	R6	346	LG	N	10	Grey gum	30/06/2022	11:24	Go Pro	N			Nil	Moderate	No	

Annex 3 – Survey weather conditions

Date	Temperature (°C)	Rainfall (mm)	Wind (km/hr)
29/06/2022	18.4	0	20
30/06/2022	19.9	0	13
13/07/2022	17.6	0	7
14/07/2022	17.5	0	26
29/07/2022	20.3	0	17
04/08/2022	24.2	0.2	Calm
17/08/2022	21.1	0.2	11
18/08/2022	22.8	0	13
19/08/2022	23.8	0.2	6
05/09/2022	19.2	2.4	9
06/09/2022	20.0	0	9
08/09/2022	21.3	0	6
12/09/2022	22.7	0	9
11/01/2022	29.2	0	NA
12/01/2022	28.9	0	NA
17/02/2022	30.6	0	NA
18/02/2022	31.7	0.4	NA
21/02/2022	31.8	0	NA
22/02/2022	28.5	0	NA
08/03/2022	NA	0	NA
09/03/2022	28.3	0.2	Calm
10/03/2022	25.9	0	7
17/03/2022	28.4	3.4	9

Climate Data Sourced from BOM app for current location and Kempsey weather station (station number 059007).

Annex 4 – Maintenance required

Section	Zone/ cluster	Lewis' Nest Box Tree Name	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Box Cond	Maintenance required	Notes
Ku2K	AA	K2K-NBT-08	8	LG	N	15	Coastal Blackbutt	Poor - no lid	Replace	
Ku2K	NEW ZONE	K2K-NBT-90	90	Scan	S	10	Red Mahogany	Good	Replace lid and rewire	Wire double wrapped around tree.
Ku2K	NEW ZONE	K2K-NBT-96	96	Co	E	18	Coastal Blackbutt	Moderate	Screw lid shut	
Ku2K	S	K2K-NBT-58	58	LG	NE	8	Brush Box	Moderate	Drill hole to drain water.	Water in box
Ku2K	S	K2K-NBT-72	72	LG	NW	7	Turpentine	Moderate	Screw on lid	
Ku2K	S	K2K-NBT-79	79	Scan	E	6	Turpentine	Poor - no bottom	Replace	
Ku2K	T	K2K-NBT-49	49	LG	NE	9	Pink Bloodwood	Poor	Replace	LG box fallen out of tree onto bat box, no lids.
Ku2K	T	K2K-NBT-49	49	MB	SE	7	Pink Bloodwood	Poor	Replace	LG box fallen out of tree onto bat box, no lids.
Ku2K	T	K2K-NBT-56	56	Scan	E	8	Brush Box	Poor	Replace	
Ku2K	T	K2K-NBT-56	56	SG	N	8	Brush Box	Poor	Replace	
Ku2K	T	K2K-NBT-57	57	MB	N	3	Brush Box	Poor	Replace	
Ku2K	T	K2K-NBT-62	62	Co	N	14	Tallowwood	broken on ground	Replace	
Ku2K	T	K2K-NBT-64	64	LG	N	6	Grey Ironbark	no lid	Replace	
Ku2K	T	K2K-NBT-64	64	SG	E	10	Grey Ironbark	no lid	Replace	
Ku2K	T	K2K-NBT-71	71	MB	E		Flooded Gum	broken on ground	Replace	
Ku2K	U	K2K-NBT-44	44	SG	NE	5	White Mahogany	Poor - no lid	Replace	
Ku2K	V	K2K-NBT-34	34	SG	NE	10	Tallowwood	poor - no lid	Replace	
Ku2K	V	K2K-NBT-35	35	MB	W	5	Scribbly Gum	Poor - box rotting	Replace	
Ku2K	V	K2K-NBT-126	126	LG	NW	9	White Stringybark	Moderate	Drill hole to drain water.	Water in box
Ku2K	X	K2K-NBT-28	28	Poss.	E	6	White Stringybark	Poor - Water in box.	Drainage hole	
Ku2K	X	K2K-NBT-101	101	Co	E		Coastal Blackbutt	Poor - no bottom	Replace	

Section	Zone/ cluster	Lewis' Nest Box Tree Name	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Box Cond	Maintenance required	Notes
Ku2K	Z	K2K-NBT-104	104	LG	NE	11	Red Mahogany	Moderate - lid missing?	Maybe replacement/ screw down lid.	
Ku2K	Z	K2K-NBT-108	108	Poss.	NW	13	Coastal Blackbutt	Mod/Poor - Lid broken - may screw on.	Fix lid	
Ku2K	Z	K2K-NBT-109	109	LG		15	Coastal Blackbutt	Poor - Full of water -	drill drainage hole.	
Ku2K	z	K2K-NBT-132	132	Co	E	12	Tallowwood	Mod/Poor - Lid broken - may screw on.	Maybe replacement/ screw down lid.	
OH2Ku	A2		174	LG	E	10	Red Mahog	Lid broken	Maybe replacement/ screw down lid.	Old honeycomb
OH2Ku	A3		383	Poss.	E	6	Blackbutt	Poor	Replace	
OH2Ku	A4		185	Poss.	NE	8	Stringybark	Moderate	Replace	
OH2Ku	A4		186	LG	NE	8	Stringybark	Moderate	Replace	
OH2Ku	A5		171	Small owl	NE	12	Blackbutt	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	B1		399	Scan	NE	5	Tallowwood	Poor - fallen and broken	Replace	
OH2Ku	B1		402	Poss.	NE	7	Wh stringy	Poor - no lid	Replace	
OH2Ku	B2		167	SG			Blackbutt	Poor - broken lid	Maybe replacement/ screw down lid.	
OH2Ku	B2		405	Scan	N	5	Blackbutt	Poor - broken lid	Maybe replacement/ screw down lid.	
OH2Ku	C1		226	Parr	E	6	Sw mahog	Poor - no lid	Replace	
OH2Ku	C2		217	Parr	E	7	Sw mahog	Poor	Replace	
OH2Ku	C2		219	SG	NE	7	Sw mahog	Poor	Replace	
OH2Ku	C2		221	LG	N	9	Blackbutt	Poor - no lid	Replace	
OH2Ku	C3		227	Poss.	NE	8	Melaleuca quinquenervia	Poor - no lid	Replace	
OH2Ku	C3		229	Scan	E	6	Melaleuca quinquenervia	Poor - no lid	Replace	
OH2Ku	D1		355	LG	NE	10	Blackbutt	Poor - no lid	Replace	
OH2Ku	D1		358	PARR	NE	8	Tallow	poor - no lid	Maybe replacement/	

Section	Zone/ cluster	Lewis' Nest Box Tree Name	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Box Cond	Maintenance required	Notes
									screw down lid.	
OH2Ku	D2		360	SG	NE	5	Bloodwood	Poor	Replace	
OH2Ku	D2		362	Scan	N	6	Bloodwood	Poor - no lid	Replace	
OH2Ku	D3		367	Parr	N	8	Bloodwood?	poor - no lid	Replace	
OH2Ku	D4		372	LG	N	10	Blackbutt	Poor - box broken no lid/bottom	Replace	
OH2Ku	D5		375	Scan	E	5	Swamp Mahog	Poor - no lid	Replace	
OH2Ku	D5		377	LG	E	10	Blackbutt	Poor - no lid	Replace	
OH2Ku	E1		201	SG	N	7	Blackbutt	Poor - no lid	Replace	
OH2Ku	E3		196	Scan	N	5.5	Bloodwood	Poor - no lid	Replace	
OH2Ku	F1		166	Scan	NE	7	Turpentine	Poor	Maybe replacement/ screw down lid.	
OH2Ku	F1		504	SG	NE	6	P. Bloodwood	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	F2		163	Poss.	N	7	Tallowwood	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	G1		203	Poss.	N	8	Bloodwood	Moderate	Reposition	
OH2Ku	G2		215	Scan	N	5	White Stringybark	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	G3		207	SG	NE	6	Mahog sp	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	G3		208	LG	NE	8	Stringybark sp.	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	G3		210	SO	E	10	Blackbutt	Poor - lid broken	Replace	
OH2Ku	H1		385	LG	NE	10	Blackbutt	Poor - lid broken	Replace	
OH2Ku	H1		386	SG	E	7	Blackbutt	Poor - lid broken	Replace	
OH2Ku	H1		387	Parr	NE	8	Blackbutt	Poor - lid broken	Replace	
OH2Ku	H2		392	SG	NE	6	Blackbutt	Poor - lid broken	Maybe replacement/	

Section	Zone/ cluster	Lewis' Nest Box Tree Name	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Box Cond	Maintenance required	Notes
									screw down lid.	
OH2Ku	H3		393	Cock	NE	12	Blackbutt	Poor	Replace	
OH2Ku	I2		289	Parr	E	8	Blackbutt	Poor - hing broken	Maybe replacement/ screw down lid.	
OH2Ku	I2		296	Scan	NE	6	Wh. Stringybark	Poor - no lid	Maybe replacement/ screw down lid.	
OH2Ku	I3		284	Poss.	N	7	Tallowwood	Poor - broken box	Replace	
OH2Ku	I3		286	SG	NE	8	White Stringybark	Poor - no lid	Replace	
OH2Ku	I4		279	LG	NE	10	Mahog spp.	Poor - no lid	Maybe replacement/ screw down lid.	
OH2Ku	I4		281	Parr	NE	8	Mahog spp.	Poor - no lid	Replace	
OH2Ku	I5		297	SG	E	6	Wh. Mahog	Poor - no lid	Replace	
OH2Ku	I5		301	LG	NE	10	Tallowwood	Poor - no lid	Replace	
OH2Ku	I6		309	Parr	E	9	Mahog spp	Poor - no lid	Replace	
OH2Ku	I6		310	Scan	NE	5	Mahog spp	Poor - no lid	Replace	
OH2Ku	I7		312	Parr	N	7	Mahog spp	Poor - no lid	Replace	
OH2Ku	I7		314	LG	NE	10	Sw. Mahog	Poor	Replace	
OH2Ku	J2		259	LG	E	9	Red. Mahog	Poor - no lid	Replace	
OH2Ku	J2		261	Scan	N	6	Red Mahog	Poor - no lid	Replace	
OH2Ku	J2		262	SG	NE	8	Sw. Mahog	Poor	Replace	
OH2Ku	J2		263	Parr	E	8	Blackbutt	Poor - no lid	Replace	
OH2Ku	J3		264	LG	E	10	Mahog sp.	Poor - no lid	Replace	
OH2Ku	J3		267	Scan	E	6	Melaleuca sp.	Poor - no lid	Replace	
OH2Ku	J4		269	LG	N	9	Sw. Mahog	Poor - no lid	Replace	
OH2Ku	J4		270	Poss.	NE	8	Mahog sp.	Poor - no lid	Replace	
OH2Ku	J4		271	Parr	NE	7	Blackbutt	Poor - no lid	Replace	
OH2Ku	J4		273	Scan	NE	7	Blackbutt	Poor - no lid	Replace	
OH2Ku	K1		304	Scan	N	4	Melaleuca sp.	Poor	Replace	
OH2Ku	K1		305	Poss.	N	5	Melaleuca	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	K2		502	Scan	E	5	Red Mahog	Poor	Replace	
OH2Ku	K2		503	Scan	NE	5	Red Mahog	Poor	Replace	

Section	Zone/ cluster	Lewis' Nest Box Tree Name	Box # / NBT	Box type	Orientation (approx.)	Height (approx.)	Tree species	Box Cond	Maintenance required	Notes
OH2Ku	L2		352	Parr	N	8	Melaleuca quinn.	Poor - lid broken	Replace	Inaccessible
OH2Ku	L2		353	SG	NE	7	Melaleuca quinn.	Poor - no lid	Replace	Inaccessible
OH2Ku	M1		248	Scan	E	6	P. Bloodwood	Poor	Replace	
OH2Ku	M1		251	Poss.	N	8	Ironbark	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	M2		247	SG	NE	8	P. Bloodwood	Poor	Replace	
OH2Ku	M2		250	Poss.	N	7	Tallowwood	Poor	Replace	
OH2Ku	N1		355b	Scan	NE	5	Red gum	Poor - no lid	Replace	
OH2Ku	N1		357b	Parr	NE	8	Red gum	Poor - no lid	Replace	
OH2Ku	N1		358b	SG	NE	7	Red gum	Poor - no lid	Replace	
OH2Ku	N2		359b	Scan	E	5	Red gum	Poor - no lid	Replace	
OH2Ku	N2		360b	LG	ENE	6	Red gum	Poor - no bottom	Replace	
OH2Ku	N3		363	Scan	NE	6	Casuarina	Poor - no lid	Replace	
OH2Ku	N3		366	Sg	NE	6	Tallowwood	Poor - no lid	Replace	
OH2Ku	N3		365b	Lg	E	8	Tallowwood	Poor - no lid	Replace	
OH2Ku	P3		241	Scan	N	5	Stringybark spp.	Poor - no lid	Replace	
OH2Ku	P3		245	Scan	N	5	Bloodwood spp.	Poor - no lid	Replace	
OH2Ku	Q1		370	LFO	NNE	18-20	SF grey gum	Broken on ground.	Replace	
OH2Ku	Q2		372	LG	NE	8	Ironbark	Poor - no lid	Replace	
OH2Ku	R2		325	SG	NE	8	Tallow	Poor - no lid	Replace	
OH2Ku	R3		332	Co	N	14	Grey gum	Poor - lid broken	Maybe replacement/ screw down lid.	
OH2Ku	R5		344	SG	NE	8	Tallowwood	Poor - broken lid	Maybe replacement/ screw down lid.	

Niche Environment and Heritage

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