

ALBURY WODONGA THREATENED SPECIES MONITORING PROGRAM 2021 ANNUAL REPORT



Albury
Conservation
Company

DM  ecological

Cover photo: Squirrel Glider at Splitters Creek, Albury (Amy Daeche, 2021)

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The report has been prepared by Dylan McWhinney (DM Ecological) who is an experienced ecologist and project environmental manager. He has over 10 years' experience in environmental management and consulting and is a Certified Environmental Practitioner (CEnvP) as administered by the Environmental Institute of Australia and New Zealand (EIANZ).

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Executive Summary

The Albury Wodonga Threatened Species Monitoring Program (TSMP) has been strategically monitoring Albury Wodonga's wildlife since 2018, with a focus on arboreal mammals and in particular the Squirrel Glider (*Petaurus norfolcensis*). Albury Conservation Company (ACC) has engaged DM Ecological to implement the program, which started in Albury (Thurgoona – Wirlinga) and expanded into Wodonga in 2020.

In 2020, the program monitored wildlife at over 120 sites using motion-sensing cameras as the primary survey tool. Two monitoring periods occurred in the Thurgoona - Wirlinga study area in 2021, Autumn and Spring. The survey effort in each period was 66 sites and 67 sites monitored respectively. Results showed:

- 30 Squirrel Glider detections in the Autumn monitoring period (detection rate of 45%)
- 25 glider detections in the Spring monitoring period (detection rate of 37%).

There was an increase before slight decrease in overall glider detection rates from the previous year (2019), where the respective detection rates were 35% (Autumn 2020) and 38% (Spring 2020). The 2021 monitoring periods have resulted in four successive monitoring periods with glider detection rates of greater than 35%, after they had previously declined.

Two monitoring periods occurred in the Wodonga study area in 2021, Winter and Spring. The survey effort in each period was 59 sites monitored. Results were identical, showing:

- 22 glider detections in the Autumn monitoring period (detection rate of 37%)
- 22 glider detections in the Spring monitoring period (detection rate of 37%)

In each of the monitoring periods so far (Winter, Spring 2020 and Autumn, Spring 2021) there have been no glider detections in riparian habitat sites within the proposed development land use zone. Roadsides were the only habitat type with detections across all land use zones through both monitoring periods

Recommended actions include:

1. Continue implementing the TSMP in both Thurgoona – Wirlinga and Wodonga to improve knowledge of threatened species and identify critical habitats, linkages, and management interventions to ensure the populations remain viable in the face of urbanisation.
2. Develop a 'shovel ready' spotlight survey project to identify sites with Squirrel/ Krefft's glider overlap and facilitate the development of a motion sensing wildlife camera identification protocol in early 2022.
3. Pursue opportunities to fund further research or projects based on the TSMP data collected to date.
4. Prioritise the delivery of the design and delivery of the three-year funded '*Applying science to on-ground action for conservation of Albury Wodonga's threatened wildlife*' project.
5. Ensure the timely and effective delivery of the '*Applying science to inform on-ground actions for conserving Wodonga's threatened wildlife*'.
6. This program and its associated projects should be supported by Councils and other key stakeholders. It aligns with the Regional Natural Environment Strategy (RNES) and meets many of the actions in the RNES Action Plan (2020-24).

The Albury Wodonga Threatened Species Monitoring Program has been made possible with funding from Albury City Council, Ross Trust, Wettenhall Environment Trust, Wodonga Council and others.

1 Introduction

1.1 Project background

DM Ecological has been engaged by Albury Conservation Company (ACC) since April 2018 to implement a Squirrel Glider Monitoring Program (SGMP) in the greater Thurgoona / Wirlinga area of New South Wales (NSW). The SGMP at its inception had the following objectives:

- 1 To determine the impact of urbanisation on Squirrel Glider (*Petaurus norfolcensis*) populations within key 'stronghold' patches (as indicated in previous studies).
- 2 To evaluate the effectiveness of management actions designed to improve the persistence of Squirrel Glider populations in 'lower quality' patches.
- 3 Engage the community in the protection and enhancement of Squirrel Glider populations by providing avenues to participate in monitoring and restoration works.
- 4 Maintain a strong base program but be amenable to incorporating complementary research projects as funding and opportunities become available.

In line with objective four (above), the program was extended across the State border to include sites within the Wodonga Council local government area (LGA) in Victoria, after funding was received from both the Wodonga Council and the Ross Trust. This provided a substantial increase in geographic area, monitoring sites and potential threatened species presence to the work previously being funded by Albury City Council and the Wettenhall Environment Trust in the Thurgoona – Wirlinga landscape. With this extension to the program, the SGMP was renamed the Albury Wodonga Threatened Species Monitoring Program (TSMP) to account for the potential of encountering other threatened arboreal or semi-arboreal mammals such as the Brush-tailed Phascogale (*Phascogale tapoatafa*) and Spotted-tailed Quoll (*Dasyurus maculatus*).

Monitoring across the study areas (hereafter referred to as Thurgoona - Wirlinga and Wodonga) occurs biannually in Autumn and Spring. Due to delays in obtaining relevant permits/licences in Victoria, the Wodonga monitoring commenced in Winter 2020. Select sites are monitored using arboreal mounted motion sensing cameras (trail cams), paired with a scent lure (honey, water, and sugar mix) with the purpose of attracting target species in front of the camera and recording their presence. Records are verified and uploaded to publicly available datasets via the NatureMapr (<https://naturemapr.org/home>) citizen science platform ([Albury Wodonga Nature Map](#)), which feeds into the Atlas of Living Australia (ALA) (<https://www.ala.org.au/>).

In Thurgoona – Wirlinga a total of 74 sites have now been monitored at least once across the eight monitoring periods (biannually 2018-21). In Wodonga, 60 sites have been monitored at least once across the four monitoring periods (biannually 2020-21). No threatened species other than the Squirrel Glider have been detected using the motion sensing cameras so far.

1.2 Location of study area

The study area includes major growth corridors within the Albury City Council LGA and the Wodonga Council LGA. It is focused in Thurgoona – Wirlinga in NSW and the Leneva growth corridor in Victoria (VIC) extending from White-Box rise in Thurgoona to Baranduda in Wodonga (Figures 1, 2 and 3).

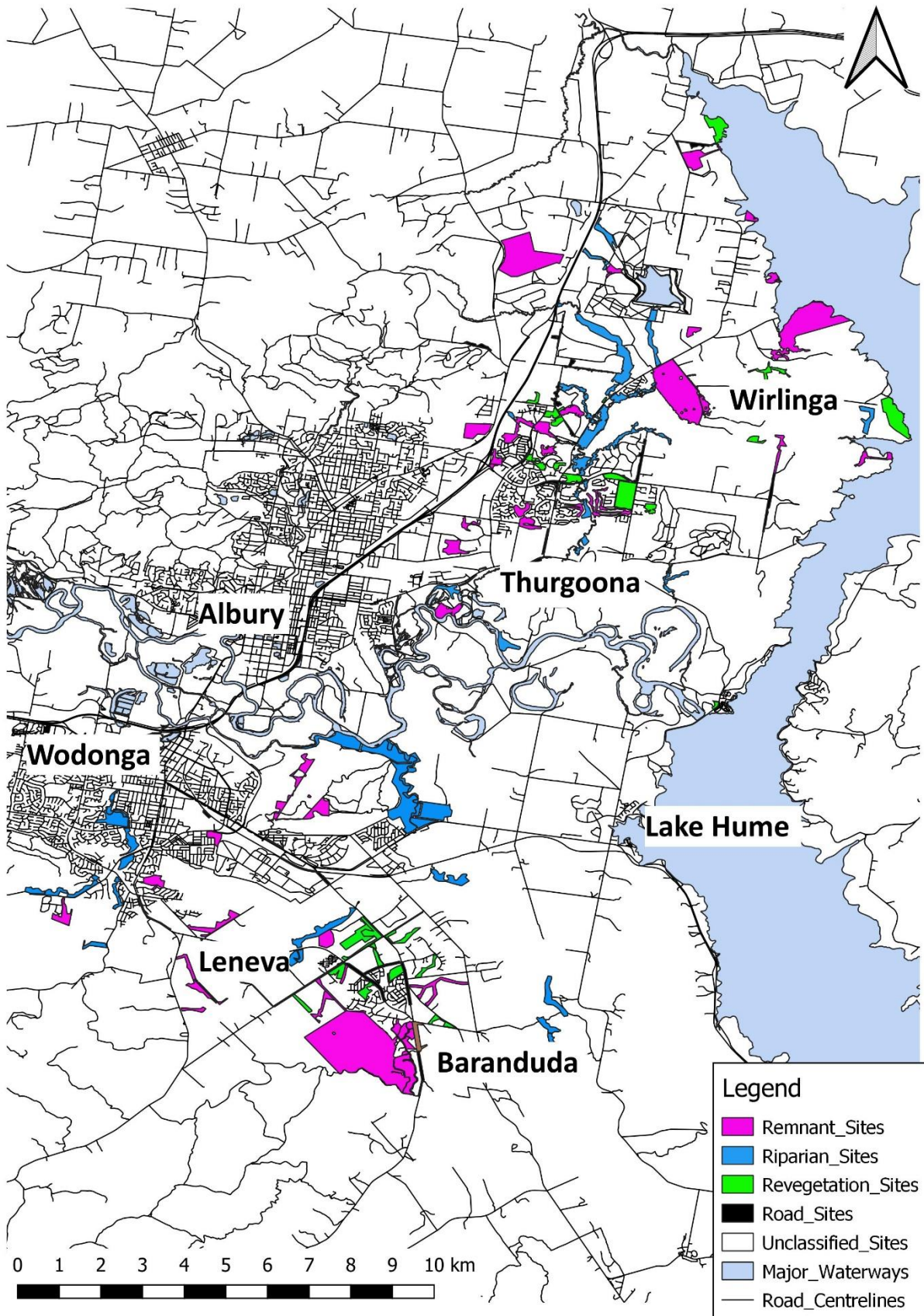


Figure 1: Entire study area including Thurgoona - Wirringa and Wodonga study areas

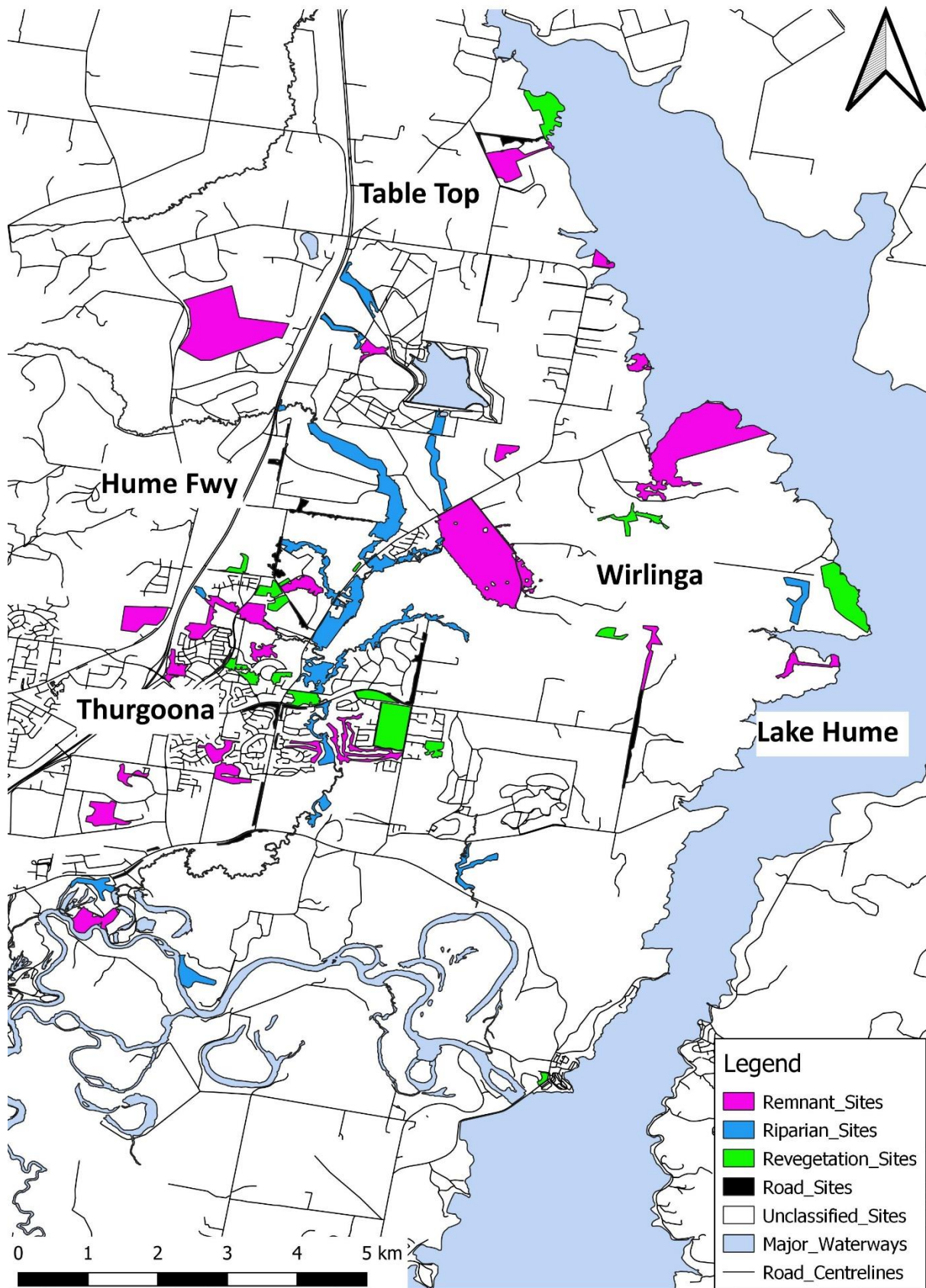


Figure 2: Thurgoona - Wirlinga study area

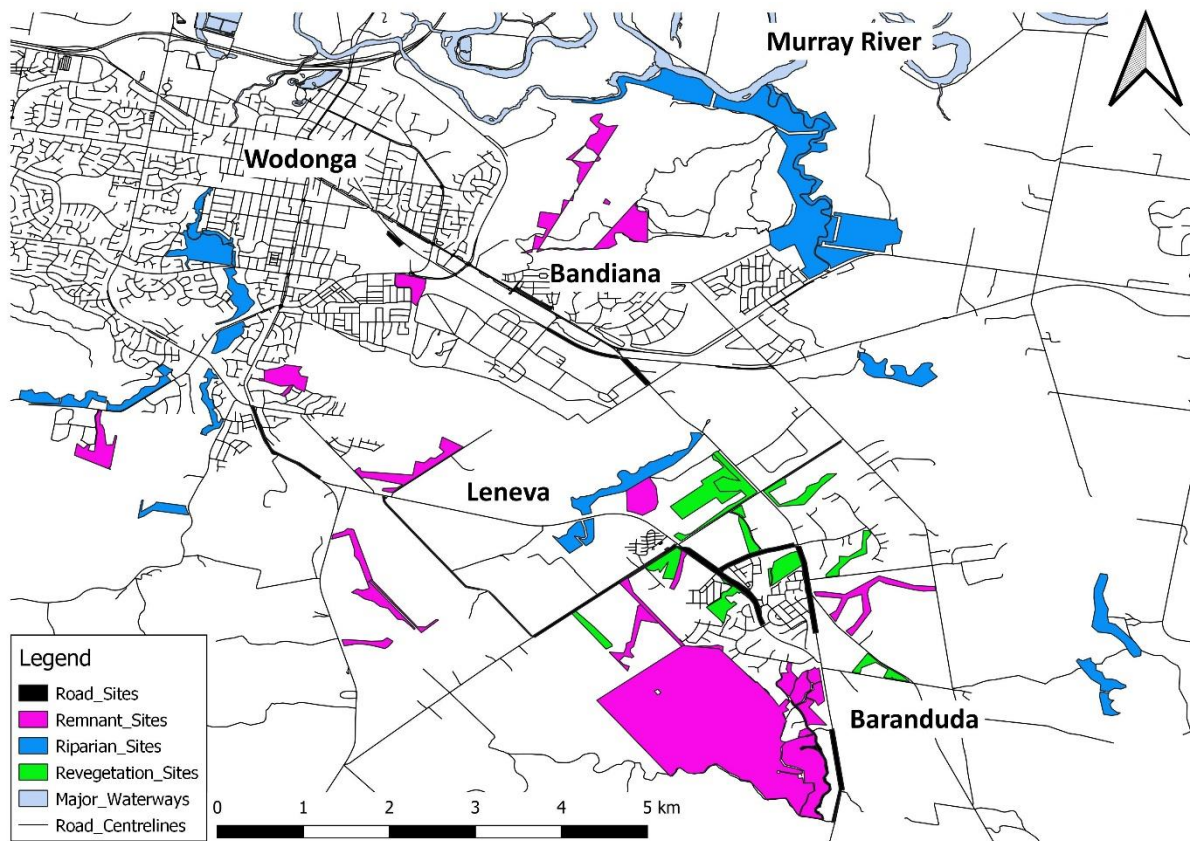


Figure 3: Wodonga study area

2 Methodology

2.1 Study Design

The TSMP involves 85 potential survey sites in Thurgoona – Wurlinga and 60 potential survey sites in Wodonga. Native vegetation greater than 5 ha was mapped and stratified by:

Habitat type:

- roadside verges,
- patches of remnant vegetation,
- riparian corridors, and
- forward tree plantings,

and land zone:

- urban,
- peri-urban (future development)
- and rural (agricultural land).

Sites delineated from this exercise were randomly selected weighted to locations with pre-existing Squirrel Glider records (Michael et.al 2021). Further potential survey sites have been identified in the field and where these are incorporated into the program, they are also defined by their broad habitat type, minimum 5ha size and zoned land use zone.

2.2 Threatened Species Monitoring Protocol

The primary survey method being used in the TSMP is motion sensing wildlife cameras (Little Acorn LTL-5610 Series and the Little Acorn LTL-6310 Series). The cameras can take 12MP High-Definition images and store up to 12GB of data. The zero-glow technology makes them ideally suited for monitoring nocturnal species. The cameras are deployed in trees at heights between 3-10 m depending on tree suitability, target area, reach, safety, and to minimise the potential for theft.

Cameras were typically placed on an auxiliary branch facing a target area on the main trunk or another branch with significant surface area. The distance from camera to target area was 1-2 m to ensure the best chance of capturing a clear image that could be positively identified. Care was taken to minimise the likelihood of leaves triggering images. With the camera installed, the target area on the tree was sprayed with an attractant mix comprised of water, honey and sugar to provide a scent lure and improve the likelihood of detecting the target species at each location. Figure 4 (page 11) demonstrates a typical camera installation.

Basic data was captured at each initial site visit, including Site ID, Camera ID, Tree Species, Approximate Height (meters), Tree Circumference (cm) and a waypoint taken using Garmin Etrex 10 Global Positioning System (GPS).

Cameras were deployed for a minimum of 10 nights and a maximum of 14 nights at each location. After cameras were retrieved, the images were downloaded and analysed by ecologists to identify wildlife observations and calculate detection rates per site. Priority is given to target (threatened species) identification and once confirmed, each record (images and GPS location) is uploaded to [Albury Wodonga Nature Map](#) where it can be verified by expert moderators. This record is accessible to Albury Wodonga Nature Map users only, however data is regularly harvested and uploaded to the Atlas of Living Australia where the records become publicly accessible.

During camera installation and retrieval, staff also recorded opportunistic bird observations with purpose of reporting other threatened species. The bird surveys provide an opportunity to identify and record other threatened species in the study area and contribute data to publicly accessible data bases (e.g. Albury Wodonga Nature Map and Atlas of Living Australia), where it will provide value in planning assessments or other population monitoring/ distribution research. Birds are recorded after being directly observed or identified via their call.



Figure 4: Typical camera placement

2.3 Limitations

ACC set the target for sites monitored at 68 in the NSW study area and 60 in the VIC study area during each monitoring period. So far, the greatest number of sites monitored as been 67 and 59 in each study area respectively. Table 1 (below) shows the monitoring efforts of the 2021 monitoring periods.

Table 1: 2021 TSMP Survey efforts (no. of sites monitored)

Monitoring Period	No. of sites monitored NSW	No of sites monitored VIC
Autumn 2021	66	59
Spring 2021	67	59

Limitations to achieving the desired survey effort has primarily been due access restrictions on private property. There have been several occasions where monitoring sites have been cleared for development and no longer provide a viable site (n=3). Wet weather was also a limiting factor preventing access to some sites in 2021. Over the course of the TSMP, four cameras have been stolen whilst deployed in the field resulting in a reduction in survey effort for the associated monitoring period.

Sites not monitored in 2021 and their associated information are shown in Table 2

Table 2: 2021 TSMP Survey limitations

Study Area	Site ID	Land Use Type	Habitat Type	Limitation
NSW	14	Urban	Revegetation	Site was cleared for development prior to Autumn 2019 period.
NSW	53	Proposed Development	Revegetation	Landholder not contactable for access
NSW	57	Rural	Revegetation	Too wet to access during Spring 2021 monitoring period
NSW	59	Rural	Riparian	Landholder did not permit access
NSW	61	Rural	Roadside	Camera stolen during Autumn 2021 period
NSW	62	Rural	Riparian	Landholder not contactable for access
NSW	66	Proposed Development	Roadside	Landholder did not permit access
NSW	69	Rural	Remnant	Too wet to access during Spring 2021 monitoring period
VIC	157	Rural	Riparian	Too wet to access during 2021 monitoring periods
VIC	TBC (FID15)	Rural	Riparian	Too wet to access during 2021 monitoring periods
VIC	TBC (FID1)	Rural	Riparian	Landholder not contactable for access during 2021 monitoring periods

In the Victoria study area, there is the added limitation of accurate species identification with the potential overlap in distribution between the Squirrel Glider (*Petaurus norfolcensis*) and Krefft's Glider (*Petaurus notatus*) which are visually similar species. The main distinguishing features between the two species the overall size, underbelly fur colour, tail size and colour and muzzle shape (See Table 3, page 13). These distinguishing features can be difficult to discern on the black and white images captured, which do not provide scale or a consistent pose amongst individuals for comparisons. Where a distinction could not be made between the two species, the records were uploaded as a glider species only, and do not contribute towards the threatened species detections. This may result in a lower detection rate within the Wodonga study area when compared to Thurgoona - Wirlinga.

Table 3: Squirrel Glider (*Petaurus norfolcensis*) and Krefft's Glider (*Petaurus notatus*) distinguishing features.

Species	Head Body Length	Tail Length	Weight	Underbelly Fur	Other
<i>P. norfolcensis</i>	170-240mm	220-300mm	190-300g	Clear White	Muzzle longer, pointed. Tail never white tipped.
<i>P. notatus</i>	160-200mm	165-210mm	90-150g	Cream White	Muzzle shorter, rounded. Tail frequently white tipped

Table source: Menkhorst and Knight 2011

Examples of discerning features between the two species as well as an image captured during the monitoring program where differentiation is not possible are provide in Figures 5-7 below.

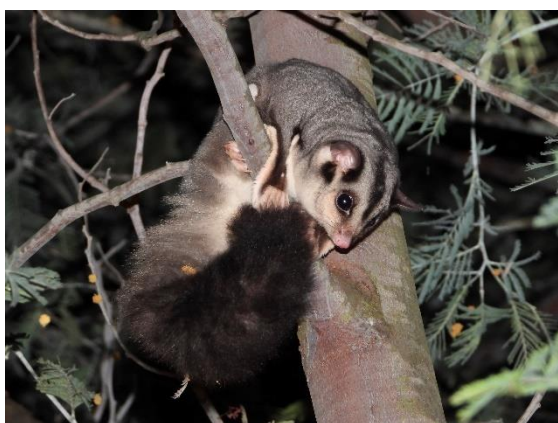


Figure 5: Squirrel Glider displaying long, pointed muzzle and tail length significantly longer than head body length. Tail fur is long and all black (Albury Wodonga Nature Map- User WingsToWander, 2020)



Figure 6: Krefft's Glider displaying shorter, rounded muzzle with a tail length comparable to head body length. Tail fur is noticeably shorter and white-tipped (Albury Wodonga Nature Map - User WingsToWander, 2020)



Figure 7: Example of an image captured by a motion sensing camera where it was not possible to definitively differentiate between the two *Petaurus* species (Albury Wodonga Nature Map - User DMeco, 2020)

3 Results

3.1 New South Wales – Albury (Thurgoona - Wirlinga)

3.1.1 Survey effort and Squirrel Glider detection rate

Two monitoring periods occurred in the Thurgoona - Wirlinga study area in 2021, Autumn and Spring. The survey effort in each period was 66 sites and 67 sites monitored respectively. They resulted in 30 Squirrel Glider (hereafter referred to as glider) detections in the Autumn monitoring period (detection rate of 45%) and 25 glider detections in the Spring monitoring period (detection rate of 37%). There was an increase in overall glider detection rate from the previous monitoring period (Spring 2020), where the detection rate was 38% before decreasing to 37% in the Spring 2021 period. The 2021 monitoring periods have resulted in four successive monitoring periods with glider detection rates of greater than 35%, after they had previously declined. Table 4 (below) shows the overall survey efforts and glider detection rates in the Thurgoona-Wirlinga study area since the beginning of the program.

Table 4: TSMP survey effort and associated Squirrel Glider detection rates between Winter 2018 and Spring 2021

Monitoring Period	Sites Monitored	Sites with Squirrel Glider Detections	Detection Rate	Trend
Winter 2018	65	26	40%	
Spring 2018	64	21	33%	↓
Autumn 2019	62	20	32%	↓
Spring 2019	63	19	30%	↓
Autumn 2020	62	22	35%	↑
Spring 2020	60	23	38%	↑
Autumn 2021	66	30	45%	↑
Spring 2021	67	25	37%	↓

3.1.2 Trends in detection rates among habitat types and land use zones

Over the course of the TSMP in Thurgoona - Wirlinga, there has been an overall downward trend in glider detection rates at roadside sites (50% in Winter 2018 to 29% in Spring 2021). Conversely, riparian sites have shown an overall upward trend in glider detection rates between the Winter 2018 and Spring 2021 periods with the rates increasing from 17% to 33%. Detection rates at remnant sites have fluctuated over the course of the TSMP. After Spring 2021 it is the habitat type with the highest detection rate (50%) as it was at the commencement of the TSMP in Winter 2018 (53%). In 2020, results showed a moderate reduction in glider detection rates at remnant and roadside sites, a stable rate at riparian sites and a significant decrease in glider

detection rates at revegetation sites (Table 5, below). The glider detection rates per habitat type for each monitoring period are shown in Figure 8, below).

Table 5: Detection rates according to habitat type in 2021

Habitat	Autumn		Spring		Trend
	Sites Monitored	Detection Rate	Sites Monitored	Detection Rate	
Remnant	19	52.63%	18	50.00%	↓
Revegetation	13	61.54%	14	35.71%	↓
Riparian	18	33.33%	18	33.33%	→
Roadside	16	37.50%	17	29.41%	↓
All	66	45.45%	67	37.31%	↓

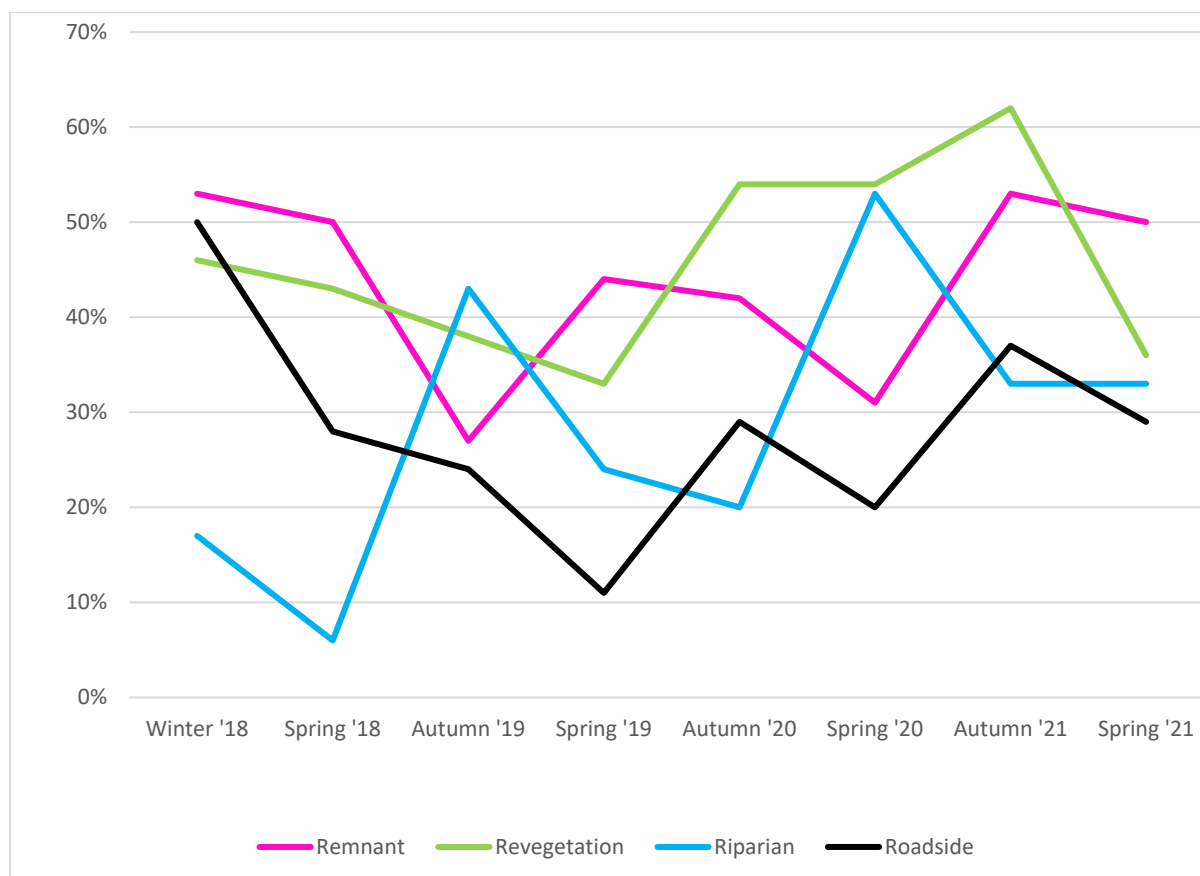


Figure 8: Squirrel Glider detection rates according to each habitat type in each monitoring period in Thurgoona - Wirlinga

Within a study period (2021 calendar year) it is difficult to discern any real habitat preference or change thereof by gliders, with detection rates showing significant variation within habitat type and land use zone across the two monitoring periods. This is not unexpected, with studies showing that Squirrel Glider home ranges are on average 5.6 - 6.2 ha, cover multiple vegetation types, often overlap and consist of multiple den sites (Sharpe and Goldingay 2007). In a study of the denning behaviour of Squirrel Gliders occupying road reserves at Euroa VIC,

individuals radio tracked for an average of 44 days used from 1–15 den sites, but the average was around 5–6 (van der Ree 2000). The Squirrel Gliders mobility and propensity to change den sites within their home range, combined with the monitoring sites being static (i.e., the same tree is monitored each monitoring period) means there is a strong probability of recording a false absence within a monitoring site, habitat type or even land use zone. That is gliders may be utilising a different part of their home range to the monitoring site at the time of monitoring. Figures 9 and 10 (below) demonstrate the difference in detection rates at each habitat and land use type within the study period (2020 calendar year).

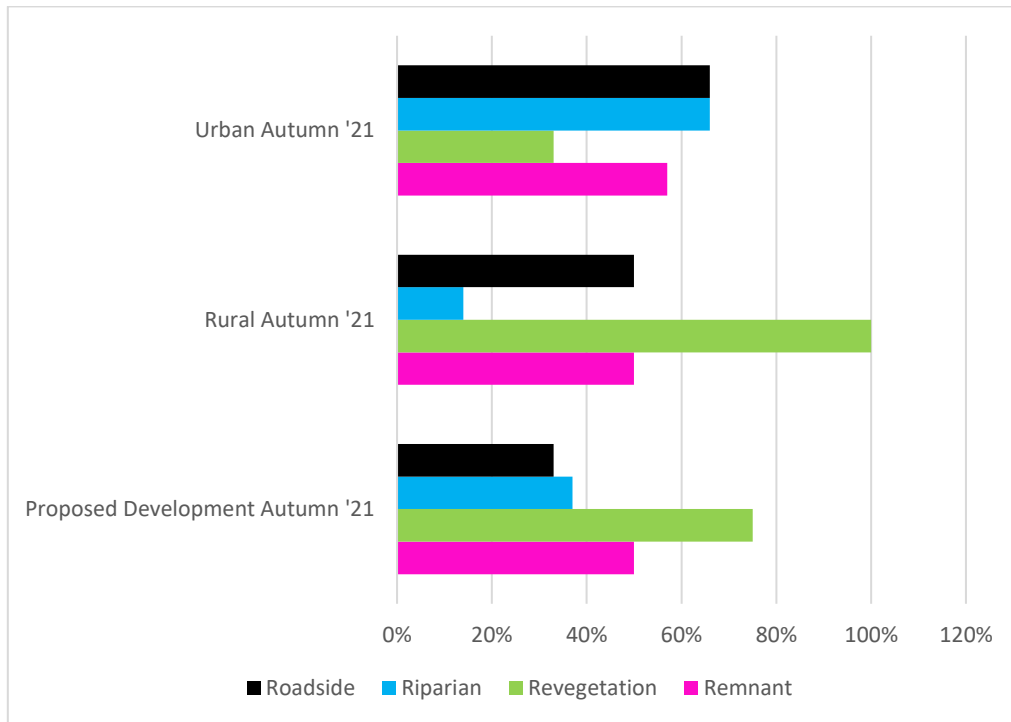


Figure 9: Squirrel Glider detection rates of each habitat type according to land use zone for the Autumn 2021 monitoring period in Thurgoona - Wirlinga

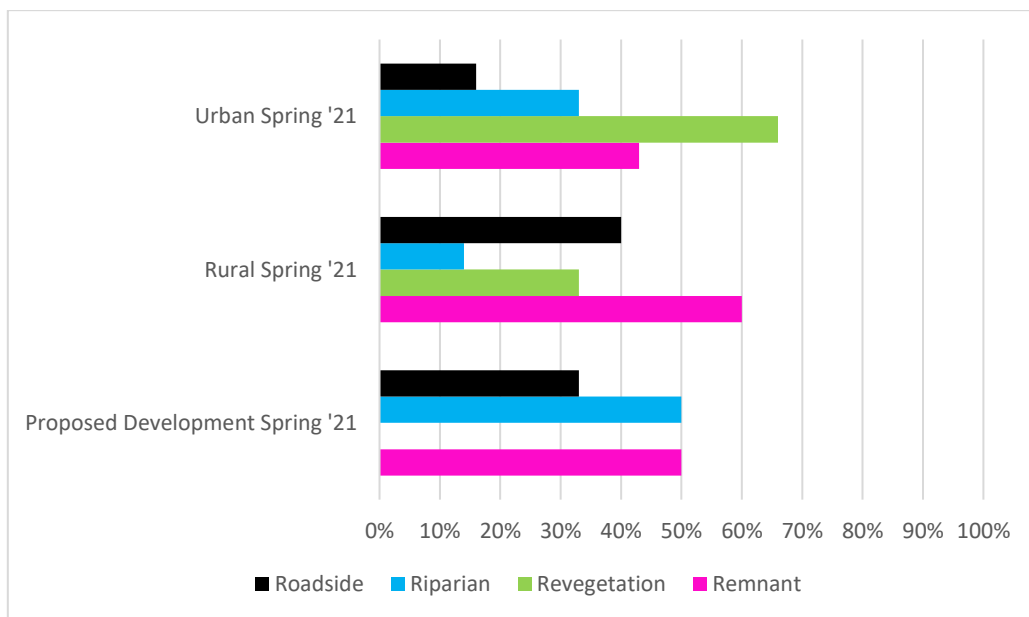


Figure 10: Squirrel Glider detection rates in each habitat type and land use zone during the Spring 2021 monitoring period in Thurgoona - Wirlinga.

Figures 9 and 10 show some variances, highlighted by revegetation sites in the proposed development land use zone going from a glider detection rate of 75% in Autumn 2021 to 0% in Spring 2021. Remnant sites seemingly provided the most 'stable' habitat across the land use zones, with detection rates between 40% - 60% over the 2021 monitoring periods.

The actual number of glider detections has been tracked over each of the monitoring periods to give a visual representation of the habitat type in each land use zone where gliders are recorded (see Figure 11, next page). This data is more representative of species habitat use given that it now extends over four years (eight monitoring periods), allowing for the identification of any geographical or seasonal trends. Since 2019 gliders have been most frequently detected in riparian sites within the proposed development land use zone. Across the rural and urban land use zones, remnant habitat types have provided the most frequent glider detections. Similarly, gliders have been detected in remnants across all three land use zones during all survey periods, highlighting the importance of this habitat type for the species.

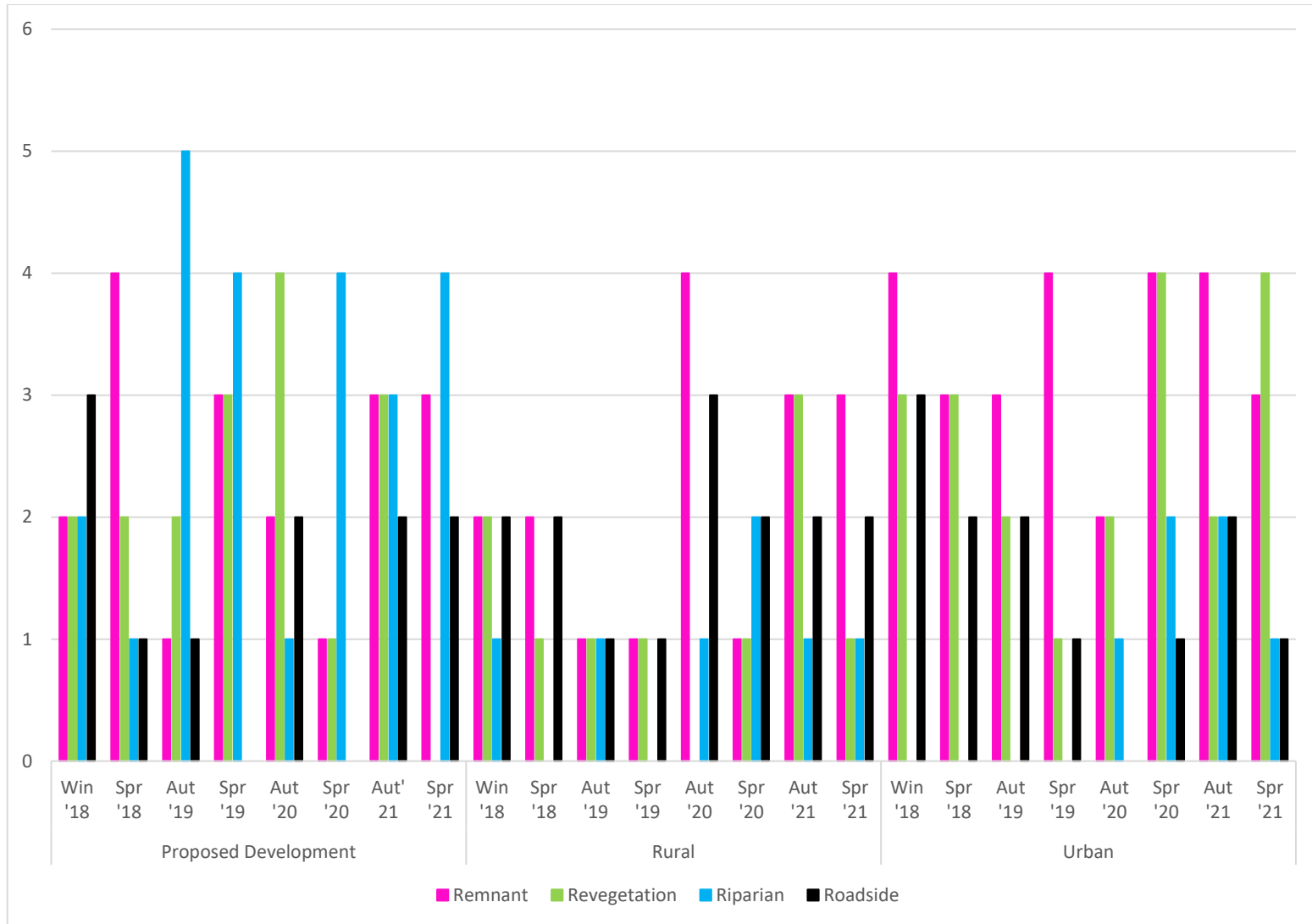


Figure 11: Total number of Squirrel Gliders detected across each monitoring period according to habitat type and land use zone in Thurgoona - Wirlinga

3.1.3 Trends in nightly detection rates

Positive identifications were recorded at 27 of the 65 sites monitored during Winter 2018, 21 of the 64 sites in Spring 2018, 20 of 62 sites in Autumn 2019, 19 of 63 sites in Spring 2019, 22 of 62 sites in Autumn 2020, 23 of 60 sites in Spring 2020, 30 of 66 sites in Autumn 2021 and 25 of 67 sites in Spring 2021. Records (images and GPS location) from each of the sites detecting Squirrel Gliders in 2020 have been uploaded to [Albury Wodonga Nature Map](#).

The number of detection nights per site from across each monitoring period is displayed in Figure 12. Gliders were detected on a maximum of 11 out of 14 monitoring nights at some sites and as few as one night at others. None of the 74 total sites monitored have detected gliders across all survey efforts (Winter and Spring 2018, Autumn and Spring 2019, Autumn and Spring 2020 and Autumn and Spring 2021). Four sites (023, 030, 037 and 056) have detected gliders in seven out of eight monitoring periods. At sites where gliders were detected, the number of detection nights averaged per monitoring period ranged from 2 (Autumn 2019) to 3.6 (Autumn 2021). This data may enable future monitoring at these sites to identify changes in population density, distribution and other characteristics.

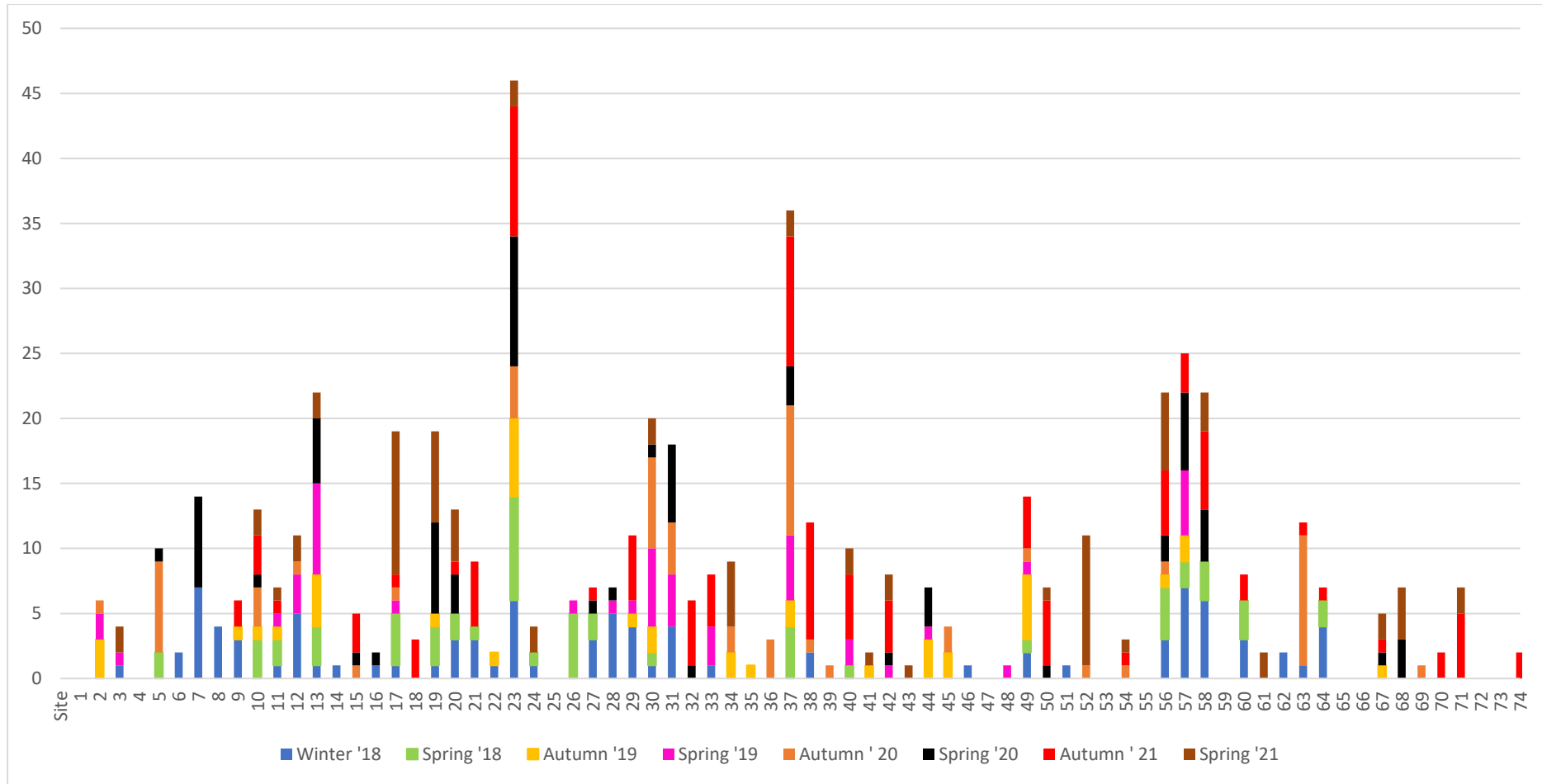


Figure 12: Total number of Squirrel Glider detection nights in each monitoring period (n=10-14nights) per site between 2018 and 2021 in Thurgoona Wirlinga.

3.2 Victoria – Wodonga (Leneva – Baranduda)

3.2.1 Survey effort and Squirrel Glider detection rate

Two monitoring periods occurred in the Wodonga study area in 2021, Autumn and Spring. The survey effort in each period was 59 sites monitored. Each monitoring period resulted in 22 detections providing a detection rate of 37%. The 2021 monitoring periods showed an increase in detection rates (37%) from the previous year, where the detection rates were 27% (Winter 2020) and 25% (Spring 2020) respectively. Table 6 (below) shows the overall survey efforts and glider detection rates in the Wodonga study from this initial year of monitoring. Included in Table 6 is an additional figure showing total *Petaurus sp.* detected, which includes the sites where a determination between Squirrel Glider and Krefft's Glider could not be made.

Table 6: TSMP survey efforts and associated Squirrel Glider detection rates between Winter 2020 and Spring 2021 in the Wodonga study area (total *Petaurus sp.* in brackets)

Monitoring Period	Sites Monitored	Sites with Squirrel Glider Detections	Detection Rate	Trend
Winter 2020	48	13 (16)	27% (33%)	
Spring 2020	53	13 (15)	25% (28%)	↓
Autumn 2021	59	22 (23)	37% (39%)	↑
Spring 2021	59	22 (28)	37% (47%)	→

3.2.2 Trends in detection rates among habitat and land use types

In Autumn, gliders were detected in 50% of revegetation sites (n = 5), 43% of roadsides (n = 7), 35% of remnants (n = 6) and 25% of riparian sites (n = 4). In Spring, the detection rates for each habitat type were exactly the same (Table 7, below). These observations indicate no change in detection rates across the seasons. The glider detection rates per habitat type for each monitoring period are shown in Figure 13, page 21).

Table 7: Detection rates according to habitat type in 2021

Habitat	Autumn		Spring		Trend
	Sites Monitored	Detection Rate	Sites Monitored	Detection Rate	
Remnant	17	35.29%	17	35.29%	→
Revegetation	10	50.00%	10	50.00%	→
Riparian	16	25.00%	16	25.00%	→
Roadside	16	43.75%	16	43.75%	→
All	59	37.29%	59	37.29%	→

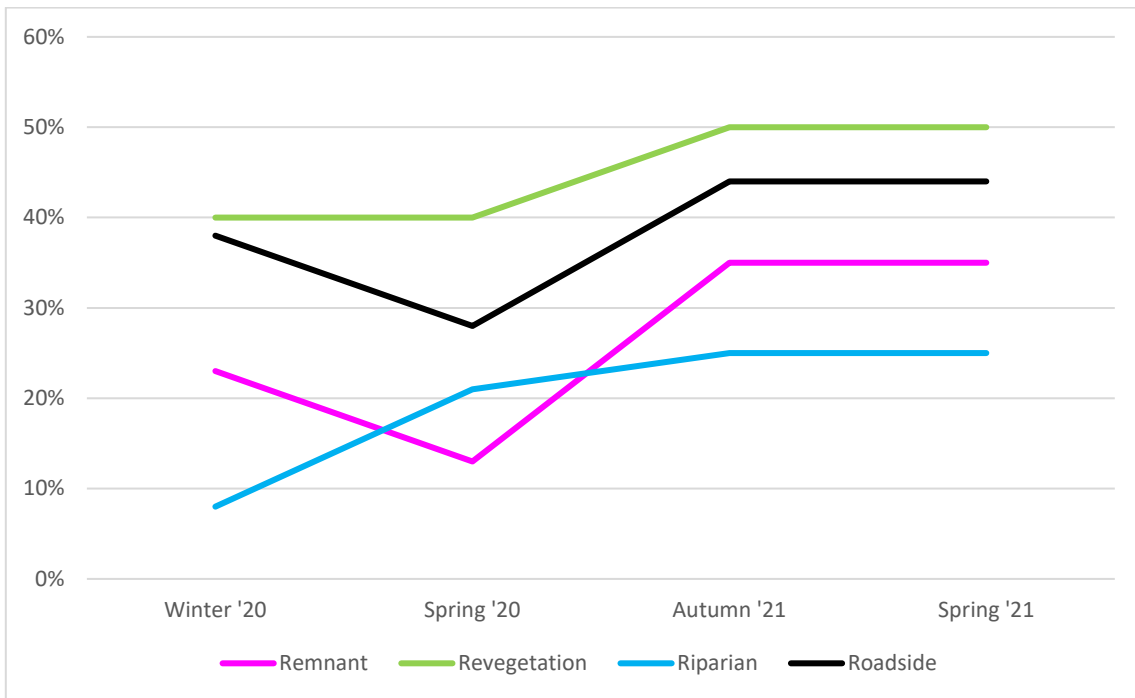


Figure 13: Squirrel Glider detection rates according to each habitat type across both monitoring periods in Wodonga

Figure 13 shows that detection rates at each habitat type increased from the previous year (Spring 2020) and remained unchanged through the Autumn and Spring 2021 monitoring periods.

Figures 14 and 15 (next page) demonstrate the difference in detection rates at each habitat type and land use zone within the study period (2021 calendar year).

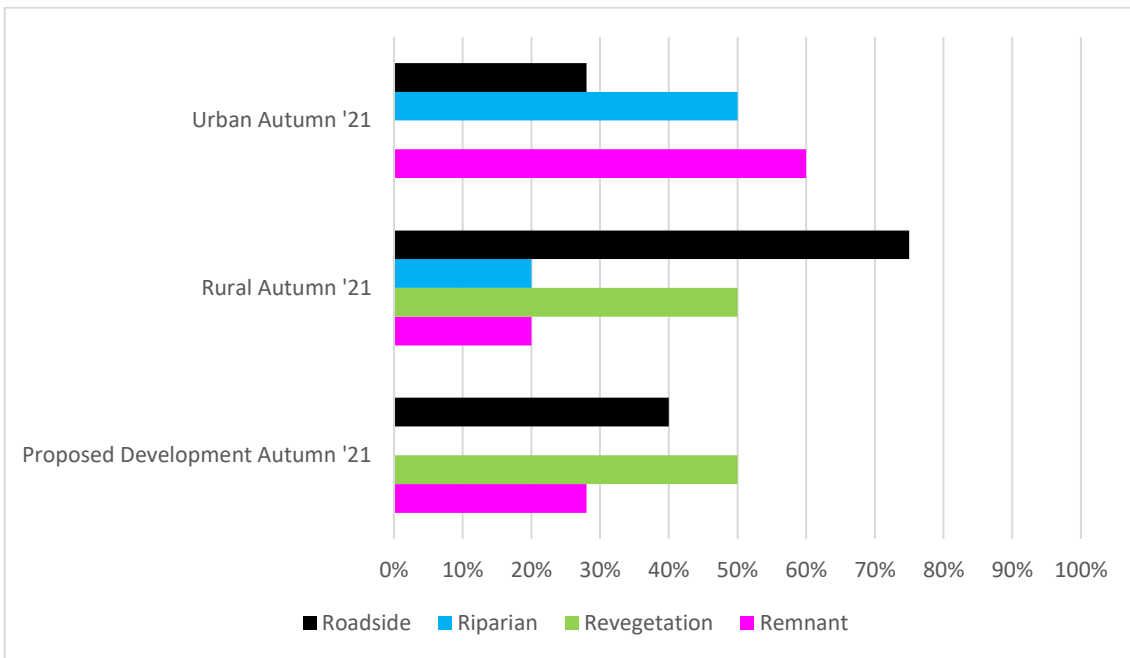


Figure 14: Squirrel Glider detection rates of each habitat type according to land use zone for the Autumn 2021 monitoring period in Wodonga

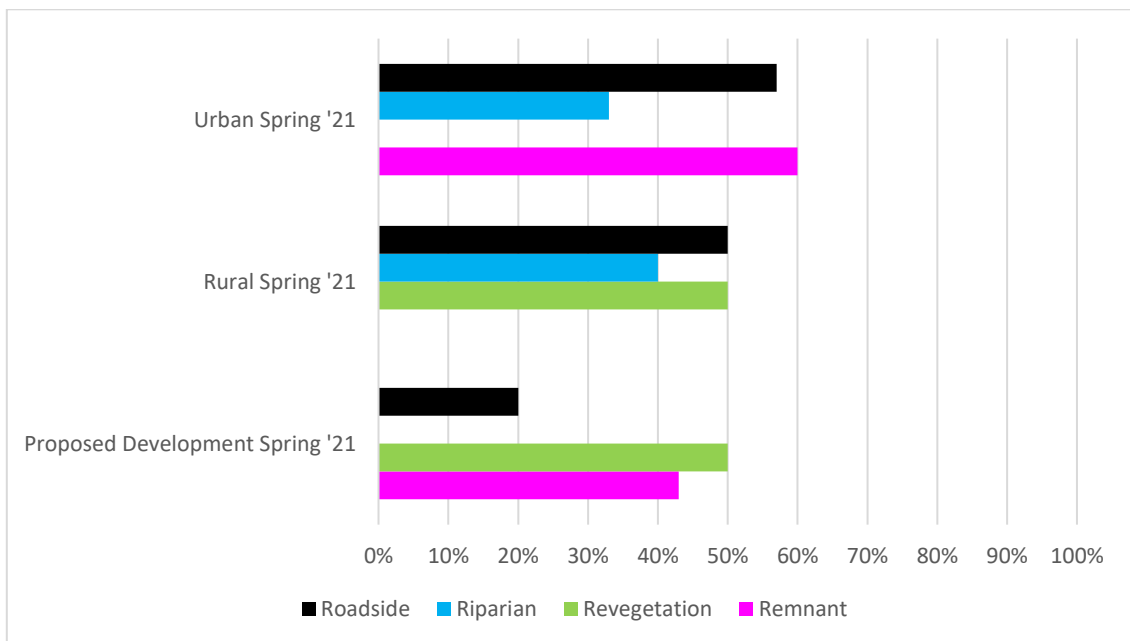


Figure 15: Squirrel Glider detection rates of each habitat type according to land use zone for the Spring 2021 monitoring period in Wodonga

Figures 14 and 15 show some variances, highlighted by a lack of detections in riparian habitat types within the proposed development land use zone in both monitoring periods. There were also no detections in remnant habitat types within the rural land use zone in the Spring monitoring period. There are no urban revegetation sites in the study area. Roadsides were the only habitat type with detections across all land use zones through both monitoring periods. As discussed in Section 3.1.2, the data in these figures provides an indication of glider detections within the given year but it is difficult to discern any significant trends in their habitat preference or movement patterns.

As per the Thurgoona - Wirlinga study area (Section 3.1.2), the actual number of glider detections will be tracked over each of the monitoring periods to give a visual representation of the habitat type in each land use zone where gliders are recorded (Figure 16). This data is more representative of species habitat use given that it will account for multiple years' worth of data, allowing for the identification of any geographical or seasonal trends.

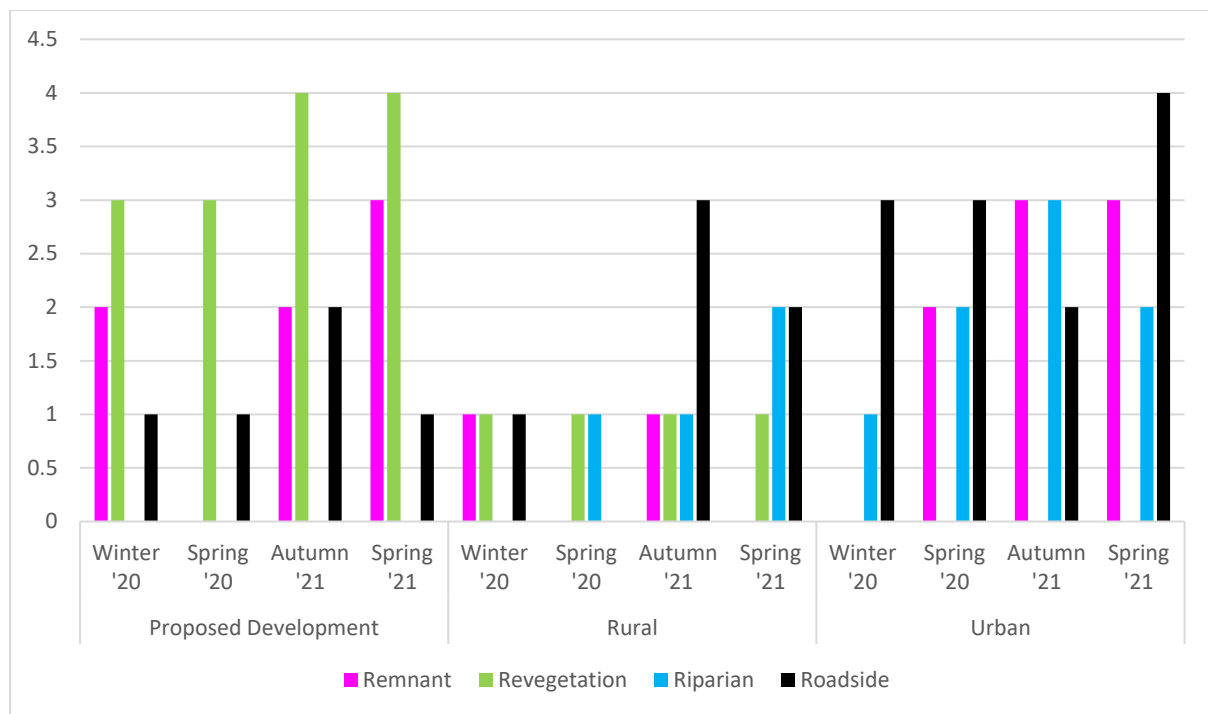


Figure 16: Squirrel Gliders detected across each monitoring period according to habitat type and land use zone in Wodonga

Figure 16 shows that the lack of glider detections in riparian habitat types within the proposed development area (n=5) has been constant since the beginning of monitoring in the study area.

3.2.3 Trends in nightly detection rates

Positive identifications were recorded at 22 of the 59 sites monitored during each of Autumn and Spring 2021. Records (images and GPS location) from each of the sites detecting Squirrel Gliders in 2021 have been uploaded to [Albury Wodonga Nature Map](#).

The number of detection nights per site from across each monitoring period is displayed in Figure 17 (next page). Gliders were detected on a maximum of ten monitoring nights at some sites and as few as one night at others. Two of the 59 total sites monitored have detected gliders across each survey effort (Winter and Spring 2020 and Autumns and Spring 2021). Whilst both the Autumn and Spring 2021 surveys detected gliders at 22 sites, there was a slight decrease in the average detection nights at these sites between monitoring periods (4.4 in Autumn 2021 and 3.5 in Spring 2021). This data may enable future monitoring at these sites to identify changes in population density, distribution and other characteristics.

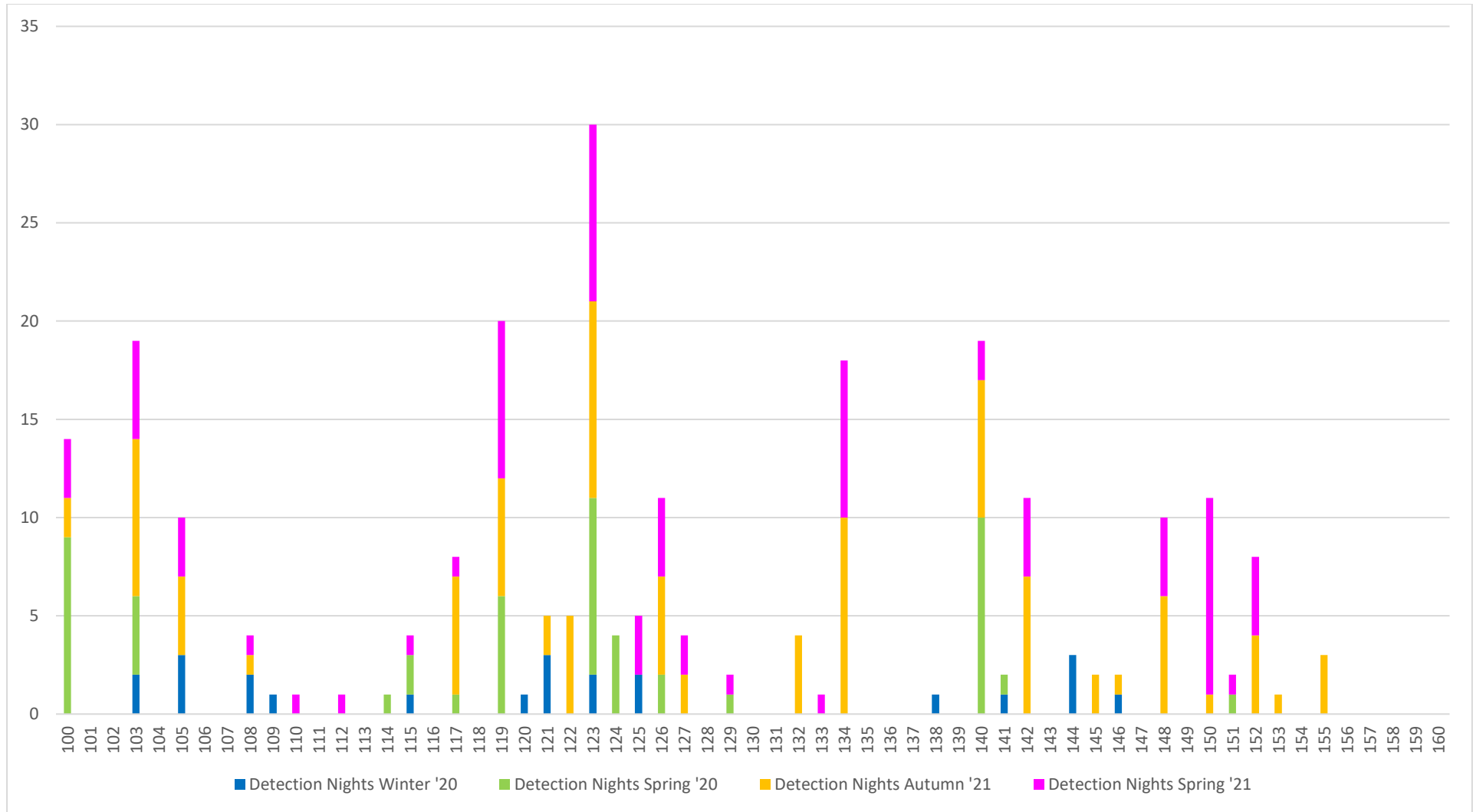


Figure 17: Total number of Squirrel Glider detection nights in each monitoring period (n = 10-14 nights) per site in 2021 in Wodonga

3.3 Other fauna species

Several other non-threatened fauna species were detected using the motion sensing cameras during the monitoring period, none of which are listed under Commonwealth or State threatened species legislation. Table 8 (below) identifies non-target species observations during the reporting period (2021 calendar year).

Table 8: Non-target fauna species detected by cameras.

Common Name	Scientific Name	Monitoring Period Detected		Applicable Sites
		Autumn '21	Spring '21	
Australian Magpie	<i>Cracticus tibicen</i>		✓	008
Australian Magpie Lark	<i>Grallina cyanoleuca</i>		✓	073
Australian Raven	<i>Corvus coronoides</i>		✓	008, 009, 153
Treecreeper species.	<i>Not identified to species level</i>		✓	003
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	✓	✓	001, 008, 013, 022, 025, 026, 032, 033, 034, 035, 042, 048, 049, 050, 054, 056, 061, 063, 068, 070, 071, 074, 101, 106, 109, 112, 113, 114, 118, 122, 123, 124, 129, 133, 134, 136, 141, 144, 150, 152, 154, 155
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>	✓	✓	001, 108, 015, 111, 125, 126, 127, 131, 133, 141, 142, 154
Eastern Grey Kangaroo	<i>Macropus giganteus</i>		✓	008
Krefft's Glider	<i>Petaurus notatus</i>	✓	✓	102, 104
Red Wattlebird	<i>Anthochaera carunculata</i>		✓	021
Southern Boobook	<i>Ninox boobook</i>	✓	✓	008, 154
Tawny Frogmouth	<i>Podargus strigoides</i>	✓	✓	032, 017, 056
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>		✓	072
White-winged Chough	<i>Corcorax melanorhamphos</i>	✓		010
Willie Wagtail	<i>Rhipidura leucophrys</i>		✓	073
Yellow-footed Antechinus	<i>Antechinus flavipes</i>	✓		071

Notes: - Sites 0-99 are in NSW and sites 100+ are in VIC

The Common Brushtail Possum (*Trichosurus vulpecula*), Common Ringtail Possum (*Pseudocheirus peregrinus*), Krefft's Glider (*Petaurus notatus*), Southern Boobook (*Ninox boobook*) and Tawny Frogmouth (*Podargus strigoides*) were each detected in both monitoring periods (Autumn and Spring 2021). Krefft's Glider was only detected in the VIC study area and Tawny Frogmouth was only detected in the NSW study area. The Common Brushtail Possum was the most frequently detected non-target species.

3.4 Bird observations

Bird species observations were recorded at TSMP sites as described in Section 2.2. These observations revealed predominantly common species occupied sites across the study area, as per the species list in Table 9 (below). A Black Falcon (*Falco subniger*) was observed at site 072 in the NSW study area. This species is listed as Vulnerable under the Threatened Species Conservation Act 1995 (NSW). A total of 72 bird species were recorded between March 2021 and December 2021, three of those being a non-native species (Common Blackbird, Common Starling and Indian Myna).

Table 9: Species list compiled from bird observations across the TSMP area in 2021

Common Name	Scientific Name	Monitoring Period Detected			
		NSW Autumn	NSW Spring	Vic Autumn	VIC Spring
Australian Magpie	<i>Cracticus tibicen</i>	✓	✓	✓	✓
Australian Pelican	<i>Pelecanus conspicillatus</i>	✓	✓		
Australian Raven	<i>Corvus coronoides</i>	✓	✓	✓	✓
Australian Reed Warbler	<i>Acrocephalus australis</i>				✓
Australian White Ibis	<i>Threskiornis molucca</i>		✓	✓	✓
Australian Wood Duck	<i>Chenonetta jubata</i>	✓	✓	✓	✓
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	✓	✓		
Black Falcon ^	<i>Falco subniger</i>		✓		
Black-fronted Dotterel	<i>Euseiornis melanops</i>		✓		
Black-shouldered Kite	<i>Elanus axillaris</i>		✓		
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>	✓	✓		
Brown Falcon	<i>Falco berigora</i>				✓
Crested Pigeon	<i>Ocyphaps lophotes</i>	✓	✓	✓	✓
Crested Shrike-tit	<i>Falcunculus frontatus</i>		✓		
Crimson Rosella	<i>Platycercus elegans</i>		✓	✓	✓
Common Blackbird *	<i>Turdus merula</i>		✓	✓	✓
Common Starling *	<i>Sturnus vulgaris</i>	✓	✓		
Dusky Woodswallow	<i>Artamus cyanopterus</i>		✓		
Eastern Koel #	<i>Eudynamys orientalis</i>		✓		
Eastern Rosella	<i>Platycercus eximius</i>	✓	✓	✓	
Egret species	<i>Not identified to species level</i>	✓			

Common Name	Scientific Name	Monitoring Period Detected			
		NSW Autumn	NSW Spring	Vic Autumn	VIC Spring
Galah	<i>Eolophus roseicapillus</i>	✓	✓	✓	✓
Golden Whistler	<i>Pachycephala pectoralis</i>	✓			
Great Egret	<i>Ardea modesta</i>		✓		
Grey Butcherbird	<i>Cracticus torquatus</i>	✓	✓		
Grey Fantail	<i>Rhipidura albiscapa</i>	✓		✓	
Grey Shrike-thrush	<i>Colluricincla harmonica</i>			✓	
Grey Teal	<i>Anas gracilis</i>		✓		
House Sparrow*	<i>Passer domesticus</i>		✓		
Indian Myna	<i>Acridotheres tristis*</i>		✓	✓	
King Parrot	<i>Alisterus scapularis</i>	✓	✓		✓
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	✓	✓	✓	✓
Little Corella	<i>Cacatua sanguinea</i>	✓	✓		
Little Friarbird	<i>Philemon citreogularis</i>			✓	
Magpie-lark	<i>Grallina cyanoleuca</i>	✓	✓	✓	✓
Masked Lapwing	<i>Vanellus miles</i>	✓	✓		
Nankeen Kestrel	<i>Falco cenchroides</i>	✓	✓		
Noisy Friarbird	<i>Philemon corniculatus</i>		✓		✓
Noisy Miner	<i>Manorina melanocephala</i>	✓	✓	✓	✓
Oriental Dollarbird	<i>Eurystomus orientalis #</i>		✓		
Pacific Black Duck	<i>Anas superciliosa</i>	✓	✓	✓	✓
Peaceful Dove	<i>Geopelia placida</i>			✓	✓
Pied Currawong	<i>Strepera graculina</i>	✓		✓	✓
Pied Butcherbird	<i>Cracticus nigrogularis</i>	✓			
Purple Swamp Hen	<i>Porphyrio porphyrio</i>	✓	✓		
Rainbow Bee-eater #	<i>Merops ornatus</i>		✓		
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>	✓	✓		
Red-browed Finch	<i>Neochima temporalis</i>	✓			✓
Red Wattlebird	<i>Anthochaera carunculata</i>	✓	✓	✓	✓

Common Name	Scientific Name	Monitoring Period Detected			
		NSW Autumn	NSW Spring	Vic Autumn	VIC Spring
Red-rumped Parrot	<i>Psephotus haematonotus</i>	✓	✓	✓	✓
Restless Flycatcher	<i>Myiagra inquieta</i>	✓			
Rufous Whistler	<i>Pachycephala rufiventris</i>	✓	✓		
Sacred Kingfisher	<i>Todiramphus sanctus</i>		✓		
Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	✓	✓	✓	
Silver Gull	<i>Chroicocephalus novaehollandiae</i>		✓		
Stubble Quail	<i>Coturnix pectoralis</i>		✓		
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	✓	✓	✓	✓
Superb Fairy-wren	<i>Malurus cyaneus</i>	✓	✓	✓	✓
Wedge-tailed Eagle	<i>Aquila audax</i>	✓			
Welcome Swallow	<i>Hirundo neoxena</i>	✓	✓	✓	✓
Whistling Kite	<i>Haliastur sphenurus</i>	✓			
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>		✓		
White-browed Babbler	<i>Pomatostomus superciliosis</i>	✓			
White-faced Heron	<i>Egretta novaehollandiae</i>	✓	✓		✓
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>	✓	✓		✓
White-throated Treecreeper	<i>Cormobates leucophaea</i>	✓			
White-winged Chough	<i>Corcorax melanorhamphos</i>	✓	✓	✓	✓
Willie Wagtail	<i>Rhipidura leucophrys</i>	✓	✓	✓	✓
Yellow-billed Spoonbill	<i>Platalea flavipes</i>	✓			
Yellow Rosella	<i>Platycercus elegans flaveolus</i>				✓
Yellow-tailed Black Cockatoo	<i>Zanda funerea</i>	✓			
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>	✓			✓

* Indicates introduced species. # Indicates migratory species. ^ Indicates conservation listed species

4. Discussion and Recommendations

The expansion of the threatened species monitoring program into the Wodonga Council local government area (LGA) provides an excellent opportunity to monitor and evaluate the distribution of threatened species at a landscape scale and aligns with the Regional Natural Environment Strategy collaboration between the two councils. The program significantly improves the knowledge on Squirrel Glider (*Petaurus norfolcensis*) distribution across the study area and provides robust data that can be used by various government and other stakeholders. Importantly, the program now provides the opportunity to detect other threatened species such as the Brush-tailed Phascogale (*Phascogale tapoatafa*) and Spotted-tailed Quoll (*Dasyurus maculatus*). Both species have historical records in the Wodonga LGA with most recent records within the study area occurring in 2015 for each species (Atlas of Living Australia, 2021).

As identified in Sections 3.1.2 and 3.2.2 of this report, the data derived from the program provides improved insight into Squirrel Glider (and potentially other species) habitat use over time. That is, the more monitoring sites which are incorporated into the program and the more monitoring periods that are undertaken, the more likely we are to draw some significant findings into how glider populations are responding to the ever-changing landscapes in the study areas. Both study areas (Thurgoona – Wirlinga and Wodonga) are experiencing rapid urban growth which is, and has the potential to, reduce and fragment existing habitat. By monitoring glider presence and absence across multiple habitat types and land use zones over time, we can identify critical habitats, linkages, and management interventions to ensure the populations remain viable in the face of urbanisation.

Key to the success of the program in providing data that can inform wildlife and habitat management is ensuring that the program continues in a consistent manner (i.e. biannual Autumn and Spring surveys in both study areas) and expands to include additional sites.

Ideally, the data provided by the monitoring program will be considered in the development application phase, particularly where population strongholds or keystone habitat (see Figures 12 and 17) have been identified. These sites should be a priority for retention and enhancement through revegetation and linkage works where required.

Critical to maintaining the population viability of Squirrel Gliders across the study areas is the application of the records informing development applications and management interventions to minimise impact on the species and their key habitat patches. The records of Squirrel Gliders, as well as non-target arboreal species identified and recorded throughout the program have the potential to identify movement barriers and priority linkages within the landscape. Squirrel Gliders, Common Brushtail Possums, Common Ringtail Possums, Yellow-footed Antechinus and Feathertail Gliders have all been recorded through this program and these, along with historical records can give a good indication of distribution and abundance throughout the study area. In 2021, there have been two examples of the data collected through the TSMP being utilised by local councils.

Albury City Council engaged Albury Conservation Company to conduct a study and produce a report highlighting the existing barriers in the Albury City area that either hamper or prevent Squirrel Glider movement throughout the landscape. 21 sites were identified as priority linkages via GIS modelling and site assessment, and these were prioritised using a benefit cost analysis. By using species records from the TSMP and historical records, key (source) populations were identified. An analysis of tree canopy cover enabled the identification of existing movement corridors and barriers. The priority linkages were identified and prioritised by modelling how they would increase the connectivity between source populations. A literature review was conducted which synthesised existing information on Squirrel Glider glide capacity, home range, use of glide poles and fauna bridges and the effectiveness of hose structures in varying scenarios (road barriers, land barriers etc). This information combined with a site assessment at each priority linkage enabled the identification and costing of an appropriate intervention (eg. Glide pole – number, height, positioning, orientation, design or; fauna bridge – length, height, design) and associated monitoring. With the final report, Albury City has a document which can

be used to identify and leverage funding opportunities to implement these interventions and hopefully improve the population viability for the Squirrel Glider in the Albury City area over time.

Wodonga Council used Squirrel Glider records from the TSMP when considering the Baranduda Fields Sporting Precinct Development. The development required the clearing of a 30-year-old 5,000 tree plantation. This plantation contained some hollow-bearing trees within it and on its edges. An adjacent plantation of the same age and species composition is a TSMP site and had recorded Squirrel Glider presence. Using these records, council identified the likely presence of Squirrel Gliders in the project area which informed the retention of some large trees. Council also incorporated pre-clearing surveys, clearing supervision and fauna salvage requirements in the development approval. Wodonga Council then engaged DM Ecological to develop and implement a fauna management plan for the clearing operations. After inspecting hollows prior to removal, two Squirrel Gliders (and nine Common Brushtail Possums) were located, captured and relocated to nearby suitable habitat.

The Squirrel Glider population appears to be relatively stable in the Thurgoona - Wurlinga study area with the most recent detection rate (Spring 2021) of 37% very near that of the initial detection rate (Winter 2018) of 40%. It has dropped as low as 30% in that time (Spring 2019) whilst the Autumn 2021 monitoring period provided the highest detection rate of the TSMP so far (45%). The fluctuations in overall detection rates are expected given the Squirrel Gliders mobility and propensity to change den sites often within their home range, combined with the monitoring sites being static (i.e., the same tree is monitored each monitoring period) meaning there is a strong probability of recording a false absence within a monitoring site, habitat type or even land use zone). Modelled distributions and occupancy should always be considered along with follow up targeted surveys before an absence is considered. From a planning perspective, the precautionary principle should apply to account for false absences.

Detection rates in the Wodonga study area improved on the initial surveys in Winter (27%) and Spring (25%) 2020, increasing to 37% in both the Autumn and Spring 2021 surveys. Six additional sites (n=59) were surveyed in 2021, providing more opportunities to detect gliders. The detection rates of each habitat type did not differ between the Autumn and Spring 2021 monitoring periods (Table 7, page 20), having all increased from the 2020 monitoring periods. Only when land use zones were considered with habitat types were any variances observed. This has identified that since the commencement of monitoring in the Wodonga study area, there have been no Squirrel Glider detections in riparian habitat types within the proposed development land use zone (n=5).

In 2021, there were seven instances of *Petaurus sp.* detections where it was not possible to differentiate between Squirrel Glider and Krefft's glider. This limitation was detailed in the [Albury-Wodonga Threatened Species Monitoring Program Annual Report - 2020](#). There are now nine sites where the possibility of species overlap has been identified. An additional survey project is being prepared to undertake spotlight surveys at these sites to enable accurate recording of arboreal species presence. This project will require funding but will lead to a more accurate representation of species distribution for both glider species in the study area. It may also help to inform an identification protocol. The aim of the spotlight survey will be to identify sites where species overlap exists, which can be surveyed to develop an identification protocol for motion sensing wildlife cameras. This project should be developed to a 'shovel ready' stage early in 2022 to allow for the identification and application of various funding opportunities.

The value of the dataset being developed by the implementation of the TSMP has been recognised in 2021 via the publishing of a technical manuscript and the successful funding of two projects that will supplement the TSMP and hopefully increase glider population viability in the two study areas.

[The conservation of arboreal marsupials in the Albury-Wodonga region of south-eastern Australia](#) (Michael et.al 2021) was published in the journal of Ecological Management and Restoration. This paper discusses that critical to sustainable development of peri-urban landscapes is a thorough understanding of the distribution, habitat requirements and resources available to maintain and improve habitat for species dependent on limited resources such as tree cavities. The information presented provides a blueprint for monitoring arboreal marsupials, including threatened species in developing regions, and will assist the Albury-Wodonga local governments in future planning of sustainable living environments. The continuation of the TSMP and

implementation of associated projects should enable research opportunities that will further develop the understanding of threatened species management in areas of peri-urban development.

Funding of a three-year project across the TSMP study areas (Thurgoona – Wurlinga and Wodonga) will enable Albury City Council and Wodonga Council to design and implement on-ground works programs that provide the most appropriate level of investment and scope of works across their municipalities, to benefit threatened species based on the data collected in the TSMP. As well as being used from a statutory and planning point of view (strategic investment and development approvals) as has been done in 2021, the councils will be able to use the data to deliver works such as revegetation, weed control, fencing, habitat augmentation and enrichment etc. backed by the scientific input from Albury Conservation Company. The project should be developed and implemented as a high priority for Albury Conservation Company as it has the potential to build on the work outlined in Michael et.al 2021 and provide some results in context to the blueprint for monitoring threatened species in peri-urban areas.

Another project has been funded in the Wodonga study area to be delivered in 2021. It will enable the installation of 50 traditional nest boxes (constructed by Wodonga Men’s Shed), [50 Habitech polypropylene modular nest boxes](#) and 50 augmented (i.e. chainsaw carved) hollows at selected TSMP sites in the study area where an increase in hollow density could be beneficial to the fauna present. Follow up monitoring of the 150 habitat interventions will allow the identification of any species preference for, or success/failure of each type of intervention to enable best outcomes for future management. By delivering this project within existing TSMP sites, it may also allow the monitoring for changes in detection rates post increase in habitat availability for arboreal hollow dependant species through the establishment of a before-after control-impact (BACI) experiment. The collection of two years of before data provides a strong baseline for contrasting and comparing management interventions (e.g. cavity augmentation and understory restoration) at sites with and without gliders to control sites where no interventions take place and also support or don’t support gliders

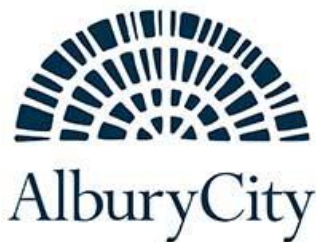
4.1 Summary of recommendations

1. Continue implementing the TSMP in both Thurgoona – Wurlinga and Wodonga to improve knowledge of threatened species and identify critical habitats, linkages, and management interventions to ensure the populations remain viable in the face of urbanisation.
2. Develop a ‘shovel ready’ spotlight survey project to identify sites with Squirrel/ Krefft’s glider overlap and facilitate the development of a motion sensing wildlife camera identification protocol in early 2022.
3. Pursue opportunities to fund further research or projects that build on or utilise the TSMP data collected to date (e.g. via HDR students at CSU).
4. Prioritise the delivery of the design and delivery of the three-year funded *'Applying science to on-ground action for conservation of Albury Wodonga's threatened wildlife'* project. In particular, identify specific sites for establishing the hollow augmentation BACI experiment.
5. Ensure the timely and effective delivery of the *'Applying science to inform on-ground actions for conserving Wodonga's threatened wildlife'*.
6. This program and its associated projects should be supported by Councils and other key stakeholders. It aligns with the Regional Natural Environment Strategy (RNES) and meets many of the actions in the RNES Action Plan (2020-24).

5. Acknowledgments

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- Users of [Albury Wodonga Nature Map](#) whose records have added considerably to local wildlife knowledge, including our target species.

This research has been approved by the Charles Sturt Animal Care and Ethics Committee (Protocol numbers A18021 and A20031) under NSW Office of Environment and Heritage scientific licence (SL102071) and Department of Crown Lands combined licence (RI596463).

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