Sydney Swans Head Quarters
Microbat Survey Report

Prepared for APP, on behalf of the Sydney Swans

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

Project Name	Sydney Swans Head Quarter Microbat Survey Report
Project Number	19SUT12417
Project Manager	Kirsten Velthuis
Prepared by	Dee Ryder and Kirsten Velthuis
Reviewed by	Rodney Armistead, Alicia Scanlon
Approved by	Meredith Henderson
Status	**Final**
Version Number	**v2**
Last saved on	**10 March 2020**

This report should be cited as 'Eco Logical Australia 2020 *Sydney Swans Head Quarters Microbat Survey Report*. Prepared for APP on behalf of the Sydney Swans.'

Template 2.8.1

Contents

List of Figures

List of Tables

1. Introduction

1.1 Project description

Eco Logical Australia Pty Ltd (ELA) was engaged by APP to undertake and report on a microbat survey at Moore Park in Sydney. This report will accompany a State Significant Development application for the proposed adaptive reuse of the Royal Hall of Industries (RHI) for a high-performance sport and community facility for the Sydney Swans.

1.2 Location

The subject site is located at 1 Driver Avenue, Moore Park (Lot 100 DP1246842).. The site consists of the RHI, and the associated courtyard area to the immediate south of the building.

Figure 1: Subject site: Royal Hall of Industries

2. Proposed development

The proposed development will largely maintain the structural integrity and façade of the RHI, while re-purposing the interior of the building to support several compatible uses and utilise the space effectively. In addition to the repurposing of the RHI, an extension of the building will be constructed

to the south of the building in the current service and courtyard area and will include a pool and a netball court.

Actions required to complete these works include:

- replacing existing roof sheeting, gutters, fascia
- demolition and removal of all redundant mechanical equipment
- installing scaffolding around the perimeter of RHI
- investigating / measure skylights
- modifying roof structure for skylights/installation of aluminium sections
- installing skylights
- reglazing external windows and restore RHI façade.

Additionally, the is a mix of native and non-native landscaping vegetation within the study area, however there are no hollows suitable for microbats in any vegetation within the study area; and as such the proposal will not impact on any roosting habitat for bats in vegetation.

The purpose of this report is to outline the methodology employed during targeted surveys undertaken to determine:

- whether microbats are using the cavities within the RHI as roosting habitat
- the species and number of microbats that are using the cavities within the RHI as roosting habitat
- the status of the roosting habitat (breeding / winter / hibernation).

3. Threatened microbat species roosting habitat potential

The following data sources were reviewed to identify microbat species with the likelihood of using the RHI as potential roosting habitat:

- BioNet / Atlas of NSW Wildlife 5 km database search (DoPIE 2019)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool 5 km database search (DotEE 2019)
- Threatened Biodiversity Data Collection (DoPIE 2019)Memorandum: Microbats in the Centennial Parklands (Anara Glynn, 12 Feb 2020)

The result of the data review identified the following threatened microbat species as having a likelihood of using the RHI as potential roosting habitat:

- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)
- *Miniopterus australis* (Little Bentwing-bat)
- *Miniopterus norfolkensis* (Eastern Free-tailed Bat)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat).

4. Survey Methods

4.1 Potential roost searches

A diurnal visual survey of potential microbat roosts at the RHI was undertaken by ELA ecologist Kirsten Velthuis for a period of 3 hours on 1 September. This survey was repeated on 18 February by ELA microbat specialist Alicia Scanlon and Kirsten Velthuis for a period of 1 person hour.

Roost searches were conducted at ground level from both the internal ground floor space of the RHI and around the full perimeter of the RHI externally. In addition, the internal surfaces of the eastern and western turrets were viewed from the landing on the first floor, accessed via internal stairs. There was no view able to be obtained of the roof cavity or wall cavities; however it is understood that there are no wall or roof cavities, with the roof filled with metal sheeting with insulation and plasterboard. Photos of potential microbat entry/exit points were taken.

4.2 Weather

Surveys occurred during suitable weather conditions for recording microbat activity; mild temperatures, calm conditions and limited rainfall. Surveys were undertaken within (or just prior to) the optimum survey period for many threatened microbat species (October to February inclusive). Weather conditions experienced during surveys are recorded in Section 4.2.

4.3 Ultrasonic detection surveys

The visual survey was followed by ultrasonic call detection surveys of the five identified potential exit / entrance sites. A detector was placed at each potential roost entry / exit point for five consecutive nights between 25 and 29 September 2019; and for two nights at each potential roost between 17- and 21 February 2020 Total ultrasonic survey effort for September 2019 and February 2020 combined was 25 nights and 10 partial nights (seven nights / partial nights per entry / exit point).

The ultrasonic detection survey involved placing detectors at a suitable location on the ground or at elevated locations (up to 1 m above the ground) facing the potential roost entrances / exits. Detector placements were all within 8 m of the base of the building. Unattended detection began 30 minutes before sunset and continued until 3 hours after sunrise on each of the five nights between 25 and 29 September. Call detection in February 2020 began 30 minutes before sunset and continued until 1.5 hours after sunset.

4.4 Emergence surveys

Observation of each potential roost entry / exit point was undertaken over one night by an ecologist from 30 minutes before sunset until 1.5 hours after sunset during the September 2019 and February 2020 surveys. The ecologist was positioned on the ground outside the RHI within 8 m of the base of the building. There were no artificial light sources used during the emergence survey. In addition, an emergence survey of the eastern turret was undertaken from within the RHI on the first floor landing of the eastern turret during both the September 2019 and February 2020 surveys.

4.5 Thermal imaging surveys

In addition to diurnal roost searches, ultrasonic surveys and emergence surveys, thermal imaging cameras were used as a survey aid to enhance visual observations at each of the potential roost entry / exit points during the February surveys. Thermal imaging was undertaken for two nights at each potential roost entry / exit point from 30 minutes prior to sunset until 1.5 hours after sunset. Cameras used were FLIR E75 24^0 advanced thermal cameras. Each camera was hand-held by the ecologist for the duration of the emergence survey and the potential roost entry / exit point was viewed through the thermal camera screen set to display temperature in a rainbow colour palette. If a microbat was observed exiting or entering a potential roost, the ecologist triggered recording of images to the internal SD card.. The specifications of the FLIR E75 camera that are relevant for conducting surveys of microbat activity are:

- Frame rate of 30Hz which is the minimum required to detect an object the size and speed of a moving microbat
- Temperature range of -15^0C to 50^0C which encompasses the weather conditions experienced during thermal imaging surveys
- Thermal resolution of 320 x 240 pixels which is the minimum required for detecting objects the size of a microbat
- Field of view of 24^0 which was large enough to encompass the potential roost entry / exit point and a radius of approximately 4 m surrounding the entry / exit point, and would allow detection of a stationary bat up to 10 m away and a moving bat up to 60 m away
- Thermal sensitivity of <40 mK, with values between 20 and 50 mK suitable for bat surveys.

Thermal camera surveys were undertaken following the guidelines for use of thermal cameras as a survey aid provided in *Thermal Imaging: Bat Survey Guidelines* (Fawcett Williams and the Bat Conservation Trust 2019). ELA microbat specialist Alicia Scanlon directed the thermal camera surveys and has completed the Thermal Imaging for Wildlife (KFW Scientific) online course.

4.6 Ultrasonic Call Analysis

Bat calls were analysed by ELA specialist microbat ecologist and experienced call analyst Alicia Scanlon, and by ELA ecologist Rachel Brown, with supervision by Alicia Scanlon using the program AnalookW (Version 4.2n 16 March 2017, written by Chris Corben, www.hoarybat.com). Alicia has over twelve years of experience in the identification of ultrasonic call recordings. Call identifications are made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al 2004); and south-east Queensland and north-east New South Wales (Reinhold et al 2001) and the accompanying reference library of over 200 calls from Sydney Basin, NSW (which is available at http://www.forest.nsw.gov.au/research/bats/default.asp).

A sample of the calls were reviewed by ELA ecologist Dr Rod Armistead who has over five years of experience in the identification of ultrasonic call recordings. External review of a sample of calls was also undertaken by Greg Ford of Balance Environmental, who has over 20 years of experience in this field.

Bat calls are analysed using species-specific call profile parameters including call shape, characteristic frequency, initial slope and time between pulses (Reinhold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et al 2006) are followed:

- Search phase calls are used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al 2002). Cruise phase or feeding calls are labelled as being unidentifiable.
- Recorded calls containing less than three pulses are not analysed and these sequences are labelled as unidentifiable, being too short to confidently determine the identity of the species making the call (Law et al 1999)
- For those calls that are useful to identify the species making the call, two categories of confidence are used (Mills et al 1996):
    - Definitely present – the quality and structure of the call profile is such that the identity of the bat species making the calls is not in doubt
    - Potentially present – the quality and structure of the call profile is such that there is some / low probability of confusion with species that produce similar calls profiles
- Calls made by bats which cannot be used for identification purposes such as social calls, short and low-quality calls, cruise and approach phase calls are labelled as unidentifiable.
- Sequences labelled as unidentifiable are of inferior quality and therefore not able to be identified to any microbat species, they can however be used as an indicator of microbat activity at the site.
- *Nyctophilus* spp. (Long-eared bats) are difficult to identify confidently from their calls and no attempt is made to identify this genus to species level (Pennay et al 2004)
- The Free-tailed Bats (previously referred to as the genus *Mormopterus*) have recently undergone taxonomic revision (Reardon et al 2014) and published reference calls for this group of species (Pennay et al 2004) are believed to contain errors (Greg Ford pers comm.). This report uses nomenclature for Free-tailed bat species as referred to in Jackson and Groves (2015). The correlation between nomenclature used in this report and that used in NSW State legislation is presented in Table 1 below.
- Sequences not attributed to microbat echolocation calls (e.g. insect buzzes, wind, train and vehicle movement) were dismissed from the analysis.

Table 1: Correlations between current and previous nomenclature for the Free-tailed bats of NSW

Current Name (Jackson and Groves 2015)	Previous Name	Common Name	*Biodiversity Conservation Act 2016* status
Austronomus australis	*Tadarida australis*	White-striped Free-tailed Bat	
Micronomus norfolkensis	*Mormopterus norfolkensis*	Eastern Coastal Free-tailed Bat	Vulnerable
Ozimops petersi	*Mormopterus* species 3 (small penis)	Inland Free-tailed Bat	
Ozimops planiceps	*Mormopterus* species 4 (long penis eastern form)	Southern Free-tailed Bat	
Ozimops ridei	*Mormopterus* species 2	Ride's Free-tailed Bat	
Setirostris eleryi	*Mormopterus* species 6	Bristle-faced Free-tailed Bat	Endangered

5. Results

5.1 Potential roost searches

The potential roost searches identified five entry / exit points considered likely to provide access to potential microbat roosting habitat within the RHI:

1. Outside the western side of Door 7 - cavities around the gutter pipe going into the building façade with some faint vertical yellow staining on the wood panel below the pipe.
2. Outside the eastern side of Door 8 - cavities around the gutter pipe going into the building façade with some faint vertical black/brown staining on the bricks below the pipe.
3. Outside the south-eastern wall of the RHI - cavities around the gutter pipe that lead into the building façade and holes in the wood panelling at the top of the façade.
4. Outside the eastern turret of the RHI - cavities that lead into the turret and a long cavity located in a wood panel along the top of the building façade.
5. Inside the eastern turret - several cavities in the internal brick wall, as well as cavities within the wooden floor separating the turret from the 1st floor. The turret in general also showed evidence of use by pigeons, as well as other animals (e.g. scats (of various sizes) evident); though none were identified in those cavities in the wall or floor which could be inspected

All potential entry / exit points are located on the second floor of the building at least 8 m above ground level. There were other entry / exit cavities sighted, but most of these were quite large and showed evidence of use by pigeons or other birds and were not considered likely to be used by microbats.

Photos of the five potential roost entry and exit points appear in Appendix A.

5.2 Weather

The weather experienced during the surveys was suitable for microbats to be active and details of temperature and rainfall are listed in Table 1.

Table 2: Survey temperatures and rainfall

Survey Date	Max Temperature	Min Temperature	Rainfall (mm)
25 September 2019	21.9	9.7	0
26 September 2019	20.8	12.6	0
27 September 2019	25.3	13.9	0
28 September 2019	21.7	15.3	0
29 September 2019	21.21	11.3	0
17 February 2020	25.3	20.8	1.2
18 February 2020	29.4	20.5	0.4
20 February 2020	25.6	18.2	0.2
21 February 2020	25.3	20.1	0

5.3 Ultrasonic detection survey

5.3.1 September 2019

A total of 25 ultrasonic survey nights were recorded across the five potential entry / exit points between 25 and 29 September 2019. Survey took place outside the RHI, looking across four of the five potential entry/ exit points, with survey of the fifth potential entry/exit point (the turret) occurring inside the RHI.

Results from the September 2019 surveys at each of the survey locations are presented in Table 4 to Table 7.

Table 3: Microbat species and number of calls recorded at potential roostentry / exit 1, Door 7, 25 – 29 September 2019

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
Chalinolobus gouldii / Ozimops ridei	Gould's Wattled Bat / Ride's Free-tailed Bat		1	1
Miniopterus orianae oceanensis	Large Bent-winged Bat	3		3
Unidentifiable				0
Total identifiable calls				4
Total calls recorded				4
Percentage identifiable calls				100%

Table 4: Microbat species and number of calls recorded at potential roost entry / exit 2, Door 8, 25 – 29 September 2019

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
Austronomus australis	White-striped Free-tailed Bat			1
Chalinolobus gouldii	Gould's Wattled Bat			1
Miniopterus orianae oceanensis	Large Bent-winged Bat	11		11
Unidentifiable				1
Total identifiable calls				13
Total calls recorded				14
Percentage identifiable calls				93%

Table 5: Microbat species and number of calls recorded at potential roost entry / exit point 3, outside the south- eastern wall, 25 – 29 September 2019

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
Austronomus australis	White-striped Free-tailed Bat	1		1
Chalinolobus gouldii	Gould's Wattled Bat	1	1	2

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
Miniopterus orianae oceanensis	Large Bent-winged Bat	3		3
Unidentifiable				0
Total identifiable calls				6
Total calls recorded				6
Percentage identifiable calls				100%

Table 6: Microbat species and number of calls recorded at potential roost entry / exit point 4, outside the eastern turret, 25 – 29 September 2019

Scientific Name	Common Name	Definitely present	Potentially present	Number
Chalinolobus gouldii	Gould's Wattled Bat	2		2
Miniopterus orianae oceanensis	Large Bent-winged Bat	4		4
Unidentifiable				3
Total identifiable calls				6
Total calls recorded				9
Percentage identifiable calls				67%

There were no calls recorded at potential roost entry / exit point 5, inside the eastern turret between 25 and 29 September 2019.

There were 33 call sequences recorded during this survey. All call sequences were recorded in close proximity to the outside of the RHI building; no calls were recorded inside the RHI building. Of these, 29 (88%) were deemed useful, because the call profile was of sufficient quality and/or length to enable positive identification of bat species. The remaining four (12%) call sequences were either too short or of low quality, thus preventing positive identification of bat species.

There were at least three and up to four species identified during the survey; including one species listed as vulnerable under the *Biodiversity Conservation Act 2016* (BC Act) (Table 3) The threatened *Miniopterus orianae oceanensis* (Large Bent-winged Bat) was definitely present on site**.** No species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were identified. Calls from the Large Bent-winged Bat were the most commonly recorded during the survey, and they accounted for 21 of the 33 calls that were recorded; accounting for 64% of the positively identified call sequences.

Table 7: Microbat species and number of calls recorded at the RHI between 25 -29 September 2019.

Scientific Name	Common Name	Present	BC Act status	EPBC Act status	Total calls
Austronomus australis	White-striped Free-tailed Bat	Definitely	Not listed	Not listed	2

Scientific Name	Common Name	Present	BC Act status	EPBC Act status	Total calls
Chalinolobus gouldii	Gould's Wattled Bat	Definitely	Not listed	Not listed	5
Chalinolobus gouldii / Ozimops ridei	Gould's Wattled Bat/ Ride's Free-tailed Bat	Potentially	Not Listed	Not listed	1
Miniopterus orianae oceanensis	Large Bent-winged Bat	Definitely	**Vulnerable**	Not listed	21
Unidentifiable					4
Total identifiable calls					29
Total calls recorded					33
Percentage identifiable calls					88%

Microbat activity at the site was extremely low with a microbat call recorded roughly every 9 hours of recording time on average throughout the 23 nights (276 hours) of survey. It is also likely that the same bat was recorded on multiple Anabat units during each recording session because of the proximity of Anabat detectors to each other, which may have inflated the actual activity levels. There were very few long sequences recorded during the survey indicating that microbats were predominantly commuting past the site. There were no feeding buzzes recorded in the data.

Most calls (25 out 33 (81%)) were recorded between the hours of 10:00 pm and 4:00 am and it is likely that these calls were made by bats flying past the site. The earliest call that was recorded in the evening was at 8:15 p.m. on a detector set beneath potential entry / exit point 1 (Door 7) on 26 September 2019 and was made by either a *Chalinolobus gouldii* (Gould's Wattled Bat) or *Ozimops ridei* (Ride's Free-tailed Bat). Calls of these two species overlap and can be difficult to separate if defining characteristics are not present.

There were three calls recorded between 5:30 a.m. and 6:10 a.m. on 27 September at potential entry / exit point 2 (Door 8) made by the Large Bent-winged Bat. These calls indicate that the Large Bent-winged Bat could be roosting very close by and potentially within the RHI.

5.3.2 Ultrasonic detection survey - February 2020

A total of 20 ultrasonic detection hours was recorded from the five potential roost entry / exit points during the February 2020 surveys. There were six call sequences recorded during this survey. Of these, three (50%) were deemed useful because the call profile was of sufficient quality and / or length to enable positive identification of bat species. The remaining three (50%) call sequences were either too short or of low quality preventing positive identification of bat species.

At least one and up to two species were recorded during this survey (Table 8). *Chalinolobus gouldii* (Gould's Wattled Bat) was definitely present and *Ozimops ridei* (Ride's Free-tailed Bat) was potentially present. Calls of these two species overlap and can be difficult to separate if defining characteristics are not present. All three calls recorded during the survey in February 2020 were from potential roost entry / exit 1 (Door 7) on 18 February. None of the recorded calls correspond with the time that a suspected microbat was observed emerging from potential roost entry / exit point 1 (Door 7) on 18 February 2020.

No species listed under the EPBC Act or the BC Act were identified in the data recorded during the February ultrasonic surveys. Calls from Gould's Wattled Bat were the most commonly recorded during the survey, and they accounted for two of the three calls that were recorded; accounting for 66.6% of the positively identified call sequences.

Microbat activity at the site was low with a microbat call recorded roughly every 3 hours on average throughout the 20 hour survey period. There were no long sequences recorded during the survey indicating that microbats were predominantly commuting past the site. There were no feeding buzzes recorded in the data.

Table 8: Microbat species and number of calls recorded at the RHI between 17-18 and 20-21 February 2020.

Scientific Name	Common Name	Present	BC Act status	EPBC Act status	Total calls
Chalinolobus gouldii	Gould's Wattled Bat	Potentially	Not listed	Not listed	2
Chalinolobus gouldii / *Ozimops ridei*	Gould's Wattled Bat/ Ride's Free-tailed Bat	Potentially	Not Listed	Not listed	1
Unidentifiable					3
Total identifiable calls					3
Total calls recorded					6
Percentage identifiable calls					50%

5.3.3 Ultrasonic call analysis limitations

Calls were only positively identified when the defining characteristics were present and there was no chance of confusion between species with overlapping and/or similar calls. In this survey, there were some call sequences that could not be positively identified to species level. Further, some species recorded in this survey can have call profiles that overlap with other species. When overlap occurs, species with similar call profiles are assigned to multi species groups of two or three potential species depending on the characteristics displayed in the recorded call sequences. Calls with intermediate characteristics were assigned mixed species labels.

The species recorded in this survey with overlapping call profiles are described below.

Gould's Wattled Bat and Ride's Free-tailed Bat have calls that overlap in the range 28.5 kHz and 33 kHz. Free-tailed Bat species calls are flat in shape with an initial slope (S1) of less than 100 octaves per second (OPS) separating them from Gould's Wattled Bat whose calls are curved with an S1 greater than 200 OPS. Gould's Wattled Bat was distinguished by a frequency of 27.5 – 32.5 kHz and alternation in call frequency between pulses. There were two call sequences recorded which did not show any alternation in call frequency and had an OPS between 100 and 200 and these calls were labelled as Gould's Wattled Bat / Ride's Free-tailed Bat.

Large Bent-winged Bat calls overlap in frequency with those of *Vespadelus regulus* (Southern Forest Bat) and *V. darlingtoni* (Large Forest Bat) in the Sydney Basin. The calls of Large Bent-winged Bats can be separated from the Forest Bats by a down-sweeping tail which neither of the Forest Bats displays (generally being up-sweeping or absent). Large Bent-winged Bat calls are often variable in pulse shape and time between pulses whereas the Forest Bats commonly have regular pulses evenly spaced pulses. There were no calls that displayed the characteristics of the Large or Southern Forest Bat.

5.4 Emergence surveys

There were observations of microbats not associated with the potential roost entry / exit points at the RHI flying overhead on all survey nights during September 2019 and February 2020. There were several observations of an animals using the cavities of the RHI during surveys. A large bird was observed flying into potential roost entry / exit 5 at 8.15 p.m. on 17 February 2020. This animal was suspected to be a *Columba livia* (Feral Pigeon), several of which are known to roost within the RHI. Two observations of *Rattus* spp., likely *Rattus rattus* (Black Rat) entering potential roost entry / exit 3 were made at 7.53 p.m. and 8.15 p.m. on 17 February 2020. Rats are known to nest inside the RHI and there are rat baits inside the building. Several *Trichoglossus moluccanus* (Rainbow Lorikeets) were seen entering potential roost entry / exit 3 at 7.30 p.m. on 20 February 2020.

The only observation of a likely microbat emerging from one of the potential entry / exit points occurred at 8.33 p.m. on 18 February 2020 at potential roost entry / exit 1 (Door 7). A single microbat was observed crawling out of the cavity and down the wall before flying directly upwards. Images of this event were captured on a thermal imaging camera and are described in Section 3.5 below.

5.5 Thermal imaging surveys

An animal believed to be a microbat was observed emerging at potential roost entry / exit 1 (Door 7) at 8.33 p.m. on 18 February 2020. The emergence was captured using a FLIR E75 thermal imaging camera and the two recorded images can be found in Appendix C. No corresponding microbat calls were captured on the detector at this location at this time to enable identification of the animal to a particular microbat species. While it is not possible to be 100% certain that the animal observed using the thermal imaging camera was a microbat, there are several lines of evidence which would suggest that it was:

- the time of emergence of the animal from the RHI (8.33 p.m.) coincided with the prime emergence time of microbats leaving roosts to forage for the evening and was after bird activity had ceased for the day
- the low light levels at the time of emergence suggest the animal was a nocturnally adapted species
- the size of the animal matches with the expected size of a microbat, but could also correlate with the size of a small bird
- the animal was observed to move / crawl slowly down the wall of the RHI beneath the cavity before flying directly upwards, a behaviour pattern that is more commonly observed in microbats rather than birds.

6. Interpretation of survey results

6.1.1 Presence of microbat roosting habitat

One of the five potential microbat roost entry/exits to the RHI (location 3) was identified to contain a rat and was considered unsuitable for microbat use. One (location 1), has been positively confirmed as a microbat roost entry / exit point from observations made of a single unidentified microbat emerging on 18 February 2020. Though no microbats were observed emerging from the remaining three potential microbat roost entry/exits, they are considered as suitable to provide potential microbat roost entry / exit points to the RHI.

Cavities in the RHI contain microbat habitat and may be used by a range of microbat species (and other fauna) throughout the year.

6.1.2 Significance of roosts

Relative microbat activity as measured using ultrasonic call recording at the site varied from low to extremely low. It was clear from emergence surveys, ultrasonic surveys and thermal imaging surveys that the cavities within the RHI do not support a significant breeding colony of any microbat species. Moderate to high levels of microbat activity would be expected outside breeding roosts if surveyed in suitable weather conditions over the spring summer breeding period.

Because microbat roosting habitat is present at the RHI, there is a chance that the threatened Large Bent-winged Bat, or other threatened microbat species not recorded during this survey but known to be present in the Sydney Basin (refer to Section 3) use cavities within the RHI as winter / hibernation roost habitat.

6.1.3 Presence of threatened microbat species

The Large Bent-winged Bat was the only threatened microbat species recorded on site. Large Bent-winged Bats (along with other threatened and non-threatened microbat species) are likely to forage in proximity to the RHI building, including in adjacent Moore Park and Centennial Park.

Large Bent-winged Bats are subterranean roosting species. Large Bent-winged Bats congregate in large numbers at a few known maternity caves outside of the Sydney Basin over spring and summer to breed and raise young and disperse to winter hibernation roosts up to 300 km away from maternity roosts in autumn (Churchill, 2008). This species is known to inhabit the Sydney Basin throughout the winter months with some non-breeding individuals remaining in the area throughout the year. There are multiple Large Bent-winged Bat records in Bionet within a 10 km radius of the study area.

The RHI is not a breeding habitat for Large Bent-winged Bats, as this species is not known to breed in buildings. Also, large aggregations (1000s) of Large Bent-winged Bats are required to sustain a maternity roost. Therefore, it would be obvious within or outside the RHI, if the subject site was being used as a breeding roost for this species.

Calls from the Large Bent-winged Bat were the most commonly recorded calls obtained during the September 2019 ultrasonic surveys, even though activity from this and all species was extremely low. There were no Large Bent-winged Bat calls recorded prior to 10.00 p.m. but there were three Large Bent-winged Bat calls recorded in the period just prior to dawn suggesting that a single or small number

of individual Large Bent-winged Bats was roosting nearby and potentially within cavities of the RHI. There were no Large Bent-winged Bat calls recorded during the February 2020 ultrasonic surveys.

7. Conclusions and recommendations

The RHI may provide potential roosting habitat for the following threatened microbat species:

- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)
- *Miniopterus australis* (Little Bentwing-bat)
- *Miniopterus norfolkensis* (Eastern Free-tailed Bat)
- Miniopterus schreibersii oceanensis (Large Bentwing-bat).

However, the survey only positively identified calls of one threatened microbat species, the Large Bentwing-bat, as well as calls of up to three non-threatened microbat species.

The Large Bent-winged Bat is a species listed as Vulnerable under the BC Act. Under the BC Act, the Large Bent-winged Bat is a dual credit species (an ecosystem credit and species credit species), but it is a species credit species for breeding habitat only.

This report identified that the RHI is not breeding habitat for Large Bent-winged Bats. This is because this species is not known to breed in buildings and no evidence of large aggregations (1000s) of Large Bent-winged Bats (required to sustain a maternity roost) has been found at the RHI.

No Large Bent-winged Bats were confidently identified during the emergence surveys or thermal imaging surveys. A single unidentified likely microbat was observed emerging from a roost within one roost entry / exit (Door 7) and the survey findings indicate that Large Bent-winged Bats forage in proximity to the RHI building. Therefore, it is possible that individuals or small numbers of Large Bent-winged Bats use the RHI as roosting habitat.

Therefore, the proposed development may have the following potential prescribed biodiversity impact on this species:

- [impacts to] human-made structures which is used as a habitat feature by a threatened species.

A Biodiversity Development Assessment Report (BDAR) has been prepared to assess prescribed biodiversity impacts for threatened species, as well as impact on native vegetation and habitat for threatened species, consistent with the Biodiversity Assessment Method (BAM).

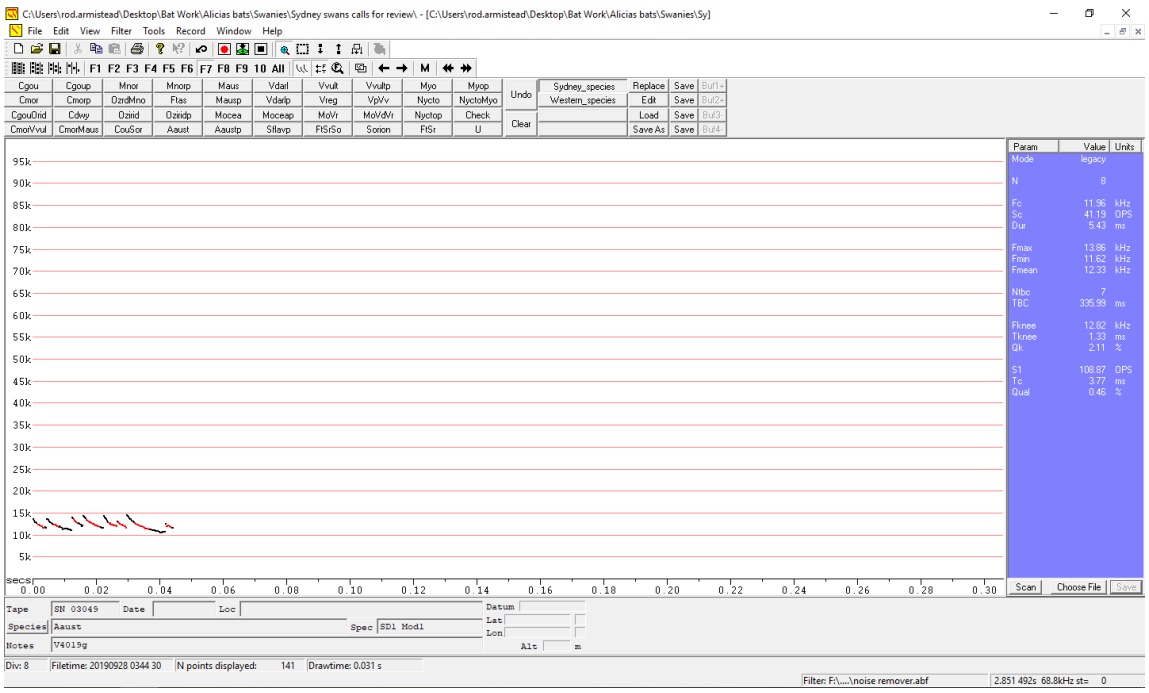
In conjunction with the preparation of the BDAR, a Microbat Management Plan (MMP) has been prepared to outline steps required to avoid, minimise and mitigate against potential impacts to microbats associated with the proposed roof replacement and building refurbishment proposed to occur at the RHI. The MMP describes the process of excluding microbats from the cavities within the RHI prior to commencement of works, including provision of a timeline for each action required under the MMP so that impacts to target threatened microbat species that may be affected by loss of non-breeding roost spaces occur at the least sensitive times of year for those microbat species.

Appendix A : Microbat survey location photos

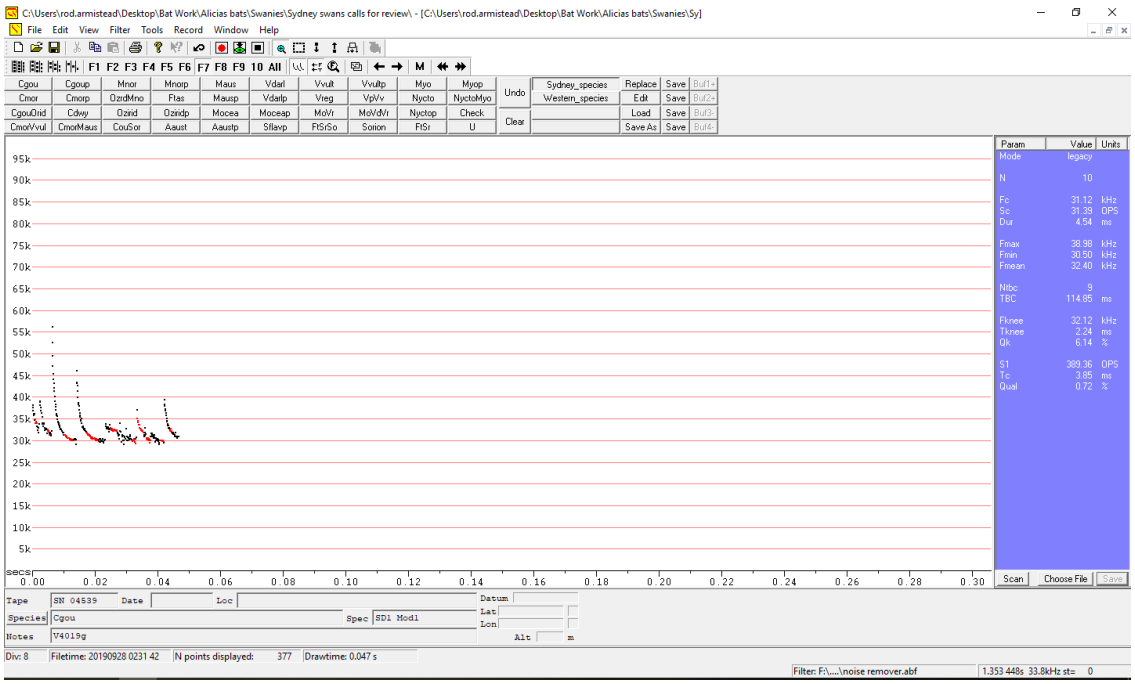
Anabat survey location	Photo	Survey finding
1: Near Door 7		Likely bat emergence from this location. Definite microbat roost entry/exit.
2: Near Door 8		Potential microbat roost entry/exit.

Anabat survey location	Photo	Survey finding
3: South-eastern facade		Rodent (likely rat) and Rainbow Lorrikeets seen within cavity. Not considered a potential microbat roost entry/exit
4: Eastern turret and facade		Considered a potential microbat roost entry/ exit
5: Inside eastern turret		Considered a potential microbat roost

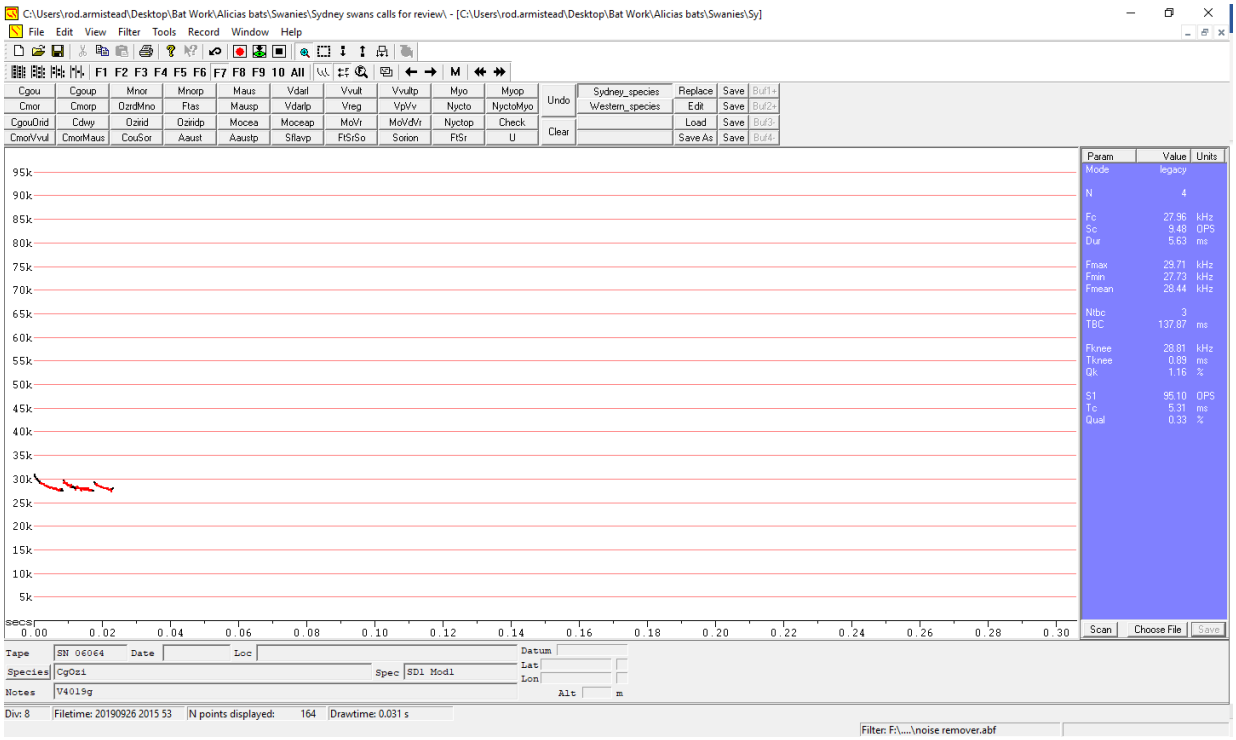
Appendix B Examples of Call Profiles



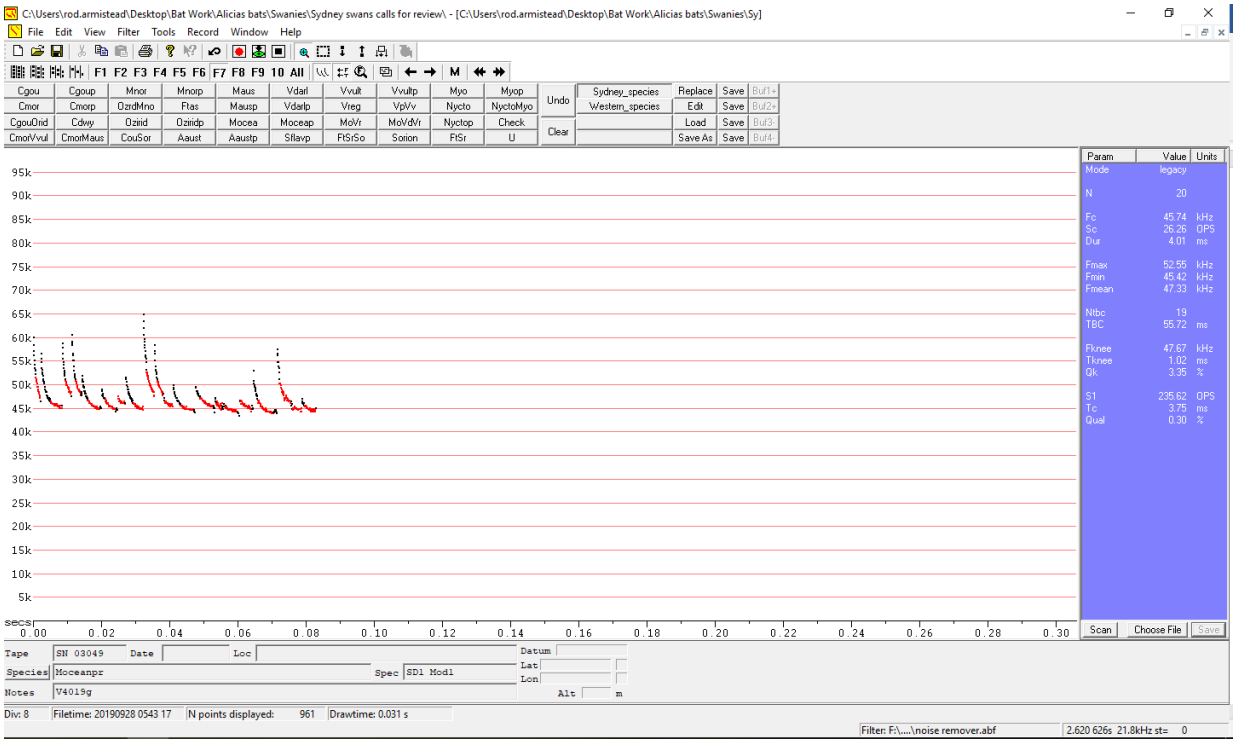
Call profile for *Austronomus australis* (White-striped Free-tailed Bat) recorded beneath Door 8 of the Royal Hall of Industries at 03:44 (3:44 am) on 28 September 2019.



Call profile for *Chalinolobus gouldii* (Gould's Wattled Bat) recorded outside the Turret of the Royal Hall of Industries at 02:31 (2:31 am) on 28 September 2019.



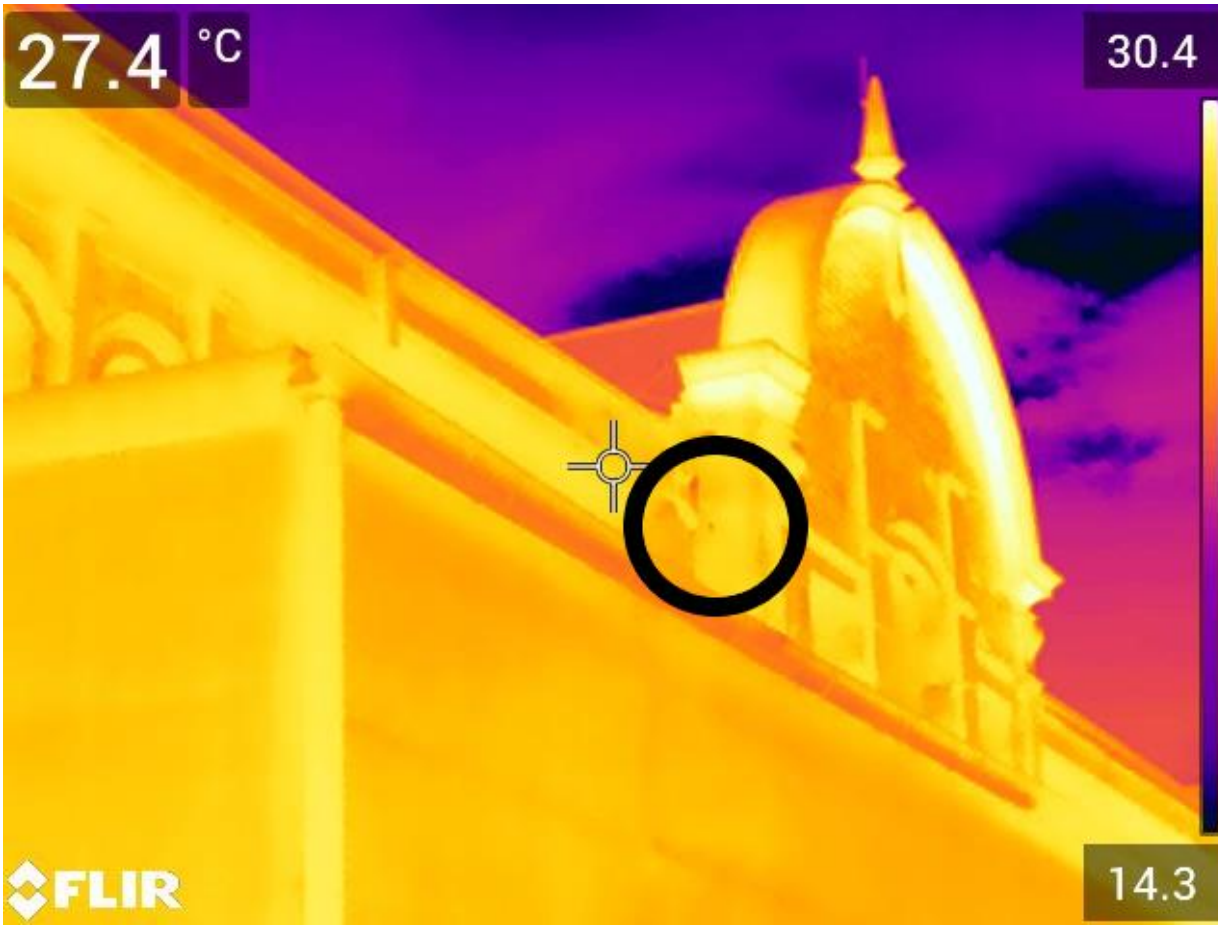
Potential call profile for *Chalinolobus gouldii* (Gould's Wattled Bat) or *Ozimops ridei* (Ride's Free-tailed Bat) recorded beneath Door 7 of the Royal Hall of Industries at 20:15 (8:15 pm) on 26 September 2019.



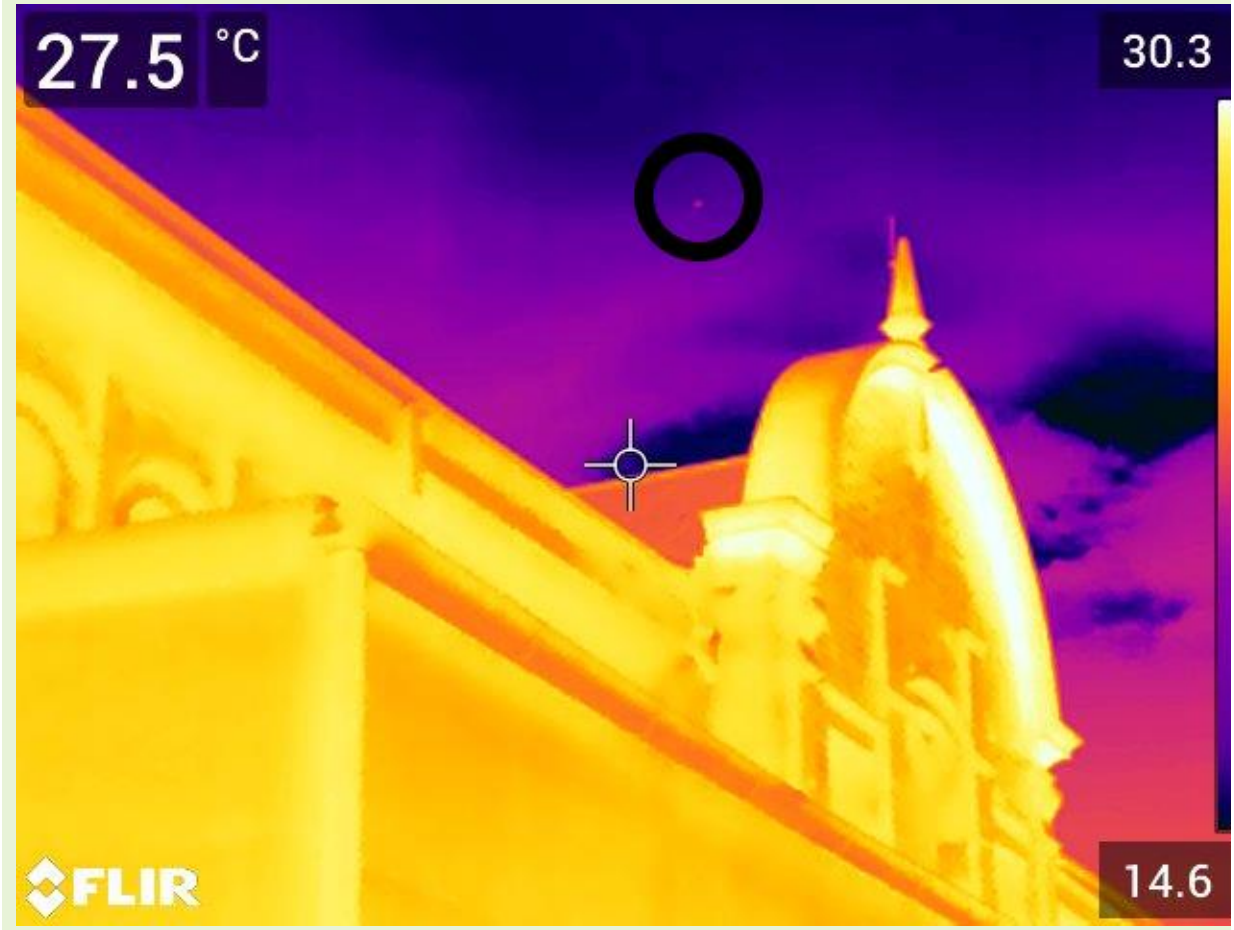
Call profile for *Miniopterus orianae oceanensis* (Eastern Bent-winged Bat) recorded beneath Door 8 of the Royal Hall of Industries at 05:43 (5:43 am) on 28 September 2019.

Appendix C Infrared thermal camera images of likely bat emergence

Infrared thermal camera image of likely bat emergence at Location 1 (door 7) on 18/02/2020 at 20.33



Infrared thermal camera image of likely bat emergence at Location 1 (door 7) on 18/02/2020 at 20.33



8. References

Churchill, S. (2008). *Australian Bats*. Second Edition. Allen & Unwin, Crows Nest, Sydney.

Glynn, A. (2020). Memorandum: Microbats in the Centennial Parklands. From Amara Glynn, Environmental Officer Centennial Parklands to Anthony Murphy, Senior Project Manager APP, 13 Feb 2020

Jackson, C. and Groves, S. (2015). *Taxonomy of Australian Mammals*. CSIRO Publishing.

Law, B. S., Anderson, J., and Chidel, M. (1999). 'Bat communities in a fragmented forest landscape on the south-west slopes of New South Wales, Australia'. *Biological Conservation* 88, 333-345.

Lloyd, A.M., Law, B.S., and Goldingay, R. (2006) 'Bat activity on riparian zones and upper slopes in Australian timber production forests and the effectiveness of riparian buffers.' *Biological Conservation* 129, 207-220.

McKenzie, N. L., Start, A. N., and Bullen, R. D. (2002). *Foraging ecology and organisation of a desert bat fauna*. Australian Journal of Zoology 50, 529-548.

Mills, D. J., Norton, T. W., Parnaby, H. E., Cunningham, R. B., and Nix, H. A. (1996). *Designing surveys for microchiropteran bats in complex forest landscapes - a pilot study from south-east Australia*. Special issue: Conservation of biological diversity in temperate and boreal forest ecosystems 85, 149-161.

Pennay, M., Law, B., and Reinhold, L. (2004). *Bat calls of New South Wales: Region based guide to echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville.

Reardon, T.B., McKenzie, N.L., Cooper, S.J.B., Appleton, B., Carthew, S. and Adams, M. (2014). A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats *Mormopterus* (Chiroptera: Molossidae). Australian Journal of Zoology 62: 109 – 136.

Reinhold, L., Law, B., Ford, G., and Pennay, M. (2001). *Key to the bat calls of south-east Queensland and north-east New South Wales.* 2001. Queensland, DNR.

ecological AUSTRALIA
A TETRA TECH COMPANY

SYSTEM CERTIFICATION ISO 9001 SGS
SYSTEM CERTIFICATION ISO 14001 SGS
SYSTEM CERTIFICATION AS 4801 SGS

1300 646 131
www.ecoaus.com.au