

MICROBATS OF BRISBANE'S INNER WEST



White-striped free-tail bat (*Austronomus australis*)
Photographer: Michael Pennay©

**A report for the Cubberla-Witton Catchments Network Inc.
& Brisbane City Council**

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Fauna Surveys on the Wing®

May 2015



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May 2015

Executive Summary

This survey investigated the microbat species richness of Brisbane's inner west. Furthermore, opportunity was taken to engage members of the Cubberla-Witton Catchments Network Inc. (CWCN) and the wider community to raise awareness of the importance the bats play in the natural environment through evening bat walks, workshops and the Bat Festival in May 2015.

The survey was conducted at 20 sites within the Cubberla, Witton, Toowong, Sandy Creek catchments and adjacent Brisbane River corridors. A total of 852 hours and over 9000 call sequences were recorded resulting in the identification of 15 microbat species:

1. Eastern horseshoe bat (*Rhinolophus megaphyllus*)
2. Yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*)
3. White-striped free-tailed bat (*Austronomus australis*)
4. Eastern (Ride's) free-tailed bat (*Mormopterus ridei*)
5. Beccari's free-tailed bat (*Mormopterus beccarii*)
6. Little bent-winged bat (*Miniopterus australis*)
7. Eastern bent-winged bat (*Miniopterus orinae oceanensis*)
8. Gould's wattled bat (*Chalinolobus gouldii*)
9. Chocolate wattled bat (*Chalinolobus morio*)
10. Hoary wattled bat (*Chalinolobus nigrogriseus*)
11. Long-eared bat (species complex) (*Nyctophilus* spp.)
12. Large-footed myotis (*Myotis macropus*)
13. Eastern broad-nosed bat (*Scotorepens orion*)
14. Broad-nosed bat (species complex) (*Scotorepens* ssp.)
15. Likely record of the golden-tipped bat (*Kerivoula papuensis*).

Several other microbat species have been recorded in earlier studies (Rhodes 2006, Hourigan 2011) in the adjoining catchments (e.g. Moggill Creek Catchment), hence the total number of microbats may even be higher than found in this study.

The CWCN's catchment microbat diversity represents over half of the total microbat species known to occur in south-east Queensland (Van Dyke and Strahan 2008); with seven of these being listed as significant fauna species in Brisbane (BCC 2014). The high bat biodiversity in these inner city suburbs highlights the important work carried out by catchment groups, such as the CWCN, to protect, enhance and manage Brisbane's environment in order to keep and sustain (and hopefully attract back) a wide range of flora and fauna species (Brisbane's Catchments Network 2012).

1. Introduction

This bat survey was commissioned by the Cubberla-Witton Catchments Network Inc. (CWCN) and funded by Brisbane City Council (BCC) and consisted of the survey of the microbat fauna found in the Cubberla, Witton, Toowong, Sandy Creek catchments and part of the Brisbane River corridors within the CWCN catchments (Figure 1). However, this survey was more than just a bat fauna inventory; it also raised community awareness by involving interested people and volunteers during the surveys and by organising a bat festival as part of the Australasian Bat Society's Australasian Bat Night 2015 event.

Raising community awareness is important as bats are an often overlooked group of mammals, frequently linked with fear and superstition. Despite that very little is known in the general public regarding the importance bats play in the natural ecosystem as well as ecosystem services they provide to people.

What are bats?

Bats have existed for at least 50 million years. They are the only mammal capable of true flight. Together with their ability to navigate through the night, they have explored a niche which has not been previously occupied by mammals: the night sky.

Bats belong to the order of Chiroptera, which literally means the 'hand-winged' animal. This is because this mammal group modified their hands to develop into wings by elongating their digits (fingers) and developing skin (wings) between these. There are around 950 bat species world-wide which makes them the second largest group of mammals after rodents (e.g. mice/rats). Australia has over 80 species with 34 in south-east Queensland (SEQ) alone. Bats occur throughout the world, except the polar regions. Some bats are known to migrate 3000 kilometres (km) from winter to summer roosts.

There are two groups (suborders) of Chiroptera:

- the megabats (Megachiroptera) and
- the microbats or insectivorous bats (Microchiroptera).

Megachiroptera: flying foxes, fruit bats and blossom bats

The megabats are usually the larger bats; they are the ones we all are familiar with in Brisbane: We see flying-foxes roosting in big numbers in amongst the trees and their nightly migration out of their camps is a familiar sight. Megabats can weigh up to 1.5 kilogram (kg) and can have wingspan up to 2 metres (m); although our smallest megabat in Brisbane, the common blossom bat (*Syconycteris australis*), only weighs 17 grams (g) with a wing span of 300 centimetres (cm).

Megabats have very good eyesight. Their eyes are large and very efficient in low light levels but they don't have true echolocation (sonar), although some species in Africa have developed clicking noises to guide them.

Megabats are important for the dispersal of seeds, the pollination of our hard wood (eucalypts) and rainforest trees due to their ability to cover large areas. They are also most important for the genetic diversity when pollinating. By being 'messy eaters' they drop the fruit and seeds close to the mother tree, hereby providing food sources for the ground-dwelling fauna below. It also ensures that the seeds are germinating close to the mother tree. On the other hand, everyone is familiar with the unwanted 'bat poo' on cars, walls, etc. However, by leaving a 'seed shadow' behind, megabats are important seed dispersers away from the mother tree.

Recent years have seen an increase of megabats in the cities. In fact, there are more flying fox camps in Brisbane now than there were 20 years ago. This is because of the loss of their natural habitat (including rainforests), hereby not only losing their roosting but also important feeding habitats. The prolonged droughts faced in recent years also push the bats out of their natural habitat in search of food and water. Cities create perfect replacement habitats: they provide roosting habitat as well as water and food sources year round; often through the planting of flowering and fruiting exotic trees (e.g. Chinese elms, mangoes, bananas, palms). Megabats are the modern day refugees of the animal kingdom.

Although the megabats are conspicuous, this survey focused on the smaller, less obvious bat group, the microchiroptera, or microbats.

Microchiroptera: insectivorous bats

The microbats are generally much smaller than the megabats. In fact, the smallest mammal in the world, the Indonesian bumblebee bat (Kitti's hog-nosed bat, *Craseonycteris thonglongyai*) weighs only 2 g. Australia's smallest bat, the little forest bat (*Vespadelus vulturnus*) is not much larger and weighs between 2.6 and 5.5 g, has a body size of only 5 cm and a wing span of 15 cm. In comparison, the ghost bat (*Macroderma gigas*), Australia's largest microbat, weighs on average 150 g. Microbats occupy a different ecological niche to the megabats as they mainly feed on insects (insectivorous) with the exception of the ghost bat which hunts birds, frogs, lizards and smaller mammals (carnivorous).

In order to hunt in complete darkness, the microbats have developed an extraordinary sense: they produce sonar, also called echolocation. Microbats emit high frequency sounds through their mouths or noses and pick up the returning echoes. This enables them to navigate through obstacles (including very dense rainforests) and capture prey. Most sounds

they produce are above the human range of hearing (> 20 kilohertz; kHz). The intensity of these calls, albeit inaudible to our hearing, can be very loud: between 80 and 110 decibel (dB), as intense as a jackhammer. This is necessary as the sound needs to travel as far as possible, although the average range of bat sonar is generally between 2 and 20 metres (depending on the species and their echolocation design).

Echolocation can be very precise. In laboratory experiments, bats were able to pick up wires the diameter of thin hair in total darkness. The frequency and form of sonar (echolocation call) differ according to species and habitat (i.e. how close the bat is to clutter, such as vegetation, obstacles, insects, etc.). It is possible to record these echolocation calls with special bat detectors to detect the presence of bats, assess whether a bat is foraging or commuting, and potentially identify the species emitting the call. This provides also information on bat abundance and activity throughout the night.

Most microbats live in enclosed roosts: hollows in trees, under bark, in caves, tunnels, abandoned mines or even in houses, letterboxes or underneath pool umbrellas. The majority of SEQ's 29 microbat species are hollow-dependent, meaning they rely on old (eucalypt) trees to provide hollows for roosting, mating and bringing up their offspring. Microbats face decline due to urban development due to the loss of important roosting and foraging habitat.

Insectivorous bats are our natural pest control (EHP 2015). Several studies confirmed that microbat eat large volumes of pests, including mosquitoes. For example, in South-central Texas, large colonies of the Mexican free-tailed bats (*Tadarida brasiliensis*) have been found to feed an incredible 1,000 tonnes of insects in a single night, which included agricultural pest species. The researchers calculated the bats' value as pest control for cotton production to be an annual value of US\$ 741,000 per year (Cleveland *et al.* 2006). Closer to home, Gonsalves and colleagues (2013) showed that two bat species feed on mosquitoes: the little forest bat (*Vespadelus vulturnus*) and the eastern forest bat (*Vespadelus pumilus*). Both species forage preferably over salt marshes, with mosquitoes making up to half of the little forest bat's prey.

2. Survey objectives

The CWCN is a community-based organisation with the aim to '*support whole of catchment projects for Cubberla, Witton, Toowong and Sandy Creek catchments, including making applications for grants and facilitating research into biophysical components of the catchments*' (CWCN 2015). In this role, CWCN commissioned this bat survey to gain information on one of the most biodiverse fauna groups, the bats – with particular emphasis on the microbats as they require specialist knowledge to record and identify them.

Hence, this survey investigated the diversity of microbat species in the CWCN catchments and to engage CWCN members and the wider community to raise awareness of the importance the bats play in the natural environment.

3. Survey area

The greater Brisbane region is located in subtropical coastal Australia. The topography of the region is characterised by coastal plains, sub-coastal ranges, occasional mountain peaks above 1000 m, and drainage systems and valleys. The region comprises many vegetation types, including subtropical rainforests, open eucalypt forests, melaleuca forests, woodlands and heathlands. The landscape is undulating to hilly. It consists of a mosaic of mostly cleared urban settings with grassed lawns, parklands with scattered mature eucalypts, dominated by forest red gum (*Eucalyptus tereticornis*), and bushland reserves ranging from less than one to 20 km² with the exception of the Brisbane Forest Park, a large remnant forest reserve (28,500 hectares) on the margins of the survey area (summarised in Rhodes 2006).

The survey was conducted in the Cubberla, Witton, Toowong, Sandy Creek catchments and adjacent Brisbane River corridors within metropolitan Brisbane (Figure 1). All field sites were located in the coastal lowlands below 100 m altitude in the Brisbane River catchment area. These catchments consist primarily of urban development and the Western Freeway runs north and south dividing Cubberla, Witton and Toowong creeks catchments.

Cubberla Creek Catchment

The headwaters from Cubberla Creek come from the foothills of Mt Coot-tha Reserve within the Brisbane Forest Park. Cubberla Creek runs south for seven kilometres to meet the Brisbane River at Fig Tree Pocket. The main tributaries are the Boblynne Street branch, Akuna Street branch and Little Gubberley Creek. The catchment area contains 10.5 km² (BCC 2012).

The upper reaches of Witton and Toowong Creeks have been piped under the Western Freeway and sections of Cubberla Creek have been diverted and piped to enable the construction of sports ovals and for flood mitigation.

Before European settlement, lush rainforests grew along the entire length of Cubberla Creek, from the foothills to the creek mouth, and on all the adjoining alluvial flats (that are now parks). While most of this rainforest was cleared for urban development, some small rainforest remnants have survived along creeks and drainage lines, these remaining remnants are remarkably rich in plant species, with more than 100 trees, shrubs and vine species represented (BCC 2012).

Witton Creek Catchment

Witton Creek descends from Mt Coot-tha through Chapel Hill and Indooroopilly before entering the Brisbane River upstream of the Walter Taylor Bridge. Witton Creek is characterised as a small, relatively steep creek, which lies immediately to the east of the Cubberla Creek catchment. Sections of the Witton Creek have been diverted due to the construction of the Western Freeway and the relocation of the Moore Park sports oval. The catchment area is approximately 4 km² (BCC 2012).

Anecdotal evidence suggests that instead of rainforest, stands of bottlebrush (*Melaleuca viminalis*) grew in the small areas of alluvial soil along the waterways (BCC 2012).

Toowong Creek Catchment

Toowong Creek starts on the eastern slope of Mt Coot-tha. It travels through the Botanic Gardens and the suburb of Toowong before entering the Brisbane River near Perrin Park. The catchment area covers an area of 3.9 km² (BCC 2012).

Sandy Creek Catchment

The Sandy Creek Catchment is probably the most impacted catchment by human settlement. The creek is hardly visible, except along Robertson Park and stretches within St. Lucia Golf Links as it travels the last two kilometres to its mouth. Sandy Creek starts in Taringa before emptying into the Brisbane River at the St Lucia Golf Links in Indooroopilly. The catchment area covers an area of 3.8 km² (BCC 2012).

Brisbane River corridors

There are several, highly ephemeral, unnamed creeks which flow directly into the Brisbane River corridors within the CWCN catchment. These tributaries are not connected to the above-mentioned creeks and were targeted in this survey. Of importance were creeks in Fig Tree Pocket and St. Lucia and the Biami Yumba lagoon in Fig Tree Pocket.

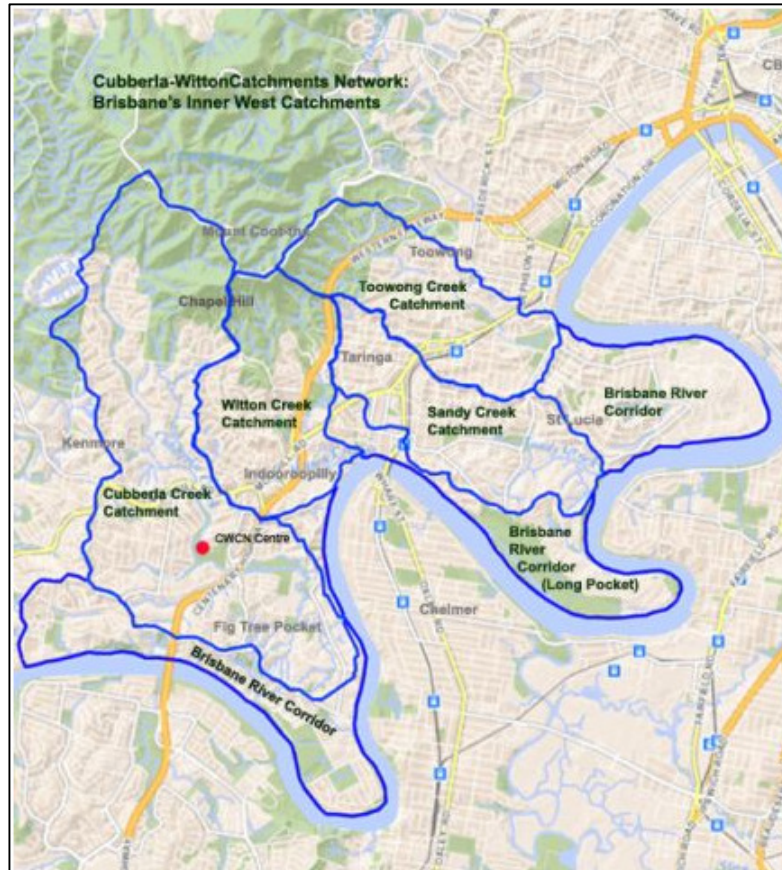


Figure 1 Map showing the Cubberla, Witton, Sandy and Toowong Creek catchments and Brisbane River corridors.

Source: <http://cwcncn.org.au/index.php/about-us>

4. Methods

Desktop searches were undertaken prior to the field surveys to obtain information on the historical and potential presence and distribution of bat species in the Cubberla, Witton, Sandy, Toowong Creek catchments and adjacent Brisbane River corridors. The desktop studies included database searches, reviews of previous bat studies undertaken in the general area, interpretation of recent high resolution aerial photography, and review of published vegetation mapping. The desktop studies refined the field methodology to target suitable vegetation communities and areas to conduct stationary bat detector recordings (ultrasonic recordings) and walking transects with mobile hand-held bat detectors.

Bat recording effort

Bat surveys were conducted between October 2014 and April 2015 in 20 different locations and consisted of 828 hours of stationary bat detector recordings and 24 hours of walking transect recordings (Figure 2; Table 1).

Trapping of bats were not undertaken as a bat study carried out in urban Brisbane by Hourigan *et al.* (2008) showed that all species captured by harp trap were also detected by bat detector and found that bat detectors recorded significantly more species per site than were captured by harp traps. The study also concluded that bat detectors were also the most cost-efficient sampling method for surveying the bat assemblage in an urban landscape.

Sampling techniques

A minimum of two sites were chosen in each of the catchments: one to carry out stationary bat detector recordings (where suitable private properties were available), and one where walking transects along each of the creeks occurred. The map in Figure 2 shows an overview of the sites. These methods are explained in more detail below.

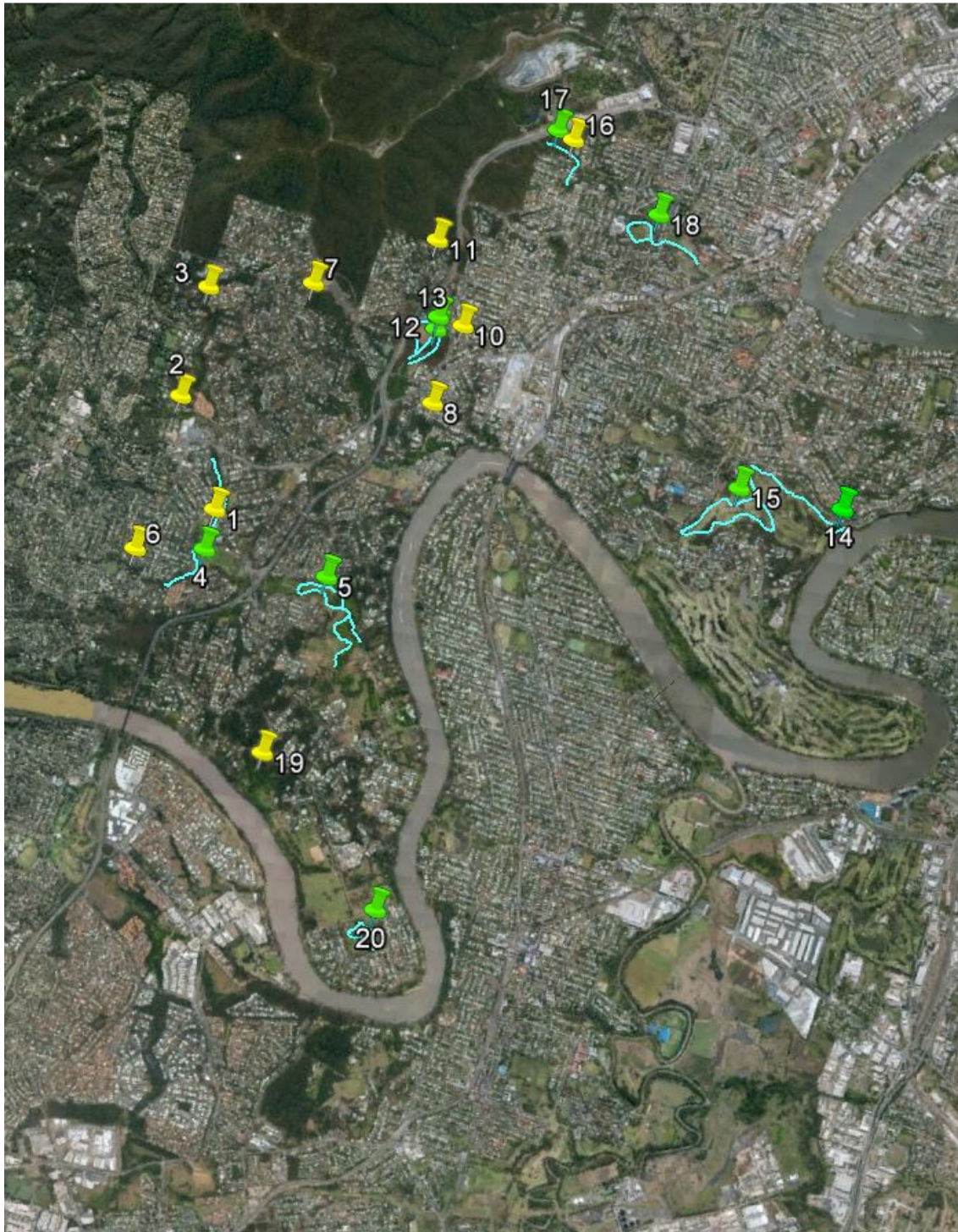


Figure 2 Map showing field sites located within the catchments of Cubberla, Witton, Sandy and Toowong Creek catchments and Brisbane River corridors.
 Numbers 1-20: locations of field sites: yellow – stationary sites; green – walking transects; light blue lines: path of transects. Sites 9 and 10 are shown as one number (10).
 For site description refer to Table 1.
 Source: Google Earth (2013), version 7.1.2.2041

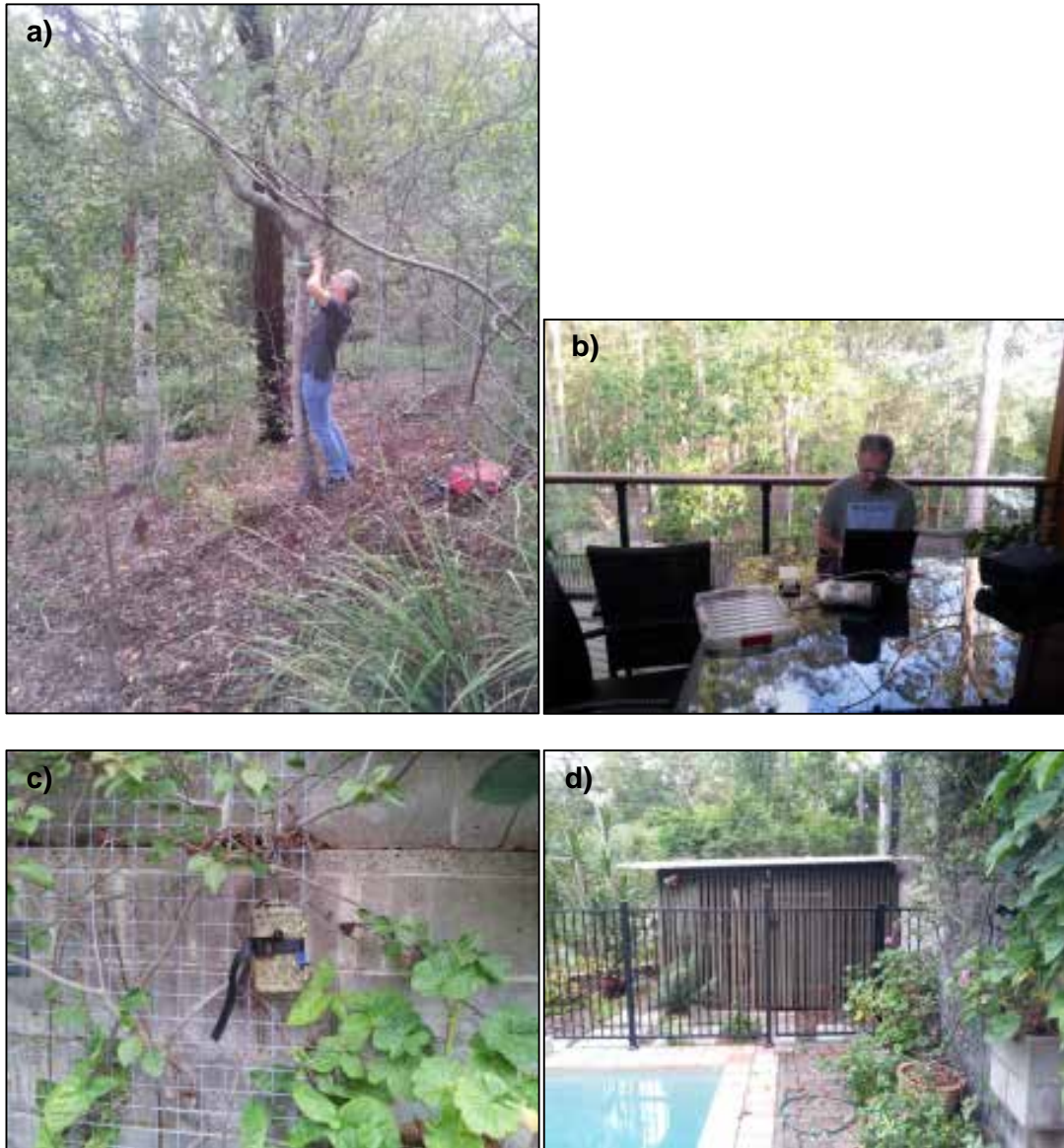
Stationary bat detector recordings

Two of the three bat detectors consisted of Anabat II detectors (Titley Electronics, Ballina, Australia) connected to a ZCAIM and laptop computer running Anabat6 software, powered by an 18 V battery. They were housed in large plastic containers. The third stationary detector involved an AnaBat Express (Titley Scientific, Brendale, Australia).

Bat detectors were installed prior sunset in locations safe from human interference (stealing equipment is common in urban environments). This required setting up the equipment in private properties. If the properties were close to the creeks, the detectors were located facing the creek. In locations away from the creeks (e.g. University of Queensland mines or private properties bordering the Brisbane Forest Park) the detectors were angled to face a gap or a possible bat flyway in the vegetation. Recording took place all night and the Anabat II detectors were collected the following morning, while the AnaBat Express detector recorded up to 2 weeks. An overview of the locations, duration and recording type is shown in Table 1.

Anabat II systems were set at ground level or on an elevated position (e.g. table) with the microphone positioned at approximately 45 degrees facing towards the creek, a flyway in the vegetation or the forest edge. The AnaBat Express detector was strapped onto a tree or other surface, also facing upright the creek or gap/flyway in the vegetation. Examples of field sites are shown in Plate 1.

All Anabat detectors use frequency division to produce data files which can be analysed using zero-crossings analysis to make them visible as sonagrams (Figure 3 and Figure 4).



Photographer: Monika Rhodes©

Plate 1 Photos showing several stationary recording locations:

- a) AnaBat Express on the University of Queensland Experimental Mine campus
- b) Anabat II on private property overlooking Mt Coot-tha Reserve
- c +d) AnaBat Express on private property near Toowong Creek.

Walking transects

Walking transects consisted of walking along a footpath near the creeks to record any bats flying along the riparian vegetation. A hand held Anabat II detector (connected to a recorder) was used during the walking transects and each bat sequence recorded was followed by a description of location, time, weather conditions, and vegetation descriptions. A typical walking transect started at sunset and lasted for approximately two to three hours.

Walking transects were generally carried out along the creeks where overnight recording was impossible due to safety reasons (theft of equipment). Sections of the Cubberla, Witton, Sandy and Toowong creeks and Brisbane River corridors were previously chosen which contained riparian vegetation, parklands and/or sports ovals, suitable for foraging bats. Many of these creeks contained footpaths or were accessible through public spaces.

As many of the footpaths along the creeks contained street lighting any observation on the flight behaviour of the bat was also recorded. No other light (e.g. spotlights) were used to observe bats.

The first microbats emerged 20 to 30 minutes after sunset, during ambient light. Hence, bat flight behaviour observations for early emerging bats were possible against the backlight (or street light) while ultrasonic recordings were carried out. Two species, the white-striped free-tailed bat (*Austronomus australis*) and the yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*), produce characteristic bat calls within the human hearing range (Figure 4). These calls were noted when heard.

Community awareness

Two workshops were held as part of this survey effort. The first one was held on 27 September 2014 prior the start of field surveys in order to introduce bats, their ecology and field survey techniques to members of the CWCN. A second public workshop was held at the Bat Festival on 9 May 2015 as part of the Australasian Bat Society's Australasian Bat Night 2015 event (Plate 2; Appendix 1).

Bat walks as part of the walking transects were also used to introduce bats to volunteers and interested persons (Plate 3). The bat detectors made bat call sequences audible to the human hearing and hence provided audible signals that a bat flew overhead. Bat observations were also possible where bats flew close to street lamps or were seen against the backlight at dusk.



Photographer: Jutta Godwin©

Plate 2 Presentation of the results of the bat survey at the Bat Festival, CWCN Centre, Chapel Hill, May 2015.



Photographer: Jutta Godwin©

Plate 3 Volunteer participation: The authors explain the use of the bat detector prior to conducting the walking transects/bat walks.

Bat call identification

Insectivorous bats produce species-specific bat calls which can be identified using the sonagrams on the bat call analysis system Analook (Reinhold *et al.* 2001). Identification of recorded bat call sequences (Anabat files) followed the procedure outlined in Hourigan *et al.* (2008):

- Anabat files were scanned and files without bat calls were discarded.
- Any noise, i.e. random dots on the screen, was removed from files containing bat call sequences.
- The characteristic frequency, end frequency, knee frequency, pulse duration and interval, and initial slope of calls were measured (as defined in Reinhold *et al.* 2001). Pulse shape and an alternation of pulse frequency were also used to identify calls to species level.
- Identified bat call sequences were compared with an identification key and existing call library for the SEQ region.
- Call sequences with less than three consecutive intact pulses were discarded.
- Sequences containing multiple bats were analysed and counted separately (e.g. if a sequence contained three bat call sequences and they could be identified to species, it was counted as three separate bats for this recording; Figure 3).

While ultrasonic detection of bat calls is an effective and non-invasive methodology to sample a wide variety of bat species, some bat species cannot be reliably distinguished to species level due to within-species regional variations, call quality, and overlap of calls between species or genera (DEC 2004). For example, in Brisbane, two long-eared bat species, the eastern long-eared bat (*Nyctophilus bifax*) and the Gould's long-eared bat (*Nyctophilus gouldi*) occur (Van Dyck and Strahan 2008; Rhodes 2006). The calls of this genus cannot be distinguished from one another using bat detectors. These calls were grouped as '*Nyctophilus* spp.' (Hourigan *et al.* 2008). Similarly, the calls of the little broad-nosed bat (*Scotorepens greyii*) and the central-eastern broad-nosed bat (*Scotorepens* sp.) are also indistinguishable and these calls were grouped as '*Scotorepens* spp.' (Hourigan *et al.* 2008). In these cases bat calls were identified to species groups ("species complex").

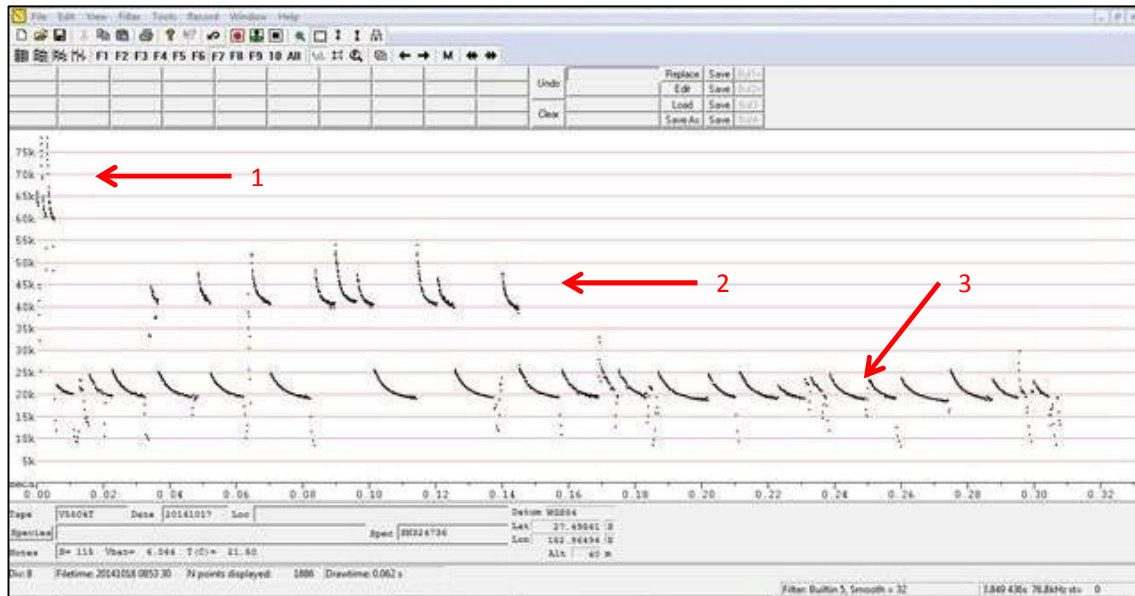


Figure 3 Sonogram recorded in Moore Park in October 2014 showing echolocation call sequences of three different species: the little bent-winged bat (1), the broad-nosed bat species (2) and the yellow-bellied sheath-tailed bat (3). The sonogram shows the time (in milliseconds) on the x-axis and the call frequency (in kilohertz) on the y-axis.

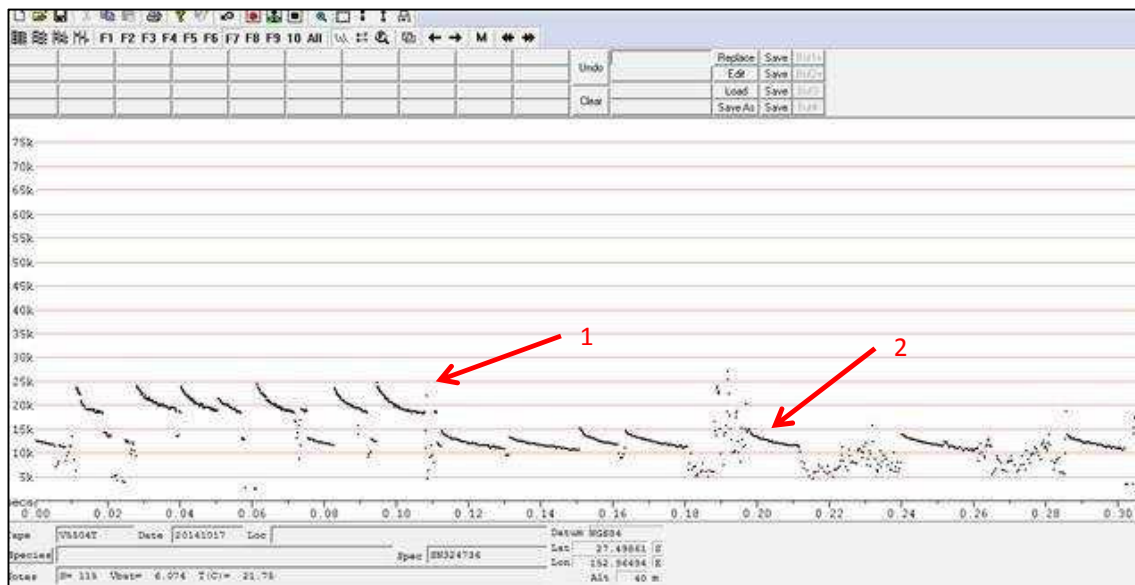


Figure 4 Sonogram recorded in Moore Park in October 2014 showing echolocation call sequences of two audible bat species: the yellow-bellied sheath-tailed bat (1) and the white-striped free-tailed bat (2).

5. Results

A total of 852 hours and over 9000 call sequences were recorded with stationary bat detectors and during walking transects, resulting in the identification of 15 microbat species (Table 1; Table 2). Some species could only be identified to genus level due to overlap of calls between species (as discussed above).

The following microbat species were recorded during this survey:

1. Eastern horseshoe bat (*Rhinolophus megaphyllus*)
2. Yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*)
3. White-striped free-tailed bat (*Austronomus australis*)
4. Eastern (Ride's) free-tailed bat (*Mormopterus ridei*)
5. Beccari's free-tailed bat (*Mormopterus beccarii*)
6. Little bent-winged bat (*Miniopterus australis*)
7. Eastern bent-winged bat (*Miniopterus orinae oceanensis*)
8. Gould's wattled bat (*Chalinolobus gouldii*)
9. Chocolate wattled bat (*Chalinolobus morio*)
10. Hoary wattled bat (*Chalinolobus nigrogriseus*)
11. Long-eared bat (species complex) (*Nyctophilus* spp.)
12. Large-footed myotis (*Myotis macropus*)
13. Eastern broad-nosed bat (*Scotorepens orion*)
14. Broad-nosed bat (species complex) (*Scotorepens* ssp.)
15. Likely record of the golden-tipped bat (*Kerivoula papuensis*).

Table 1 and Table 2 provide an overview of where these species were recorded in the CWCN catchments and how (stationary or walking transect). The results clearly showed that bat species diversity (i.e. the number of different bat species recorded) increased with proximity to the Brisbane Forest Park (Mt Coot-tha Reserve) and well-vegetated creeks. The lowest bat diversity was recorded in areas of denser housing where the creeks were less vegetated and heavily modified through diversions, such as along Sandy Creek at the St. Lucia Golf Links, the lower Toowong Creek near Miskin Street or at the man-made lagoon at the Biami Yumba Park which does not have a connecting creek (Figure 5).

Bat fauna found in other bat surveys

In Clare Hourigan's PhD study of insectivorous bats in urban Brisbane (Hourigan 2011), five of her field sites were also located in the same catchments of this study, namely in two locations in Taringa (Sandy Creek Catchment), two in Chapel Hill (Witton Creek Catchment) and one location inside the Indooroopilly Golf Links (Brisbane River Corridor).

Clare recorded over a two year period (2004-2006) nine different bat species in these five locations, of which all were also identified in this survey:

1. White-striped free-tailed bat
2. Little bent-winged bat
3. Eastern bent-winged bat
4. Gould's wattled bat
5. Hoary wattled bat
6. Long-eared bat species complex (*Nyctophilus* ssp.)
7. Broad-nosed bat species complex (*Scotorepens* ssp.)
8. Eastern / Ride's free-tailed bat
9. Large-footed myotis.

Although all species found by Clare Hourigan (2011) were also identified during this survey, Clare's data provided important information on the species distribution in each of the CWCN catchments (Table 2).

Table 1 Overview of survey sites, dates, recording length, survey site characteristics, recording method, and species recorded

| Site number ¹ | Location | Date | Recording length (hours) | Survey site characteristics ² | Recording method ³ | Bat species recorded |
|---------------------------------|---|-------------------------|--------------------------|--|-------------------------------|---|
| Cubberla Creek Catchment | | | | | | |
| 1 | Private property: Burns Parade, Chapel Hill, overlooking Cubberla Creek and park | 4-5/10/14 27-30/1/15 | 12 36 | R, C, P | S | <ul style="list-style-type: none"> • Little bent winged bat • Eastern bent-winged bat • Broad-nosed bat species complex • Gould's wattled bat • White-striped free-tailed bat • Long-eared bat species complex |
| 2 | Private property: Karabil Street, Chapel Hill, overlooking Cubberla Creek | 2-7/03/15 | 60 | R, C | S | <ul style="list-style-type: none"> • Eastern horseshoe bat • Beccari's free-tailed bat • Eastern (Ride's) free-tailed bat • Little bent-winged bat • Eastern bent-winged bat • Broad-nosed bat species complex • Eastern broad-nosed bat • Gould's wattled bat • Yellow-bellied sheath-tailed bat • White-striped free-tailed bat |
| 3 | Private property: Alana Court, Chapel Hill, overlooking Cubberla Creek | 7-12/03/15 | 60 | R, C | S | <ul style="list-style-type: none"> • Eastern horseshoe bat • Broad-nosed bat species complex • Little bent-winged bat • Eastern bent-winged bat |
| 4 | Akuna Street Park (Chapel Hill/Kenmore): Cubberla Creek, Little Gubberley Creek, Akuna Street Branch | 4/10/14 | 2 | C, P, SG, S | WT | <ul style="list-style-type: none"> • Little bent-winged bat • Broad-nosed bat species complex |
| 5 | Cliveden Park (Fig Tree Pocket): Lower Cubberla Creek, including Rainbow Forest Park, Brisbane Girls Grammar sports oval (Moorfields St to Jesmond Rd) | 4/10/14 | 2 | C, P, SG, S | WT | <ul style="list-style-type: none"> • Large-footed myotis • Gould's wattled bat • Broad-nosed bat species complex • Eastern broad-nosed bat |

Microbats of Brisbane's Inner West

| Site number ¹ | Location | Date | Recording length (hours) | Survey site characteristics ² | Recording method ³ | Bat species recorded |
|-------------------------------|--|---------------------------|--------------------------|--|-------------------------------|---|
| | | | | | | <ul style="list-style-type: none"> White-striped free-tailed bat |
| 6 | Private property: Glencarron St, Kenmore, overlooking Little Gubberley Creek | 24/03-01/04/15 | 96 | R, C | S | <ul style="list-style-type: none"> Gould's wattled bat Little bent-winged bat Broad-nosed bat species complex Eastern broad-nosed bat White-striped free-tailed bat Eastern (Ride's) free-tailed bat |
| Witton Creek Catchment | | | | | | |
| 7 | Private property: Kiandra Street, Chapel Hill, overlooking Brisbane Forest Park, Green Hill Reservoir | 18-19/10/14 | 12 | R, F(ds) | S | No bats recorded all night |
| 8 | University of Queensland Experimental Mine; Isles Road, Indooroopilly | 13-18/12/14 | 60 | F(ds) | S | <ul style="list-style-type: none"> Little bent-winged bat White-striped free-tailed bat Broad-nosed bat species complex Gould's wattled bat |
| 9 +10 | Adjacent private properties (2): Taringa Parade, Indooroopilly | 26-27/01/15 21-22/3/15 | 12 12 | R, B | S | <ul style="list-style-type: none"> Yellow-bellied sheath-tailed bat White-striped free-tailed bat Gould's wattled bat Little bent-winged bat Eastern bent-winged bat Broad-nosed bat species complex |
| 11 | Private property: Lytham Street, Indooroopilly, overlooking Brisbane Forest Park | 17-26/01/15 | 108 | P, F(ds) | S | <ul style="list-style-type: none"> Eastern horseshoe bat Chocolate wattled bat Gould's wattled bat Broad-nosed bat species complex Eastern broad-nosed bat Little bent-winged bat Eastern bent-winged bat White-striped free-tailed bat |

Microbats of Brisbane's Inner West

| Site number ¹ | Location | Date | Recording length (hours) | Survey site characteristics ² | Recording method ³ | Bat species recorded |
|--------------------------------|--|------------|--------------------------|--|-------------------------------|---|
| 12 | Moore Park: Indooroopilly, oval and footpath/track | 18/10/14 | 2.5 | P, SG, S | WT | <ul style="list-style-type: none"> Gould's wattled bat Little bent-winged bat Broad-nosed bat species complex Yellow-bellied sheath-tailed bat White-striped free-tailed bat |
| 13 | Moore Park: Indooroopilly, along Witton Creek | 18/10/14 | 2.5 | C, P | WT | <ul style="list-style-type: none"> Gould's wattled bat Little bent-winged bat Broad-nosed bat species complex White-striped free-tailed bat |
| Sandy Creek Catchment | | | | | | |
| 14 | Public park: Hillside Tce, St. Lucia | 31/01/15 | 2.5 | P, S, C, BR | WT | <ul style="list-style-type: none"> Little bent-winged bat Eastern bent-winged bat White-striped free-tailed bat Broad-nosed bat species complex |
| 15 | St. Lucia Golf Links: Along Sandy Creek, small pond and golf course | 31/01/15 | 5 (2 x 2.5) | C, L, SG | WT | <ul style="list-style-type: none"> Little bent-winged bat Eastern bent-winged bat White-striped free-tailed bat (including roost tree of this species) |
| Toowong Creek Catchment | | | | | | |
| 16 | Private property: Kent St, Toowong, overlooking Toowong Creek | 10-17/1/15 | 96 | P, C, F(ds) | S | <ul style="list-style-type: none"> Hoary wattled bat Eastern broad-nosed bat Eastern (Ride's) free-tailed bat Gould's wattled bat Little bent-winged bat Eastern bent-winged bat Long-eared bat species complex White-striped free-tailed bat |

Microbats of Brisbane's Inner West

| Site number ¹ | Location | Date | Recording length (hours) | Survey site characteristics ² | Recording method ³ | Bat species recorded |
|--|---|---|--------------------------|--|-------------------------------|---|
| 17 | Forest remnant behind Kent St, Toowong, along Toowong Creek | 10/01/15 | 2.5 | C, F(ds), S | WT | <ul style="list-style-type: none"> Gould's wattled bat Eastern bent-winged bat Broad-nosed bat species complex White-striped free-tailed bat |
| 18 | Oakman Park, and Queensland Academy for Science Mathematics and Technology sports oval along Toowong Creek (Union St, Miskin St; Toowong) | 10/01/15 | 2.5 | C, P, SG, S | WT | <ul style="list-style-type: none"> Eastern bent-winged bat Broad-nosed bat species complex Eastern (Ride's) free-tailed bat |
| Brisbane River corridors | | | | | | |
| 19 | Private property: Fig Tree Pocket Rd, Fig Tree Pocket, overlooking small unnamed creek tributary to the Brisbane River | 30/12/14 – 9/01/15 1-12/2/15 28/02/15 | 120 132 12 | R, C, BR, F(ws;r) | S | <ul style="list-style-type: none"> Likely golden-tipped bat Gould's wattled bat Long-eared bat species complex Little bent-winged bat Broad-nosed bat species complex White-striped free-tailed bat Yellow-bellied sheath-tailed bat Eastern (Ride's) free-tailed bat |
| 20 | Biami Yumba Park: Fig Tree Pocket, lagoon and public park | 13/12/14 | 2.5 | P, L | WT | <ul style="list-style-type: none"> Eastern (Ride's) free-tailed bat Eastern bent-winged bat Long-eared bat species complex Gould's wattled bat |
| Total hours of recording and total number of bat species identified | | | 852 hours | | | 15 microbat species |

¹**Site number:** Number corresponds to field sites shown on Figure 2.

²**Survey site characteristics:** R – residential property; P – public park; SG – sports ground; C – creek; BR – Brisbane River; L - Lake/pond; F(ds) – dry sclerophyll forest remnant; F(ws) – wet sclerophyll forest remnant; F(r) – rainforest remnant; S – street/pedestrian footpath; B – backyard.

³**Recording method:** S – stationary bat detector recording; WT – walking transect with hand-held bat detector.

Table 2 Bats of Brisbane's inner west

Overview of the bat species, where and how they were recorded (includes data from other studies)

| Common species name | Scientific species name | Catchment/s ¹ | Recording type ² |
|----------------------------------|--------------------------------------|--------------------------|-----------------------------|
| Eastern horseshoe bat | <i>Rhinolophus megaphyllus</i> | CC, WC | S |
| Yellow-bellied sheath-tailed bat | <i>Saccolaimus flaviventris</i> | CC, WC, BR | WT, S, H |
| White-striped free-tailed bat | <i>Austronomus australis</i> | CC, WC, TC, SC, BR | WT, S, H, D |
| Eastern / Ride's free-tailed bat | <i>Mormopterus ridei</i> | CC, WC, TC, SC, BR | S, D |
| Beccari's free-tailed bat | <i>Mormopterus beccarii</i> | CC | S |
| Little bent-winged bat | <i>Miniopterus australis</i> | CC, WC, TC, SC, BR | S, D |
| Eastern bent-winged bat | <i>Miniopterus orinae oceanensis</i> | CC, WC, TC, SC, BR | S, D |
| Gould's wattled bat | <i>Chalinolobus gouldii</i> | CC, WC, TC, SC, BR | S, WT, D |
| Chocolate wattled bat | <i>Chalinolobus morio</i> | WC | S |
| Hoary wattled bat | <i>Chalinolobus nigrogriseus</i> | CC, TC, SC | S,D |
| Long-eared bat species complex | <i>Nyctophilus ssp.</i> | CC, TC, SC, BR | S, D |
| Eastern broad-nosed bat | <i>Scotorepens orion</i> | CC, WC, TC | S |
| Broad-nosed bat species complex | <i>Scotorepens ssp.</i> | CC, WC, TC, SC, BR | S, D |
| Large-footed myotis | <i>Myotis macropus</i> | CC, BR | D |
| Likely golden-tipped bat | <i>Kerivoula papuensis</i> | BR | S |

¹CC – Cubberla Creek; WC – Witton Creek; TC – Toowong Creek; SC – Sandy Creek; BR – Brisbane River corridors.

²S – stationary bat detector; WT – walking transect; H – heard (audible echolocation calls); D – data records from Hourigan (2011).

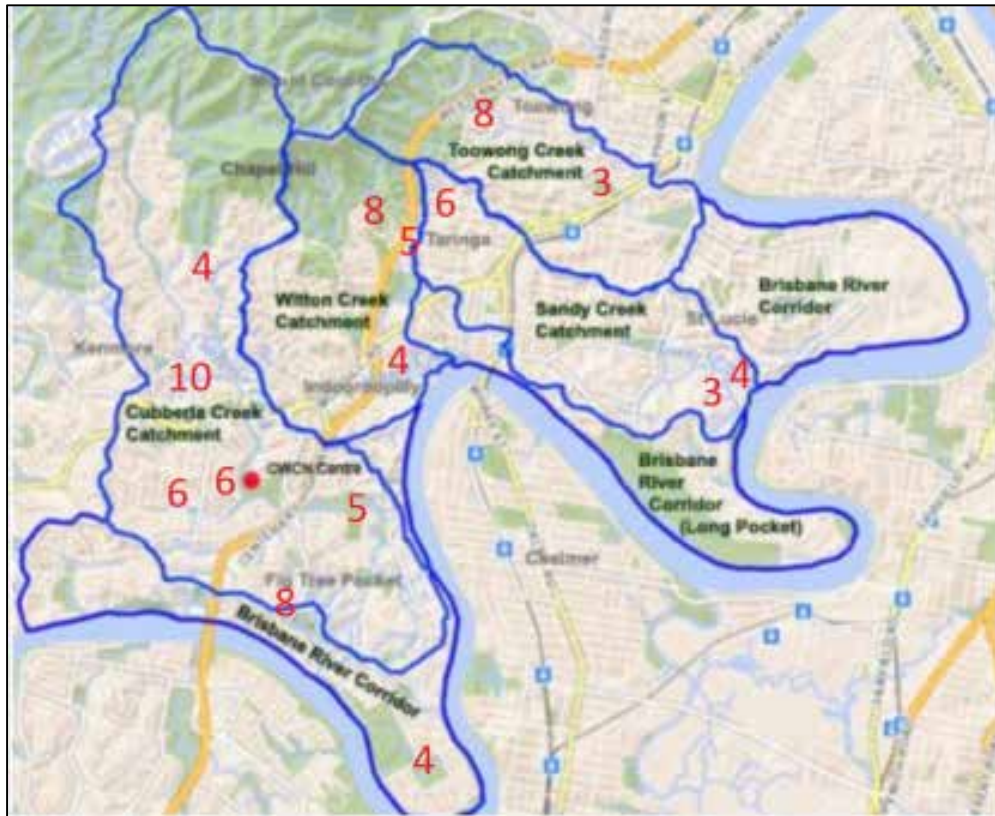


Figure 5 CWCN catchments map showing the numbers of bat species recorded on most of the 20 sites surveyed. The species diversity generally increased with proximity to the Brisbane Forest Park (Mt Coot-tha Reserve) and well-vegetated creeks.

Species profiles of microbats recorded in CWCN catchments

The 15 microbat species identified in the CWCN catchments are described in more detail below. Information for the bat species were summarised mainly from The Mammals of Australia (Van Dyck and Strahan 2008) and the Field Companion to the Mammals of Australia (Van Dyck *et al.* 2013). Information on the specific locations where each species was recorded during this survey is found in Table 1 and Table 2.

Eastern horseshoe bat (*Rhinolophus megaphyllus*)



Photographer: Bruce Thomson©

The eastern horseshoe bat is a medium sized bat, with a body weight of 7-13 gram (g) and is characterised by its horseshoe-shaped nose leaf. The species is mainly distributed along the east coast of Australia and roosts in caves, disused mines, tunnels, culverts, boulders and occasionally in houses. The bat forages within or at the edge of, stand of vegetation, including rainforest, eucalypt forest and woodland. It is a slow and fluttery flyer and can be found foraging up to two kilometres away from its roosts. They feed on moths, beetles, bugs, cockroaches, dragonflies, flies, grasshoppers and wasps (Van Dyke and Strahan 2008).

Brisbane Forest Park provides numerous suitable roost sites for this bat, including abandoned gold mines. This species relies on denser vegetation

for foraging, hence this species has been recorded in this survey in only three locations: site#2 and site#3 in the Cubberla Creek catchment and on site#11 in the Witton Creek catchment. All three sites are located in the Brisbane Forest Park and are connected by bushland or the Cubberla and Witton creeks, highlighting the necessity of a wildlife corridor to the larger forest. The eastern horseshoe bat is classified as a significant fauna species in Brisbane (BCC 2014).

Yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*)



Photographer: Julie Broken-Brow©

The yellow-bellied sheath-tailed bat is a large bat species, weighing between 30 and 60 g. The species is found throughout Australia, except western South Australia and southern Western Australia. It is adapted to high-flying, high-speed foraging above canopy height, usually in mallee or open country. It roosts in tree hollows and has been found occasionally in abandoned nests of sugar gliders (Van Dyke and Strahan 2008). Little is known about its ecology, including feeding behaviour.

It is one of two audible bat species, meaning that their echolocation calls are within the human hearing (below 20 kHz) and can be picked up by an experienced bat specialist (Figure 4).

In this study the species was found in open areas, in the Cubberla, Witton Creek and Brisbane River catchments. In Moore Park (site#12) it was recorded soon after sunset, indicating a tree roost close by. Moore Park contains several old eucalypt trees suitable to contain colonies of yellow-bellied sheath-tailed bats (Rhodes & Hall 1997). The yellow-bellied sheath-tailed bat is rarely recorded or heard during urban bat surveys in Brisbane. It is classified as a significant fauna species in Brisbane (BCC 2014).

White-striped free-tailed bat (*Austronomus australis*, formerly known as *Tadarida australis*)



Photographer: Michael Pennay©

The white-striped free-tailed bat is a medium to large bat species, weighing between 26 and 48 g. It has long narrow wings which enables it to fly in open spaces (Rhodes 1999). It is specialised to fly high above ground and can reach up to 80 km/h (Rhodes 2006). The white-striped free-tailed bat is found in a range of habitats, including open woodlands, forests, farmlands, semiarid areas, tropical savannahs and urban areas. It is found throughout Australia except the northern regions of Western Australia, Northern Territory

and Queensland (Van Dyke and Strahan 2008).

In Brisbane, the species was found to be an obligate hollow user. It forms big colonies centred on a large communal roosts with up to several hundred individuals roosting in one hollow eucalypt tree, with small groups from that colony using a network of smaller roosts that were distributed over 200 km² in Brisbane (Rhodes 2006).

The white-striped free-tailed bat produces characteristic search calls which can be heard frequently during summer. Together with the yellow-bellied sheath-tailed bat, it is also one of two audible bat species, meaning that their echolocation calls are within the human hearing (below 20 kHz) and can be picked up by an experienced bat specialist (Figure 4).

In this study the species was found in all CWCN catchments. A colony of white-striped free-tail bats was also found during the walking transect at the St. Lucia Golf Links with individuals observed leaving, entering and circling an eucalypt tree. This old eucalypt tree is known to be used by this species for over 20 years (MP & M Rhodes, unpublished data). The species is classified as a significant fauna species in Brisbane (BCC 2014).

Eastern free-tailed bat or Ride's free-tailed bat (*Mormopterus ridei*; formerly known as *Mormopterus* sp. 2)



Photographer: Bruce Thomson©

The eastern free-tailed bat is a small bat species, weighing between 8 and 13 g. The species occurs mainly from Cape York along the east coast to southern Victoria and eastern South Australia. Its habitat includes swamps, river, creeks and the river red gum forests of the more arid waterways. The eastern free-tailed bat forages for bugs, beetles, flies and moths in open areas, through the forest canopies or open paddocks and around isolated paddock trees. A study in Victoria found it to feed on the agricultural pest, the Rutherglen bug.

This species roosts in tree hollows but is often found in roofs of buildings and houses where it shares the space with the Gould's wattled bat and the eastern broad-nosed bat. Several hundred individuals can roost together, although smaller

numbers are more common (Van Dyke and Strahan 2008).

In this survey, the eastern free-tailed bat was also recorded in the Cubberla Creek, Toowong Creek and the Brisbane River corridor catchments. The species was also found occupying a house in Fig Tree Pocket (M. Rhodes, unpublished data).

Beccari's free-tailed-bat (*Mormopterus beccarii*)



Photographer: Bruce Thomson©

The Beccari's free-tailed bat is a small to medium-sized bat species, weighing between 10 and 18 g. This tropical species occurs mainly in northern Australia. Its habitat ranges from rainforest, riverine and floodplain margins paperbark and pandanus, and eucalypt forests to arid and semiarid regions. Beccari's free-tailed bat roost in tree hollows and occasionally in buildings. It can scurry on surfaces and is found to feed on flightless insects, beetles and moths (Van Dyke and Strahan 2008).

In this survey the Beccari's free-tailed bat species was recorded only once in a property bordering Cubberla Creek (site#2). This property also recorded another seven microbat species.

Little bent-winged bat (*Miniopterus australis*)



Photographer: Bruce Thomson©

The little bent-winged bat is a small bat species, weighing between 5 and 10 g. The species is distributed along the east coast from Cape York down to southern New South Wales. It is a cave-dwelling bat and forms large aggregations with an estimated 200,000 individuals counted from a nursery site at Bat Cleft at Mt Etna, central coastal Queensland. Some females migrate distances of 200 km or more between hibernation and maternity roosts. They also roost in tunnels, culverts, tunnels, mines and stormwater drains. Little is known of its diet, but individuals have been recorded eating moths, wasps and ants (Van Dyke and Strahan 2008). The abandoned gold mine shafts in Brisbane Forest Park make excellent roost sites for this species.

The little bent-winged bat was one of the most abundant bat species recorded in this survey and found in all catchments, including the Brisbane River corridors (Table 1, Table 2). Interestingly, at site#1, overlooking Cubberla Creek, the little bent-winged bat was recorded throughout the night, with the first bats emerging at 6.25 p.m. (30 minutes after sunset) and the last bat recorded at 5 a.m. (sunrise was at 5.25 a.m.). This indicates that a roost must be very close by. This species is classified as a significant fauna species in Brisbane (BCC 2014).

**Eastern bent-winged bat (*Miniopterus orinae oceanensis*,
formerly known as *Miniopterus schreibersii*)**



Photographer: Bruce Thomson©

The eastern bent-winged bat is a small to medium bat species, weighing between 10 and 17 g. The species is distributed along the east coast from Cape York down to southern Victoria. It is a common cave-dwelling species and forms large maternity colonies with up to 100,000 individuals. The 12 maternity roost sites that are known, are located in limestone and sandstone caves, abandoned gold mines, concrete bunkers and lava tubes. It is known to migrate several hundred kilometres between winter and summer roosts (Van Dyke and Strahan 2008).

The eastern bent-winged bat forages in open areas and above the tree canopy, waterways and tracks in a fast and direct flight. It feeds on moths and has been seen to forage around streetlights (Van Dyke and Strahan 2008).

In this study, the species was also recorded in all CWCN catchments. This species is classified as a significant fauna species in Brisbane (BCC 2014).

Gould's wattled bat (*Chalinolobus gouldii*)



Photographer: Lindy Lumsden©



Photographer: Bruce Thomson©

The Gould's wattled bat is a small to medium bat species, weighing between 8 and 18 g. The species is widespread throughout Australia, including Tasmania, except Cape York. It is a generalist and found in a wide range of habitats, such as open forests, woodlands, mallee, tall shrubland, dense forest, farmland and is common in urban areas. It feeds on moths, beetles, bugs, flies, crickets, ants and larvae. The species roosts in tree hollows, birds' nests, buildings and bat boxes (Van Dyke and Strahan 2008). In Brisbane it was found to be the most common bat box user during a study carried out between 2000 and 2003 (Rhodes 2006).

It is one of the first bats to emerge from its roosts and hence, can fall prey to pied butcherbirds and currawongs. In country Victoria it was found to forage up to 11 km from their roosts. While it will commute over open areas, it is most often found foraging in and around remnant vegetation, including single paddock trees (Van Dyke and Strahan 2008).

The Gould's wattled bat was one of the most abundant bat species in this survey where it was found foraging especially along the canopy of the riparian vegetation. Its early emergence made it possible to observe it foraging while being recorded on bat detectors. The echolocation calls, made audible on the bat detectors, make a characteristic flip flop noise which can be identified while listening to it. This made it easy for the volunteers to separate the Gould's wattled bat calls from others and created much excitement.

Chocolate wattled bat (*Chalinolobus morio*)



Colony of chocolate wattled bats
Photographer: Bruce Thomson©

The chocolate wattled bat is a small bat species, weighing between 8 and 11 g. The species is distributed along the east coast, in Tasmania, in south-west Western Australia and sporadically in central Australia. It is common in rainforests, sclerophyll forests, semiarid mallee shrubland, and even in the treeless Nullarbor Plains. The species roosts in tree hollows, but can also form large colonies of several hundred individuals in buildings and caves (Van Dyke and Strahan 2008).

In this survey this species was recorded only once in a property bordering the Mt Coot-tha reserve (site#11; Witton Creek catchment).



Photographer: Bruce Thomson©

Hoary wattled bat (*Chalinolobus nigrogriseus*)



Photographer: Michael Pennay©

The hoary wattled bat is a small bat species, weighing between 7.5 and 10 g. The species is distributed predominantly in northern Australia, restricted to tropical, subtropical and semiarid zones. Although common, very little is known about its ecology. It prefers more open habitats, such as tall forest, open woodlands, grasslands, mangroves and beach scrubs. The species roosts

in tree hollows. Its diet includes beetles, moths, flying ants, bugs, leafhoppers, weevils, cockroaches, lacewings and spiders (Van Dyke and Strahan 2008).

The hoary wattled bat was only recorded once, namely on site#16 (Kent Street property overlooking the Toowong Creek). However, it was also recorded in the Witton and Sandy Creek catchments during Clare Hourigan's study (2011).

Large-footed myotis (*Myotis macropus*, formerly known as *Myotis moluccarum*)



Photographer: Bruce Thomson©

The large-footed myotis is a small bat species, weighing between 7 and 12 g. The species is distributed along the northern coast of Western Australia, Northern Territory and Queensland, as well along the east coast from Cape York to Victoria. Some inland populations are found in Victoria, New South Wales and South Australia.

The species roosts in caves, mines, tunnels, tree hollows, under bridges, and in buildings and were found even in dense foliage in tropical parts. Breeding colonies consist of one male with a harem of several females. The large-footed myotis forages over waterbodies (creeks, lakes, ponds) where it rakes its large hind feet through the water surface to catch fish and insects (Van Dyke and Strahan

2008). Hence, the bat is also sometimes called the 'fishing bat'.

Despite over 9000 call sequences over 852 hours of recordings in total, and despite targeting creeks and ponds, this species was recorded only once during a walking transect along Cubberla Creek in Cliveden Park (Fig Tree Pocket; site#5). Similarly, Clare Hourigan (2011) recorded this species only in the Indooroopilly Golf Club within the CWCN catchments. In other catchments, Clare consistently found the large-footed myotis in parklands but not residential areas and bushland. She concluded that this would be probably due to the presence of free standing waterbodies of which this species forages to catch its prey. Clare's data and the data from this study clearly indicate the particular foraging habitat requirements of this species: parklands with permanent waterbodies. The large-footed myotis is classified as a significant fauna species in Brisbane (BCC 2014).

Species complex *Nyctophilus* ssp.

As outlined above, echolocation records cannot distinguish between two long-eared bat species, the eastern long-eared bat and the Gould's long-eared bat. Hence, this report can only refer to these as the 'species complex *Nyctophilus* ssp'.

Bats of the genus group *Nyctophilus* are specialised to hunt in dense vegetation. Their long ears are used for passive listening for prey while their quiet echolocation call design enables them to pick up insects against dense vegetation. Their echolocation calls are much quieter compared to other species as loud calls would produce too many echoes from unwanted targets (clutter; such as vegetation). Hence, long-eared bats are also known as 'whispering bats'.

Based on their morphology and echolocation design, we expected the long-eared bats to forage in and amongst remnant bushland, along riparian vegetation and forest edges, and occasionally open areas. This was confirmed in the survey, where it was found foraging within and along the riparian vegetation of the Cubberla Creek (sites#1 and 5), the Toowong Creek (site#16), the unnamed creek in Fig Tree Pocket (Brisbane River corridor; site#19) and the vegetation bordering the pond in Biami Yumba Park (site#20).

Eastern long-eared bat (*Nyctophilus bifax*)



The eastern long-eared bat is a small bat species, weighing between 7 and 13 g. The species is distributed across northern Australia and along the east coast of Queensland from Cape York down to northern New South Wales, ranging from dry sclerophyll woodland to tall open forest, riverine forests to gallery forest and rainforest. It roosts in foliage and tree hollows, beneath peeling bark, among epiphytes and between strangler figs and host trees. The eastern long-eared bat feeds on moths, ants and click-beetles and tends to forage along the edge of tree canopy rather than among the foliage (Van Dyke and Strahan 2008). In Brisbane it was found to occupy bat boxes (Rhodes 2006).

Photographer: Bruce Thomson©

Gould's long-eared bat (*Nyctophilus gouldi*)



Photographer: Bruce Thomson©

The Gould's long-eared bat is a small bat species weighing between 9 and 13 g. Its distribution ranges from Cairns to Victoria. The species is also found in south-west Western Australia. It occupies eucalypt forests and woodlands, extending west to dry woodlands, often in association with river red gums forests of major rivers. It roosts in tree hollows, roofs and under peeling bark. Maternity roosts in forest are found in hollow-bearing trees and contain up to 20 females (Van Dyke and Strahan 2008). In Brisbane it was found to occupy bat boxes (Rhodes 2006).

The Gould's long-eared bat is specialised to forage in dense vegetation due to its broad wings. However, this species is also able to commute over open areas. It catches flying insects, but is

also able to glean insects. It employs the 'sit and wait strategy'; listening out for prey on the forest litter before it drops down to capture the prey between its wings (Van Dyke and Strahan 2008).

The Gould's long-eared bat is classified as a significant fauna species in Brisbane (BCC 2014).

Eastern broad-nosed bat (*Scotorepens orion*)



Photographer: Michael Pennay©

The eastern broad-nosed bat is a small to medium bat species, weighing between 9 and 15 g. The species is distributed along the east coast from Brisbane to Melbourne and usually occurs in low numbers along the Great Dividing Range. It is found in tall, wet forest and rainforest, but can also be found in open forest on the western slopes of the Dividing Range in New South Wales and in the Cairns region. The eastern broad-nosed bat roosts in tree hollows, but very little is

known about its ecology (Van Dyke and Strahan 2008).

The species was only recorded occasionally in the Cubberla Creek catchment (sites# 2, 5, 6) and the Toowong Creek catchment (site#16). All of these survey sites consisted of well vegetated creeks with tall trees.

Species complex *Scotorepens* ssp.

Echolocation records cannot distinguish between the following two broad-nosed bat species, the little broad-nosed bat (*Scotorepens greyii*) and the central-eastern broad-nosed bat (*Scotorepens* sp.). Hence, this report can only describe these as the 'species complex *Scotorepens* ssp'.

In the survey, this species complex was one of the most abundant species, found in all catchments. It is usually one of the first bats to emerge from its roost. Hence, observations against the backlight are possible while recording this species (M. Rhodes, unpublished data). Along the Cubberla Creek near the CWCN Centre in Chapel Hill it was the first bat recorded at 6.17 pm, even before the little bent-winged bat was recorded.

Both species are described in more detail below.

Little broad-nosed bat (*Scotorepens greyii*)



Photographer: Michael Pennay©



Photographer: Bruce Thomson©

The little broad-nosed bat is a small bat species, weighing between 8 and 12 g. The species is distributed over most parts of Queensland, except the most northern part, inland of New South Wales, most of Northern Territory, northern parts of Western Australia and inland of South Australia. However, its distribution is difficult to pin point as it is hard to distinguish it from the

Northern broad-nosed bat and the eastern broad-nosed bat. The species' habitat includes dry grassland, woodland, sandy deserts, inland rivers, monsoon forests and paperbark swamps. It roosts in tree hollows but is also found in buildings, telegraph poles and hollow centres of old fence posts. It feeds on moths, sometimes on moths of its size (Van Dyke and Strahan 2008).

Central-eastern broad-nosed bat (*Scotorepens* sp.)



Photographer: Julie Broken-Brow©

The central-eastern broad-nosed bat is a small bat species, weighing between 6.5 and 12 g. The species is distributed only in a very small area in SEQ and northern New South Wales. However, its taxonomic relationships remain unclear and almost nothing is known of its ecology. Its habitats include dry sclerophyll forests, brigalow-belah forests and woodlands (Van Dyke and Strahan 2008).

Golden-tipped bat (*Kerivoula papuensis*, formerly known as *Phoniscus papuensis*)



Photographer: Bruce Thomson©

The golden-tipped bat is named after the golden tips of its fur. It is a small bat species, weighing between 5 and 9 g. The species is distributed along the east coast of Australia in moist, closed forests that receive high summer rainfall. The best sites are where wet and dry forests meet, often in the vicinity of creeks (Van Dyke and Strahan 2008).

In New South Wales it was found to live in the lower 50-150m elevations; however, in the greater Brisbane region it is known to occur mainly in the higher elevations of the Brisbane Forest Park.

The golden-tipped bat is specialised in feeding on web-building spiders and only takes small quantities of insects. Its short, steep, quiet, high-

frequency echolocation calls enable it to detect the spiders in their webs or on other surfaces (Van Dyke and Strahan 2008). Its broad, lightly loaded wings, afford the species unique flight characteristics to allow flight in dense vegetation (Rhodes 1999). The species occupies a wide range of roosts, from foliage to roofs. In north-east New South Wales over 95% of the roosts occurred in suspended nests of the yellow-throated scrubwren (*Sericornis citreogularis*) and the brown gerygone (*Gerygone mouki*). Maternity roosts of ten individuals were found in eucalypt trees (summarised in Van Dyke and Strahan 2008).

During the recent bat survey a single call sequence was recorded on 9 January 2015 on site#19, an unnamed creek in Fig Tree Pocket (Figure 6). This creek is part of the Brisbane River corridor and forms part of an important fauna corridor to the Brisbane Forest Park. Although the creek is heavily modified since European settlement, it contains good riparian vegetation (including wet sclerophyll, remnant rainforest and many introduced species) suitable for the golden-tipped bat (Plate 4).

The call sequence was sent to an independent bat expert specialised in bat call analysis for independent verification. The call sequence was sent together with generic information on the general area (SEQ) and habitat, but without naming the exact location. The bat expert identified the call sequence also most likely to belong to the golden-tipped bat.

Golden-tipped bats produce characteristic echolocation calls: they consist of very short and steep frequency-modulated (FM) calls with a frequency between 95 and 70 kHz. This species is a notorious hard species to record on bat detectors and in a recent study of bat fauna in Cape York, out of over 76,000 call sequences recorded, only a handful were of the golden-tipped bat; although the bat was caught in traps (Luke Hogan, personal communications).

The record (call sequence; Figure 6) is the first record of the golden-tipped bat in urban Brisbane. However, as this bat has not been captured in Brisbane before, the survey results should be taken as a likely occurrence of this species. Further trapping surveys would need to be conducted to verify the presence of this species in Brisbane. This species is classified as a significant fauna species in Brisbane (BCC 2014).

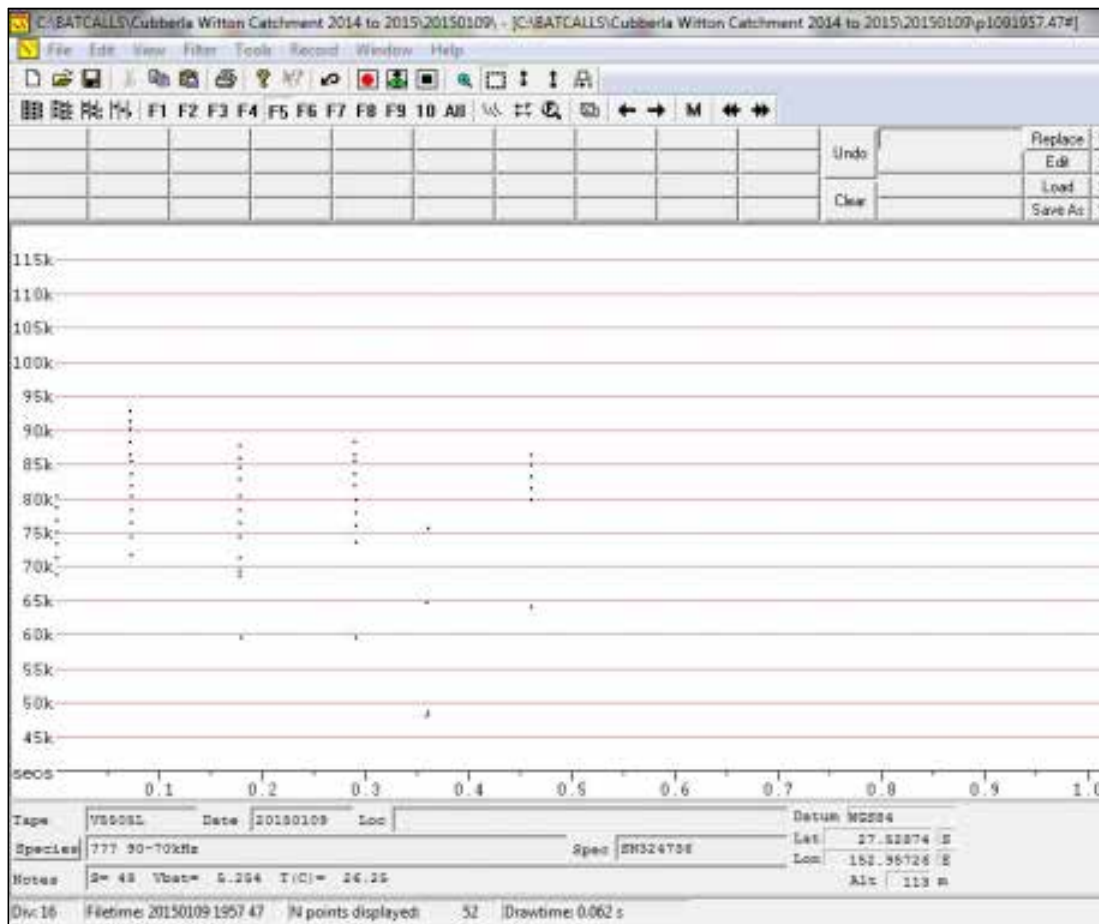


Figure 6 Call sequence recorded at 9 January 2015 in an unnamed creek in Fig Tree Pocket which is part of the Brisbane River corridor.



Photographer: Monika Rhodes ©

Plate 4 Photo taken from site#19, an unnamed creek where the likely call sequence of the golden-tipped bat was recorded. The creek was mainly dry at the time of the recording, with remnant pools of water.

6. Discussion

Microbat species richness of the Cubberla, Witton, Toowong, Sandy catchments and adjacent Brisbane River corridors

With more than 80 species, bats comprise a third of all Australian mammals. Of these, SEQ alone has 34 bat species, 29 microbat and five megabat species (Van Dyck and Strahan 2008; Van Dyck *et al.* 2013). Fifteen microbat species were recorded in the CWCN catchments during the recent survey. Seven of these 15 species are listed as significant fauna species in Brisbane (BCC 2014). The results represent a conservative number as some species cannot be distinguished on their bat calls alone, such as the long-eared bat and broad-nosed bat species complex. The likelihood that these two species complex represent up to four species is very high.

Looking at the suitable habitat present in the CWCN catchments the microbat diversity could be even higher. Results from microbat studies in adjoining catchments found several more species. Hourigan (2011) recorded an additional species in nearby Pullenvale: the eastern forest bat (*Vespadelus pumilus*). Bat boxes erected in the St. Lucia Golf Links contained a colony of Gould's wattled bats, while bat boxes in nearby Kenmore Hills (Moggill Creek Catchment) contained eastern long-eared bats and Gould's long-eared bats (both recorded in this survey as the long-eared bat species complex); as well as species not recorded in this survey, like the greater broad-nosed bats (*Scoteanax rueppellii*) and an unidentified forest bat (*Vespadelus* sp.) (Rhodes 2006).

These results suggest that there is a high possibility that the additional microbat species recorded in the adjacent catchments also occur in the CWCN catchments but have not been recorded yet; especially in the forested areas, like the Mt. Coot-tha Reserve.

The CWCN catchments also provide roost and foraging habitat for the megabats. Three of the five SEQ megabats are recorded to roost along the Brisbane River in the Indooroopilly Golf Course: the black flying-fox (*Pteropus alecto*), the grey headed flying-fox (*Pteropus poliocephalus*) and the little red flying-fox (*Pteropus scapulatus*). Although not specifically surveyed in this study, the black flying fox and the grey-headed flying fox were frequently encountered during the walking transects, feeding in flowering trees along the creeks. Both flying-fox species are listed as significant fauna species in Brisbane (BCC 2014) and the grey-headed flying fox is also listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

The outcomes of this survey show that the use of non-invasive survey methods, such as bat detectors, can provide important information on the species diversity of bats which are otherwise difficult to capture in urban environment (Hourigan 2011). However, bat detectors can have disadvantages. Some species cannot be identified down to species level, such as the long-eared bat and broad-nosed bat species complexes. Furthermore, when species are recorded in areas not previously captured, like the golden-tipped bat, the validation of the presence of a species must be confirmed through capture. This is a regular occurrence in bat fauna surveys where a new species is recorded first on bat detectors and then later confirmed through capture (e.g. Feuser 1995).

The results of this survey clearly showed that high bat biodiversity was linked to well vegetated creeks and proximity to the Mt. Coot-tha Reserve and hence the Brisbane Forest Park. This diversity declined with increasing house density and the lack of well vegetated creeks (Figure 5). This highlights the important work carried out by SEQ catchment groups, such as the CWCN, to protect, enhance and manage Brisbane's environment in order to keep and sustain (and hopefully attract back) a wide range of flora and fauna species (Brisbane's Catchments Network 2012).

The likely presence of the golden-tipped bat at site#19 highlights the importance of riparian vegetation as wildlife corridors connecting the Brisbane Forest Park with the Brisbane River. Site#19, located in Fig Tree Pocket, had eight bat species, despite its distance to a larger forest remnant. This unnamed creek is well vegetated with a range of different trees, shrubs and undergrowth. Furthermore, the creek and its riparian vegetation are well looked after by nearby residents. In comparison, site #20, a lagoon at the Biami Yumba Park in Fig Tree Pocket and not far from site#19, contained only four bat species. The lagoon is surrounded by trees, but has no wildlife corridor connecting to other creeks or the Brisbane Forest Park (Figure 6).

Hence, the restoration work the CWCN and its members play in these catchments are invaluable to preserve the biodiversity of the greater Brisbane region. Furthermore, the high bat biodiversity found in this catchment can be contributed to the great variety of habitats remaining in the inner western suburbs as the ecology of each species differs. Some species require dense forests to forage and caves to roost (e.g. the horseshoe bat), while others can forage easily over open spaces but require old mature eucalypt trees to roost (e.g. the white-striped free-tail bat and the yellow-bellied sheath-tailed bat). Others species, like the Gould's wattled bat, are more flexible and are able to use the modified urban environment for foraging and roosting (e.g. in buildings or trees). However, for any of these species to persist in an urban environment, the full range of different foraging and roosting habitats will need to be preserved, otherwise these species will slowly disappear.

Hollow-bearing trees provide important roost habitats for most microbats. Many of the mature trees along the riparian corridors provide this habitat but are in danger of being removed due to public safety and ongoing clearing for development (Rhodes 2006). Hence, while restoration of the waterways is important by planting new vegetation (trees, shrubs, ground cover), the protection of the old, often several hundred year old trees, must also be considered. The usage of one particular mature river red gum by white-striped free-tailed bats for over 20 years at the St. Lucia Golf Links, highlights the importance of protecting single standing trees. This particular tree was estimated to be around 450 years old (A. Borsboom, pers. communications). Planning for the retention and protection of habitat trees must incorporate landscape features, landscape context, and management issues such as ongoing urbanisation and health and safety concerns (Rhodes 2003). These factors then have to be combined with the roosting and foraging ecology of hollow-dependent species to maximise the chances of survival of these species in urban environments (Rhodes 2006).

Ecosystem services of bats

Ecosystems services refer to goods or services the natural environment supplies, or any benefits the community obtains from natural environments (Brisbane Community Biodiversity Strategy 2012). Unbeknownst to many, bats provide important ecosystem services to Brisbane's residents by reducing the numbers of mosquitoes and insects (microbats) and pollinating and dispersing seeds of native trees (megabats). Hence, by providing important habitat, keeping wildlife corridors connected and providing food, the catchments provide habitats for our native animals, which in return provide important ecosystem services to the residents.

Community awareness

The objectives of this survey were not only to identify the bat species richness of the CWCN catchments, but also to raise the awareness and understanding to valuing and conserving an important part of Australia's biodiversity at the community level. This is in line with the values outlined in the Brisbane Community Biodiversity Strategy 2012.

Two workshops were held as part of this survey effort. The first one was held on 27 September 2014 prior to the start of field surveys in order to introduce bats, their ecology and field survey techniques to members of the CWCN. A second public workshop was held as part of the Australasian Bat Society's Australasian Bat Night 2015 event, a '*public awareness programme aimed to show people the fascinating world of bats and to promote their conservation*' (ABS 2015). The bat night was held on 9 May 2015 and included

activities for children, displays, a bat workshop presenting the results of this survey and a bat walk (Appendix 1; Plate 2).

Evening bat walks (walking transects) were found to be excellent medium to educate volunteers and interested persons, including children. As the bat detectors made bat call sequences audible to the human hearing, the volunteers were able to listen passively to the bats – an experience most people not previously had. Bat observations were also possible where bats flew close to street lamps or were seen against the backlight at dusk.

Workshops, bat night and walking transects proved to be good events to educate people on the bat biology and the significant roles they play in the ecosystems, including the urban areas environment.

Conclusion

The suburbs in Brisbane's inner west are home to a high diversity of bats (mega- and microbats). Fifteen microbat and three megabat species were confirmed, and another five microbat species are possible to occur, resulting in an overall bat diversity of well over 20 species of the known 34 bat species in SEQ. This is an astonishing result for a metropolitan city.

However, this biodiversity is only possible if suitable foraging and roosting habitats will be preserved and enhanced. The pressure through ongoing development has resulted in the loss of remnant bushlands, parks and wildlife corridors in Brisbane (Rhodes 2003; 2006) and with predictions of increased population pressure, this trend may continue. After all, people chose to live in the 'leafy western suburbs'; a saying that is becoming soon a statement of the past. Therefore, city planners and residents alike may want to reconsider the ongoing urbanisation of these remnant green spaces as they not only provide important habitat for our native animals and plants, but also provide important recreational and health values (ecosystem services) for residents alike (e.g. Swanwick *et al.* 2003). Furthermore, studies have linked house prices with green spaces, because attractive environments are more likely to increase house prices (e.g. Luttik 2000). Hence, the protection of green spaces and their biodiversity in urban Brisbane will also provide long-term socioeconomic benefits.

Acknowledgements

We would like to thank all volunteers and landholders who came along to the evening bat walks (walking transects) and/or provided field sites for this survey. Without their help this survey would have not been possible. In particular we would like to thank Lois Eden, Henry & Lilly Camacho, Joan & Rodger Wilkinson, Julia Blumhardt, Lyn & Phil Cole, Janet Spillman, Laurie Hodgman, Des & Carolyn Hoban, and Kristal & Mark Szttybel.

Special thanks go to Niki & Vernon Hill and the *Foam Bark Gully Gang*, Melanie Venz, Ian Gynther, Luke Hogan and Greg Ford for additional help in regards to identifying and locating the golden-tipped bat. Although we were unsuccessful in locating this bat other than through the echolocation sequence, one day we will eventually confirm this elusive bat species.

We are grateful for Clare Hourigan to share her PhD data; and for the generosity of Bruce Thomson, Michael Pennay, Lindy Lumsden and Julie Broken-Brow to provide photographs of bats for this report.

The biggest thanks; however, must go to Jutta Godwin, at the time of the survey the President of the CWCN. Without her support, her hard work, connections to landholders, local knowledge and enthusiasm, this survey would have not been as successful.



Photographer: Monika Rhodes©

Plate 5 The keelback snake (*Tropidonophis mairii*)

This freshwater snake was encountered in the Rainbow Forest Park, lower Cubberla Creek, during the walking transect in October 2014.

The keelback snake is a non-venomous, inoffensive species that feeds mainly on frogs, fish, reptile eggs and mammals, and is one of the few Australian vertebrates to successfully prey on the introduced cane toad. It is usually found at ground level, but can climb well (Source: Queensland Museum, <http://www.qm.qld.gov.au/>).

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Appendix 1



Bat Festival

Sat, 9th May 2015

4.00pm – 7.30pm

CWCN Centre, 47 Hepworth St, Chapel Hill
(Brisbane UBD 178 A11)

- ★ **Face Painting**
- ★ **Prize for Best Bat Costume**
- ★ **Craft Activities**
- ★ **Bat Games for Kids**



- ★ **Nightly Neighbours:**

Presentation of Inner West Survey Results

- ★ **Bat Rescue Inc**

Display - Orphaned live bats - **Stella** a costume bat.

- ★ **Displays**

Bat skeleton, microbat specimens from the museum, harp trap used by researchers, more.

- ★ **Microbat Discovery Walk**

with Julie, Monika and Martin & bat detectors.

- ★ **Win the Bundy Rum, Green Beans and Mosquitoes Quiz**

- ★ **Sausage Sizzle, Cake & More**



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