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SOUNDS OF THE SUNSET COAST

# Integrating trapping and acoustics for monitoring southwest Australian bats

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**ABSTRACT**

Acoustic monitoring and trapping remain key methods for surveying echolocating bats, each with distinct strengths and limitations. Trapping provides direct evidence of species presence, sex, and age class but is labour-intensive and often biased toward certain species. Acoustic surveys are less invasive and offer broader spatial coverage but are constrained by call overlap, species-specific behaviours, incomplete call libraries and variation in detectability. This study compared trapping and acoustic monitoring data collected over 23 nights at 12 sites across southwest Western Australia. We tested the use of Autobat acoustic lures broadcasting synthesised bat calls to attract individuals to harp traps. Lures increased overall capture rate by 4.5 times across all eight species caught, including *Nyctophilus spp*. and *Falsistrellus mackenziei,* which were under-represented in concurrent acoustic recordings. Trapping also enabled the collection of high-quality echolocation reference calls, addressing key gaps in regional call libraries. At each trapping site we piloted passive acoustic monitoring to expand coverage and document bat activity of those avoiding traps. Preliminary results highlight the value of combining trapping with acoustic monitoring to improve species detection and enhance survey design. This integrated approach supports more effective planning for bat conservation.

## 1. INTRODUCTION

Selecting appropriate survey methods is critical for obtaining reliable data on wildlife, particularly for cryptic and nocturnal species such as bats. In Australia, bat researchers commonly use either trapping or acoustic monitoring to survey bat communities with acoustic surveys increasingly favoured due to their non-invasive nature and broader spatial coverage. Each method has distinct advantages and limitations, and their effectiveness can depend on factors including target species, habitat type, and the specific research or conservation objective. Therefore, aligning survey methods with study goals is essential to ensure data quality, reduce bias, and support effective conservation outcomes (Walters et al. 2013; Russo et al. 2017; Runkel et al. 2021; Zamora-Gutierrez et al. 2021).

Capturing bats provides important biological data, such as species confirmation, sex, age class, and condition, that acoustic methods cannot yield. However, some species are underrepresented in traps due to flight behaviour or the ability to detect and avoid trap structures (Walters et al. 2013). Conversely, passive acoustic detectors record echolocation calls over extended periods with minimal disturbance, often detecting a wider array of species. Yet, acoustic surveys can miss species that emit quiet calls or whose call parameters overlap with others, complicating species-level identification (Law et al. 2002; Russo et al. 2017; Zamora-Gutierrez et al. 2021).

Relying on a single method risks incomplete or biased assessments of bat diversity and activity. Without evaluating the relative performance of trapping and acoustic monitoring across species and habitats, species of concern may be overlooked, or habitat use misinterpreted (Russo et al. 2017). To investigate the potential complementarity of these methods, we conducted a preliminary comparison of harp trapping (with Autobat acoustic lures) and passive acoustic monitoring at multiple sites in southwest Western Australia. Acoustic data were used to detect species potentially present but not captured, rather than to generate a comprehensive call dataset. We aimed to assess how the methods complement each other and offer practical guidance for improving bat survey design in Australian ecosystems.

## 2. METHODS

### 2.1 Study location

We carried out bat trapping surveys and concurrent acoustic monitoring at locations across the southwest of Western Australia (Fig 1). Each site was situated on private property and supported either native Eucalyptus woodlands or wetland-associated vegetation, such as Paperbark. This area experiences a Mediterranean-type climate, with annual rainfall averaging around 600-1,200 mm.

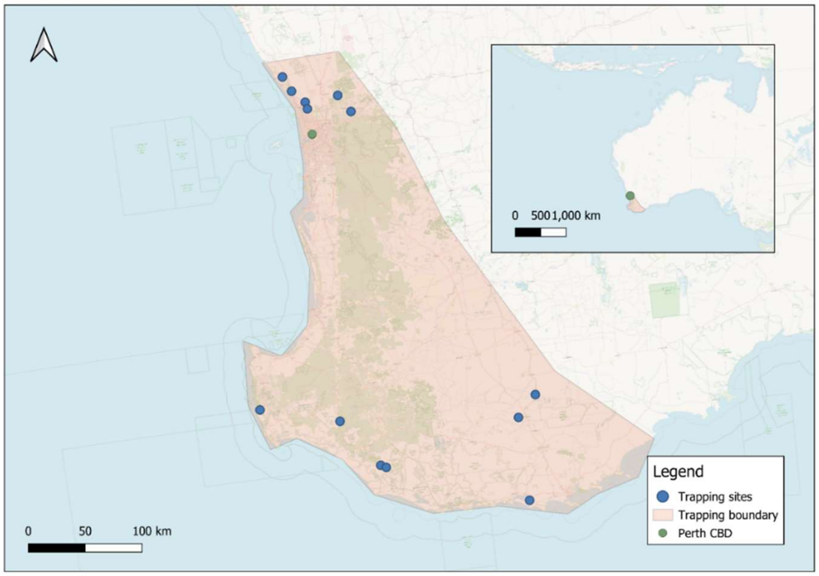


Figure 1. Location of the bat trapping and acoustic sites included in this study.

### 2.2 Survey design

We conducted bat surveys at each site using a combination of harp trapping and acoustic monitoring from November 2024 to January 2025. Five Ausbat harp traps were deployed per site, with two fitted with Autobat acoustic lures. Traps were placed in locations considered optimal for capturing the full range of the nine bat species known to occur in the region (Table 1). Surveys commenced at sunset and ran for 4–8 hours, aligning with peak bat activity, and were conducted only on nights with minimal wind, no rainfall, and overnight temperatures above 10 °C to optimise bat activity. Traps were checked every 30 minutes. Captured bats were placed in clean calico bags, with trap number and capture time recorded. Each bat was identified to species, sexed, aged, marked with a non-toxic chalk pen, and measured (forearm length, weight) before being released at the capture site. All procedures were approved under Animal Ethics Permit No. WAEC 23-10-60.

Acoustic activity was monitored using a Song Meter SM4BAT FS with an SMM-U2 microphone (Wildlife Acoustics, Maynard, USA), placed approximately 1 m above ground on a bamboo cane, angled away from reflective surfaces. Detectors were positioned in similar habitat and within 100 m of the nearest trap in locations likely to detect all nine local bat species if present. Each detector recorded continuously for the duration of the trapping session. As this was a pilot comparison acoustic monitoring was not intended to provide a comprehensive dataset but to detect species potentially present but not captured, complementing the trapping data.

Table 1. Bat species present in the study area and their endemism to Western Australia

| Common Name | Scientific Name | Endemic to Western Australia |
|---|---|---|
| Gould's wattled bat | *Chalinolobus gouldii* | No |
| Chocolate wattled bat | *Chalinolobus morio* | No |
| Lesser long-eared bat | *Nyctophilus geoffroyi* | No |
| Holt's long-eared bat | *Nyctophilus holtorum* | **Yes** |

| Common Name | Scientific Name | Endemic to Western Australia |
|---|---|---|
| Western long-eared bat | *Nyctophilus major major* | **Yes** |
| Southern forest bat | *Vespadelus regulus* | No |
| Western falsistrelle | *Falsistrellus mackenziei* | **Yes** |
| South-western free-tailed bat | *Ozimops kitcheneri* | **Yes** |
| White-striped free-tailed bat | *Austronomus australis* | No |

### 2.3 Acoustic analysis

Kaleidoscope v. 5.4.1 was used to extract bat echolocation sequences. Calls were then analysed to species where possible, with the exception of Long-eared bats (*Nyctophilus* spp.), which were recorded together as one group due to overlapping call parameters. Call sequences with less than 3 pulses were disregarded from the analysis. Species identification was based on regional reference calls collected during bat trapping (Sheldrick, unpublished data, 2025) and published literature (Reinhold et al. 2001; Milne 2002; Pennay et al. 2004; Russo et al. 2017).

## 3. RESULTS

In combined trapping and acoustic data, all nine species were detected at three or more of the 12 sites. Trapping with Autobat lures was especially effective for Long-eared bats and the Western falsistrelle, while acoustic monitoring better detected the two high-flying free-tailed bats and Gould’s wattled bat (Fig. 2). Although not detailed here, Autobat lures increased capture rates by ~4.5 times (Sheldrick & Hill, in preparation). One or more species of long-eared bats was caught at 11 of the 12 sites, while their calls were recorded at only eight sites.

Capture rates of long-eared bats differed between the southern and the Perth regions (Fig. 3). Both sexes of lesser long-eared bat were caught in both regions, but the capture rate was higher in the north. The Western long-eared bat was caught only in the southern region and Holt’s long-eared bat was caught at a higher rate in the south than on the north. In Perth, all female long-eared bats were caught at one site, and males at three others.

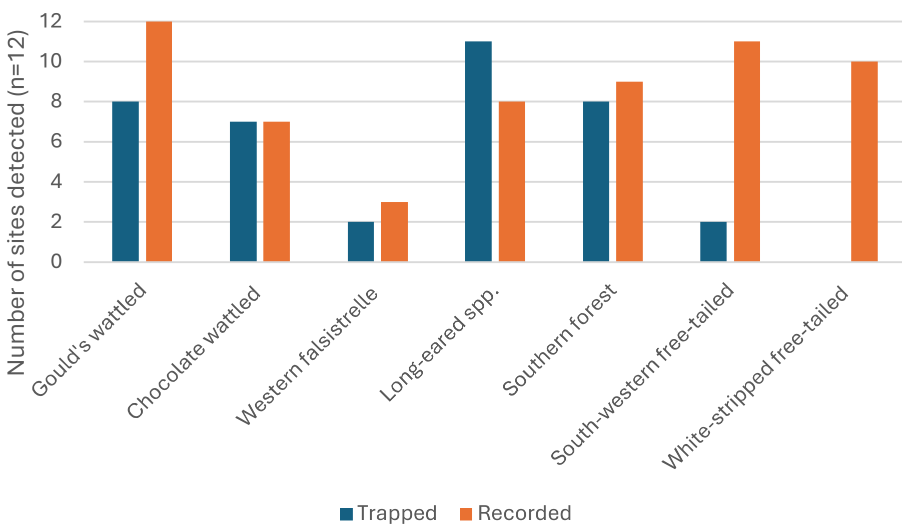


Figure 2. Number of sites (n=12) where a species was detected acoustically vs captured during trapping. Note Long-eared species (*Nyctophilus* spp) have been grouped due to overlapping parameters.

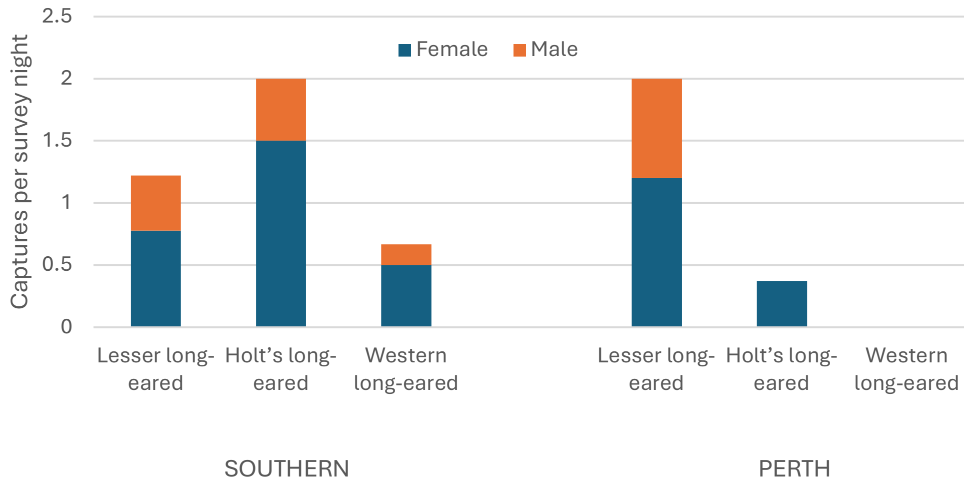


Figure. 3 Capture rates for each species of Long-eared bats (*Nyctophilus* spp) at southern sites and Perth area.

## 4. DISCUSSION

This pilot study demonstrates the value of combining trapping and acoustic monitoring for surveying bat communities. Comparison of species detected through trapping and acoustic monitoring revealed differences in detection sensitivity between methods. Acoustic monitoring was more effective at detecting high-flying species with loud distinctive calls that can evade traps, such as the freetailed bats. Conversely, trapping proved essential for species with quieter or overlapping echolocation calls, particularly long-eared bats whose echolocation pulses are quiet, and call parameters overlap making identification challenging (Pennay et al. 2004; Reinhold et al. 2001).

Additionally, the study shows that trapping can provide critical information, such as confirmation of the species of long-eared bat and sex of bats present. This information is unattainable through acoustic surveys alone but is essential for assessing the conservation value of a site. For example, western long-eared was caught exclusively in the southern region, suggesting that the distribution of this endemic may be more confined to the south. Similarly, the Holt's long-eared was captured more frequently in the south, and at only one of five sites in the Perth region. Also, while both sexes of lesser long-eared were caught in both regions, all females caught in the Perth region were at one site, while males were caught at three other sites. Several studies have found evidence of sexual segregation in bat populations with females being associated with higher quality habitats than males (e.g. Senior et al., 2005). This is thought to reflect the higher energetic demands females face during pregnancy and lactation. These differences highlight the importance of distinguishing long-eared species, as species composition and sex ratios can vary spatially and have significant conservation implications (e.g. Senior et al., 2005).

Although constrained by limited sampling sites and a single detector, this pilot highlights key practical considerations for survey design. The findings emphasise integrating multiple methods to overcome the inherent limitations of any single approach. This reinforces the need for preliminary evaluations of survey methods, which can inform more systematic assessments of methodological effectiveness and potential biases in future studies.

## 5. CONCLUSION

Ultimately, selecting appropriate survey methods for bats depends on species ecology, research objectives, and logistical constraints. Combining trapping with acoustic monitoring offers a balanced approach that maximises species detection and data quality. This integrative strategy is essential for advancing bat acoustic research and supporting evidence-based conservation management.

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