Lodge Environmental
ABN: 85 631 988 148
www.lodgeenviro.com.au

Patrick Tegart
Environment Officer Biodiversity Projects and Community Education
Wingecarribee Shire Council
E: Patrick.Tegart@wsc.nsw.gov.au
P: 02 4868 0888

1 May 2024

Project: LE1864

Subject: Gibbergunyah Reserve Bat Survey Summary Report – 2024

Dear Patrick,

Lodge Environmental were engaged by Wingecarribee Shire Council to conduct a microbat survey across Gibbergunyah Reserve. Survey point placement has been informed by pre-determined fire management units, with survey results intended to inform ongoing management, including cultural burns.

To date, there has been no formal survey of bats within Gibbergunyah Reserve. The conservation significance of this reserve is underpinned by its size and proximity to urban areas. This report summarises outcomes of a brief literature review, survey methodology and results, with recommendations for ongoing monitoring and management included.

Should the reader have any further questions regarding the content of this report, please do not hesitate to contact the author for further information or assistance.

Yours sincerely,

Max de Beer

| Senior Ecologist
| Lodge Environmental
| Level 2, Suite 1, The Central | Innovation Campus, Squires Way North Wollongong 2500
| **Mobile**: 0478 560 999
| **Email**: maxdebeer@lodgeenviro.com.au

Introduction

Gibbergunyah Reserve (the Study Area) spans over 185ha, representing a significant stand of native vegetation in the Wingecarribee Shire Council LGA. Five Plant Community Types (PCT) are present in Gibbergunyah, per the State Vegetation Type Map (DPE 2022) (**Figure 1**). Gibbergunyah Reserve hosts a mix of wet sclerophyll and dry sclerophyll forest; a broad, wet gully bisects much of the reserve, with drier forest along ridge tops and hillsides. Prominent rocky outcrops and small cliffs are a common feature. Structural diversity within the reserve is high, with an abundance of large hollow-bearing trees, rock crevices and small caves evenly distributed. PCT allocation within the reserve is understood to be accurate, with ongoing vegetation plots being conducted by DCCEEW.

The reserve is bordered by cleared land, both agricultural and residential, with limited connectivity to surrounding reserves. Threatened species previously recorded in Gibbergunyah include Powerful Owl, Greater Glider and Koala, with Yellow-bellied Glider considered likely to occur. Other than for large vertebrates, limited formal fauna survey has been conducted in Gibbergunyah. The NSW Wildlife Atlas has no previous records of microbats in the reserve, rendering bat diversity unknown. To bridge this fundamental knowledge gap, Lodge Environmental were engaged by Wingecarribee Shire Council to conduct the first formal bat survey in Gibbergunyah Reserve.

Cultural burning has recently returned to Gibbergunyah Reserve, improving the temporal and spatial diversity of fire application within the reserve. Across Australia, the application of fire has been significantly altered since European colonisation, with particularly drastic changes in the past 100 years (Fensham 2012). In southeastern Australia, low intensity mosaic burns have often been replaced by higher intensity hazard reduction burns, aimed at reducing fuel loads, to mitigate the risk of fire near human habitation (Cary & Banks 2009). The impact of different fire regimes on biodiversity is a vibrant area of research, with a growing body of literature highlighting the benefits that cultural burns have for improving biodiversity outcomes, while also reducing fire risk. Conservation faces increasing fire-related challenges as wildfires continue to become more frequent and intense. Appropriate and effective fire management can be a powerful tool in mitigating some of these challenges.

An improved understanding of faunal occupancy is a crucial element to assessing the efficacy of cultural burns, while further informing adaptive management actions as necessary. Results of this survey will directly inform ongoing cultural and/or ecological burns and other management activities, as well as provide valuable insights into the conservation significance of this large, remnant patch of native vegetation.

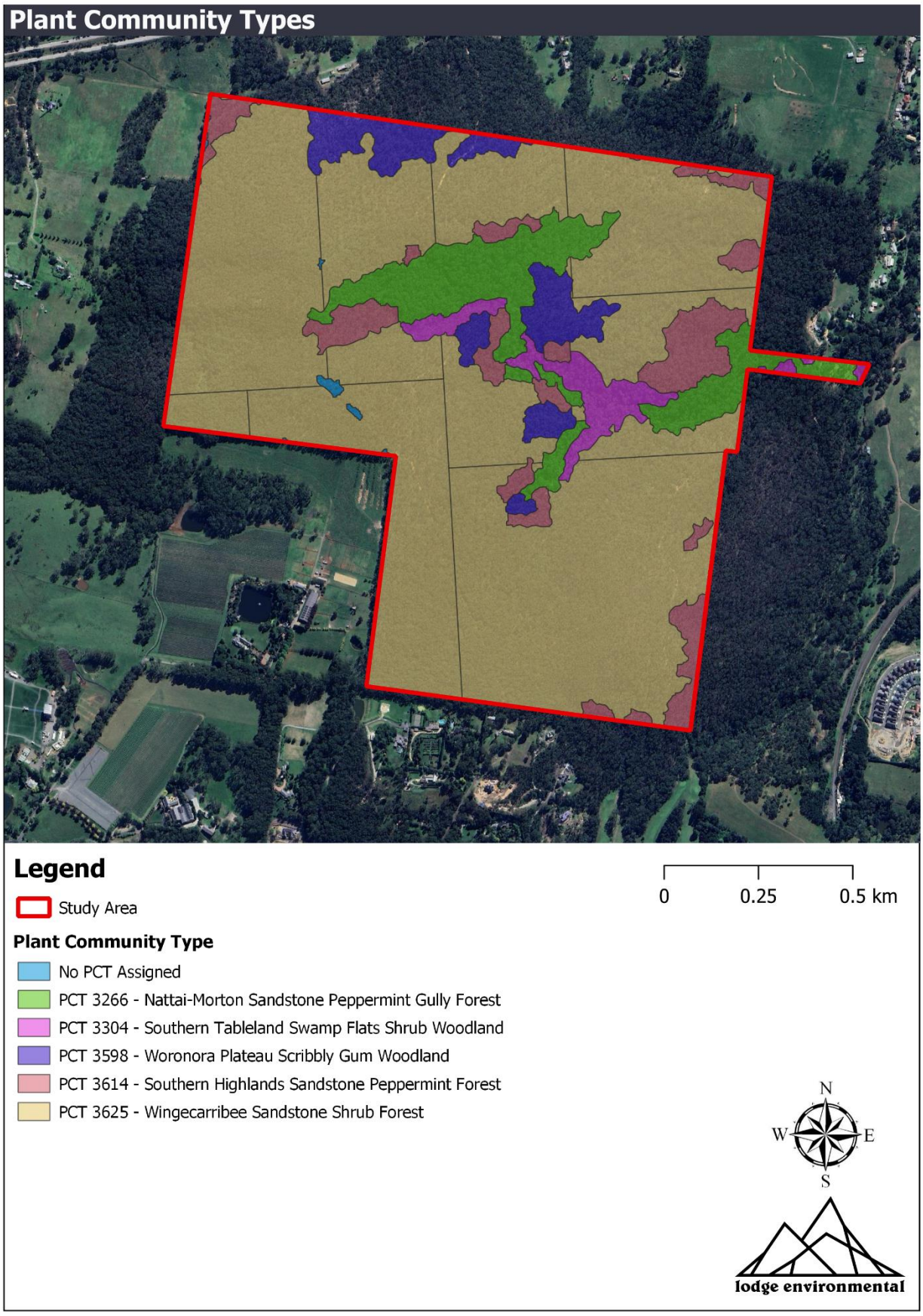

Figure 1: State Vegetation Type Map (DPE 2022)

Survey Methods

Survey Points

Ten survey points were established across Gibbergunyah Reserve (**Figure 5**). Survey points were selected based on their position within, or proximity to, a Fire Management Unit (FMU). Each FMU is subject to either hazard reduction burns (conducted by NSW RFS) or cultural/ecological burns (implemented by cultural/ecological burn practitioner). Two FMUs were subject to recent burns, with a survey point located in each (**Figure 5**).

Data Collection

Ten ultrasonic recorders were deployed across the Study Area on 28th February 2024. Recorders were attached to trees with a diameter that did not exceed that of the recorder, limiting any distortion that may be experienced if affixing to larger trees. Recorders were placed approximately 1.3m-1.5m above the ground, in areas that were relatively open and free from dense vegetation. Positioning along potential flight paths or near areas that may offer roosting sites was a consideration in recorder placement. Recorders were left in place for a 16-night survey period.

Figure 2: Song Meter deployed near rocky outcrop with potential roosting sites at Survey Point 1

Figure 3: Anabat Swift deployed in open habitat at Survey Point 3

Figure 4: AudioMoth deployed in wet gully vegetation at Survey Point 9

Three recorder types (Anabat Swift, Song Meter Mini Bat II and AudioMoth) were used for this survey. A validation survey was conducted prior to deployment, with one of each recorder type deployed for two nights. Data from these recorders was analysed, with results cross-referenced to ensure consistent detection of microbat species. The validation survey recorded nine bat species across all three detector models. Software validation was also performed across the two programs used.

The recorder type and coordinates of each survey point is summarised in **Table 1**.

Table 1: Survey point details

Survey Point ID	Coordinates	Recorder Type
1	-34.45042,150.40361	Song Meter Mini Bat II
2	-34.45417,150.40648	AudioMoth (v1.2.0)
3	-34.45695,150.40848	Anabat Swift
4	-34.45598,150.41283	Anabat Swift
5	-34.45546,150.41617	AudioMoth (v1.2.0)
6	-34.45320,150.40671	Song Meter Mini Bat II
7	-34.44941,150.41000	Anabat Swift
8	-34.45014,150.41296	AudioMoth (v1.2.0)
9	-34.45067,150.40985	AudioMoth (v1.2.0)
10	-34.44914,150.40648	AudioMoth (v1.2.0)

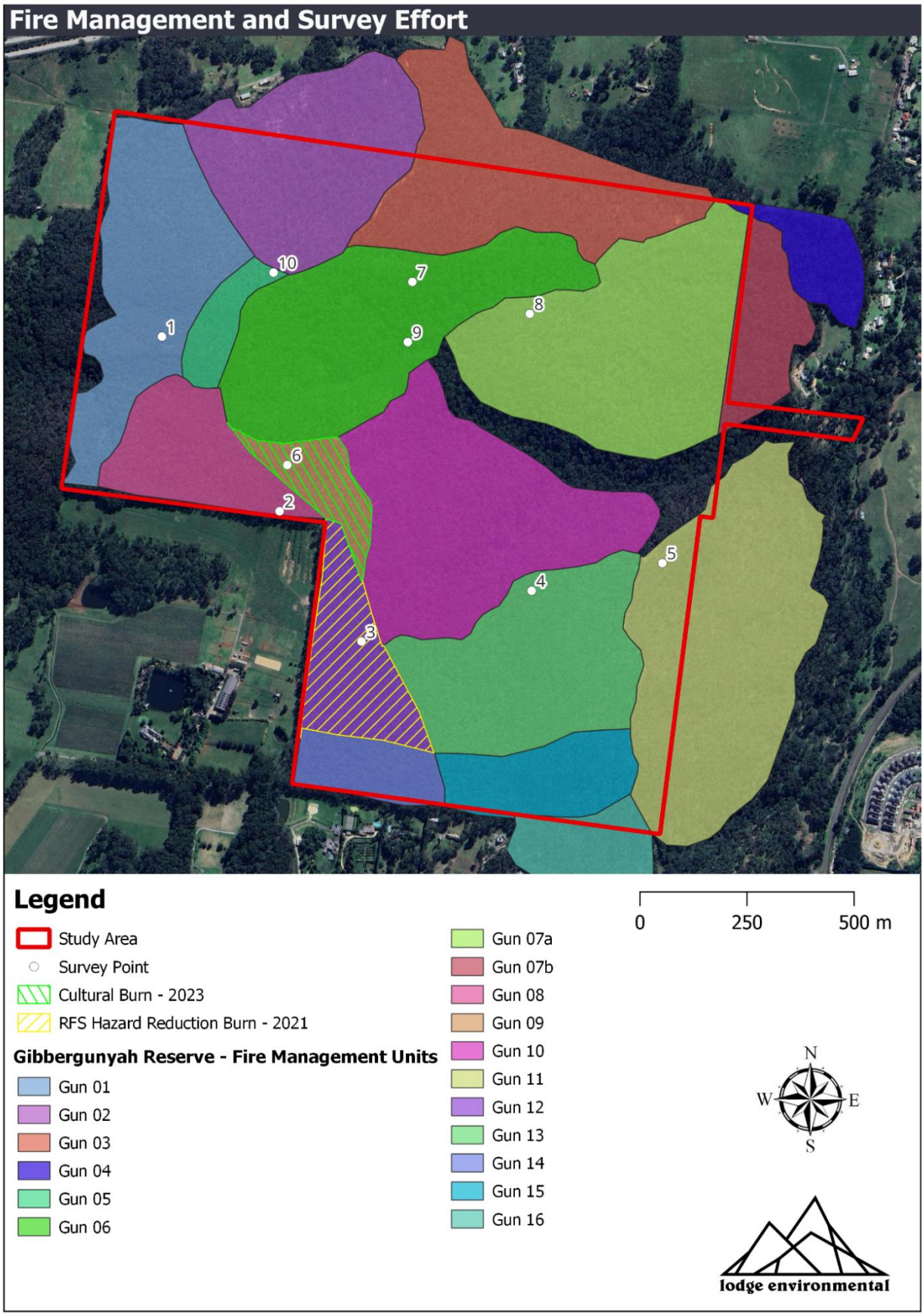

Figure 5: Fire Management Units and survey effort

Data Analysis

Audio data was curated into a standardised 2-hour survey window for each survey night. The 2-hour tranche commenced from 20-minutes after the official sunset time (BOM 2024). Due to budget constraints, alternate nights were analysed for each recorder, with analysis commencing from 28th February for odd-numbered survey points and 29th February for even-numbered survey points. This approach allowed for a representative amount of survey data to analysed.

Call identifications were made by Lodge Environmental ecologists Max de Beer and Olivia Gobran using the microbat echolocation call guides that have been developed for New South Wales (Pennay *et al*. 2004) and the south-east Queensland and north-east New South Wales (Reinhold *et al*. 2001). No microbats were captured during this survey and no site-specific reference microbat ultrasonic calls were collected. Consequently, the call identifications attained during this assessment followed the examples provided in the microbat echolocation call guides that have been developed for New South Wales (Pennay *et al* .2004) and the south-east Queensland and north-east New South Wales (Reinhold *et al* .2001).

The Study Area is located within the Sydney Basin, as defined in Pennay *et al*. (2004). Region-specific call characteristics were reviewed when identifying microbat species present (or potentially present) within the Study Area.

The confirmation of a species as being present within the Study Area (based upon the call profiles) was supported by a review of the known distribution of each species (Churchill (2008); Pennay *et al*. (2011); Van Dyck and Strahan (2008); Van Dyck *et al*. (2013) and the Australian Bat Society BatMap.

The ultrasonic microbat calls recorded during this survey were analysed in a full spectrum format using the software programs Kaleidoscope (Wildlife Acoustics) or Anabat Insight (Titley Scientific). While analysing the recorded microbat ultrasonic call data, the following protocols were applied:

- Low-quality and short calls (e.g. with less than three pulses) were removed from data manually or through the Decision Tree function available via Anabat Insight (**Figure 6**).
- For those calls that could be used to identify a species or genus making the call, two categories of confidence were used:
    - A microbat genus or species was identified as being 'present' when the quality and the structure of the call profile was of sufficient length (e.g., more than three pulses) and quality that the identity of the bat species can be made with some confidence.
    - Microbat genus or species was identified as being 'potentially present' if the quality and structure of the call profile cannot be resolved to species because the call is either of insufficient length (e.g., less than three pulses), is of poor quality, or overlaps or is similar to the recognized call profile of another non-threatened or threatened species.

Analysis output was compiled into raw data sheets and amended for this report. No statistical analyses were run as part of this survey, rather species lists per survey point were gathered. Any notes on activity or presence are anecdotal only.

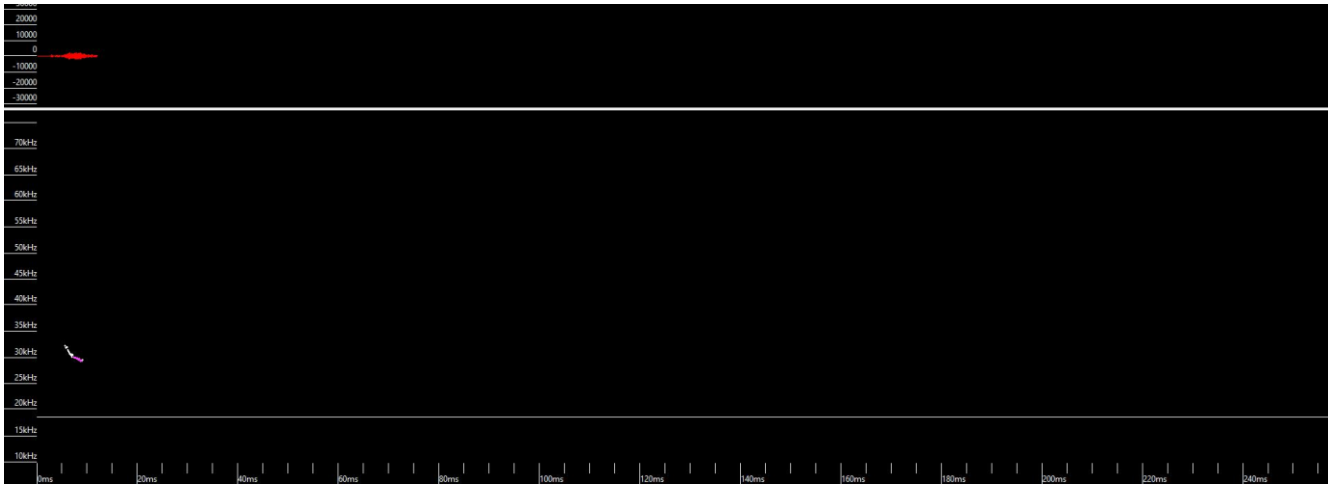

Figure 6: Example of a poor-quality call discarded from analysis

Results

Weather

Weather during the survey period was conducive to high bat activity, with relatively warm and dry conditions for the whole survey period. Bats were recorded on every survey night, with no weather-related constraints noted.

Table 2: Weather during survey period. Observations drawn from Moss Vale AWS (station 068239).

Date	Temperature Range	Rainfall
28th February	15.8 – 25.6°C	0.4mm
29th February	19.6 – 32.6°C	0mm
1st March	16.4 – 31.4°C	0.4mm
2nd March	17.8 – 20.3°C	0mm
3rd March	14.9 – 27.1°C	1mm
4th March	11.9 – 19.3°C	0mm
5th March	8.7 – 22.5°C	0mm
6th March	12.6 – 27.4°C	0mm
7th March	12.3 – 21.0°C	0mm
8th March	16.3 – 25.8°C	0mm
9th March	15.3 – 26.2°C	0mm
10th March	14.8 – 25.0°C	0.2mm
11th March	16.6 – 25.0°C	0mm
12th March	12.6 – 29.8°C	0mm
13th March	14.6 – 26.8°C	0mm
14th March	15.4 – 30.1°C	0mm
15th March	12.7 – 19.1°C	10.8mm

Bat Detections

Overall, bat activity was high across the entire Study Area. Recorders at Survey Points 1 and 6 stopped recording after seven nights due to extremely high detection rates draining batteries faster than anticipated. All other recorders operated for the full survey period.

At least 13 bat species were recorded (**Table 3**) with a high degree of confidence, including four threatened species:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) – Vulnerable (BC Act)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) – Vulnerable (BC Act)
- Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*) – Vulnerable (BC Act)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – Vulnerable (BC Act)

Large Bent-winged Bat and Yellow-bellied Sheath-tailed Bat are both summer visitors to the Southern Highlands, while Eastern False Pipistrelle and Greater Broad-nosed Bat may be resident within the reserve year-round.

In cases where a call could not be identified to species level, potential species have been lumped as a complex and noted as such. Calls attributed to Long-eared Bats have been identified to genus level (*Nyctophilus*) only, as differentiating between *Nyctophilus* species solely from call data is not accurate. Species tallies in **Table 3** include *Nyctophilus* as a 'species' count, despite being identified to genus level. Other records that cannot be identified to species level are noted as such, with such records omitted from the species count for each survey point. A subset of spectrograms generated during call analysis is provided in **Appendix A**.

Species richness was lowest at Survey Point 9, with six taxa recorded. Survey Point 9 is located in dense, wet gully forest, representing an anomalous vegetation type compared to the remaining survey points. At this survey point, Little Forest Bat was the most frequently recorded species.

Survey Point 3 (subject to a hazard reduction burn in 2021) had the lowest species count of all survey points in PCT 3625. By contrast, the next closest survey points (Survey Points 2 and 6) recorded eight and nine species respectively. Survey Point 6 was subject to a cultural burn in 2023.

Survey Point 10 recorded at least ten species. This was the only site where *Scotorepens orion* was recorded, a species for which there is little published on their foraging and roosting behaviour.

All species recorded are potentially susceptible to adverse impacts of high intensity fire, particularly if fire results in canopy scorching or loss of hollow-bearing trees.

Fire Management Unit Gun12 was subject to an RFS hazard reduction burn in 2021. Numerous stags (i.e. dead trees) in this FMU were noted as having fallen since the fire and unlikely to be utilised as roosting habitat. Some stags that were still standing have been hollowed out, with no protected cavities remaining. Loss of hollows from high intensity fire further depletes valuable roosting habitat. Vegetation in FMU Gun09 was subject to a cultural burn in 2023. Stags and live hollow-bearing trees retain good hollow structure, with no evidence fire-related hollow loss.

Table 3: Microbat detection per survey point. Bold denotes threatened species.

Survey Point	1	2	3	4	5	6	7	8	9	10
Taxa										
White-striped Free-tailed Bat *Austronomus australis*										
Gould's Wattled Bat *Chalinolobus gouldii*										
Chocolate Wattled Bat *Chalinolobus morio*										
Eastern False Pipistrelle *Falsistrellus tasmaniensis*										
Falsistrellus/Scotorepens/*Scoteanax* (indistinguishable calls)										
Large Bent-winged Bat *Miniopterus orianae oceanensis*										
Large Bent-winged Bat/Large Forest Bat (indistinguishable calls)										
Long-eared Bat sp. *Nyctophilus* sp.										
Ride's Free-tailed Bat *Ozimops ridei*										
Yellow-bellied Sheath-tailed Bat *Saccolaimus flaviventris*										
Eastern Broad-nosed Bat *Scotorepens orion*										
Greater Broad-nosed Bat *Scoteanax rueppellii*										
Large Forest Bat *Vespadelus darlingtoni*										
Southern Forest Bat *Vespadelus regulus*										
Little Forest Bat *Vespadelus vulturnus*										
Little Forest Bat/Large Bent-winged Bat (indistinguishable calls)										
Total: Distinct species	**8**	**8**	**6**	**8**	**7**	**9**	**6**	**8**	**5**	**10**

Recommendations

The following recommendations are provided with the aim of ensuring ongoing management of Gibbergunyah Reserve continues to benefit biodiversity, with bats acting as useful proxy taxa for fire-related impacts.

Monitoring

Ongoing surveys should follow similar survey methodology as outlined in this report, with established survey points to be re-used. A follow-up monitoring survey should occur within six months of any fire; either cultural burn or hazard reduction burn. The duration for a post-fire survey does not need to exceed one week, assuming weather conditions are conducive to bat detections. If suboptimal conditions occur, the survey window may be extended.

If no planned burns occur in a calendar year, monitoring should continue at a frequency of 2-3 years, with a subset of survey points deemed suitable if all survey points cannot be re-assessed.

Statistical analyses should be incorporated in future monitoring to assess the significance of fire treatment or burn frequency on bat occupancy and activity. Data collected during this survey will serve as a useful baseline for much of the Study Area.

Burn Planning

Timing of fire should be considered when planning cultural or hazard reduction burns. Some threatened species may only utilise Gibbergunyah on a seasonal basis, while other threatened species are likely resident. Similarly, buffer zones around potential roosting sites should be implemented. Rocky outcrops, such as is present near Survey Point 1, should have at least a 25m buffer implemented during any planned fire event.

Bats are generally susceptible to fire through loss of roosting habitat and changes to the availability or productivity of foraging habitat. Mosaic burning creates areas of varying productivity with regards to foraging, while retaining areas of unburned vegetation that can continue to provide safe roosting habitat; this is likely to benefit bats in the long-term, compared with high intensity burns that may deplete hollow availability across larger areas. Ensuring hollow-bearing trees are marked prior to a burn, with suitable buffer areas implemented, will limit habitat loss for hollow-dependent species.

While results in this report have not been subject to the rigours of statistical analysis, there are promising signs of the benefits of cultural burns over hazard reduction burns. In any instance where cultural style burning may be appropriate, it is recommended that this avenue be pursued. Gathering additional pre- and post-fire vegetation data is also recommended, in addition to data on fauna occupancy.

Conclusion

This study represents the first formal survey of microbats in Gibbergunyah Reserve and has yielded valuable insights into species diversity present in the reserve. At least 13 species of microbat were recorded, with four threatened species detected. Species richness was relatively consistent across the reserve, with the lowest species count coming from an anomalous survey point in dense, wet gully forest. No statistical analyses were completed, however, it is recommended that further analysis is conducted in future monitoring events.

Low intensity fire, typical of cultural burns, facilitates the retention of roosting habitat for bats. Hazard reduction burns have been demonstrated as leading to loss of roosting habitat in Gibbergunyah. Areas of high hollow density and stags should be carefully surveyed pre-fire, with measures put in place to avoid burning old growth trees.

Mosaic burns drive changes in habitat structure and prey availability for bats, with low intensity burns likely the most favourable for increasing prey abundance. Increased pyrodiversity (temporal and spatial diversity of fire) in Gibbergunyah through the application of cultural burns and hazard reduction burns will continue to support strong bat diversity, while limiting the risk of intense wildfire.

Results of this survey demonstrate the importance of Gibbergunyah Reserve for conservation in the Southern Highlands. Ongoing management will continue to enhance the ecological integrity of Gibbergunyah, with routine monitoring an essential component in quantifying the efficacy of management actions.

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Appendix A: Bat Call Spectrograms

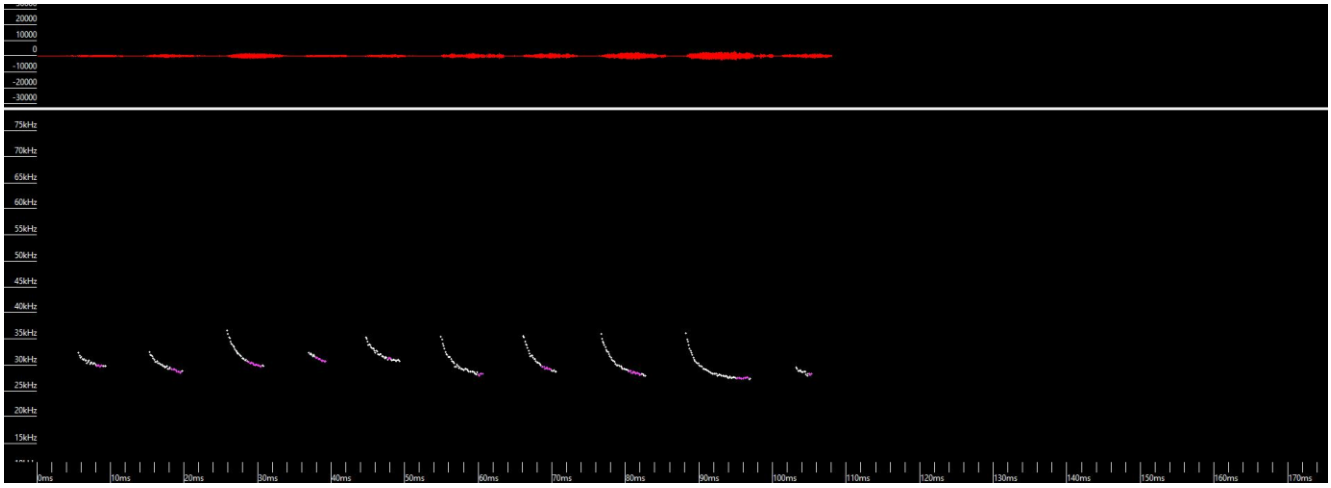

Figure 7: Gould's Wattled Bat (*Chalinolobus gouldii*)

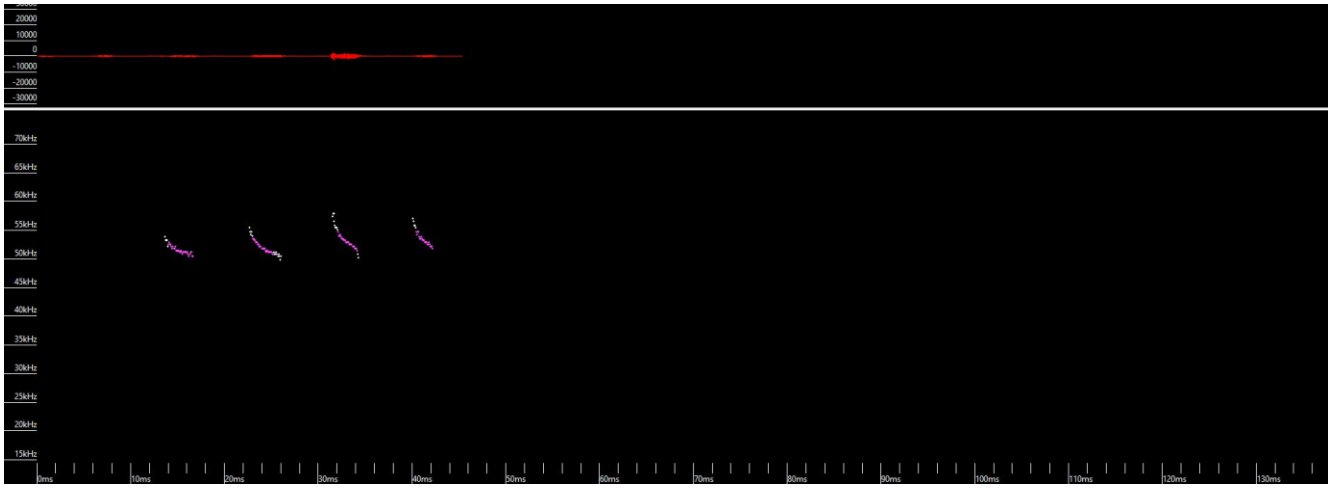

Figure 8: Chocolate Wattled Bat (*Chalinolobus morio*)

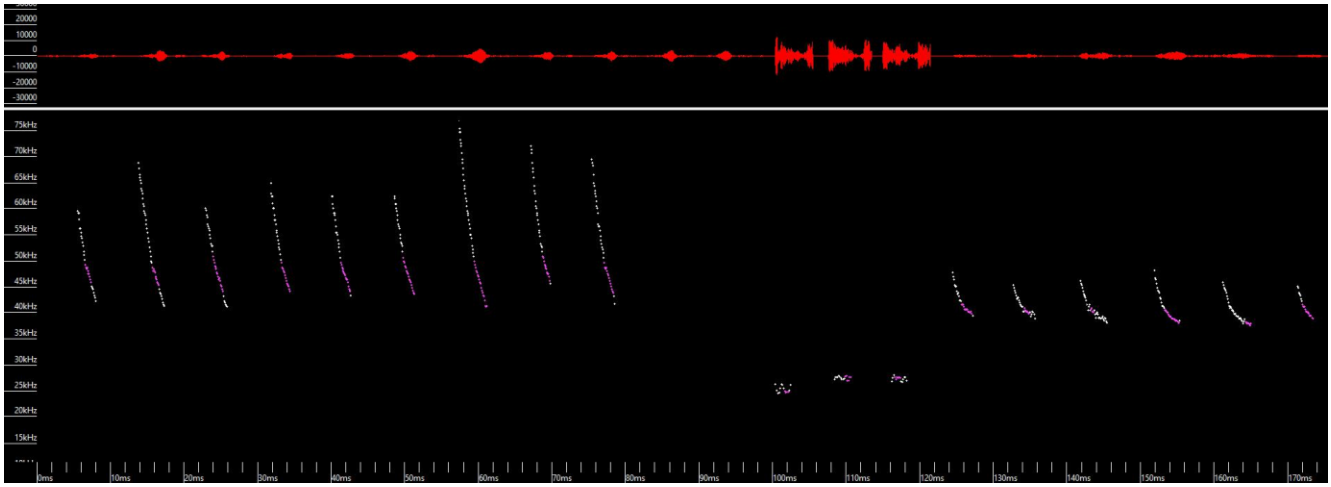

Figure 9: *Nyctophilus* sp. (left hand side) and *Vespadelus* sp. (right hand side)

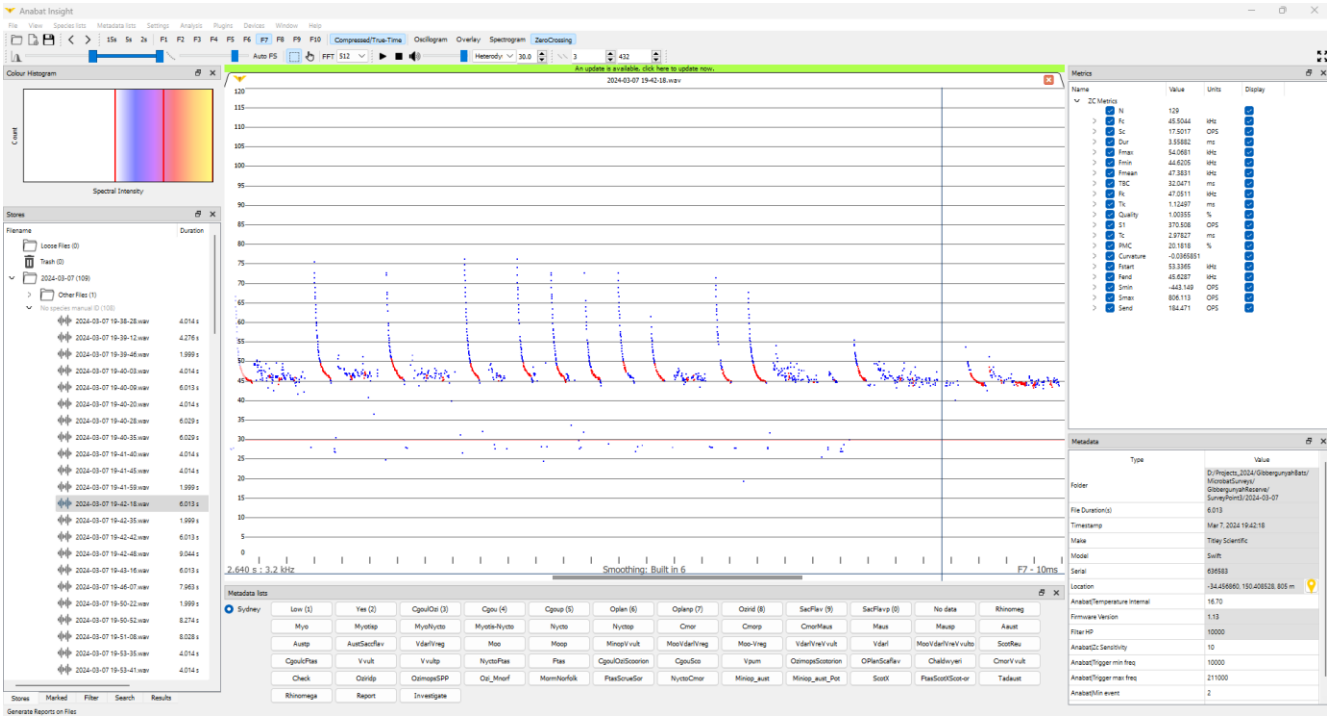

Figure 10: Large Bent-winged Bat (*Miniopterus orianae oceanensis*)

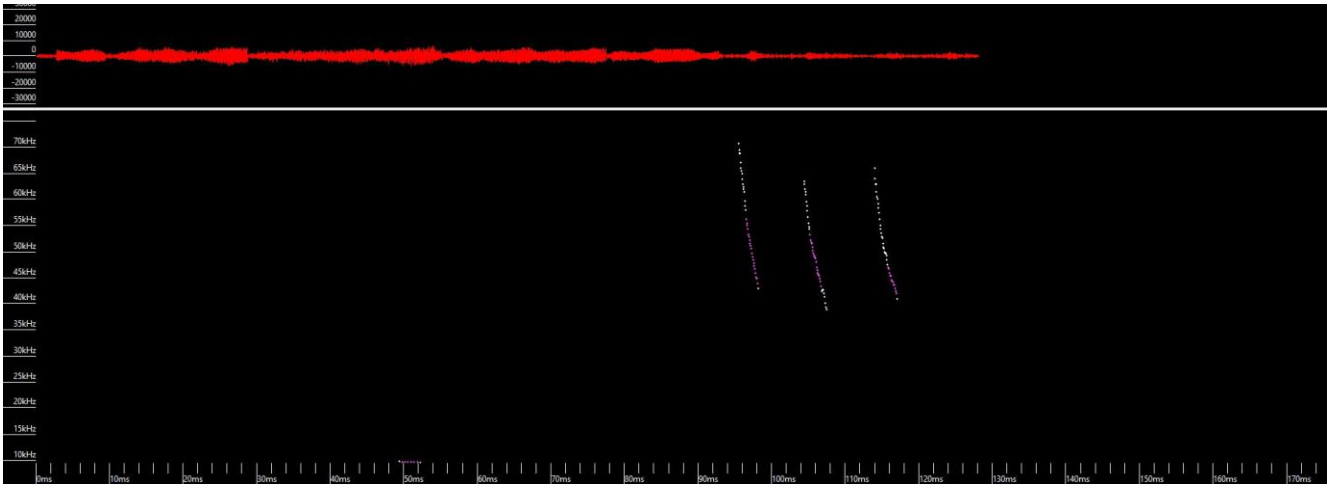

Figure 11: *Nyctophilus* sp.

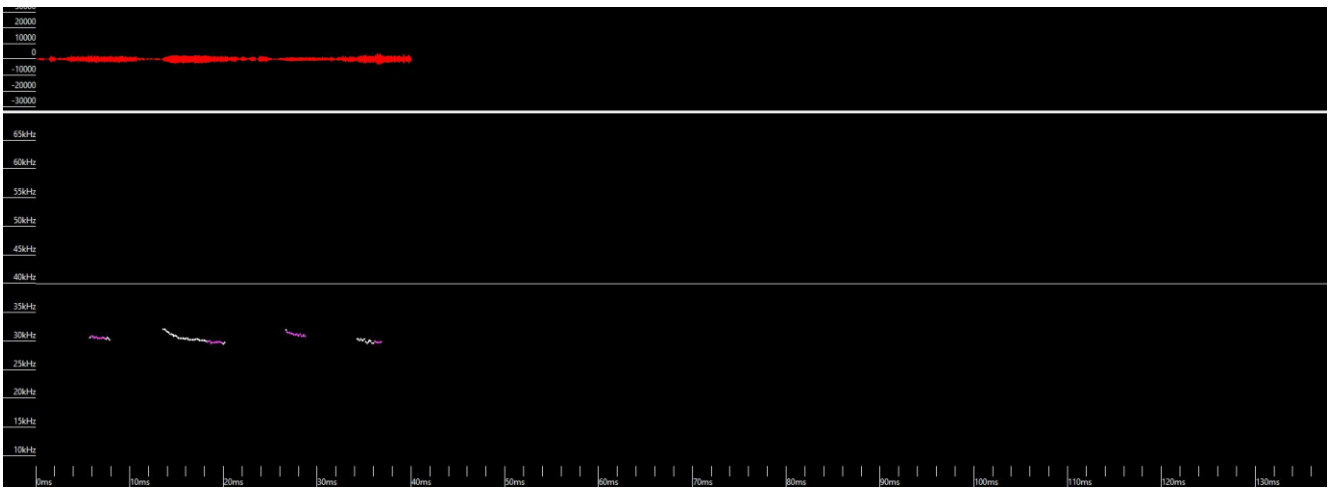

Figure 12: Ride's Free-tailed Bat (*Ozimops ridei*)

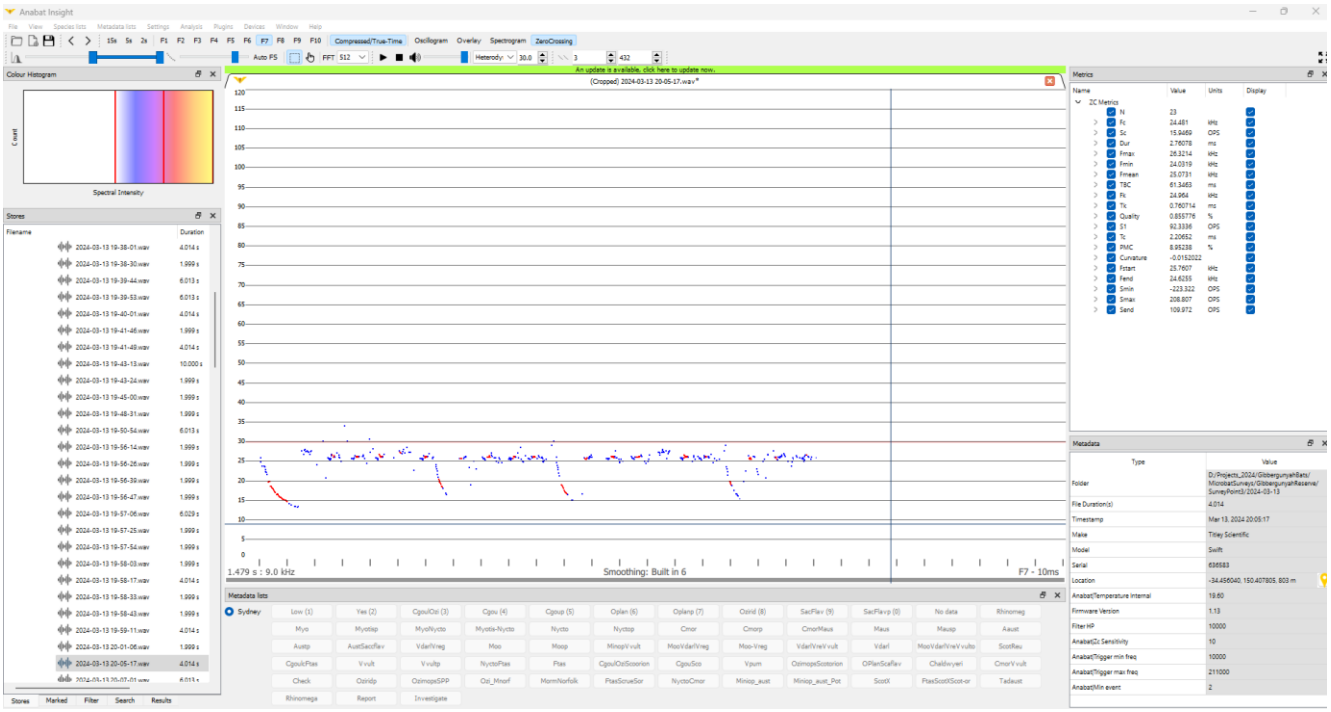

Figure 13: Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*)

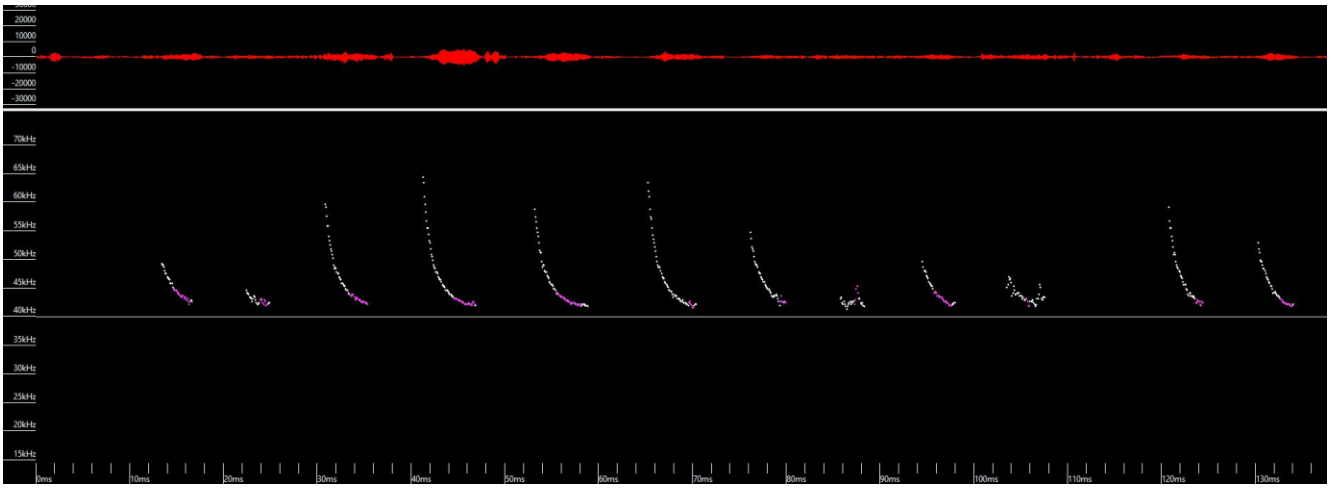

Figure 14: Large Forest Bat (*Vespadelus darlingtoni*)

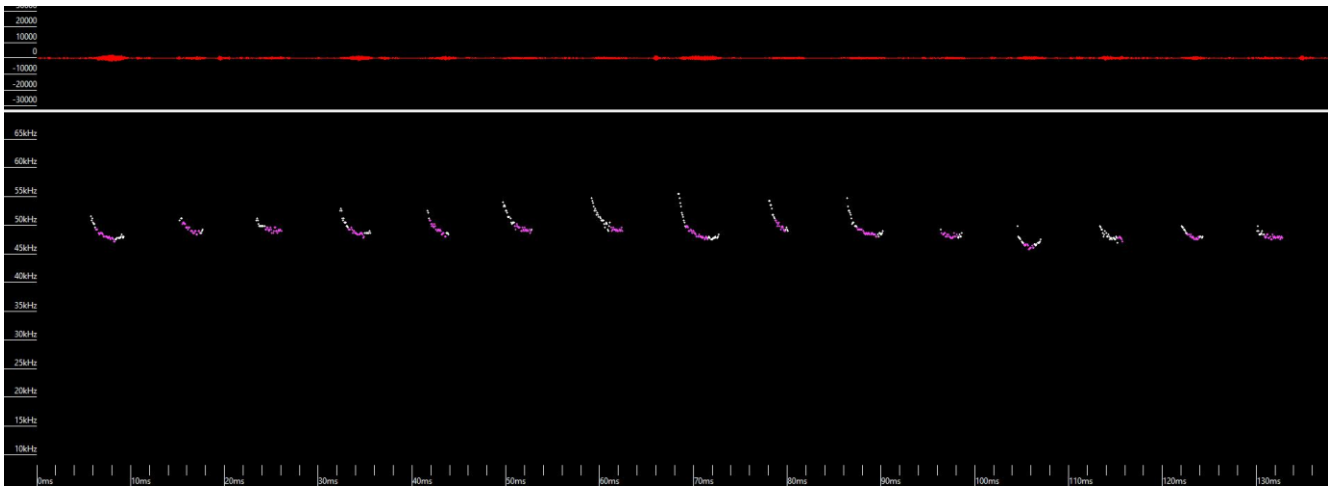

Figure 15: Little Forest Bat (*Vespadelus vulturnus*)