AFRICAN BAT CONSERVATION

REPORT FOR MULANJE FOREST RESERVE

April 27th – May 2nd 2025

CONTENTS

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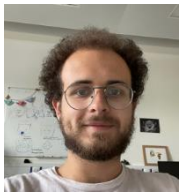

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1. Summary

1.1. African Bat Conservation visit Mulanje Mountain Forest Reserve for Felix Tuff's PhD

The African Bat Conservation (ABC) team visited the stunning Mulanje Mountain Forest Reserve from April 27th – May 2nd 2025 to complete bat surveys in and around the reserve.

The surveys during were conducted in support of Felix Tuff's PhD research, which is investigating the impacts of habitat disturbance on bat populations by combining ecological and genomic methods. Felix is based at the University of Bath in the UK and completing his research in partnership with ABC.

This research will identify how bat species diversity and activity are influenced by disturbance, species at particular risk from habitat loss, and landscape features contributing to population and genetic connectivity. Results from this study will be critical in informing landscape management decisions and can provide a basis for reforestation initiatives.

We employed passive acoustic monitoring (PAM) methods, using static bat detectors, to understand bat diversity and activity levels at sites that spanned a habitat disturbance gradient. This comprised four sites, in order of increasing disturbance these were: a forest patch within the reserve, at a transitional habitat between forest and tea plantation within the reserve, Chisitu, and Muloza. For the genetic component of the study, we caught bats at three locations within the reserve and collected tissue samples.

All detectors were successfully deployed and are awaiting sound analysis.

We caught a total of 20 bats comprising seven species. All bats were successfully processed and released without complication.

Following analysis, the results of this research will help distinguish habitat features of importance to bat diversity and population connectivity. This information can be used to guide land management decisions and inform reforestation initiatives.

2. Bats and Habitat Disturbance

2.1. Introduction

Bats play a crucial role in ecosystem function through pollination, seed dispersal, and insect regulation but are threatened by habitat loss, urbanisation, and agricultural development. Worldwide, habitat loss negatively affects bats by reducing roosting and foraging resources whilst disrupting population connectivity. Nevertheless, the effects of habitat loss on African bats, particularly in Malawi, are understudied. Despite this, Malawi is home to diverse bat species and is a key region for bat conservation in Africa. Furthermore, Malawi's human population has doubled in the past 25 years from 11 million to 22 million and as a result, Malawi has experienced widespread land conversion into agriculture and urban settlements. Consequently, we are seeking to understand how habitat loss is impacting Malawian bats at both ecological and genetic levels with the aim to inform land management practices.

Principally, our research aims to address three objectives:

1. *How is the bat community as a whole being affected by habitat disturbance?*

2. *Is habitat disturbance impacting genetic connectivity of Malawian bats and do particular ecological characteristics put certain species at greater risk?*

3. *Are certain subpopulations of Malawian bats at greater risk of local extinction due to climate change and is this exacerbated by habitat loss?*

2.2. Methods

2.2.1 Bat Community Monitoring

To monitor the changes in bat community assemblage, diversity, and activity levels, PAM methods were used. This method involves deploying static bat detectors equipped with ultrasonic microphones to record echolocation calls produced by bats throughout the night. This approach takes advantage of the fact that each species of bat typically produces a unique echolocation call which it uses to

navigate its surroundings and find prey, such as mosquitoes, to eat. By looking at call shape, frequency, and duration, it is possible to distinguish between species.

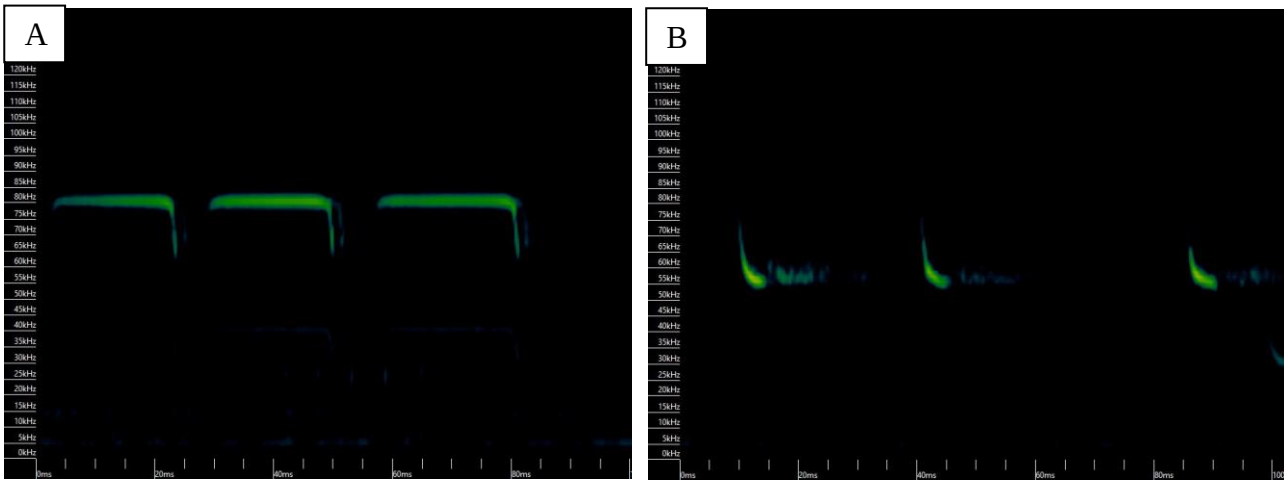

Figure 1. Sonograms of Geoffroy's horseshoe (Rhinolophus clivosus; A) and a long-eared bat (Laephotis sp.) recorded within Mulanje Mountain Forest Reserve, demonstrating the difference in call characteristics between species

Using this method, we installed Wildlife Acoustic Song Meter Mini 1 bat detectors at four sites across the habitat disturbance gradient. In order of increasing disturbance this included a forest patch within Mulanje mountain forest reserve, at a transitional habitat between forest and tea plantation within the reserve, Chisitu police station, and Muloza police station. The detectors were left in place for three to five nights at each site between April 28th and May 2nd 2025. Approximate site location was preselected by studying maps of the area and this was confirmed through the local knowledge of staff members at Mulanje Mountain Forest Reserve, the Mulanje Mountain Conservation Trust (MMCT), and the invaluable support of Raheela Ahmed.

Figure 1. Map of acoustic detector locations in and around Mulanje Mountain Forest Reserve. Photograph demonstrating detector installation at the Chisitu police station site. Similar deployments were conducted at the other sites.

At each site, a habitat survey was completed to investigate local scale variables that may be contributing to the occurrence of particular bat species. Additionally, by observing and quantifying the habitat condition, it was possible to assess the level of habitat disturbance. To undertake this, a 25 x 25m square was first marked out with rope, with the bat detector as the central point. Once established, the habitat survey was completed to record measurements on the following parameters:

- Habitat type
- Number of living trees
- Number of dead trees
- Dominant tree species
- Number of cavities in trees that bats could roost in
- Percentage of clutter
- Percentage of canopy cover
- Percentage of impermeable surfaces
- Percentage of vegetated ground
- Percentage of roads
- Percentage of cropland
- Number of buildings
- Number of anthropogenically cut tree stumps
- Number of footpaths
- Number of fire observations
- Number of people seen within the square

2.2.2 Bat Trapping

To understand how bats are dispersing through the landscape and mating with other populations of the same species in different areas, we can use genetic methods. By observing genetic similarities between populations, we can reveal how well those populations are mixing and correlate this with environmental features such as forest cover.

Over three nights, we used a combination of mist nets and harp traps at three locations within Mulanje Mountain Forest Reserve. Both methods involved placing either a mist net or a harp trap across a potential bat flight corridor, which bats may use to travel at nighttime between roosting and foraging locations.

Upon capture of a bat we removed it from the net or trap, and brought it to our processing table where we took biometric measurements (*i.e.* weight, forearm length), identified the species, and took two 2mm wing puncture samples. The wing punctures provide tissue samples from which DNA can be extracted and the

genetic analysis conducted. Biopsies such as this are known to heal extremely rapidly in bats (2-4 weeks)and cause minimal stress or behavioural changes.

Additionally, hair clippings were taken to enable monitoring of pollutant exposure, and faeces samples were preserved for dietary analysis. Following processing, all bats were released back into the wild.

Figure 2. Mapped locations of trapping sites within Mulanje Mountain Forest Reserve

2.2.3 Acoustic classifier

During the release of bats, a handheld bat recorder was used to collect an echolocation call sample from each individual. These recordings can then be matched to the species so that we build our knowledge base of the types of calls each species can produce (*e.g.* figure 1).

By building an extensive collection of release calls, combined with historic data collected by ABC, Felix will develop an acoustic classifier that uses AI to automatically process a sound recording and identify if a bat is present and if so,

what species it is. Upon completion, the classifier will be used to analyse all the sound data collected.

2.3. Results

2.3.1 Bat Community Monitoring

All four detectors were successfully installed thanks to the field support and knowledge of Mackford and Bridgette from MMCT and the cooperation from Muloza and Chisitu police stations. Analysis of this data will not be possible until the acoustic classifier has been created and tested. Therefore, such results may not be available until 2026, when they will be shared with Mulanje Mountain Forest Reserve and MMCT.

2.3.2 Bat Trapping

With assistance of Mackford and Bridgette, over the three nights of trapping we caught a total of 20 bats comprising seven species from three different families. One individual could only be categorised to Vesper (A) level. This is a group of very similar looking species that are extremely challenging to distinguish in the field and can typically only be separated via genetic analysis. Additionally, one *Laephotis* sp. and one *Rhinolophus* sp. were caught, which will require genetic analysis for confirmation. An additional unidentified Rhinolophid was captured but released immediately due to a suspected pregnancy. Two individuals were caught that were identified as *Myonycteris angolensis/goliath*, due to the morphological similarities of the two species. Genetic confirmation will be required to confirm their identity. All bats were successfully processed and released without complication.

Table 1. Inventory of bats caught whilst surveying in Mulanje Mountain Forest Reserve in April and May 2025. LC: Least Concern

Latin name	Common name	Family	Location	Number	IUCN status
Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	Pteropodidae	MU01, MU01.1, MU01.2	4	LC
Myonycteris angolensis/goliath	Angolan soft-furred fruit bat/ Harrison's soft-furred fruit bat	Pteropodidae	MU01.1	2	LC
Rhinolophus blasii	Blasius' horseshoe bat	Rhinolophidae	MU01, MU01.1, MU01.2	7	LC

Rhinolophus clivosus	Geoffroy's horseshoe bat	Rhinolophidae	MU01, MU01.1	3	LC
Rhinolophus sp.	Horseshoe bat	Rhinolophidae	MU01, MU01.1	2	N/A
Laephotis sp.	Long eared bat	Vespertillionidae	MU01.1	1	LC
Vesper (A)	Plain faced bat	Vespertilionidae	MU01	1	LC

All genetic analyses are yet to be completed but will hopefully be undertaken in 2026 with results ready to disseminate to Mulanje in 2026/2027.

2.3. Next Steps

The development of the acoustic classifier has commenced and will hopefully be applied to the echolocation data collected at Mulanje soon. Additionally, DNA extraction and genetic analysis will begin towards the end of 2026, which will provide important insights into how bat populations at Mulanje are connected with those in the rest of Malawi.

Our surveys in April and May provided data of bat activity during the hot, rainy season when dense vegetation was present. The next stage of the project is to return towards the end of the dry season in October/November once all the vegetation has dried and died back to compare the seasonal influence on bat activity. To complete this, we will install the bat detectors in the exact same locations as previously, but we will undertake bat trapping surveys in different areas to try collect information on additional bat populations.

2.3. Acknowledgements

A huge thank you is extended to everyone at Mulanje Mountain Forest Reserve and MMCT, in particular to Raheela who was instrumental in facilitating our research, accommodation, and wellbeing during our visit. Special thanks go to Mackford, Bridgette, and Coriena for joining our field team and helping with all our surveys. Finally, a massive thank you to Stanford, Kenneth, and all the members of the Lujeri Tea Estate Security team that permitted us access and the peace of mind to complete our surveys safely.

Our research could not happen without this sort of support, so we are extremely grateful and look forward to the continuation of this collaboration to work as one team to conserve bats in Malawi.

3. Photos

Figure 4. Geoffroy's horseshoe bat (*Rhinolophus clivosus*)

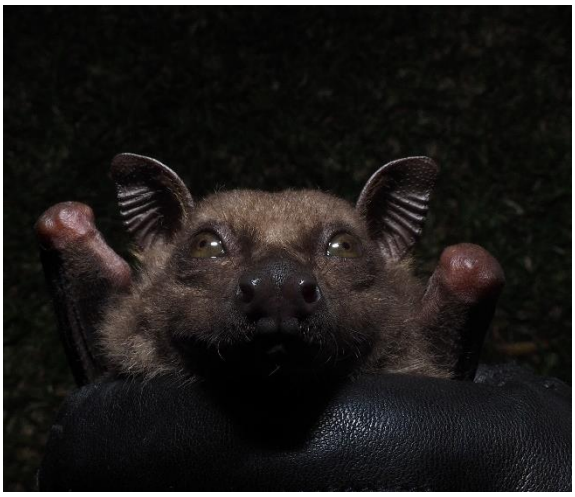

Figure 5. Angolan soft-furred fruit bat/ Harrison's soft furred fruit bat *(Myonycteris angolensis/goliath*)

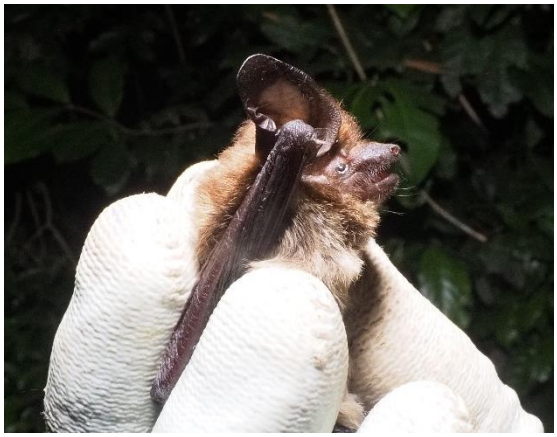

Figure 6. Laephotis sp.

Figure 6. A rare orange variant of a Blasius' horseshoe bat (*Rhinolophus blasii*)

Figure 7. Research Manager Kieran releasing a bat whilst PhD student Felix records its echolocation

Figure 8. Orange Blasius' *horseshoe (Rhinolophus blasii)* posing for the camera

4. OUR PARTNERS AND SPONSORS