Appendix G.8

BATS IMPACT ASSESSMENT

Bat Monitoring and Impact Assessment Report for the proposed Groothoek Wind Energy Facility (Verkykerskop WEF Cluster) in the Free State

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Compiled for: Groothoek Wind Power (Pty) Ltd

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Declaration of Independence

Inkululeko Wildlife Services (Pty) Ltd (IWS) is an independent consultancy. IWS has no legal or financial connection with the developer except for having fulfilled the tasks required for this assessment. Remuneration to IWS for conducting this assessment is not linked to the authorisation of the project by the competent authority. In addition, IWS has no interest or connection to any secondary or future development associated with the approval of this project. This report was compiled by Dr Jarryd Alexander, Dominique Greeff, Myles Bushell, and Leandri de Kock, and reviewed by Dr Caroline Lötter, who is registered with the South African Council for Natural Scientific Professions (SACNASP).

Signed for Inkululeko Wildlife Services (Pty) Ltd by:

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Executive Summary

Presented in this report is a Pre-construction Bat Monitoring and Impact Assessment for the proposed Groothoek Wind Power (GWP) Wind Energy Facility (WEF), which forms part of the Verkykerskop WEF Cluster, in the north-eastern Free State Province, South Africa. The Assessment was based on a desktop review, seven site visits and 14 months of passive monitoring of local bat call activity which commenced in May 2023 and ended in July 2024.

The most salient findings from the monitoring are as follows:

- Signs of bat roosting were found onsite in both unoccupied and occupied farmhouses and outbuildings.
- The passive acoustic monitoring revealed that at least twelve bat species frequent the study area, *viz*. the Egyptian Free-tailed Bat (*Tadarida aegyptiaca*), Cape Serotine (*Laephotis capensis*), Natal Long-fingered Bat (*Miniopterus natalensis*), Lesser Long-fingered Bat (*Miniopterus fraterculus*), Mauritian Tomb Bat (*Taphozous mauritianus*), Little Free-tailed Bat (*Mops pumilus*), Midas Free-tailed Bat (*Mops midas*), Temminck's Myotis (*Myotis tricolor*), Dusky Pipistrelle (*Pipistrellus hesperidus*), Long-tailed Serotine (*Cnephaeus hottentotus*), Lesueur's Wing-gland Bat (*Cistugo lesueuri*) and *Rhinolophus cervenyi*. Seven of the twelve detected species have a High fatality risk of collision with turbines, while the Temminck's Myotis and Dusky Pipistrelle have a Medium-High fatality risk of collision with turbines.
- The Egyptian Free-tailed Bat was the dominant species in turbine rotor sweep height, contributing more than 94 % of all bat calls while the Cape Serotine and Little Free-tailed Bat respectively contributed up to 1 % and 4 % of all bat calls recorded at 88 m a.g.l. It is, therefore, anticipated that during operation of the WEF, most of the turbine-related bat fatalities will comprise Egyptian Free-tailed Bats. Little Free-tailed Bats and Cape Serotines and possibly other species will likely also be killed during operation, but in fewer numbers.
- Near ground level (9.5 – 10 m), Egyptian Free-tailed Bats and Cape Serotines were dominant, contributing, respectively, 32 – 62 % and 7 – 51 % of all bat calls made, followed by Little Free-tailed Bats that contributed 8 – 11 % of all bat calls. Long-tailed Serotines, Natal Long-fingered Bats and Lesueur's Wing-Gland Bat contributed 11 % or less of all bat calls near ground level. These findings suggest that a great diversity (species richness and abundance) of bats will be at risk of fatality from turbines with blades that approach closer to ground level. The risk of fatalities of Species of Conservation Concern (e.g. Natal Long-fingered Bat and Lesueur's Wing-Gland Bat and possibly others) will also increase with blades that approach closer to ground level.
- An overall average of 13.82 bat passes (bp) per night (or 1.14 bp per hour) at 88 m, and 48.04 bat passes (bp) per night (3.99 bp per hour) near ground level was recorded. The levels of bat activity recorded through four microphones, were within the typical ranges of bat activity recorded in the Drakensberg Grasslands ecoregion.
- Nights, when the highest total numbers of bat passes were recorded at height, occurred during March and April. On nights when the levels of Egyptian Free-tailed bat activity at 88 m can be 5.75 times higher than the average level of 13.82 bat passes per night at 88 m, fatalities will be likely without effective mitigation.
- Due to their protracted night-time activity, Egyptian Free-tailed Bats and to a lesser degree Cape Serotines, will be at risk of fatality from turbines throughout the night whenever favourable weather, insects, and possibly other (e.g. lunar) conditions prevail. In contrast, species like the Natal Long-fingered Bat will likely be at greatest risk of fatality for 1-3 hours after sunset, and in some areas (near

roosts) for 1-3 hours before sunrise. These taxon-specific differences should be taken into consideration if/when fatality mitigation measures are implemented.

- Most (>95% of) bat activity in rotor sweep height was recorded during temperatures above 9 and below 22°C. Half of the time, bats were active onsite during wind speeds stronger than 5 m/s at 88 m a.g.l. If the bat fatality threshold is exceeded during operation, only 50% of activity of all bat species onsite would be protected below a cut-in wind speed of 5 m/s at 88 m should turbine curtailment be implemented.

A final bat sensitivity map for the Verkykerskop cluster site was compiled, where:

- **High** bat sensitive areas include:
  - Confirmed roosts with a 500 m buffer around these, based on evidence of bat roosting activity and suitable roosting habitat.
  - Potential roosts with a 200 m buffer around these, based on the strong possibility that occupied and abandoned dwellings may provide suitable roosting habitat for certain cavity/roof-roosting bat species.
  - Significant natural rocky terrain including cliff faces, overhangs, cavities, crevices, and/or exfoliating rock, and a 200 m buffer extending downslope from these.
  - Rivers, dams, wetlands, and pans, and a 500 m buffer around the large dam and river onsite, and 200 m buffer around all other hydrological features.
- **Medium-High** bat sensitive areas include:
  - Patches of indigenous and exotic woody vegetation, and a 200 m buffer around dense stands.
- **Medium** bat sensitive areas include:
  - A 2.5 km buffer around the VK5 and VK6 monitoring stations, where a cave and other significant roosts are suspected, and exceptionally high levels of bat activity were recorded.
- The remaining areas were rated with **Low** sensitivity.
- Seven protected areas are situated within only 10 km of the proposed Verkykerskop WEF Cluster site, and, therefore, a 0-2.5 km High and 2.5-5 km Medium sensitivity buffer was assigned around each of the seven closest protected areas.

The sensitivity mapping should be interpreted as follows:

- **High** bat sensitive areas represent **No-Go** areas for the construction of WEF infrastructure especially turbines, substations, buildings, construction camps, laydown areas, and possible quarries (to avoid disturbing key bat roosting, foraging, and/or commuting habitat, and to avoid high bat fatalities in these areas where high bat activity is anticipated). No turbine, including its full rotor swept area and a 2 m pressure buffer around this, should occur in High sensitive areas. Consequently, turbines should be located a minimum of one blade length plus 2 m away from High sensitive areas. Construction of linear infrastructure such as roads and underground powerlines and cabling is only permissible in High Bat Sensitive Areas if this will not result in destruction or disturbance of bat roosts.

- **Medium-High** bat sensitive areas represent areas where the construction of infrastructure and other disturbances should be avoided where possible (to avoid areas where bat activity is likely to be concentrated). No turbine towers should be positioned in Medium-High sensitive areas. Turbine blades are permitted to encroach on Medium-High sensitive areas.

- In the 2.5 km **Medium** Bat Sensitive buffers around VK5 and VK6, where a cave and other significant roosts are suspected, and exceptionally high levels of bat activity were recorded, all turbines will require bat fatality mitigation.

- Disturbances in **Low** sensitive areas should be minimized.

Potential impacts on bat species, habitats, and ecosystem services from wind energy development in the WEF site were assessed, and measures to mitigate these have been recommended. Potential impacts include: i) bat roost disturbance; ii) terrestrial habitat loss, and possible displacement of bats; iii) bat fatalities from collision with turbines, and possible population declines; and iv) compromised bat ecosystem services. The cumulative impact on bats from the three proposed WEFs comprising the Verkykerskop cluster is of greatest concern.

Without mitigation, the proposed Groothoek WEF may have a potential Very High impact in terms of bat fatalities from their collision with turbines, and a High impact on bat roosts, terrestrial (bat foraging) habitat, and bat ecosystem services.

With diligent mitigation as recommended in this report, the WEF is expected to have a Moderate impact in terms of bat fatalities, on terrestrial habitat and bat eco-services, and a Low impact on bat roosts.

Recommended bat impact mitigation measures for the WEF include the following:

- **Avoid High sensitive areas**, including all bat significant features and the buffers around these. No turbine, including its full rotor swept area and a 2 m pressure buffer around this, should occur in High sensitive areas.
- **Avoid Medium-High sensitive areas** where possible. No turbine towers should be positioned in Medium-High sensitive areas. Turbine blades are permitted to encroach on Medium-High sensitive areas.
- **Minimise the length and breadth of proposed roads** to thus minimise the loss and fragmentation of terrestrial (bat foraging) habitat.
- **Minimize the number of proposed turbines** to potentially reduce the extent of the road network and the overall extent of the wind farm and thus, the extent of terrestrial habitat loss and possible displacement of bats.
- **Avoid blasting within 2 km of a confirmed roost.**
- **Consult a Bat Specialist if a bat roost is encountered** during any phase of the WEF, and refrain from disturbing the roost until appropriate advice has been obtained.
- **Minimise the degradation of terrestrial habitat** by implementing and maintaining effective dust, stormwater, erosion, sediment, and invasive alien plant control measures.
- **Rehabilitate disturbed terrestrial habitats** by comprehensively and diligently implementing effective rehabilitation measures based on consultation with an appropriate vegetation specialist.
- **Minimise artificial lighting on site** (excluding compulsory civil aviation lighting) – especially high-intensity, steady-burning, sodium vapour, quartz, halogen, and other bright lights at substations, offices, and turbines (to avoid disturbing roosts of certain sensitive bat species). All non-aviation lights should be hooded downward and directed to minimise horizontal and skyward illumination. Where possible, solar-powered motion-sensitive lights should be used.
- **Monitor bat fatalities as soon as the first turbine starts spinning** – as per the latest SABAA guideline for this (Aronson *et al*. 2020 or later) and the latest (2023 or later) IFC Good Practice Handbook on post-construction bird and bat fatality monitoring for onshore WEFs in emerging market countries. At the very least, bat fatality monitoring should be conducted during the WEF's first two years of operation, and then every fifth year thereafter. The monitoring and data analysis are to be conducted to a high standard so that there is confidence in the estimated numbers of actual bat fatalities.
- **Conduct passive monitoring of live bat activity (at least on the VK8 met. mast)** as soon as the first turbine starts spinning and whenever bat fatality monitoring is performed during the WEF's operation.

This will allow for comparison of operational bat activity levels with pre-construction bat activity levels and operational bat fatalities, and it will help to assess the efficacy of any implemented bat fatality mitigation measures.

- **Mitigate bat fatalities adaptively** by consulting the latest SABAA guideline for this (MacEwan *et al.* 2018 or later), and the best available relevant scientific information. Taxon-specific differences should be taken into consideration if/when fatality mitigation measures are implemented. The calculation of bat fatality thresholds (as described by MacEwan *et al.* 2018) is dependent, inter alia, on the final (constructed) layout of turbines. Adequate financial provision should be made to permit effective monitoring, management, and mitigation of bat fatalities throughout the life of the WEF.

- **Forward all (live and fatality) bat monitoring data** to the database recommended by the South African Bat Assessment Association (SABAA) to expand the scientific knowledge base for more informed decision-making and mitigation.

Under the current 43-turbine layout for the Groothoek WEF, **10 turbines are positioned in areas where their rotor sweep will encroach on Medium-High sensitive areas. Where possible, these 10 turbines should be removed or shifted slightly to avoid encroachment on Medium-High sensitive areas.**

Going forward, the Client is strongly advised to carefully ensure that there is adequate financial planning and provision for high standard operational bat fatality and activity monitoring, and bat fatality mitigation in the form of blanket or smart turbine curtailment or bat deterrents - should the need for this arise.

All bat impact mitigation measures recommended in this report must, so far as applicable, be followed and included in the Wind farm's Environmental Management Programme (EMPr).

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1. Introduction

Groothoek Wind Power (Pty) Ltd proposes to develop the Groothoek Wind Energy Facility (WEF), in the north-eastern Free State Province, South Africa (**Figure 1**). Inkululeko Wildlife Services (IWS) was appointed by Groothoek Wind Power to undertake pre-construction bat monitoring and impact assessment for the WEF as per the current South African guidelines on bat monitoring for proposed wind farms (MacEwan *et al*. 2020a). The assessment work was based on a desktop review, seven IWS site visits, and 14 months of passive acoustic monitoring of bat activity which commenced in May 2023 and ended in July 2024. (**Figure 1**). Presented in this report is the Pre-construction Bat Monitoring and Impact Assessment for the proposed Groothoek WEF (located in the south-western section of the Verkykerskop WEF Cluster).

2. Site and Project Description

The Verkykerskop WEF Cluster site is approximately 19 506 ha in extent and is situated in the Free State Province roughly 35 km south-west of Newcastle and 65 km north-east of Harrismith, almost adjacent to the border of KwaZulu-Natal. The primary vegetation type is the Vulnerable (Collins 2024) Eastern Free State Sandy Grassland, followed by Low Escarpment Moist Grassland in the east, some Basotho Montane Shrubland in the south-east, and Southern Mistbelt Forest occurring in a single landowner's property in the far east of the site (Mucina and Rutherford 2006). Various hydrological features are present in the site including rivers, dams, pans, and herbaceous wetlands (**Figure 1**). Commercial crop (mainly maize) cultivation and livestock (mainly cattle) farming are the predominant forms of land-use.

The Groothoek WEF is one of three WEFs comprising the Verkykerskop Cluster. The other two WEFs are referred to as Kromhof and Normandien. The Groothoek WEF site covers an area of 6 170 ha consisting of mainly cattle grazing pastures and seasonal agricultural fields (primarily maize and potato) with numerous small to large, man-made and natural dams, two main wetlands in the south-west section and near the northern boundary, and scattered farm buildings and infrastructure (reservoirs). A small stream and its accompanying vegetation (Ouhout, *Leucosidea sericea*) runs through the northern extent of Groothoek, winding along the base of one of the two main ridges, the other ridge is situated on the southernmost extent of the Groothoek WEF boundary. The terrain in between the ridges could be described as undulating.

The up to 300 MW Groothoek WEF is planned to comprise up to 43 turbines (**Figure 2**) with a maximum hub height of up to 150 m and a rotor diameter of up to 200 m, reaching to a maximum blade tip height of 250 m. Turbines will be placed on permanent hardstands covering up to 0.8 ha per turbine. After construction, the laydown footprint will be covered with soil. In addition, the Groothoek WEF project is currently proposed to comprise one site (construction) camp with a site office occupying 4 ha, a temporary laydown area totalling 8 ha, and one batching plant totalling 1 ha. Furthermore, the site will comprise one operational and maintenance (O&M) building occupying 1 ha, one on-site substations (2 ha) and battery storage units (totalling up to 7 ha). Internal access roads linking the various structures on site will be 8 m wide.

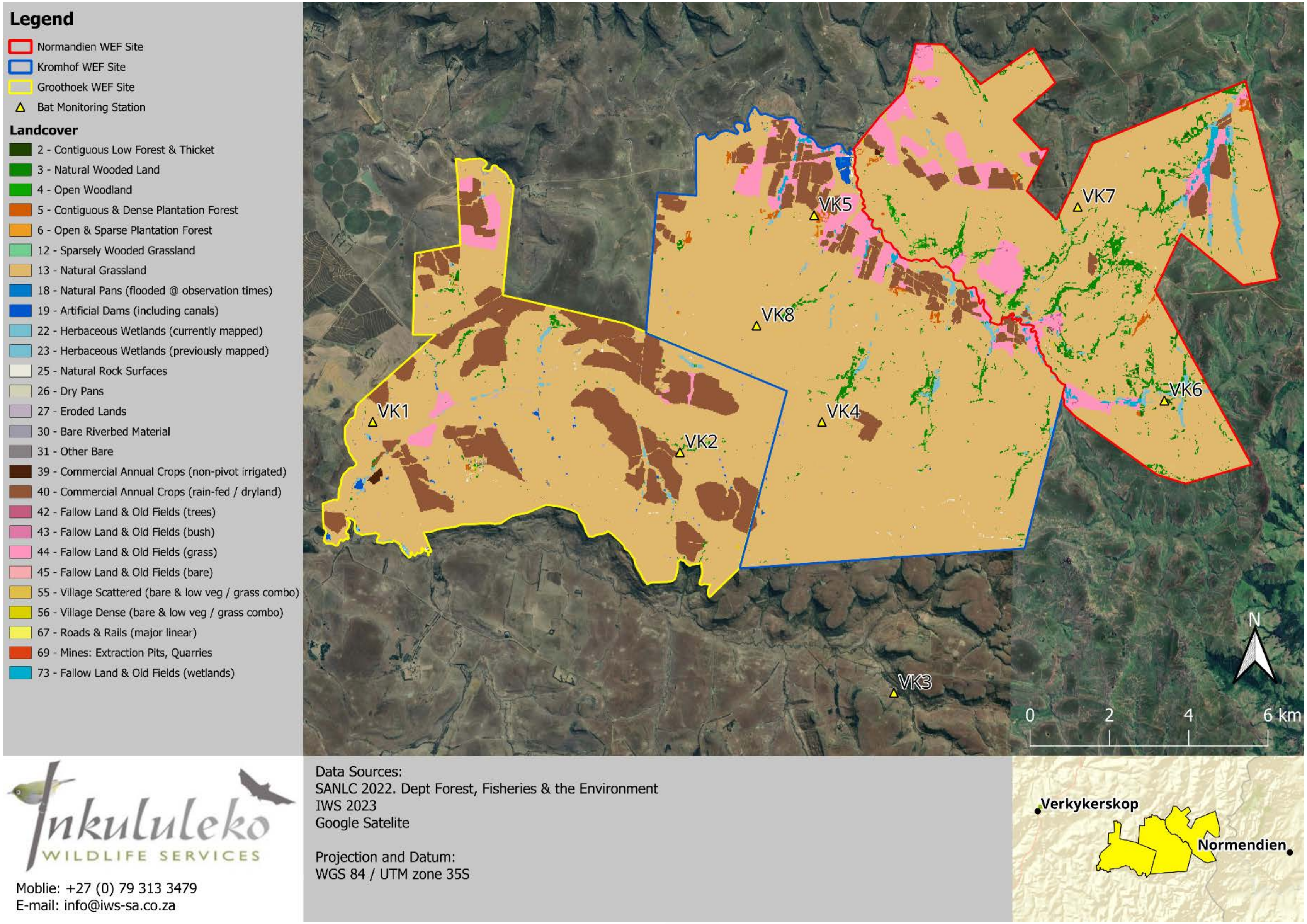


Figure 1 National landcover in the proposed Verkykerskop WEF cluster site, and the locations of the eight onsite bat monitoring stations (VK1 to VK8)

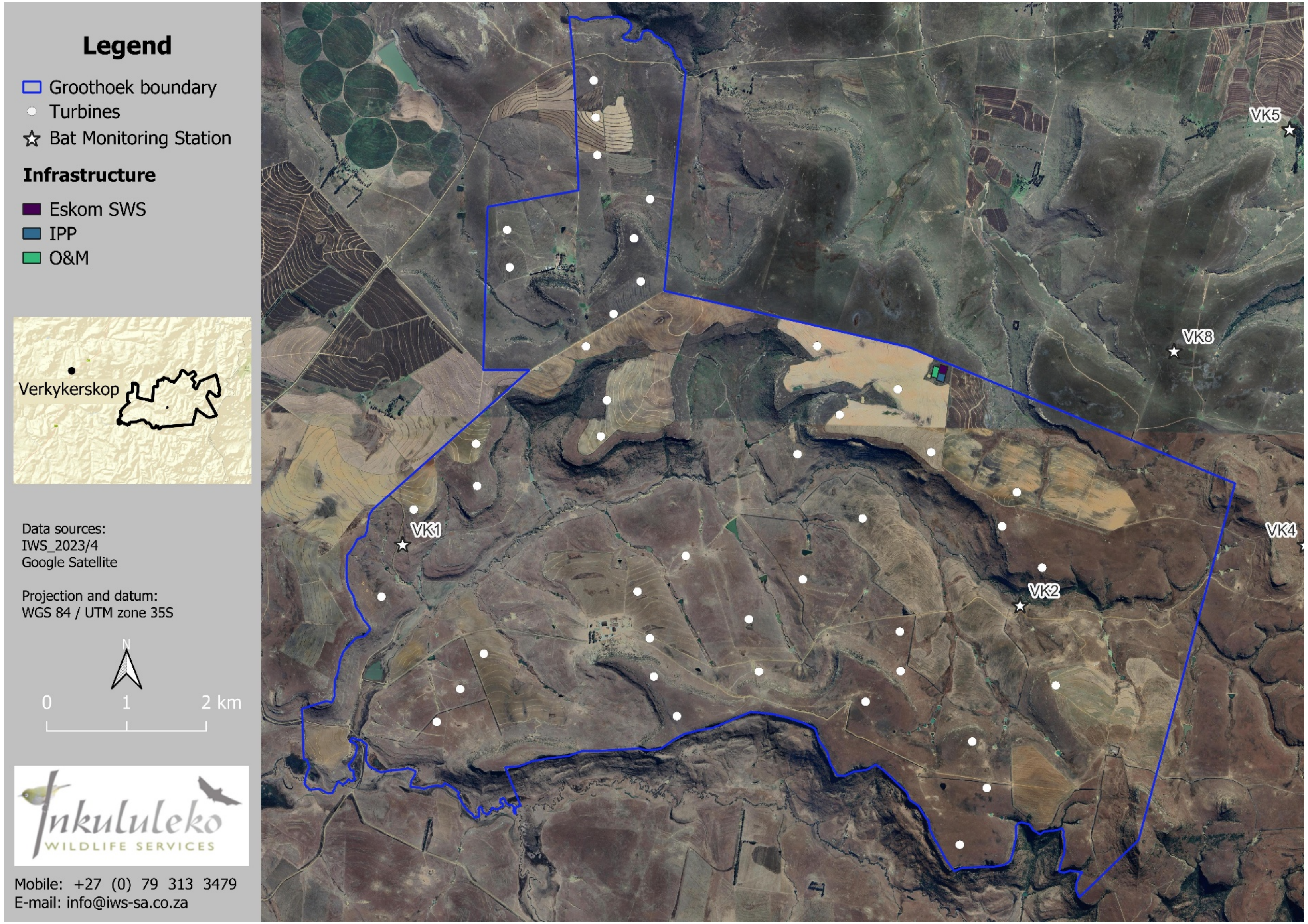


Figure 2 **The proposed Groothoek WEF site, including the locations of the two onsite bat monitoring stations (VK1 and VK2), the closest met. mast-mounted bat station (VK8) and the proposed infrastructure layout**

3. Legislation and Guidelines

3.1 International agreements

Convention on Biological Diversity (CBD)

It is recognized by the CBD that biological diversity is about more than plants, animals and micro-organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air, clean water, shelter, and a healthy environment in which to live. It is an international convention signed by 150 leaders at the Rio 1992 Earth Summit. Namibia is a signatory. An important principle encompassed by the CBD is the precautionary principle which essentially states that where serious threats to the environment exist, lack of full scientific certainty should not be used as a reason for delaying management of these risks. The burden of proof that an impact will not occur lies with the proponent of the activity posing the threat.

(Bonn) Convention on the Conservation of Migratory Species (CMS) of Wild Animals

The CMS Convention, signed in 1979, serves to conserve terrestrial, marine and aerial migratory species throughout their range. South Africa is a party to this Convention. Therefore, the Convention affords protection to a broad spectrum of migratory fauna in South Africa including migratory bat species such as the locally occurring Natal Long-fingered Bat (*Miniopterus natalensis*), Lesser Long-fingered Bat (*Miniopterus fraterculus*), and Temminck's Myotis (*Myotis tricolor*).

3.2 National legislation

The Constitution of the Republic of South Africa

The Constitution (Act 108 of 1996) is the supreme law of the land and Section 24 states that: 'Everyone has the right – (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that – (i) prevent pollution and ecological degradation (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.'

National Environmental Management Act (NEMA)

NEMA (Act 107 of 1998) is the statutory framework to enforce Section 24 of the Constitution of the Republic of South Africa and is intended to promote co-operative governance and ensure that the rights of people are upheld but also recognising the necessity of economic development. It is the key legislation in South Africa governing environmental authorisation which is managed by the Department of Forestry, Fisheries, and the Environment at local, provincial, and national levels of the government.

Sections 2(2) to 2(4) are applicable to every person that does something that may impact on the environment. Under NEMA, every person must take reasonable measures to prevent degradation of the environment, which is defined as including 'animal life'. The listed activities in Section 24 of NEMA are associated with various regulations including the 2014 Environmental Impact Assessment Regulations, which were amended on 7 April 2017, when Government Notice Regulation 326 came into effect. Environmental degradation, in so far as it is authorized by law or cannot reasonably be avoided or stopped, must be minimized and rectified (Section 28).

It should be noted that under NEMA a person has the right to disclose information regarding an environmental risk, through the correct channels (Section 31(5)). The Act also authorises private prosecutions, which makes it possible for private people to take erring companies to court. An official of a company can now be charged personally. He/She cannot hide behind the fact that he/she acted on behalf of the company.

National Environmental Management: Biodiversity Act (NEM:BA)

NEM:BA (Act 10 of 2004) provides, inter alia, for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act (Act 107 of 1998); the protection of species and ecosystems that warrant protection; and the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources. Under NEM:BA, the Threatened Or Protected Species (TOPS) Regulations provide for the listing and protection of national Threatened Or Protected Species. Presently no bat species is listed as a Threatened of Protected Species under NEM:BA.

National Environmental Management: Protected Areas Act (NEM:PAA)

NEM:PAA (Act 57 of 2003) – as amended - provides, inter alia, for: the conservation and protection of ecologically viable areas in South Africa that characterise the country's biological diversity and natural land and seascapes; declaration and categorisation of different kinds of protected areas (including national, provincial, and local protected areas); management authorities, plans, monitoring and restrictions in respect of protected areas; intergovernmental co-operation and public consultation in matters concerning or related to protected areas; and also offences, and penalties for contravention of the Act.

National Strategy on Buffer Zones for National Parks

This policy (published in Government Gazette 35020 on 8 February 2012) sets out the South African government's national strategy on the establishment and management of buffer zones around national parks so these may better meet their objectives. Guiding principles of this policy include: the intrinsic value of all life forms; the duty of care of all people and organizations to avoid negative impacts on biodiversity; and the precautionary principle. The number one objective of a buffer zone, according to this policy, is to "Ensure the persistence of important species and ecological processes." According to this policy "Buffer zones must be established around all national parks." Furthermore, it is stated that **"**Development outside a national park, and in its buffer zone, depending on its type may be controlled at any one of the three spheres of government. All development in the buffer zone which may have a negative impact on the national park will be strictly controlled."

3.3 Provincial legislation

Free State Nature Conservation Ordinance 8 of 1969

This Ordinance, assigned to the Free State Department of Small Business Development, Tourism, and Environmental Affairs (DESTEA) on 17 June 1994 states that all species in the region, other than specifically listed invasive species should be protected and may only be removed, traded, hunted, or otherwise impacted by individuals in possession of a valid permit. National and private protected areas are to be treated in the same regard and may not be impacted in any way unless an activity has been formally permitted.

3.4 Best practice guidance

International Finance Corporation (IFC) Performance Standard 6 (PS6)

The IFC Performance Standards (IFC 2012) provide guidance on how to identify sustainability risks and impacts and are designed to help avoid, mitigate, and manage them as a way of doing business in a more sustainable way. PS6 recognizes that "Biodiversity loss can result in critical reductions in the resources provided by the earth's ecosystems, which contribute to economic prosperity and human development. This is especially relevant in developing countries where natural resource-based livelihoods are often prevalent… protecting and conserving biodiversity, maintaining ecosystem services, and managing living natural resources adequately are fundamental to sustainable development."

South African best practice guidelines for pre-construction bat monitoring at WEFs

The document by MacEwan *et al.* (2020a) provides technical guidance on bat monitoring for proposed wind farms in South Africa. It is principally directed at ecological consultants and environmental impact assessment practitioners to ensure that pre-construction bat studies are sufficiently comprehensive for the evaluation of wind farm applications by authorities. The document includes, inter alia, a synopsis of wind farm impacts on bats, an outline of the minimum requirements for pre-construction bat studies, and methodological considerations for planning and executing these studies.

4. IWS Team

Inkululeko Wildlife Services has undertaken long-term bat monitoring for over 70 pre-construction and 10 operational wind farm projects in southern Africa, including three projects in Namibia, and one each in Malawi, Zambia, and Zimbabwe. IWS team members were involved with the bat sensitivity analysis of the Strategic Environmental Assessment for South Africa's Renewable Energy Development Zones (REDZs), and have performed numerous specialist bat assessments for mines, power lines, the Square Kilometre Array, and other developments, and for caves and protected areas.

The core IWS Team comprises:

- **Dr Caroline Lötter**

Caroline, the IWS Managing Director and Senior Zoologist, has since 2011 been involved with numerous bat screening, scoping, monitoring, impact, and review studies for wind, solar, mining, infrastructure, and other projects in southern Africa. Caroline is a co-author of the current South African best practice guidelines for pre-construction bat monitoring studies at WEF developments (MacEwan *et al*. 2020), and a peer-reviewed paper on bat activity and its implications for wind farm development in South Africa (MacEwan *et al*. 2020b). Caroline currently sits on the Committee for the South African Bat Assessment Association (SABAA). She has a PhD in Zoology and is a member of the Zoological Society of southern Africa and the South African Council for Natural Scientific Professions.

- **Trevor Morgan**

Trevor has worked for more than 12 years as the IWS Senior Technician and Bat Data Analyst on all the various bat monitoring projects. For several years he served as an active member on the GNorBIG Committee. Trevor is very knowledgeable on South African bats and has extensive experience with bat detectors, their related software, mist-netting, and harp-trapping. By trade, Trevor is an electrician and an inventor and has constructed his own harp trap and heterodyne bat detector. Trevor's considerable field-based involvement and bat data analysis for all long-term bat monitoring and several bird monitoring studies has been invaluable. Trevor is also a co-author on the MacEwan *et al*. (2020b) article on bat activity and its implications for wind farm development in South Africa.

- **Dominique Greeff**

Dominique holds a MSc in Ecology and Environmental Conservation and is an IWS Zoologist with bat specialist expertise spanning fieldwork, GIS mapping, data analysis, report writing, project management, social media, and more. Prior to joining IWS, Dominique spent nearly 2 years focused on bat research and conservation in Malawi, where she acquired a wealth of hands-on experience with mist-netting, harp-trapping, radio-tracking, hand-netting, and identifying a broad diversity of African bats. Prior to this, at the National Zoological Gardens in Pretoria, South Africa, Dominique acquired hands-on and laboratory-related research experience working with animals ranging from African elephants to sungazer lizards and bullfrogs.

- **Dr Jarryd Alexander**

Jarryd holds a PhD in Ecological Sciences and is employed as a Zoologist with avian specialist expertise at IWS, where he contributes to fieldwork, report writing, project management, and more. Prior to joining IWS, Jarryd worked for the Mabula Ground Hornbill Project as the Research Manager where his focus was to manage the research outputs of the organisation and the national monitoring of the Endangered Southern Ground-hornbill. His work led to effective conservation action plans being developed and implemented for the species. During his time with the project, he was also involved as a specialist for species specific assessments at wind energy sites. During his time completing his PhD in ecological sciences Jarryd provided specialist consulting on environmental health; pre- and post-development, with specific focus on terrestrial- and avifauna but also including bats and herpetofauna. Jarryd was also contracted as a specialist avifaunal consultant for several environmental assessments post completing his PhD.

- **Myles Bushell**

Myles is an IWS Junior Zoologist who completed his BSc (Hons) in Wildlife Management at the University of Pretoria, where he investigated the partitioning of food resources among Meletse insectivorous bat species using stable isotope analysis as a proxy for diet. Myles then worked as a Research Assistant in the University's Centre for Viral Zoonoses, where he acquired useful experience with deploying bat equipment and catching live bats. Additionally, Myles has experience as a field guide, so is well versed with environmental management and a broad understanding of most ecological practices.

- **Su-Mari Swanepoel**

Su-Mari is an IWS Project Manager who has accumulated a wealth of experience and insight from managing bat (and bird) fatality monitoring work at three wind farms in the Eastern Cape. Although Su-Mari's roots are in applied natural sciences, she has worked as a Zoologist for 8 years in animal husbandry at the National Zoological Garden of South Africa (SANBI) and as part of the pre-opening team at SeaWorld Abu Dhabi (United Arab Emirates). Su-Mari has a BTech Degree in Nature Conservation from TUT, and has lectured in natural resource management, plant studies, and basic statistics for Diploma students at South African registered tertiary institutions and co-ordinated practical courses. Environmental education and nature guiding played an integral part of her early career which kicked off as a Savanna Guide at Disney's Animal Kingdom Lodge, Orlando, USA. Her experience in technical aspects on research projects include vegetation community mapping, phytomass estimations, animal counts, biodiversity surveys, and ecological assessments in grassland and savanna areas, and assisting compiling environmental scoping reports and EIA's.

- **Leandri de Kock**

Leandri is a new Junior Zoologist at IWS, who recently obtained an MSc in Statistical Ecology from the University of Cape Town and holds a BSc (Hons) in Zoology from the University of Pretoria. During her studies, she used statistical methods to analyse large empirical datasets of penguins and southern elephant seals. Leandri has strong experience with data analysis, management, and visualisation to apply her skills to any animal species. Leandri has several years of fieldwork experience, including working as an overwintering field assistant on Marion Island. In this role, she installed, maintained, and downloaded data from wind stations and carried out carcass searches. She also has experience in population monitoring of birds and seals, biologging, animal handling, project management and reporting. Leandri is a multidisciplinary, analytically competent researcher that can apply her broad range of skills to multiple projects.

- **Kate MacEwan**

Kate, the Founding Director of IWS, now uses her over 23 years of zoological and practical bat conservation experience, in an advisory capacity at IWS. Kate is full-time employed by Western EcoSystems Technology, Inc. (WEST) in the United States as a consulting biologist and to broaden their international footprint. Kate was also the founding chairperson of SABAA for seven years and is the lead author / co-author of the current South African best practice guidelines regarding bat monitoring studies at proposed and operational wind farms (MacEwan *et al*. 2020 and Aronson *et al.* 2020, respectively), and regarding bat fatality thresholds (MacEwan *et al.* 2018). She has published several peer-reviewed articles on bats at wind farms in Africa, and was part of the core technical team that compiled the 2023 IFC Good Practice Handbook and Decision Support Tool on Postconstruction Bird and Bat Fatality Monitoring for Onshore Wind Energy Facilities in Emerging Market Countries.

5. Methodology

5.1 Desktop review

A desktop review involved (but was not limited to) consultation and consideration of: the latest bat species records and distribution maps for the region provided by Monadjem *et al.* (2020), the African Chiroptera Report (2022), and MammalMAP (FAIO 2023); and the current South African and global Red List status of the listed bat species (Child *et al.* 2016; IUCN 2024-1).

5.2 Fieldwork

The Verkykerskop WEF Cluster site was first visited during 15–19 May 2023 and 31 May–2 June 2023, when IWS installed passive acoustic bat monitoring equipment on two meteorological (met.) masts and six 10 m masts onsite (**Figure 1**). Bat stations VK7 and VK8 were established on the 92 m and 100 m met. masts, respectively. The VK7 and VK8 monitoring stations comprised two SongMeter 4 (SM4) bat detectors each connected to an ultra-sonic omni-directional SMM-U2 microphone installed separately at ~ 88 m and ~10 m above ground level (a.g.l.). Bat stations VK1-VK6 were established on 10 m portable masts whereon a detector was connected to a single microphone installed at 9.5m a.g.l.

The study area was re-visited during August and November in 2023, and in February, April, and July 2024 to retrieve data from the detectors. During the various field visits, IWS also performed ground truthing surveys to search for possible bat roosts in e.g. old and new farm houses, informal dwellings, ruins, out-buildings (sheds, pump houses, etc.), bridges, and rocky terrain with crevices and cavities.

5.3 Data analysis

Wildlife Acoustics Compressed (.wac) files of bat calls recorded by the SM4 detectors were converted to wave (.wav) and zero crossing (.zc) files using the Kaleidoscope software program (Wildlife Acoustics Inc., USA). The converted call data were analysed in AnalookW (Titley Scientific, Australia) and BatSound (Pettersson Elektronik, Sweden) to identify bat species based on their diagnostic call characteristics. Microsoft Excel was used to generate graphs from the recorded data. Wind speed and atmospheric temperature data from the met. masts were used for comparison with the bat activity data recorded onsite. Professor Peter Taylor from the University of the Free State was consulted over the recently discovered/named *Rhinolophus* species recorded on site. He also assisted in the identification of certain bat calls, where the bat species was not considered to be in the Verkykerskop area.

5.4 Sensitivity mapping

Preliminary sensitivity mapping was based on the desktop review and observations during IWS' site visits, as well as the national web-based Environmental Screening Tool (https://screening.environment.gov.za/screeningtool/#/pages/welcome), and specifically took into consideration, within the study area (where present):

- Known and potential cave, mine tunnel, or other significant bat roosts (IWS, unpubl. data).

- Landcover including rocky terrain, natural and artificial permanent, seasonal, and ephemeral surfaces, water resources, woody vegetation, croplands, and more (SANLC 2022).
- Local buildings and ruins (CDNGI 2020; OpenBuildings dataset from Google).
- Statutory and private protected and conservation areas (SAPAD 2022; SACAD 2022).

Buffering of buildings, ruins, and certain land-cover classes, was based on recommendations in the South African guidelines on bat monitoring for proposed wind farms (MacEwan *et al*. 2020a), and IWS' professsional judgement.

5.5 Impact assessment and mitigation

Potential direct, indirect and cumulative impacts on bats (including species, habitats, and ecosystems services), were assessed for the different project phases, with and without mitigation, using the methodology and templates for this, which were provided by the project Environmental Assessment Practitioner, WSP (**Table 1**). As stipulated by WSP, IWS' mitigation recommendations follow the hierarchy of*:* avoid/prevent, minimise, rehabilitate/restore, offset and no-go - in successive order.

Table 1 WSP impact assessment criteria and scoring system

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

5.6 Protected Areas and Bat Roost Sites in the Region

According to the spatial data and other information sources that were consulted by IWS, seven protected areas are situated within only 10 km of the proposed Verkykerskop Cluster site and one within 10 km of the Groothoek WEF site. Bats which should be conserved within these protected areas could potentially be impacted in various ways by each WEF within the Cluster and, therefore, a 0-2.5 km High and 2.5-5 km Medium sensitivity buffer has been assigned around each of the seven closest protected areas.

5.7 Limitations

- Not all cave and possible mine tunnel locations are necessarily known in the region.
- Information on bat migration in South Africa is limited.
- Bat activity in an area can fluctuate dramatically between years in response to changes in weather, land use, and other factors.

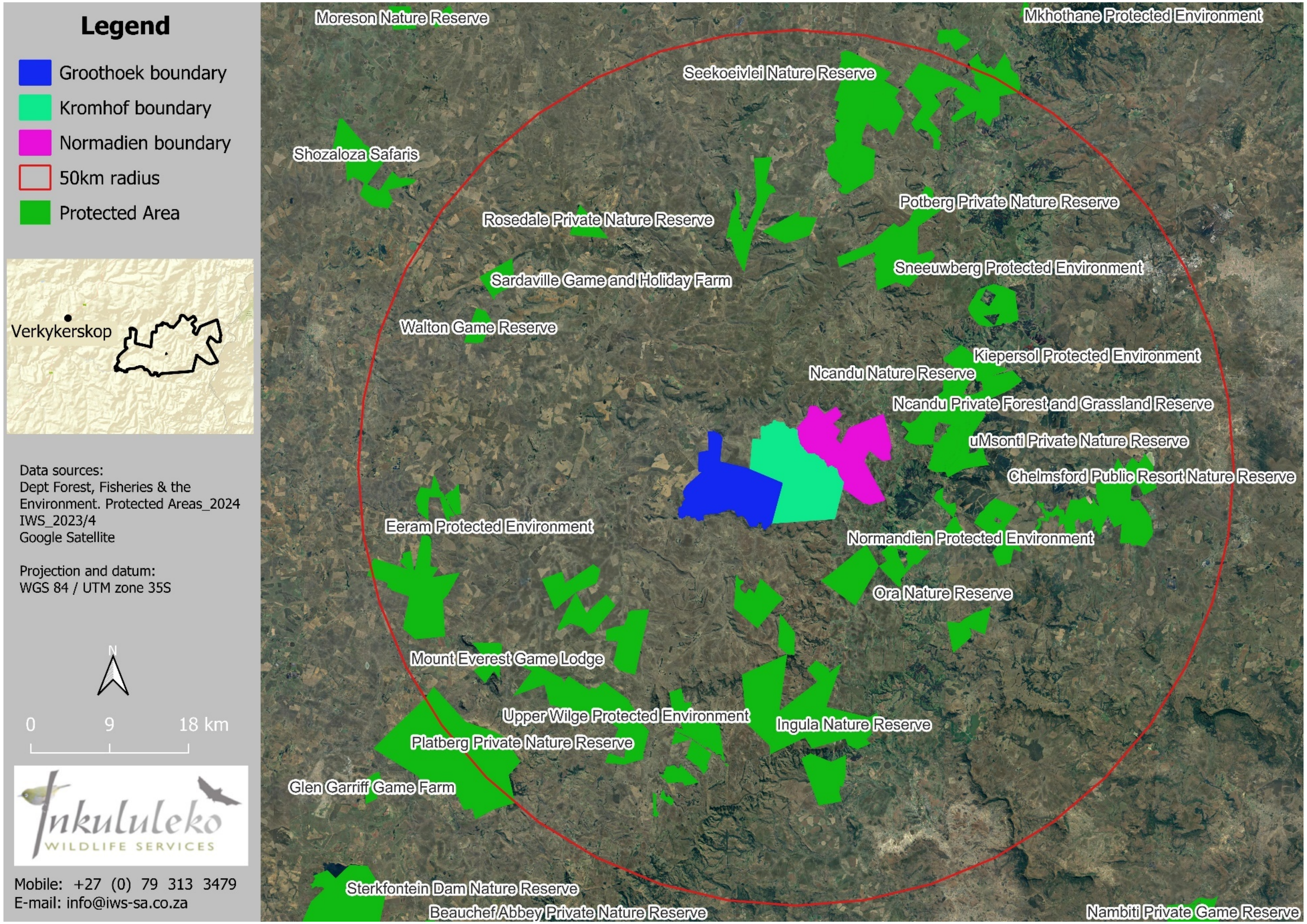


Figure 3 **Protected areas within (and beyond) a 50km radius of the proposed Verkykerskop/Groothoek WEF site**

6. Results and Discussion

6.1 Recording success

The recording success of the passive bat monitoring equipment within the cluster site during the 14-month monitoring period is shown in **Figure 4**. In the Groothoek WEF site, recording was 95.3 % and 79 % successful at the VK1 and VK2 microphones respectively, both located at a height of 9.5 m. The closest at-height bat monitoring (~88 m) occurred at the VK8-1 microphone, where 98 % recording success was achieved, while the VK8-2 microphone at a height of 10 m achieved 100 % recording success.

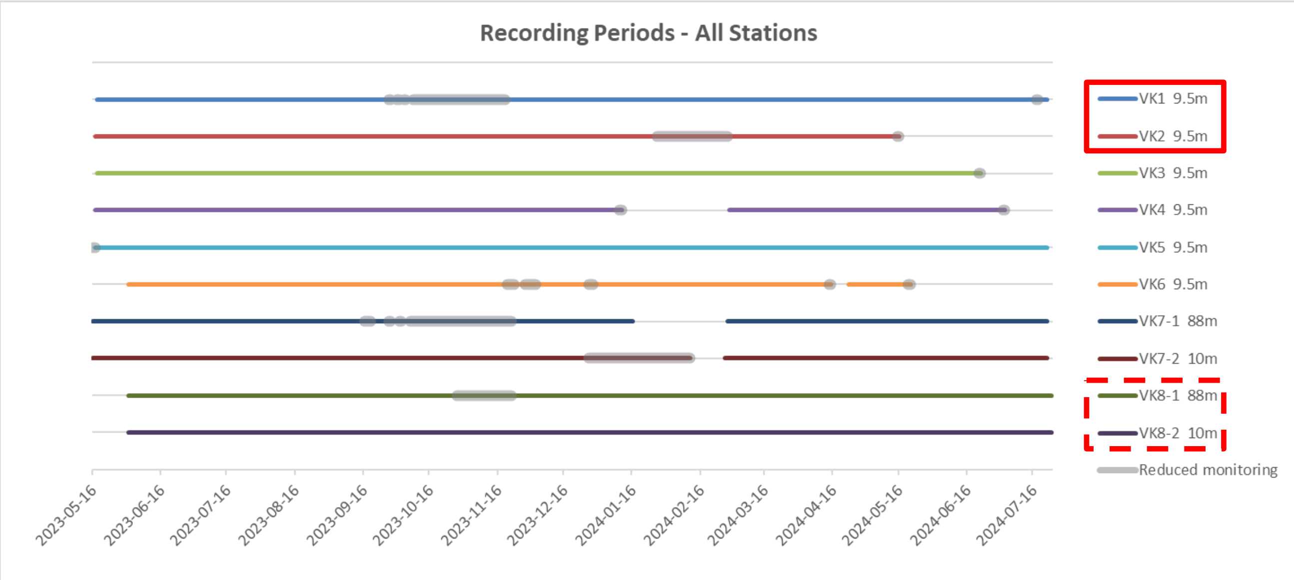


Figure 4 Recording success at all Verkykerskop WEF bat monitoring stations during the 14 months of monitoring. The Groothoek microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8-1 and VK8-2) are outlined in dashed red

6.2 Potentially occurring and detected bat species and roosts

Bat species which have been detected or which potentially occur in the Verkykerskop WEF cluster study area are listed in **Table 2**, together with their current Red List status, conservation significance, and turbine fatality risk (as given in MacEwan *et al*. 2020a). Of 18 bat species that are listed for the study area, 14 species were recorded within the Verkykerskop cluster site. Among these 14 recorded species, seven have a High fatality risk of collision with turbines, and two have a Medium–High fatality risk. Two fruit bat species were rated with a Low potential occurrence.

The 14 months of passive monitoring of bat call activity revealed the presence of at least 12 species in/near the Groothoek WEF site, including the Egyptian Free-tailed Bat (*Tadarida aegyptiaca*), Cape Serotine (*Laephotis capensis*), Natal Long-fingered Bat (*Miniopterus natalensis*), Lesser Long-fingered Bat (*Miniopterus fraterculus*), Mauritian Tomb Bat (*Taphozous mauritianus*), Little Free-tailed Bat (*Mops pumilus*), Midas Free-tailed Bat (*Mops midas*), Long-tailed Serotine (*Cnephaeus hottentotus*), Dusky Pipistrelle (*Pipistrellus hesperidus*), Lesueur's Wing-gland Bat (*Cistugo lesueuri*), Temminck's Myotis *(Myotis tricolor*) and *Rhinolophus cervenyi* (which has recently been classified, and does not yet have a common name). Geoffrey's Horseshoe Bat (*Rhinolophus acrotis*) and Swinny's Horseshoe Bat (*Rhinolophus swinnyi*) were not recorded (but could occur) at Groothoek.

The widespread aerial-feeding Egyptian Free-tailed Bat and Cape Serotine and migratory Natal Long-fingered Bat have been killed most often at wind farms in South Africa (Aronson 2022).

Of the 18 listed species; the following eight species are regarded by IWS as Species of Conservation Concern (SCC):

- Natal Long-fingered Bat: known to roost in large numbers (sometimes hundreds or thousands of individuals) and to migrate hundreds of kilometres (Miller-Butterworth *et al.* 2003; Kearney *et al.* 2017; MacEwan *et al.* 2016).
- Lesser Long-fingered Bat: endemic to South Africa and Eswatini where the core of its distribution is in the montane grasslands of the escarpment. Cave-dependent and migratory; this species congregates in far smaller numbers than the Natal Long-fingered Bat (Monadjem *et al.* 2020)
- Temminck's Myotis: Known to undertake seasonal migrations similar to the Natal Long-fingered Bat (Monadjem *et al.* 2020).
- Long-tailed Serotine: Near-endemic (Monadjem *et al*. 2020; IUCN 2024-1). This bat occurs widely but sparsely in southern Africa. The patchy distribution of this species is probably due to its specific roosting requirements. Individuals roost in small groups of two to four individuals in caves and rock crevices.
- Lesueur's Wing-gland Bat: Near-endemic to South Africa and Lesotho. Currently Red Listed as Least Concern, but experiencing a global population decline (IUCN 2024-1).
- Swinny's Horseshoe Bat (*Rhinolophus swinnyi*): a rare cavity-roosting species listed as regionally Vulnerable (Child *et al.* 2016) and endemic to South Africa, where it appears to be associated with temperate Afromontane forests (Monadjem et al. 2020).
- De Winton's Long-eared Bat (*Laephotis wintoni*): Regionally Vulnerable (Child *et al*. 2016). This species occurs at high altitude (>1 500 m above sea level) in the Free State and Lesotho, where it has been collected from montane grasslands. The echolocation call of this species has not yet been recorded, and little else is known about this species. It is presumed to use crevices in rock faces (Monadjem *et al*. 2020).
- African Straw-coloured Fruit Bat: Globally and nationally Near Threatened. Known to roost in large numbers and migrate hundreds of kilometres (Monadjem *et al*. 2020).

Of the eight SCC, the Natal and Lesser long-fingered bats have the Highest risk of fatality from turbines, followed by Temminck's Myotis and the Long-tailed Serotine, which have a Medium-High and Medium fatality risk, respectively. The other SCC have a Low fatality risk. Records in the study region of the High-risk African Straw-coloured Fruit Bat are most likely representative of vagrant individuals.

The nearest known major bat roost is ~103 km north-east of the Verkykerskop WEF site, in old mine tunnels referred to as Yzermyn. Here, sizeable populations of the migratory Natal Long-fingered Bat, Geoffroy's Horseshoe Bat, Temminck's Myotis, and the Vulnerable endemic Swinny's Horseshoe Bat have been recorded (NSS 2013). Given the distance from the Yzermyn tunnels, the proposed Verkykerskop WEF Cluster is not expected to have a major impact on bats from that roost site.

However, several active or potential bat roost sites were identified at various locations throughout the cluster. Primary roost locations included farmhouses, outbuildings, and crevices in rocky ridges (**Figure 5**). The specific roosts in each WEF site are listed below, with accompanying photographs.

<u>Normandien:</u>

a) Outbuildings and shed in north-east extent with crevices in between stone walls and guano inside buildings.

b) Outbuilding and shed in western extent with guano stains inside buildings.

c) Abandoned farmhouse and outbuilding near border with north-east extent of Kromhof WEF.

d) Rocky outcrops along the Kromhof border and rocky ridges in the southeast extent toward VK6.

e) Old shed and abandoned building with guano inside, located in the central extent, east of VK7.

f) Old trees with loose bark and crevices, for example in the south-eastern extent near to VK6.

Kromhof:

g) Farm sheds with guano inside, near VK5.

h) Rocky outcrops and ridges in the eastern extent.

i) Farmhouse with gaps in the roof near VK4.

j) Rocky outcrops and ridges along the southwestern and southeastern extent.

Groothoek:

k) Rocky ridges and outcrops along the northern extent behind VK2.

Off-site:

l) Rocky outcrops and ridges in areas immediately surrounding the boundary of the various WEFs, e.g., rocky outcrop south of Kromhof.

m) Farmhouse, outbuilding, and farm infrastructure immediately outside the borders of the various WEFs, e.g., farmhouse with known bat roost.

Table 2 Bat species detected and potentially occurring in the proposed Verkykerskop WEF Cluster site

FAMILY	SPECIES	COMMON NAME	OCCURRENCE POTENTIAL IN THE VERKYKERSKOP CLUSTER[1,2,3,4]	RED LIST STATUS		SPECIES OF CONSERVATION CONCERN[2,5]	TURBINE FATALITY RISK[7]
				Global[5]	Regional[6]		
MINIOPTERIDAE	*Miniopterus natalensis*	Natal Long-fingered Bat	Recorded	LC (U)	LC	**Migratory**	High
MINIOPTERIDAE	*Miniopterus fraterculus*	Lesser Long-fingered Bat	Recorded	LC (U)	LC	**Near-endemic; Migratory**	High
MOLOSSIDAE	*Tadarida aegyptiaca*	Egyptian Free-tailed Bat	Recorded	LC (U)	LC	-	High
VESPERTILIONIDAE	*Laephotis capensis*	Cape Serotine Bat	Recorded	LC (S)	LC	-	High
EMBALLONURIDAE	*Taphozous mauritianus*	Mauritian Tomb Bat	Recorded	LC (U)	LC	-	High
MOLOSSIDAE	*Mops midas*	Midas Free-tailed Bat	Recorded	LC (D)	LC		High
MOLOSSIDAE	*Mops pumilus*	Little Free-tailed Bat	Recorded	LC (U)	LC		High
VESPERTILIONIDAE	*Myotis tricolor*	Temminck's Myotis	Recorded	LC (U)	LC	**Migratory**	Medium–High
VESPERTILIONIDAE	*Pipistrellus hesperidus*	Dusky Pipistrelle	Recorded	LC (U)	LC		Medium-High
VESPERTILIONIDAE	*Cnephaeus hottentotus*	Long-tailed Serotine	Recorded	LC (U)	LC	-	Medium
RHINOLOPHIDAE	*Rhinolophus swinnyi*	Swinny's Horseshoe Bat	Recorded	LC (D)	**VU**	**Endemic**	Low
RHINOLOPHIDAE	*Rhinolophus acrotis*	Geoffroy's Horseshoe Bat	Recorded	LC (U)	LC	-	Low
VESPERTILIONIDAE	*Cistugo lesueuri*	Lesueur's Wing-gland Bat	Recorded	LC (D)	LC	**Near-endemic**	Low
RHINOLOPHIDAE	*Rhinolophus cervenyi*		Recorded	**Not evaluated**	**Not evaluated**		Low
NYCTERIDAE	*Nycteris thebaica*	Egyptian Slit-faced Bat	High	LC (U)	LC	-	Low
VESPERTILIONIDAE	*Laephotis wintoni*	De Winton's Long-eared Bat	Medium–High	LC (U)	**VU**	-	Low
PTEROPODIDAE	*Epomophorus wahlbergi*	Wahlberg's Epauletted Fruit Bat	Low	LC (S)	LC	-	High
PTEROPODIDAE	*Eidolon helvum*	African Straw-coloured Fruit Bat	Low	**NT (D)**	LC	**Migratory**	High

Status: D: Decreasing; EN: Endangered; LC: Least Concern; NT: Near Threatened; S: Stable; U: Unknown; VU: Vulnerable.

Source: [1]Monadjem *et al.* (2020); [2]African Chiroptera Report (2022); [3]FIAO (2023); [4]IWS (unpubl. data); [5]IUCN (2024-1); [6]Child *et al.* (2016); [7]MacEwan *et al.* (2020a)


a) Normandien – outbuilding with guano inside


a) Normandien – crevice inside building with guano


a) Normandien – guano and moth wings


b) Normandien – outbuilding with guano


b) Normandien – outbuilding guano stains


c) Normandien – abandoned farmhouse and outbuilding

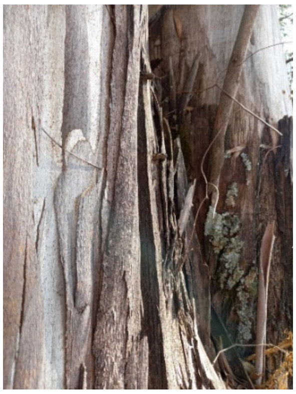

d) Normandien – rocky outcrop with crevices


d) Normandien – rocky ridge with crevices


e) Normandien – old shed with guano

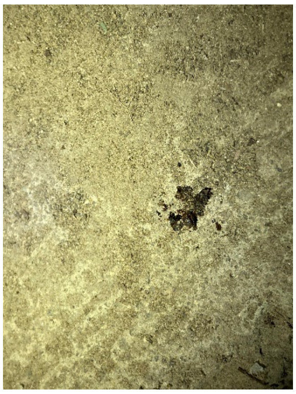

e) Normandien – guano in shed


e) Normandien – guano in abandoned house


f) Normandien – trees with loose bark and crevices

f) Normandien – trees with loose bark and crevices

g) Kromhof – sheds with guano



g) Kromhof – guano in shed

h) Kromhof – rocky outcrops and ridges with crevices

i) Kromhof– gap with smudgemarks in farmhouse roof

j) Kromhof – rocky outcrops and ridges with crevices

j) Kromhof – rocky outcrops and ridges with crevices

j) Kromhof – rocky outcrops and ridges with crevices

k) Groothoek – rocky ridges

l) Off-site - rocky outcrop with crevices south of Kromhof

m) Off-site – farmhouse north-east of Normandien

m) Off-site – farmhouse north-east of Normandien

Figure 5 **Examples of localities where potential bat roosting habitat or evidence of bat roosting was found**

6.3 Bat species composition at different heights

In the Verkykerskop WEF cluster, the Egyptian Free-tailed Bat, Little Free-tailed Bat, and Cape Serotine Bat were recorded at all stations and monitoring heights (**Figure 6; Figure 7**).

At turbine rotor sweep height, the Egyptian Free-tailed Bat was the dominant bat species recorded in the Verkykerskop WEF cluster. Calls made by this species contributed 94 – 96 % of all bat calls recorded at 88 m a.g.l in 2023/2024. The Little Free-tailed Bat contributed 3-4 % of all bat calls and the Cape Serotine contributed 1 % of all bat calls recorded at 88 m a.g.l. **These findings suggest that during operation of the WEF cluster, most of the turbine-related fatalities will comprise Egyptian Free-tailed Bats. Little Free-tailed Bats and Cape Serotines and possibly other species will likely also be killed during operation, but in fewer numbers.**

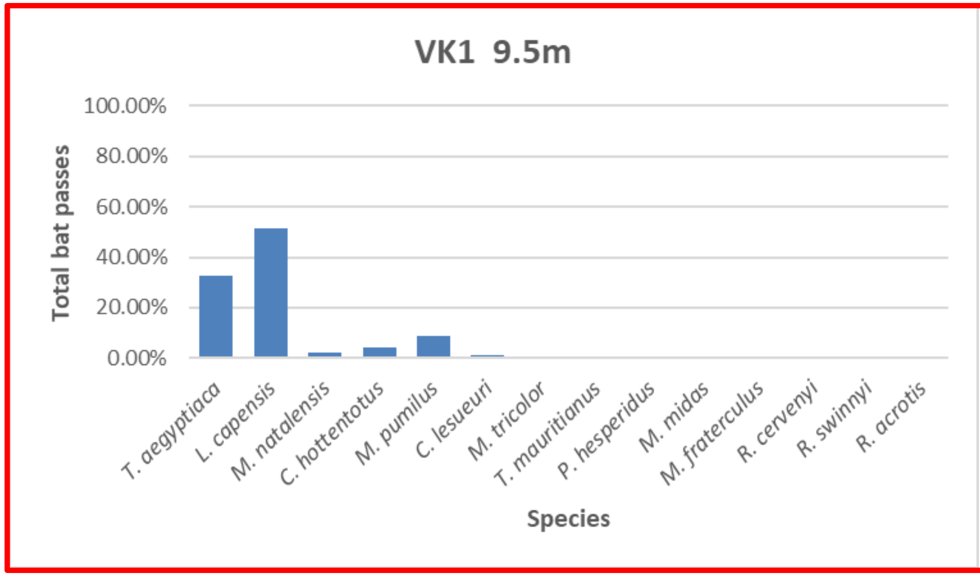
The Egyptian Free-tailed Bat, Cape Serotine Bat, Natal Long-fingered Bat, Long-tailed Serotine Bat, Little Free-tailed Bat, and Lesueur's Wing-gland Bat were recorded at all near ground-level stations (VK1 – VK8, 9.5 – 10 m a.g.l.) in the Verkykerskop WEF cluster. The Egyptian Free-tailed Bat contributed between 18 – 63% of the recorded calls made near ground-level at all monitoring stations. The Egyptian Free-tailed Bat was the dominant species at five of the monitoring stations (VK2, VK3, VK4, VK7-2 and VK8-2), while the Cape Serotine was the dominant species at VK1, VK5 and VK6 (32-51 % of all bat calls recorded). Overall, Cape Serotines contributed 1 – 51 % of the total amount of bat calls recorded near ground level. The Natal Long-fingered Bat contributed 1 – 29 % of all bat calls, with the greatest contribution by this species at VK 5. The Long-tailed Serotine contributed 4 – 30 % of all recorded bat calls near ground level and was the second most dominant species recorded at VK6 and VK7-2. The Little Free-tailed Bat and Lesueur's Wing-gland Bat, respectively, contributed 3 – 11 % and 1 – 4 % of all bat calls recorded near ground level. **These findings indicate that a greater diversity (species richness and abundance) of bats will be at risk of fatality the closer that turbine blades sweep down towards ground level.**

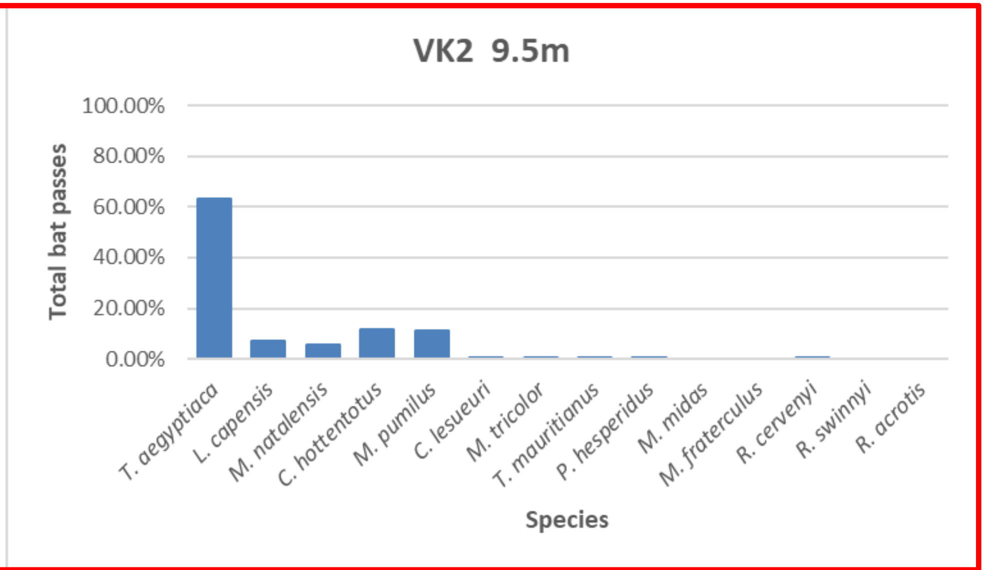
Near the Groothoek WEF site (stations VK1, VK2 and VK8), the Egyptian Free-tailed Bat was the dominant species in rotor sweep height (88 m a.g.l), contributing 94 % of all bat calls at VK8-1. Near ground level, the Egyptian Free-tailed Bat was the dominant species at VK2 (63 % of all bat calls) and VK8-2 (48 % of all bat calls), followed by Cape Serotines contributing 7 – 32 % of all bat calls recorded at those stations. Cape Serotines dominated at VK1 contributing 51 % of all bat calls recorded. The amount of Cape Serotine bat calls was relatively low at VK2 (7 % of all bat calls) compared to VK1 and VK8-2. Little Free-tailed Bats were recorded at all monitoring heights, contributing 4 – 11 % of all bat calls. Specifically, at rotor sweep height, Little Free-tailed Bats contributed 4 % of all bat calls. **These findings suggest that during operation of the Groothoek WEF, most of the turbine-related fatalities will comprise Egyptian Free-tailed Bats. Little Free-tailed Bats and Cape Serotines and possibly other species will likely also be killed during operation but in fewer numbers.**

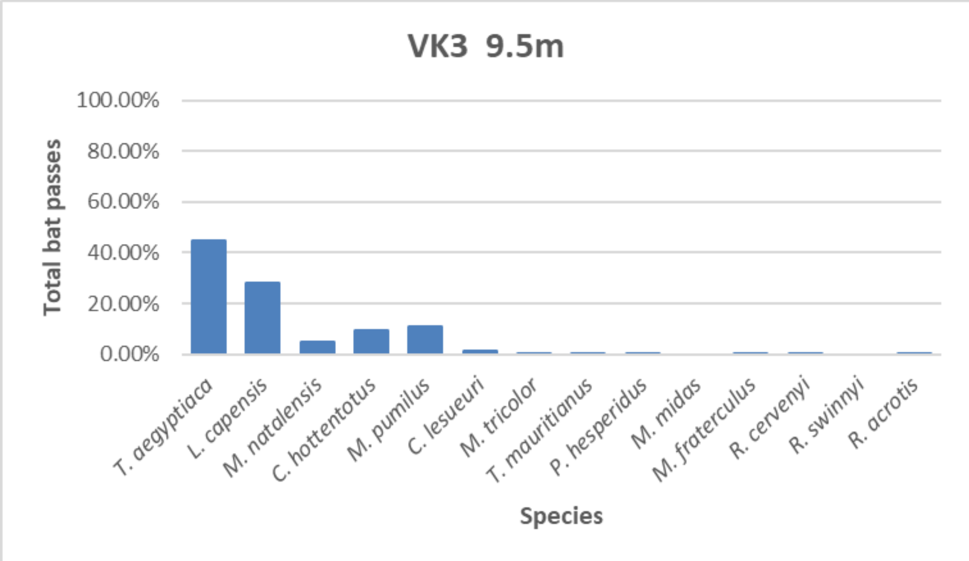
The Natal Long-fingered Bat, Long-tailed Serotine Bat and Lesueur's Wing-gland Bat were only recorded near ground level. The Long-tailed Serotine Bat and Little Free-tailed Bat were the second most dominant species recorded at VK2, both contributing 11 % of all bat calls recorded. Lesueur's Wing-gland Bat only contributed 1-2 % of the bat calls recorded on site.

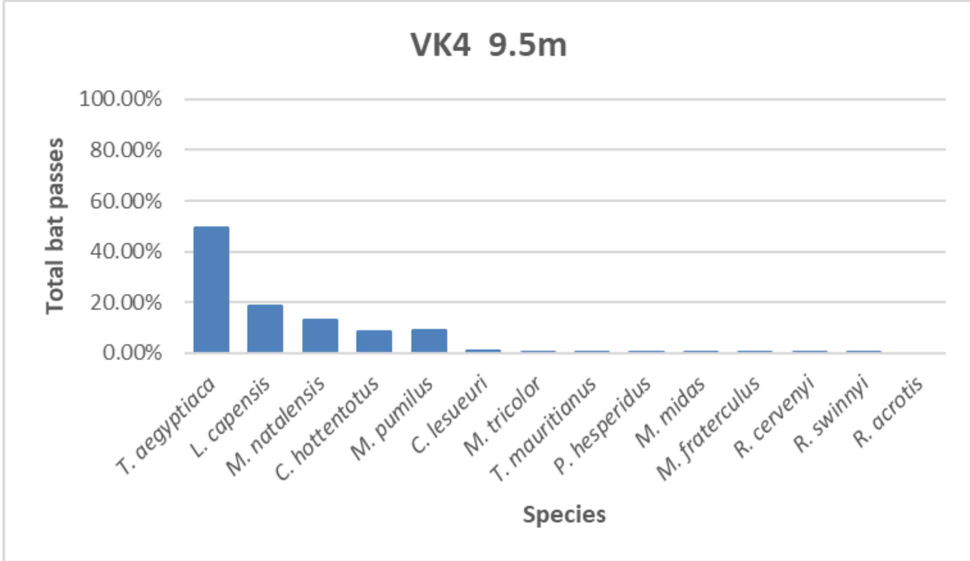
In/Near the Groothoek WEF site, at least 12 different species were recorded near ground level over the monitoring period. For example, at VK2, at least 10 species were recorded and at VK8-2, 12 species were recorded. Aside from the afore-mentioned species, these included Temminck's Myotis, Mauritian Tomb Bat, Dusky Pipistrelle, Midas Free-tailed Bat, Lesser Long-fingered Bat and *Rhinolophus cervenyi*, which were recorded only a handful of times each contributing less than 1 % of all bat calls. **Certainly, a greater diversity (species richness and abundance) of bats will be at risk of fatality from turbines with blades that approach closer to ground level. Although these species were only recorded a handful of times, the risk of fatalities of SCC (e.g. Temminck's Myotis, Lesser Long-fingered Bat, Lesueur's Wing-gland Bat, and possibly others) will also increase with blades that approach closer to ground level. This is a very important consideration.**

Differences in species composition between seasons at all monitoring heights can be seen in **Appendix 1**.


VK1 9.5m
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK2 9.5m
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK3 9.5m
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK4 9.5m
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

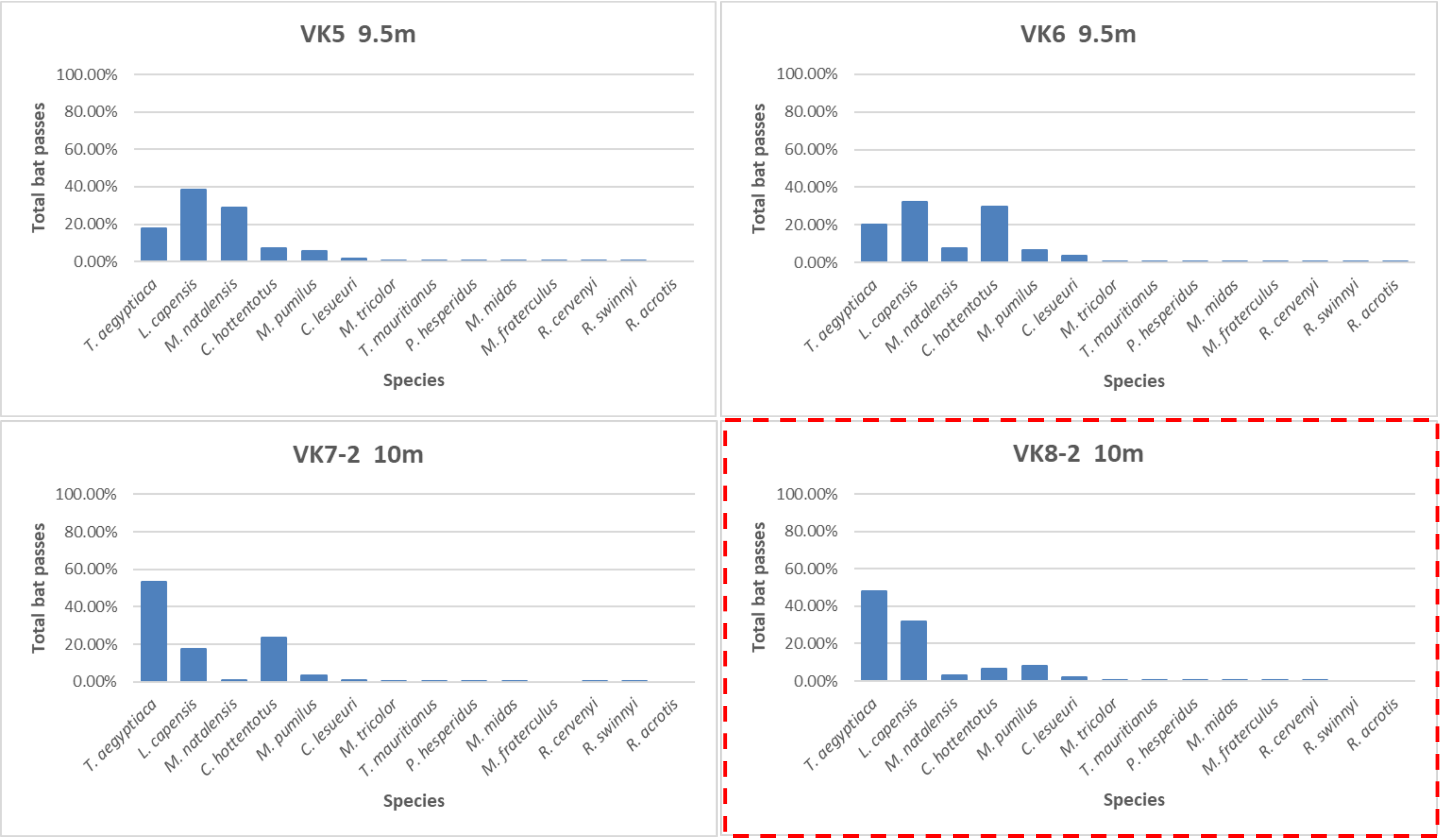
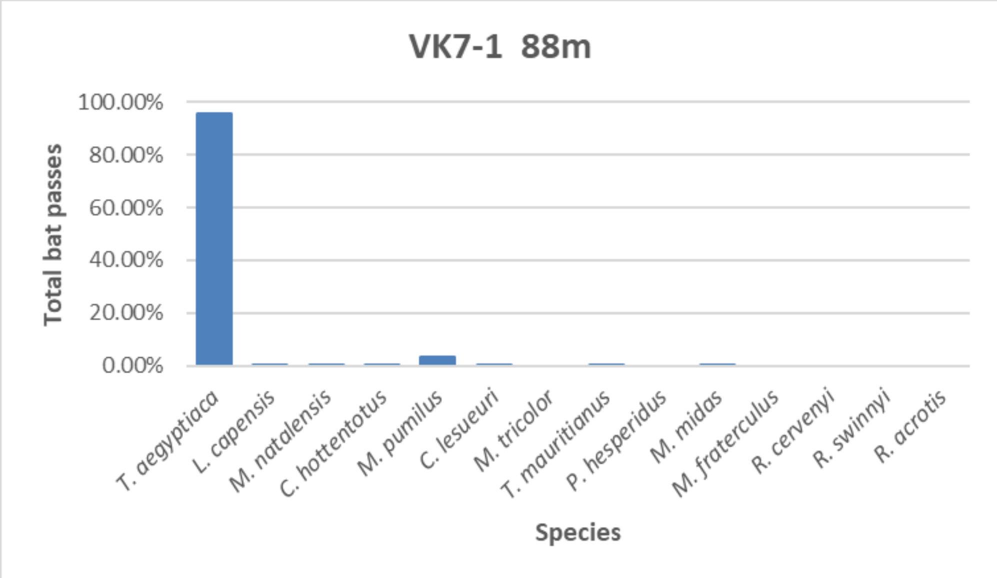


Figure 6 Species composition of bat calls recorded near ground level at VK1-VK8. The Groothoek microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8-2) are outlined in dashed red



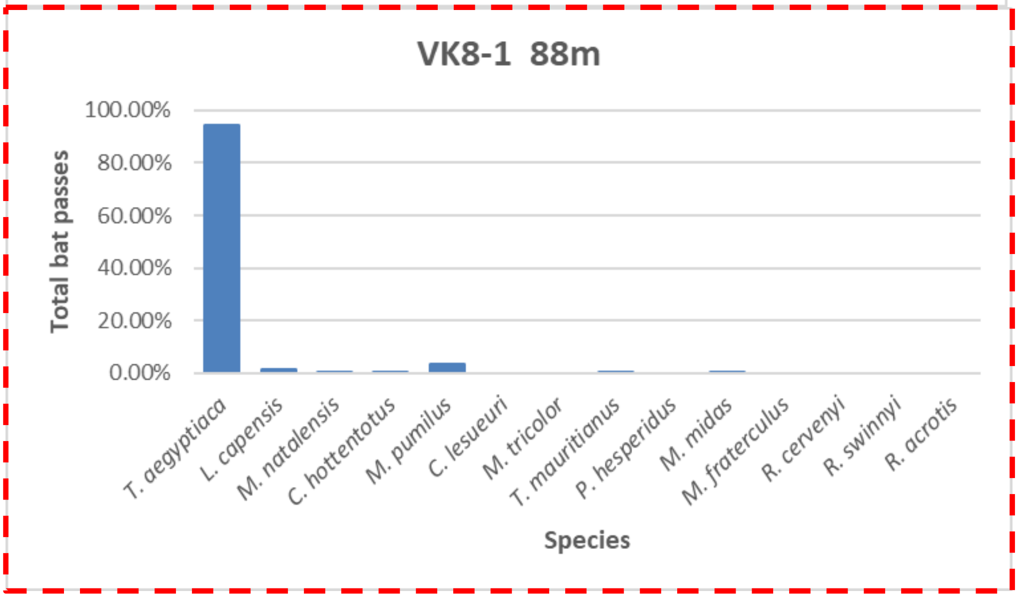
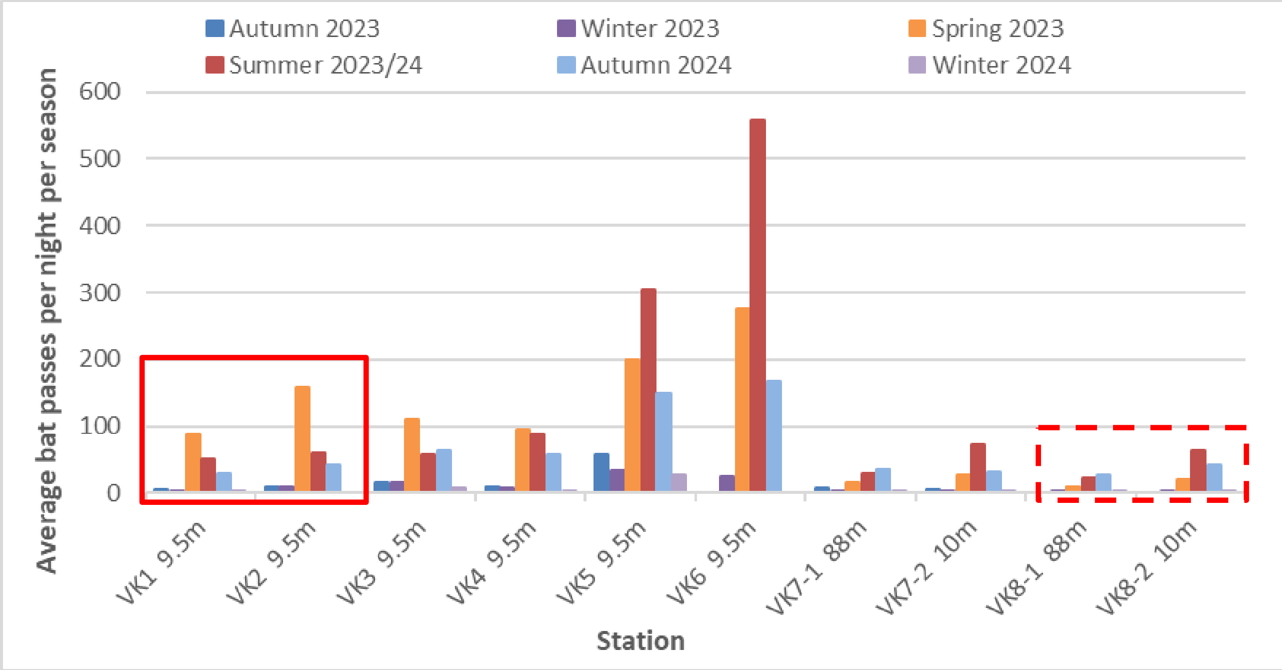


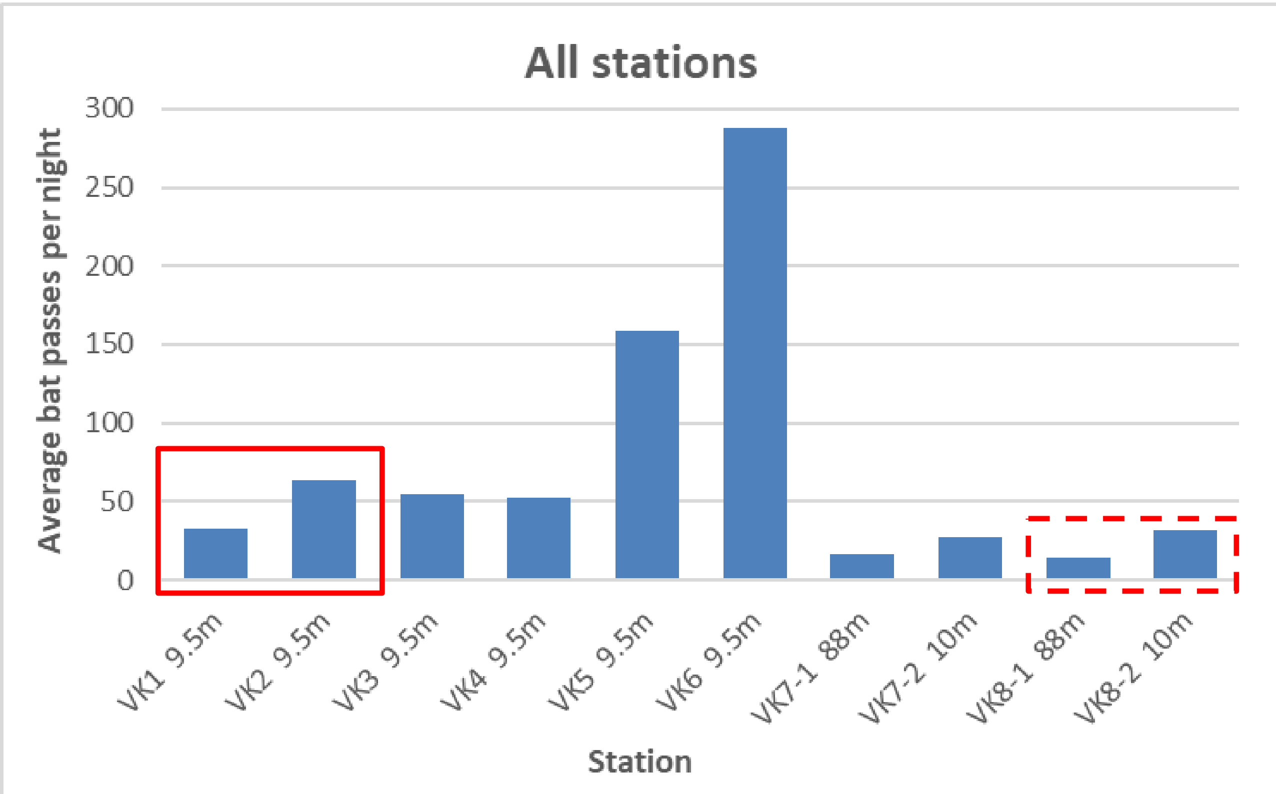
Figure 7 Species composition of bat calls recorded in rotor sweep height at VK7 and VK8. The closest microphones from a met. mast (VK8-1) to the Groothoek WEF are outlined in dashed red

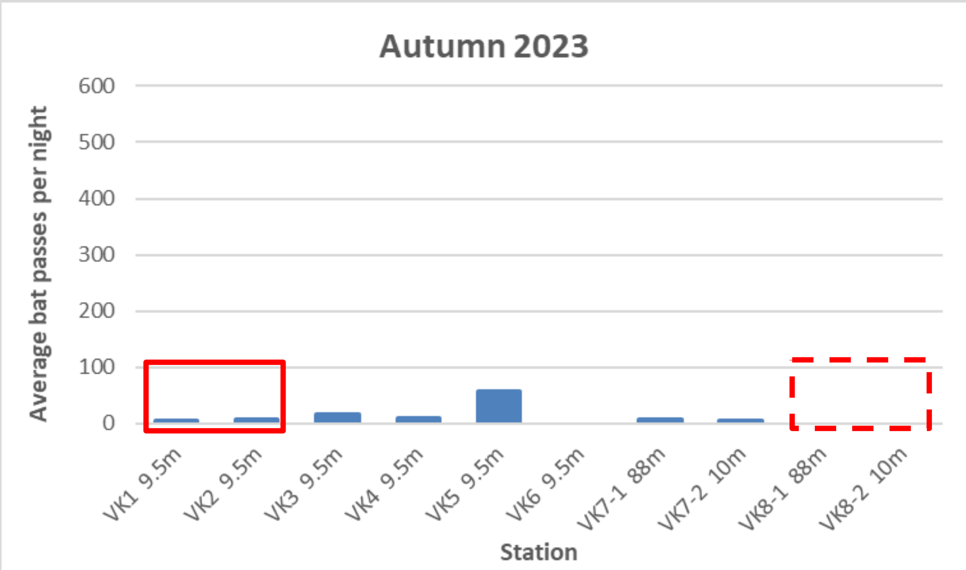
6.4 General bat activity at different heights and locations and during different seasons

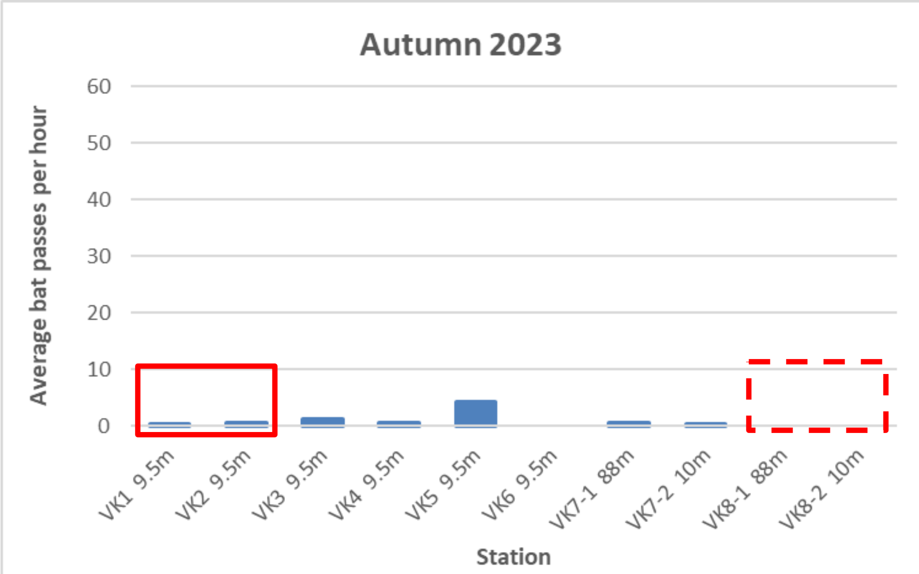
Overall, the Verkykerskop cluster site had a high level of bat activity per night, with an average of 15.39 bat passes (bp) recorded at rotor sweep height, and 88.59 bp recorded near ground level. Per hour, 1.26 bp were detected in rotor sweep height, and an average of 7.38 bp were detected near ground level (**Figure 8**). **The overall levels of bat activity recorded in the Verkykerskop cluster site are appreciably higher than those recorded elsewhere in the Drakensberg Grasslands ecoregion** (Dinerstein *et al*. 2017), where activity at height (60 m) averaged 0 bp/h (range: 0 – 2 bp/h), and near-ground activity averaged 2 bp/h (range: 0 – 6 bp/h) (MacEwan *et al.* 2020b). The recorded high bat activity levels are at least partly explained by the extensive availability of suitable bat habitat including rocky outcrops with crevices, farm buildings, woody vegetation, and water in the form of dams, streams, other wetlands, and reservoirs.

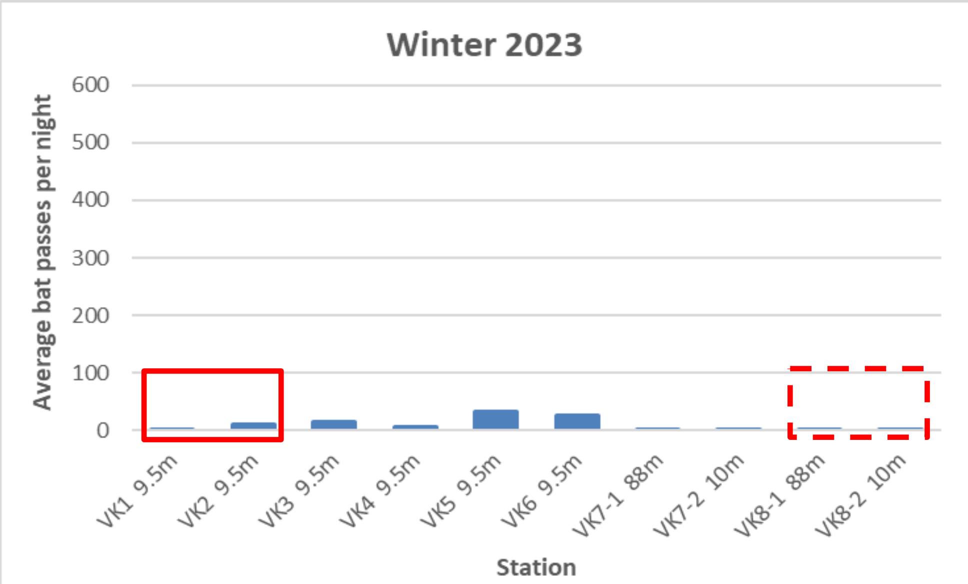
At the bat monitoring stations in/near the Groothoek WEF site, an average of 13.82 bp/night was recorded in rotor sweep height (at VK8) and an average of 48.04 bp/night was recorded near ground level (**Figure 8**). Hourly, an average of 1.14 bp were detected in rotor sweep height, and 3.99 bp were detected near ground level on average. **The recorded bat activity in/near the Groothoek WEF site is within the range of bat activity reported for the Drakensberg Grasslands ecoregion** (MacEwan *et al.* 2020b).

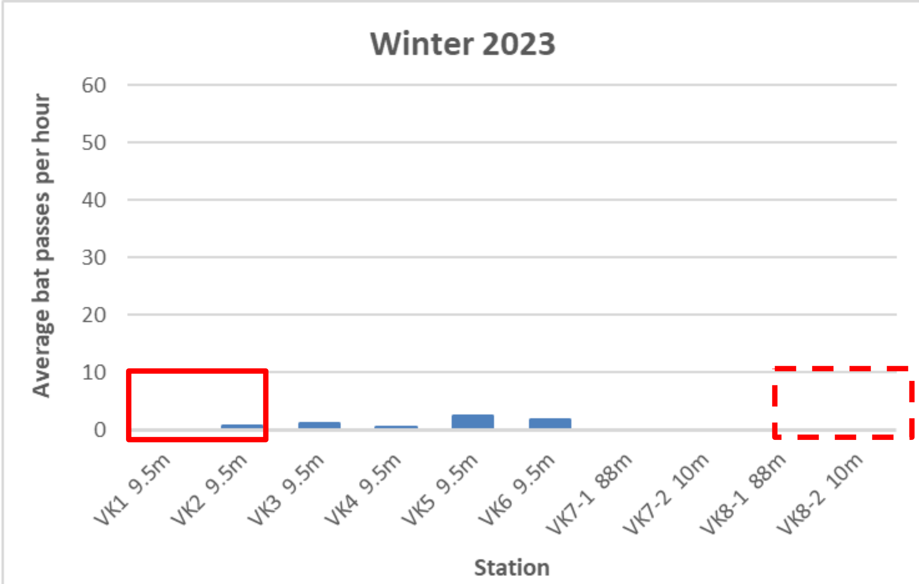

Autumn 2023
Winter 2023
Spring 2023
Summer 2023/24
Autumn 2024
Winter 2024
Average bat passes per night per season
600
500
400
300
200
100
0
VK1 9.5m
VK2 9.5m
VK3 9.5m
VK4 9.5m
VK5 9.5m
VK6 9.5m
VK7-1 88m
VK7-2 10m
VK8-1 88m
VK8-2 10m
Station

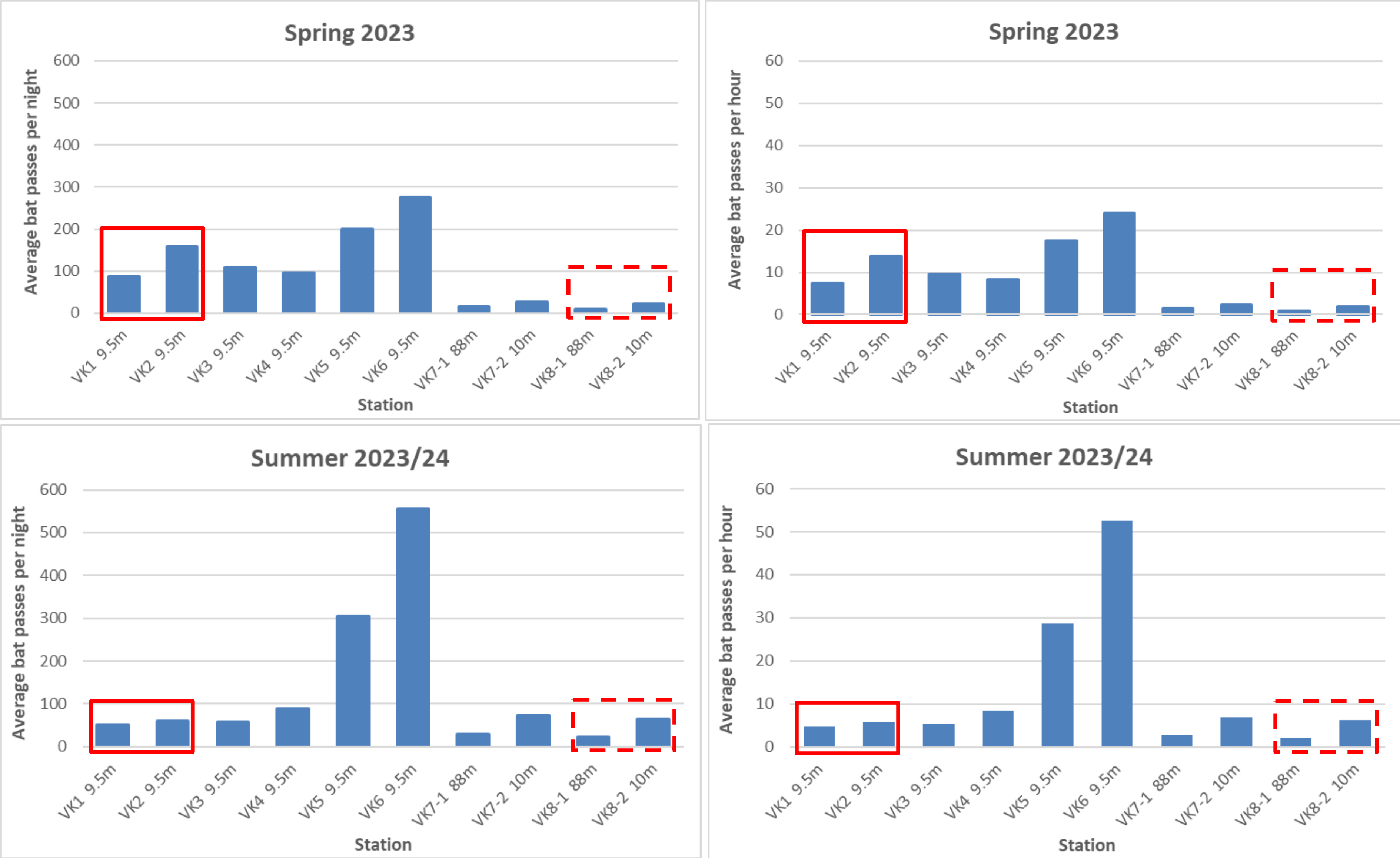

All stations
Average bat passes per night
300
250
200
150
100
50
0
VK1 9.5m
VK2 9.5m
VK3 9.5m
VK4 9.5m
VK5 9.5m
VK6 9.5m
VK7-1 88m
VK7-2 10m
VK8-1 88m
VK8-2 10m
Station


Autumn 2023
Average bat passes per night
600
500
400
300
200
100
0
VK1 9.5m
VK2 9.5m
VK3 9.5m
VK4 9.5m
VK5 9.5m
VK6 9.5m
VK7-1 88m
VK7-2 10m
VK8-1 88m
VK8-2 10m
Station


Autumn 2023
Average bat passes per hour
60
50
40
30
20
10
0
VK1 9.5m
VK2 9.5m
VK3 9.5m
VK4 9.5m
VK5 9.5m
VK6 9.5m
VK7-1 88m
VK7-2 10m
VK8-1 88m
VK8-2 10m
Station


Winter 2023
Average bat passes per night
600
500
400
300
200
100
0
VK1 9.5m
VK2 9.5m
VK3 9.5m
VK4 9.5m
VK5 9.5m
VK6 9.5m
VK7-1 88m
VK7-2 10m
VK8-1 88m
VK8-2 10m
Station


Winter 2023
Average bat passes per hour
60
50
40
30
20
10
0
VK1 9.5m
VK2 9.5m
VK3 9.5m
VK4 9.5m
VK5 9.5m
VK6 9.5m
VK7-1 88m
VK7-2 10m
VK8-1 88m
VK8-2 10m
Station


Spring 2023
Average bat passes per night
600
500
400
300
200
100
0
VK1 9.5m
VK2 9.5m
VK3 9.5m
VK4 9.5m
VK5 9.5m
VK6 9.5m
VK7-1 88m
VK7-2 10m
VK8-1 88m
VK8-2 10m
Station
Spring 2023
Average bat passes per hour
60
50
40
30
20
10
0
Station
Summer 2023/24
Average bat passes per night
Station
Summer 2023/24
Average bat passes per hour
Station

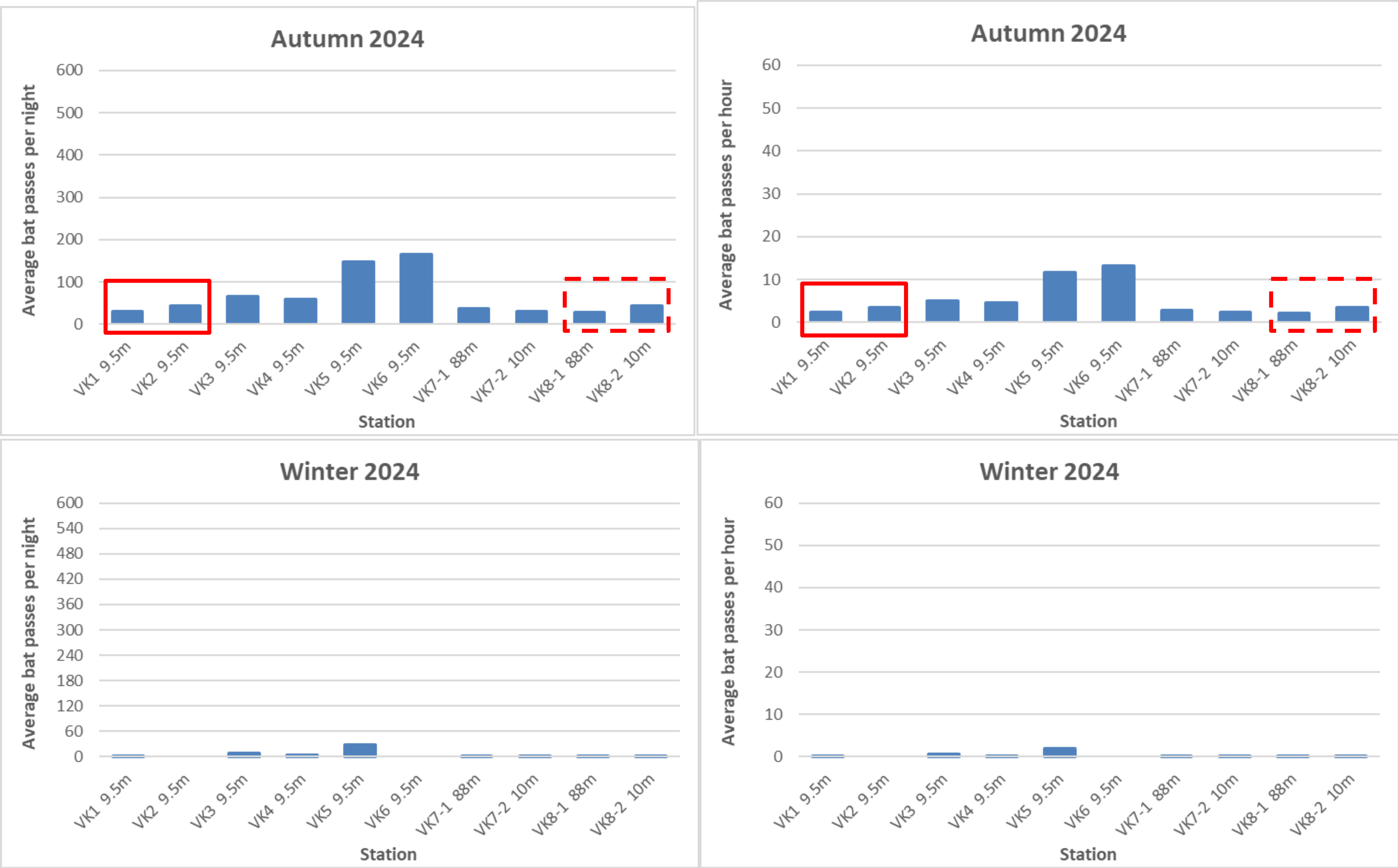
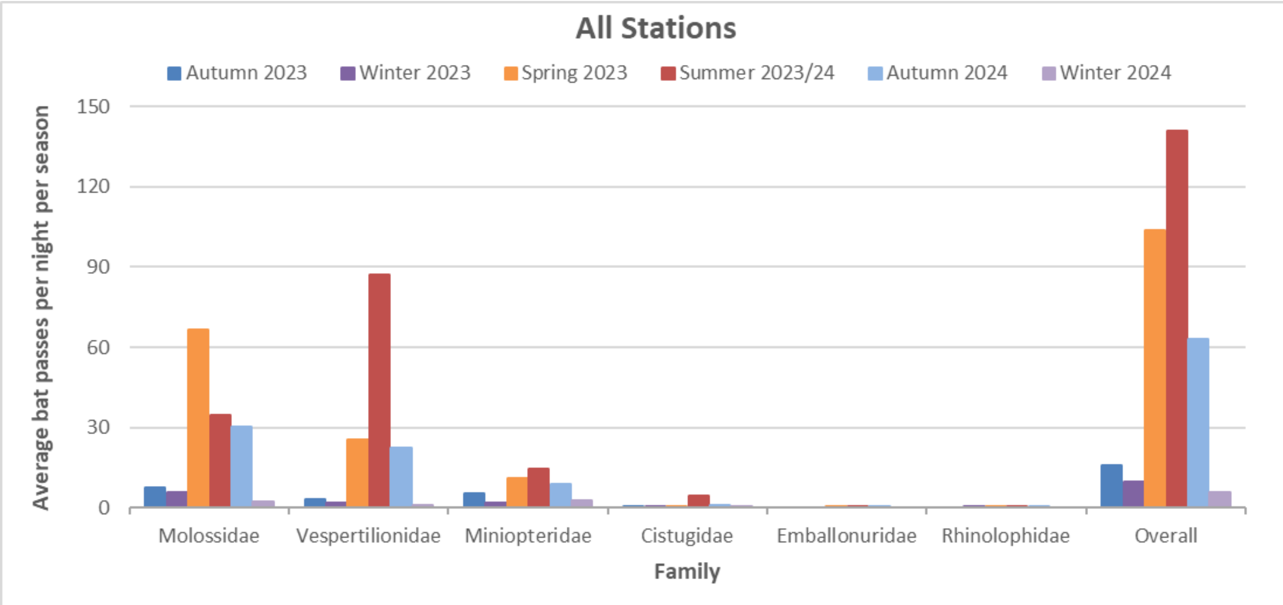
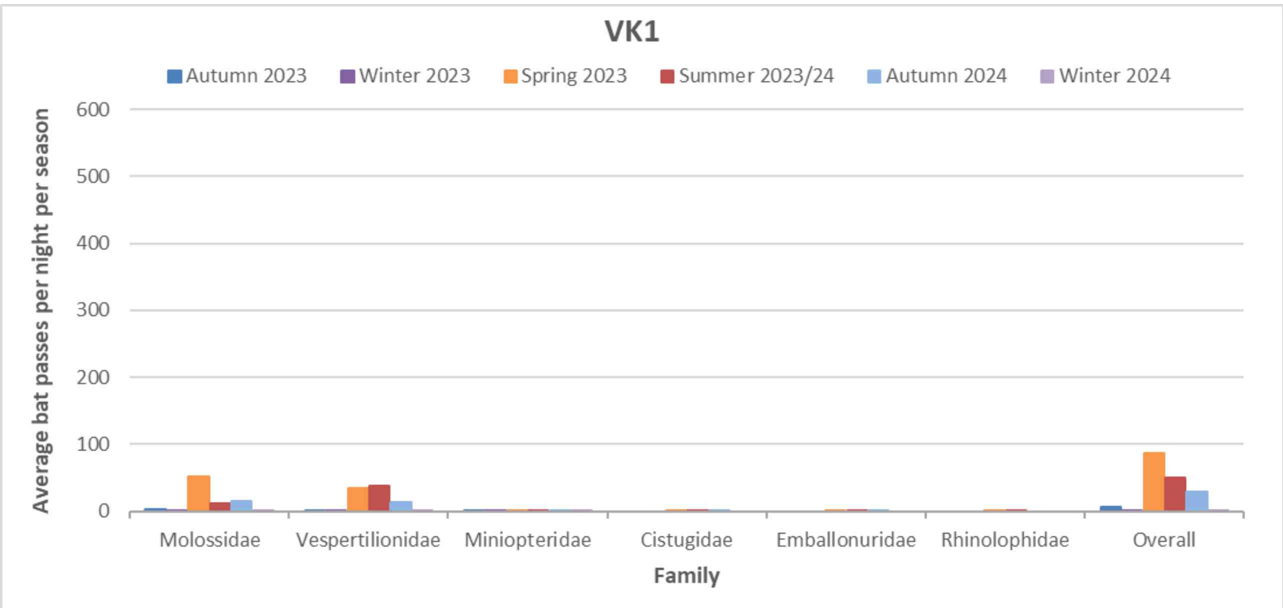


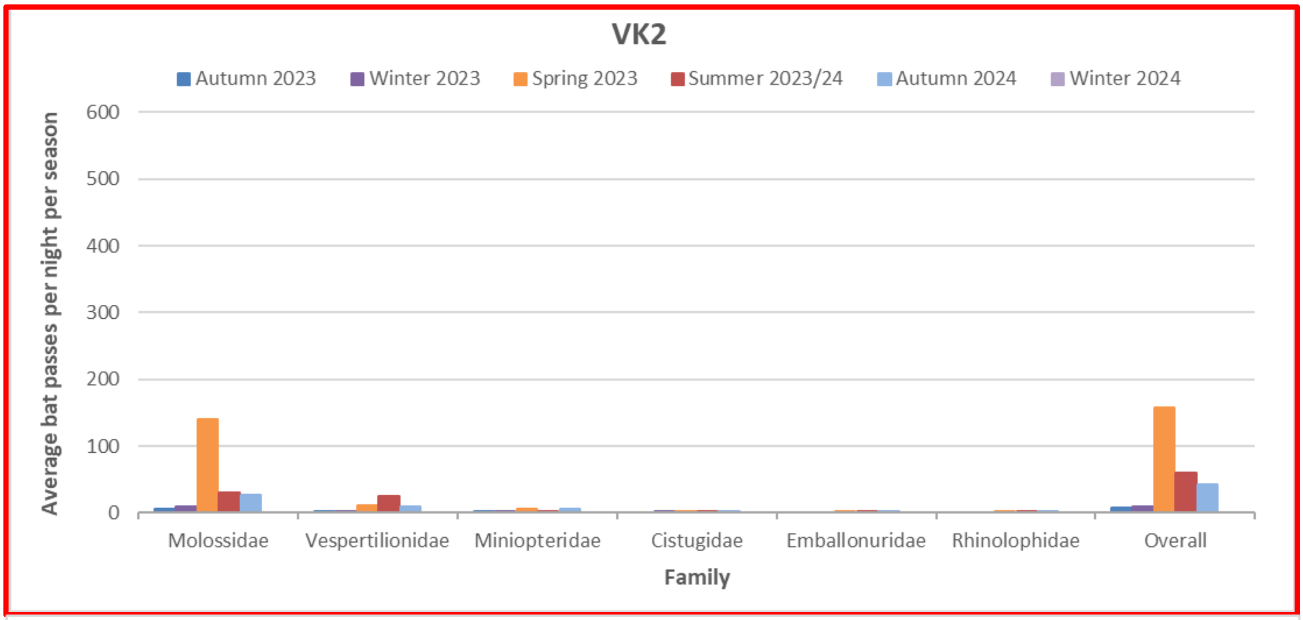
Figure 8 Average seasonal bat activity measured in passes per night (left) or per hour (right) recorded on site. The Groothoek microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8) are outlined in dashed red

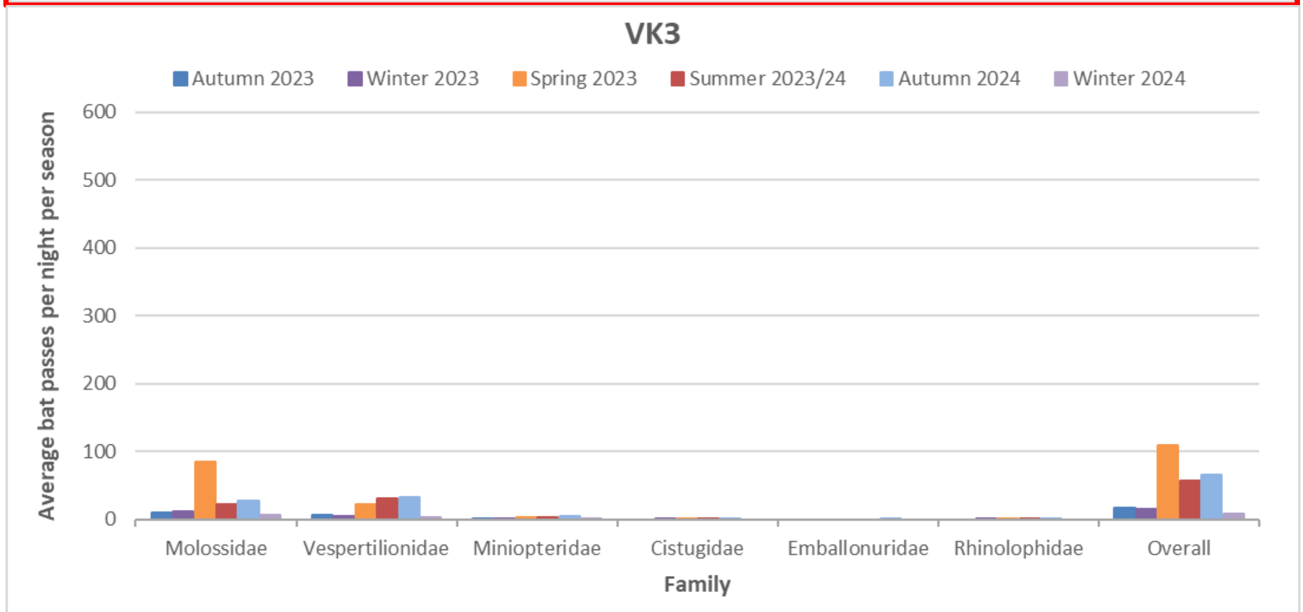
6.5 Activity of different bat families at different heights and locations and during different seasons

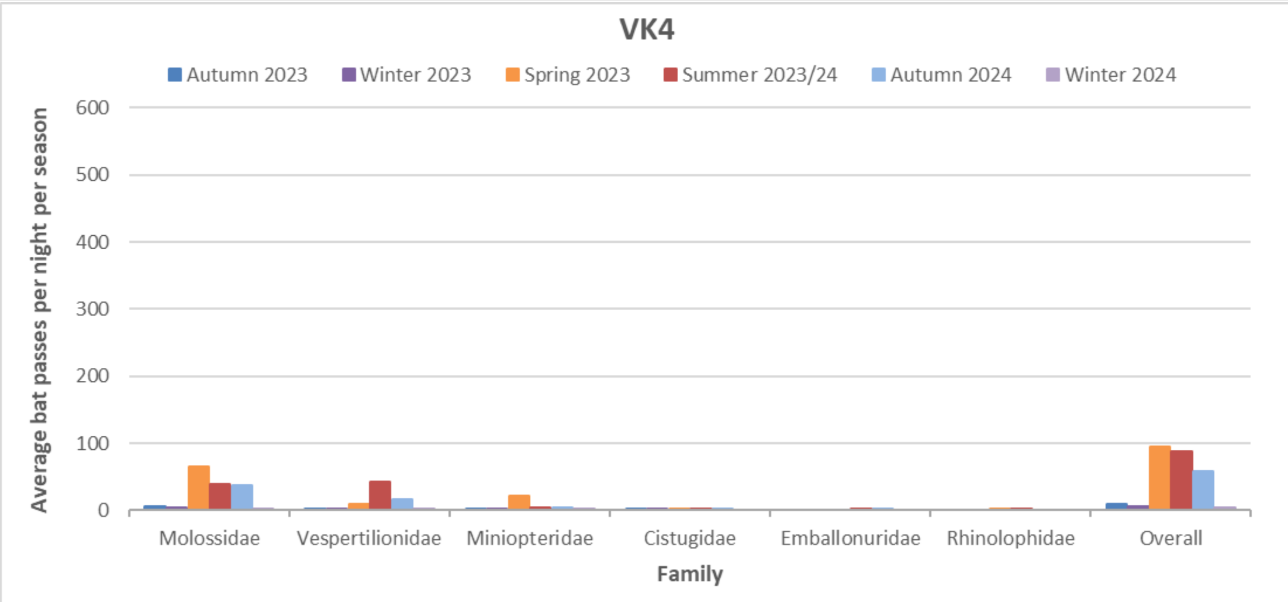
Overall bat activity levels were highest in summer, spring, and autumn, with the lowest activity levels present in winter. The different bat taxa exhibited distinct seasonal patterns of activity (**Figure 9**). Egyptian Free-tailed Bats (of the Molossidae family) were generally most active in spring and summer. Cape Serotines (of the Vesertilionidae family) were most active during summer, possibly because this is when females have pups to feed and wean (Monadjem *et al*. 2020). The Natal Long-fingered Bat (of the Miniopteridae family) exhibited the highest levels of activity mostly in summer, spring, and autumn possibly due to their breeding and migratory patterns (Pretorius *et al.* 2020). The other recorded families had distinctly lower activity levels but exhibited similar patterns across all seasons. These patterns in family activity levels over the seasons were mirrored by the recordings at the bat monitoring stations at the Groothoek WEF site. **These taxon-specific differences should be taken into consideration if/when fatality mitigation measures are implemented.**

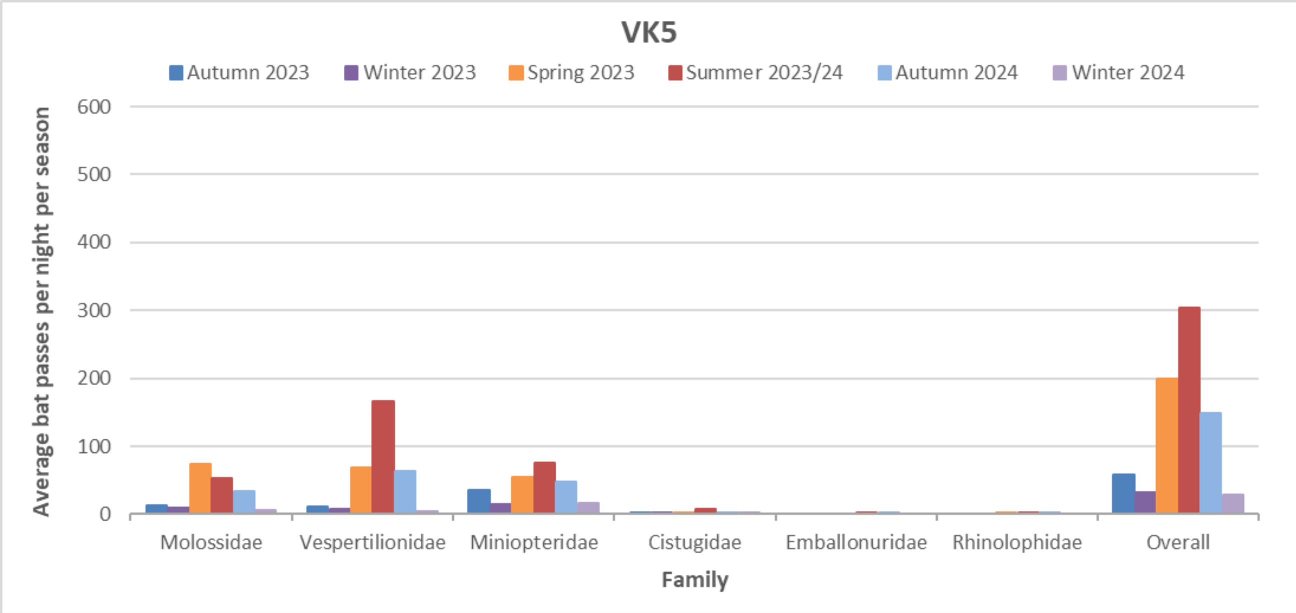


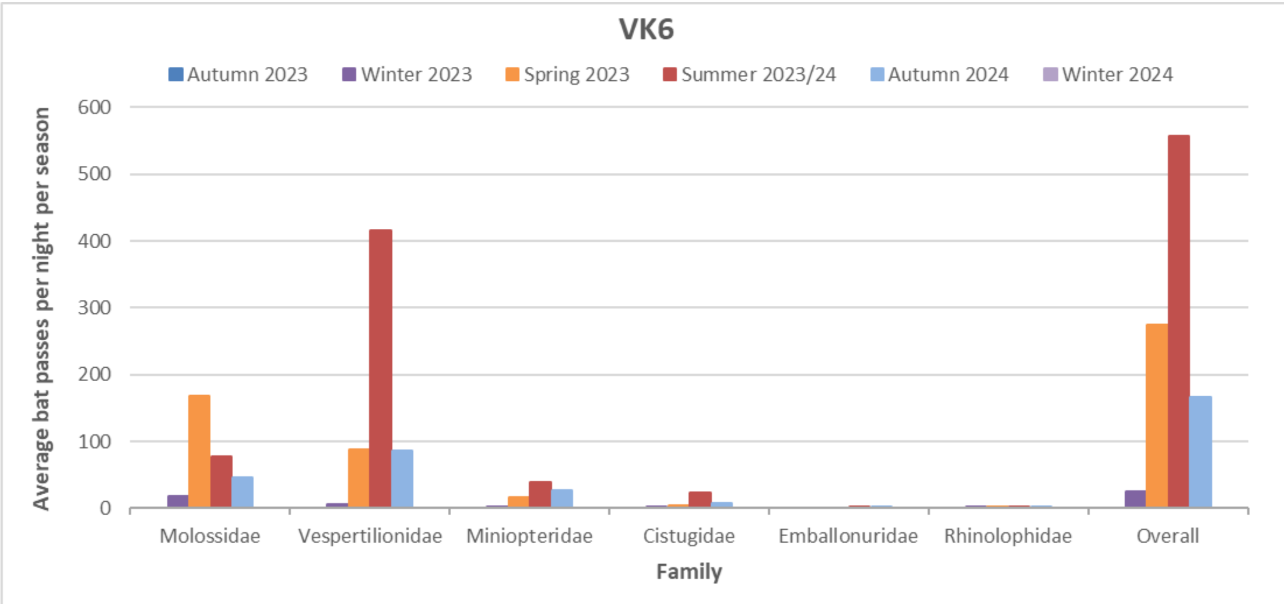


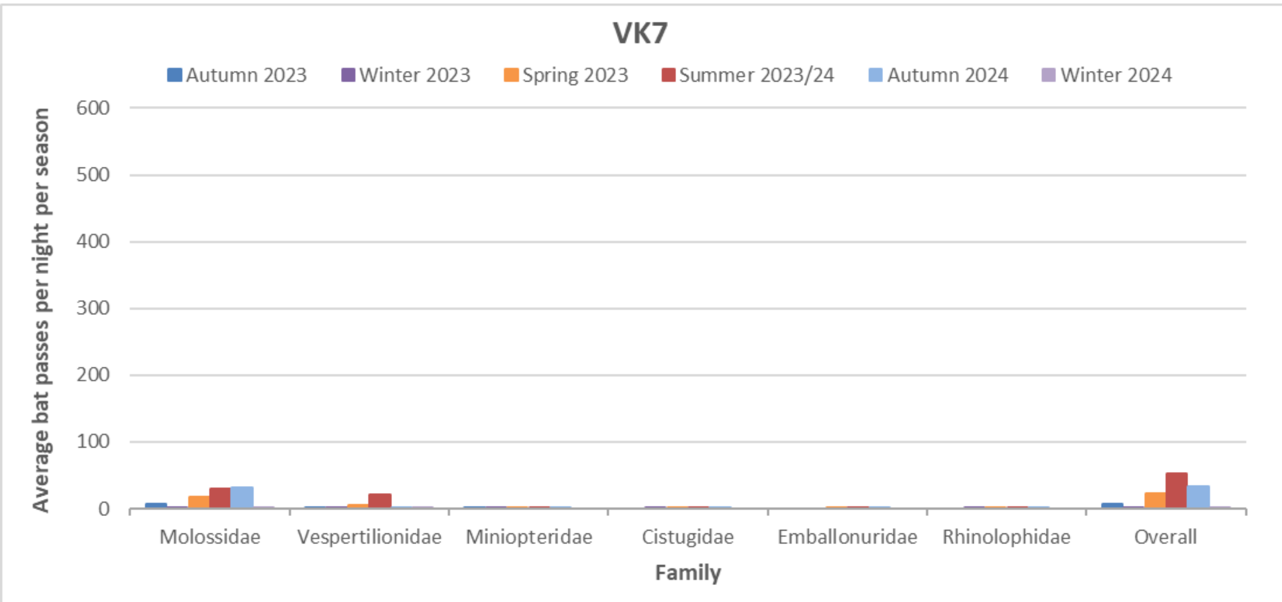

VK2
Autumn 2023
Winter 2023
Spring 2023
Summer 2023/24
Autumn 2024
Winter 2024
Average bat passes per night per season
0
100
200
300
400
500
600
Molossidae
Vespertilionidae
Miniopteridae
Cistugidae
Emballonuridae
Rhinolophidae
Overall
Family


VK3
Autumn 2023
Winter 2023
Spring 2023
Summer 2023/24
Autumn 2024
Winter 2024
Average bat passes per night per season
0
100
200
300
400
500
600
Molossidae
Vespertilionidae
Miniopteridae
Cistugidae
Emballonuridae
Rhinolophidae
Overall
Family


VK4
Autumn 2023
Winter 2023
Spring 2023
Summer 2023/24
Autumn 2024
Winter 2024
Average bat passes per night per season
0
100
200
300
400
500
600
Molossidae
Vespertilionidae
Miniopteridae
Cistugidae
Emballonuridae
Rhinolophidae
Overall
Family


VK5
Autumn 2023
Winter 2023
Spring 2023
Summer 2023/24
Autumn 2024
Winter 2024
Average bat passes per night per season
600
500
400
300
200
100
0
Molossidae
Vespertilionidae
Miniopteridae
Cistugidae
Emballonuridae
Rhinolophidae
Overall
Family


VK6
Autumn 2023
Winter 2023
Spring 2023
Summer 2023/24
Autumn 2024
Winter 2024
Average bat passes per night per season
600
500
400
300
200
100
0
Molossidae
Vespertilionidae
Miniopteridae
Cistugidae
Emballonuridae
Rhinolophidae
Overall
Family


VK7
Autumn 2023
Winter 2023
Spring 2023
Summer 2023/24
Autumn 2024
Winter 2024
Average bat passes per night per season
600
500
400
300
200
100
0
Molossidae
Vespertilionidae
Miniopteridae
Cistugidae
Emballonuridae
Rhinolophidae
Overall
Family

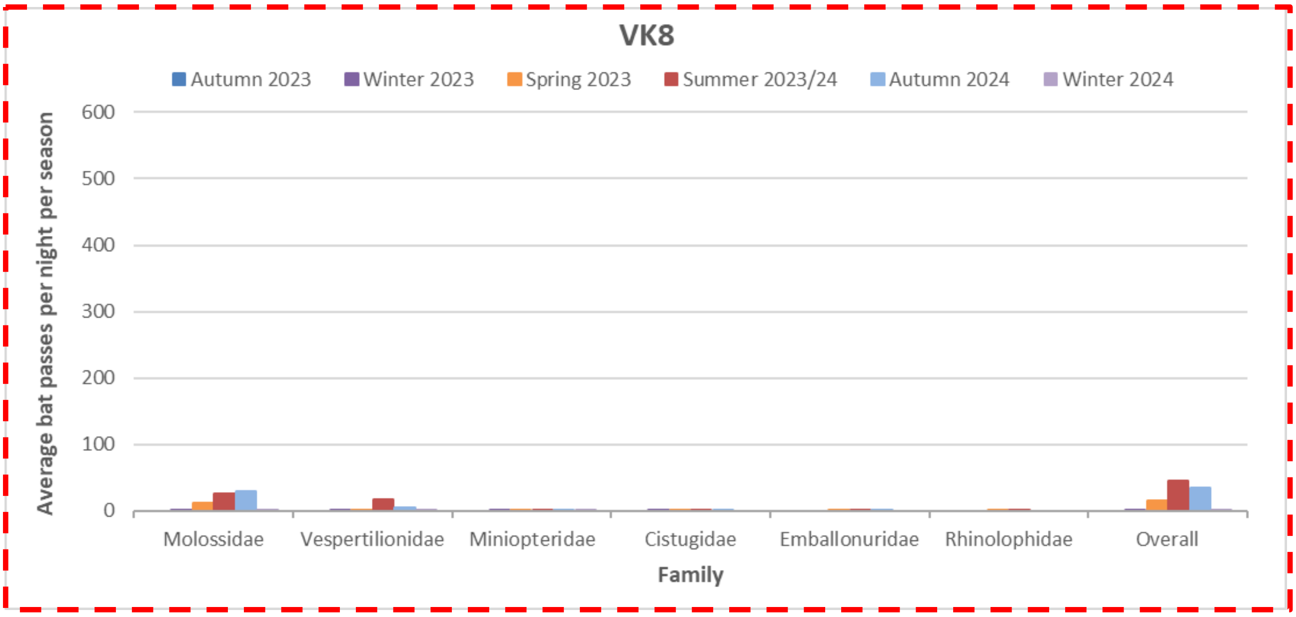


Figure 9 Average activity (measured in passes per night per season) of the different bat families onsite. The Groothoek microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8) are outlined in dashed red

6.6 Nights when bat activity peaked

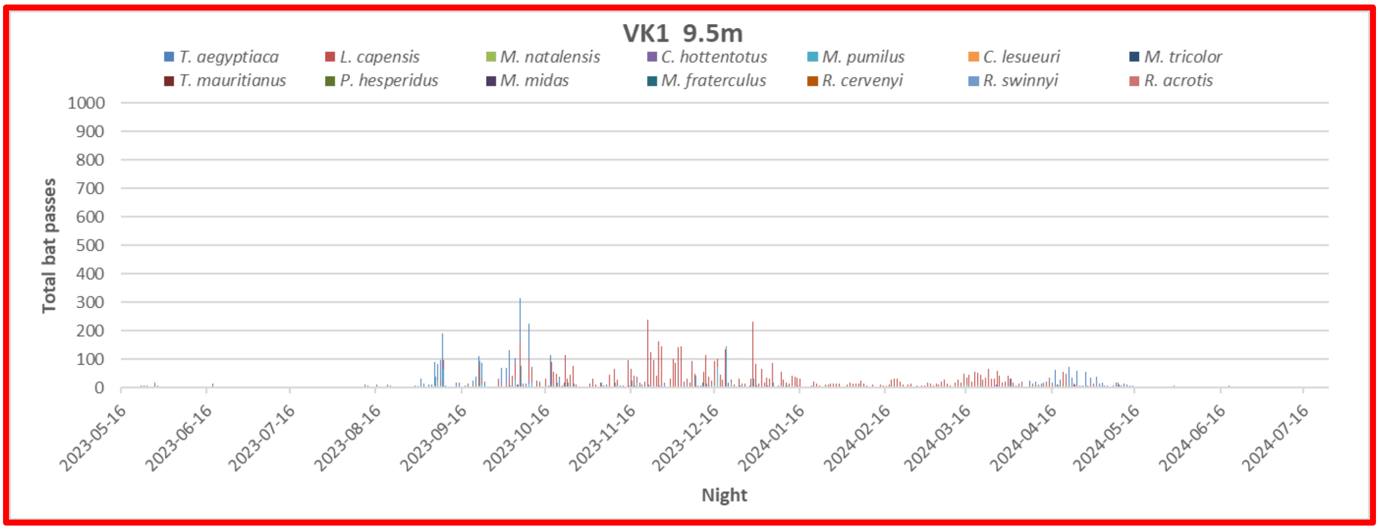
Across the Verkykerskop cluster site, the highest total numbers of bat passes were recorded mainly during nights between mid-September to mid-March (early spring to late summer). The highest peaks in nightly bat activity were observed during summer, when as many as 1099 bp, 1505 bp, and 1521 bp per night were recorded at VK6. Higher peaks in bat activity were observed closer to the ground (10 m) then at rotor sweep height (88 m).

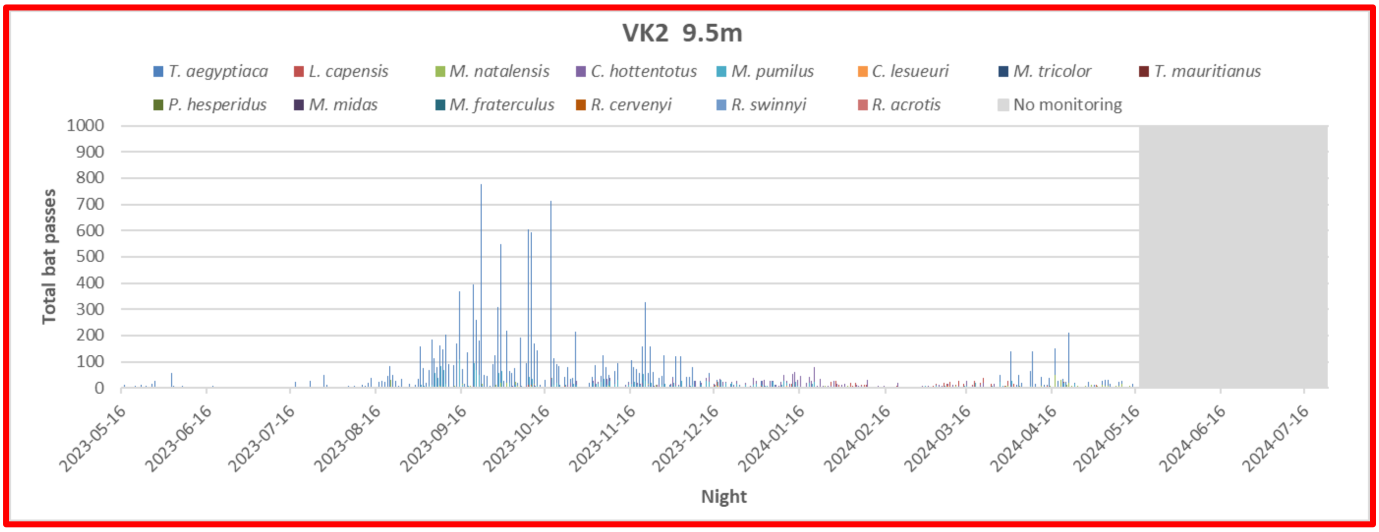
At the Groothoek WEF site, nights with the highest total number of bat passes were recorded generally from mid-September to mid-March (early spring to late summer), but most often during spring (September – November), specifically mid-September and early October (**Figure 10**).

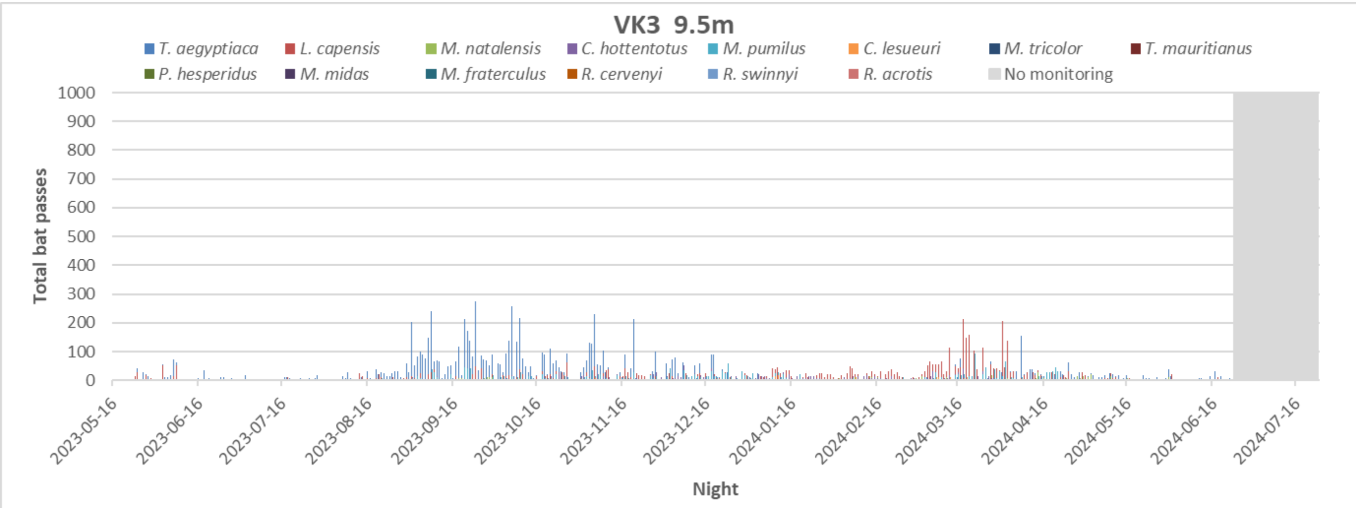
Egyptian Free-tailed Bat activity at 9.5 m peaked on multiple nights particularly from September to November, with the highest number (778 bp) recorded at VK2 9.5 m on 23 September 2023. In rotor sweep height, the activity of this species reached 176 bp at VK8-1 88 m on 1 April 2024. During such nights, fatalities of Egyptian Free-tailed Bats will be inevitable without effective mitigation.

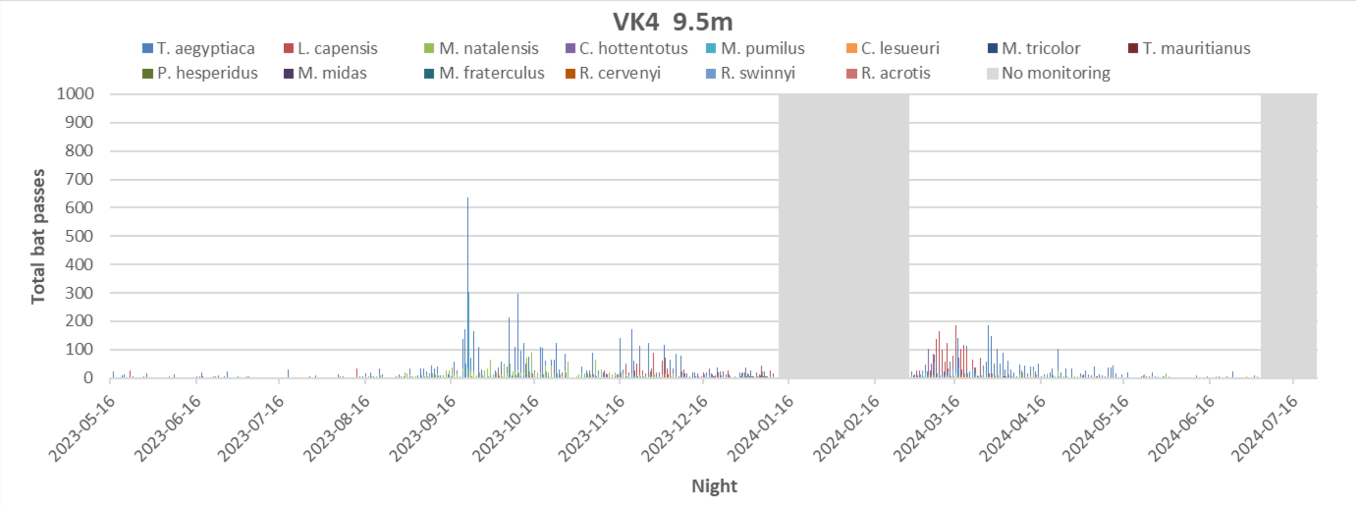
Cape Serotine activity reached up to 404 bp on 15 March 2024 at VK8-2 10 m, and 238 bp on 22 November 2023 at VK1, compared to a considerably lower peak of 39 bp on 18 October 2023 at VK2. These differences are likely a reflection, inter alia, of the proximity of these stations to the nearest Cape Serotine roost(s). Cape Serotine activity was much lower at height, with peaks reaching up to 31 bp at 88 m at VK8-1 on 5 March 2024.

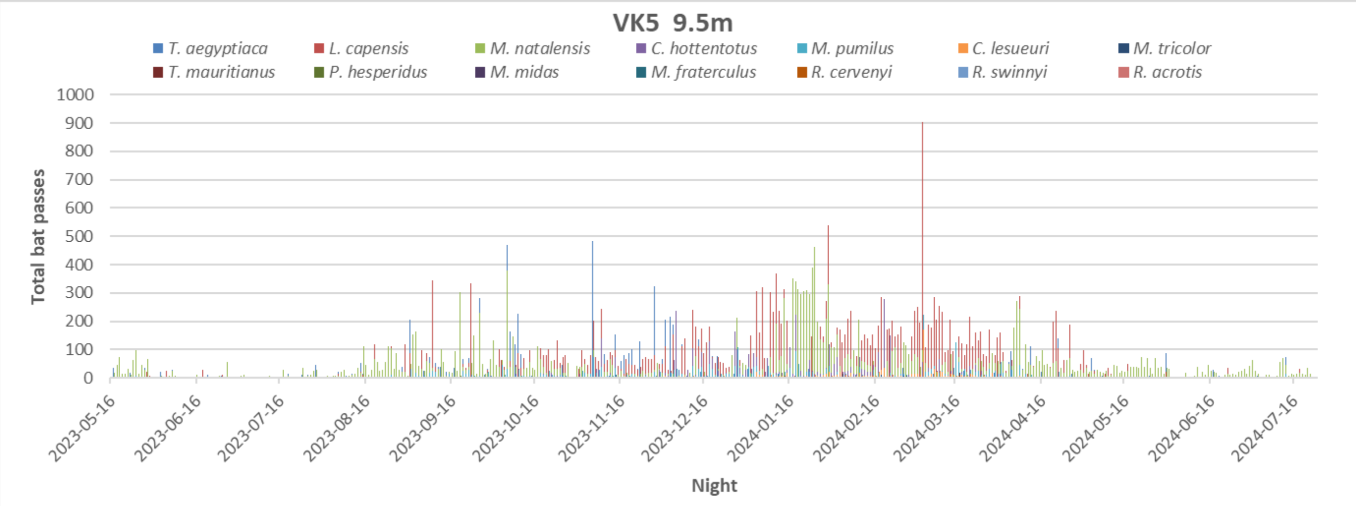
The comparatively lower nightly activity of the other bat species, included but not visible in **Figure 10**, is presented in **Appendix 2**. Miniopteridae bats are often most active in autumn (and winter), which was the case at VK2. These taxon-specific differences should be taken into consideration if/when fatality mitigation measures are implemented. Should Natal Long-fingered Bat fatalities exceed the WEF's threshold for this species, mitigation may be required during autumn and winter.

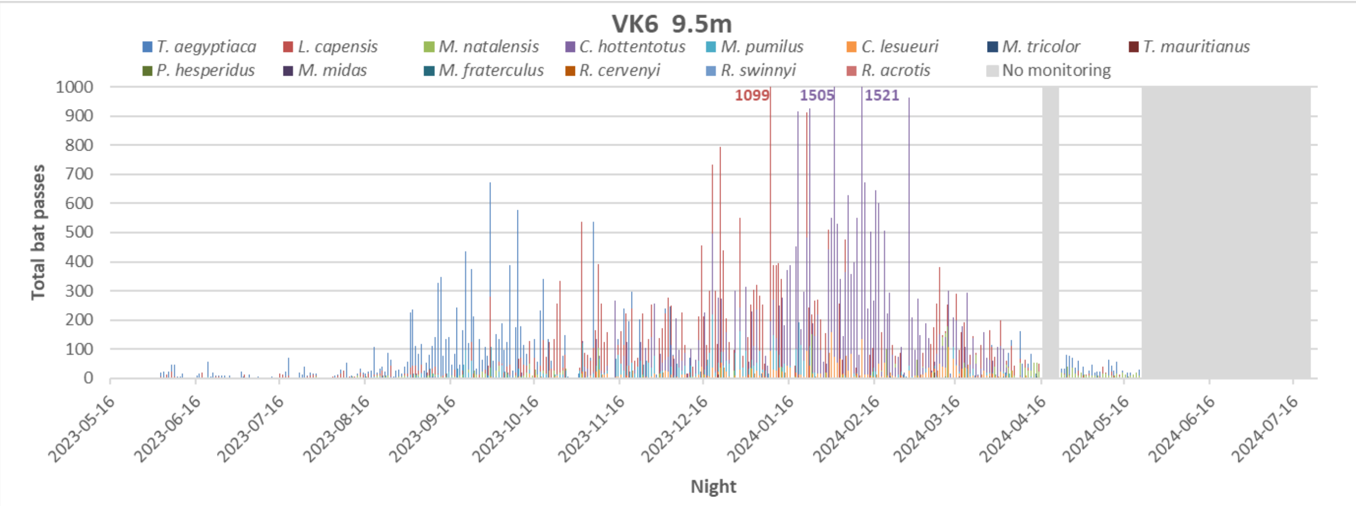

VK1 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Total bat passes
Night

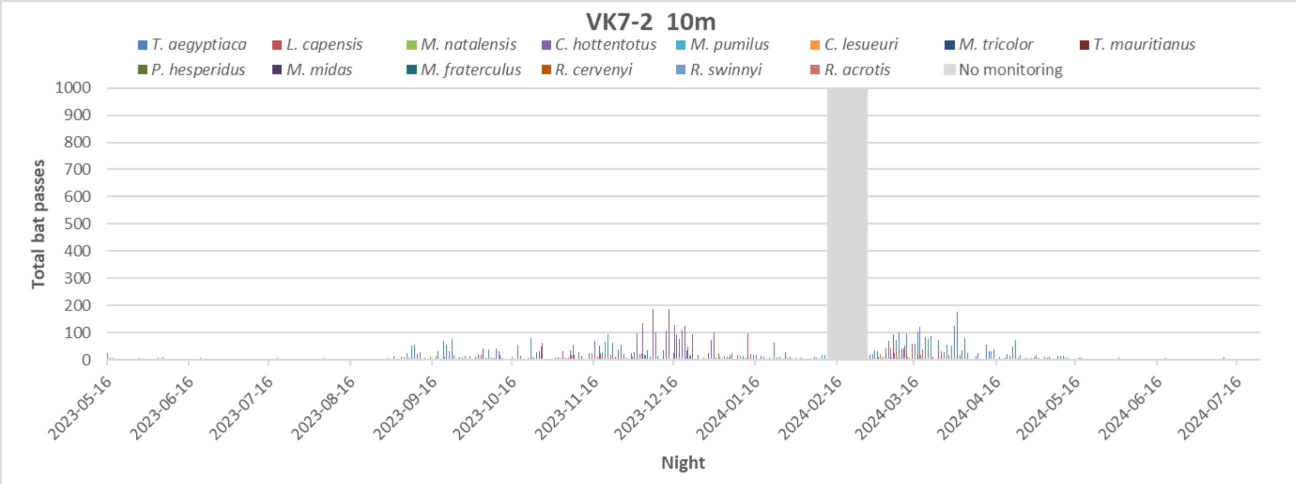

VK2 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
No monitoring
Total bat passes
Night

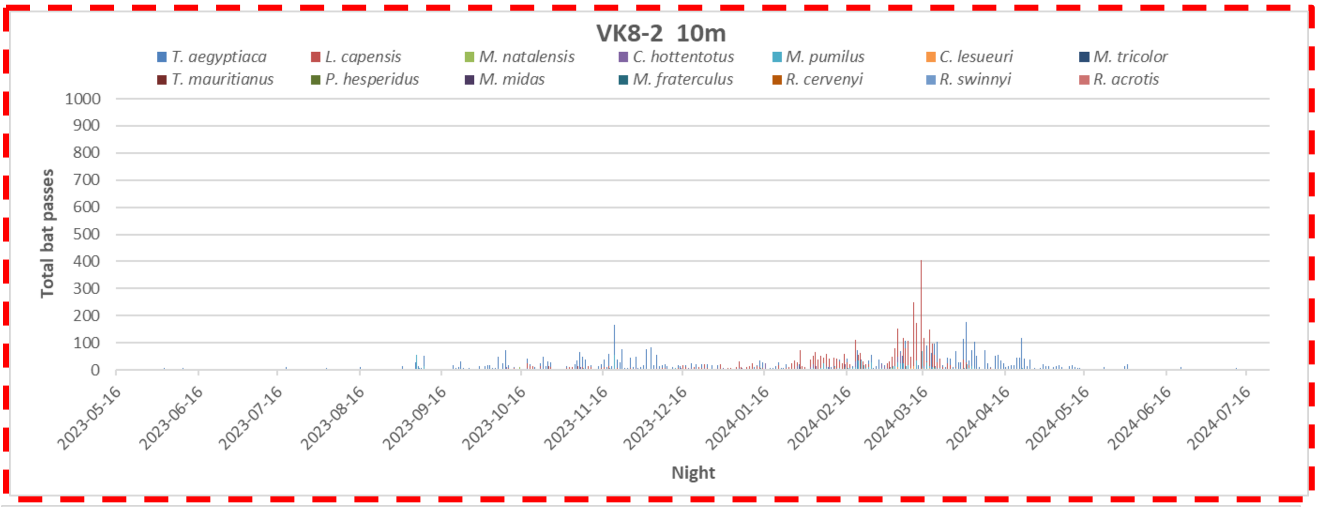

VK3 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
No monitoring
Total bat passes
Night

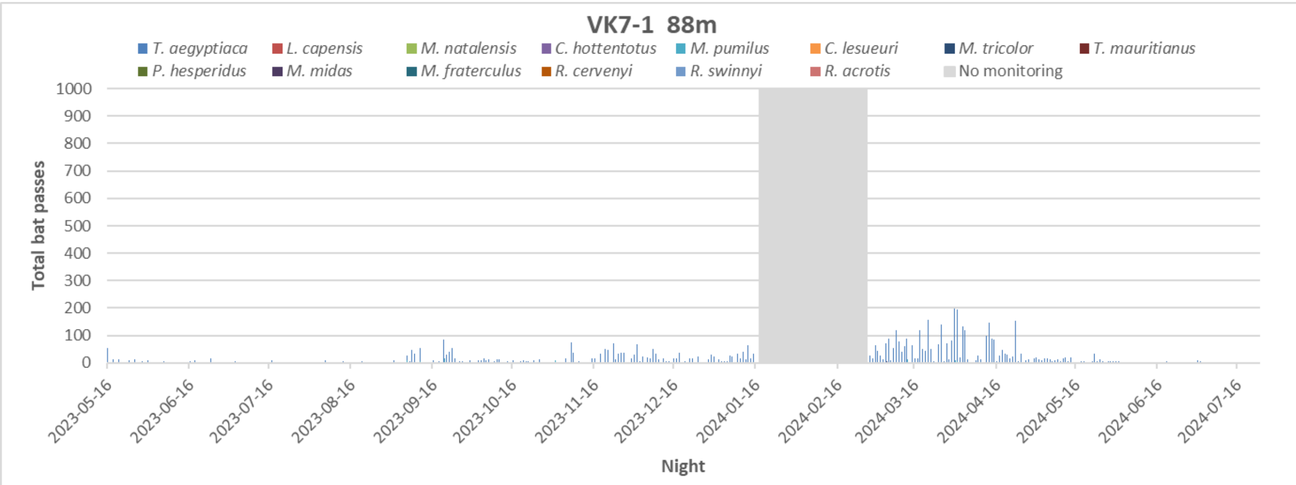

VK4 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
No monitoring
Total bat passes
Night


VK5 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Total bat passes
Night


VK6 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
No monitoring
1099
1505
1521
Total bat passes
Night


VK7-2 10m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
No monitoring
Total bat passes
Night


VK8-2 10m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Total bat passes
Night


VK7-1 88m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
No monitoring
Total bat passes
Night

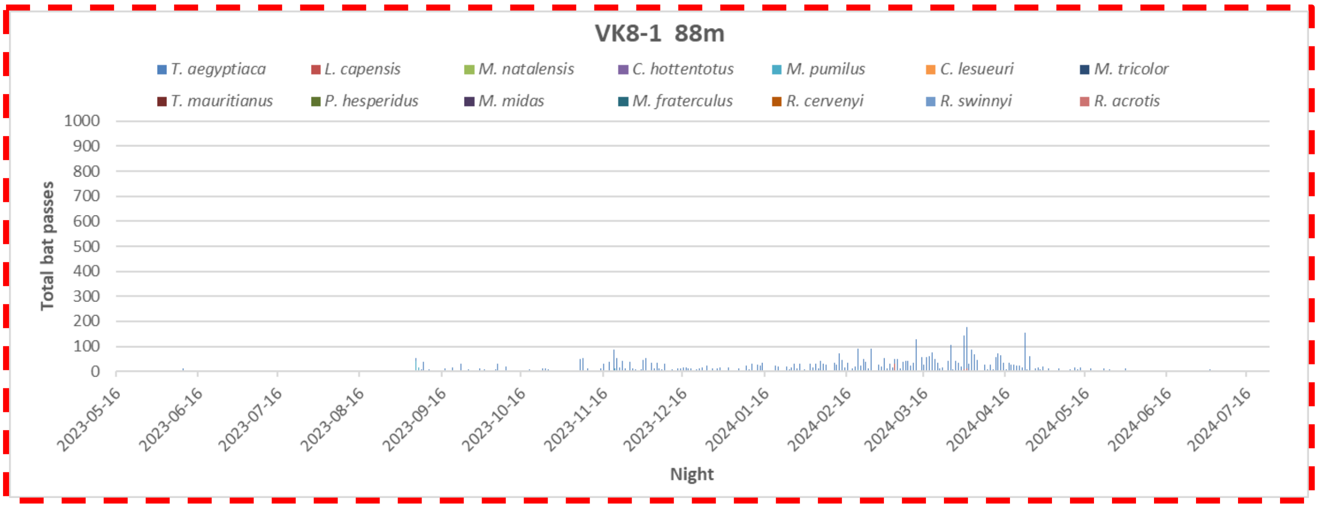
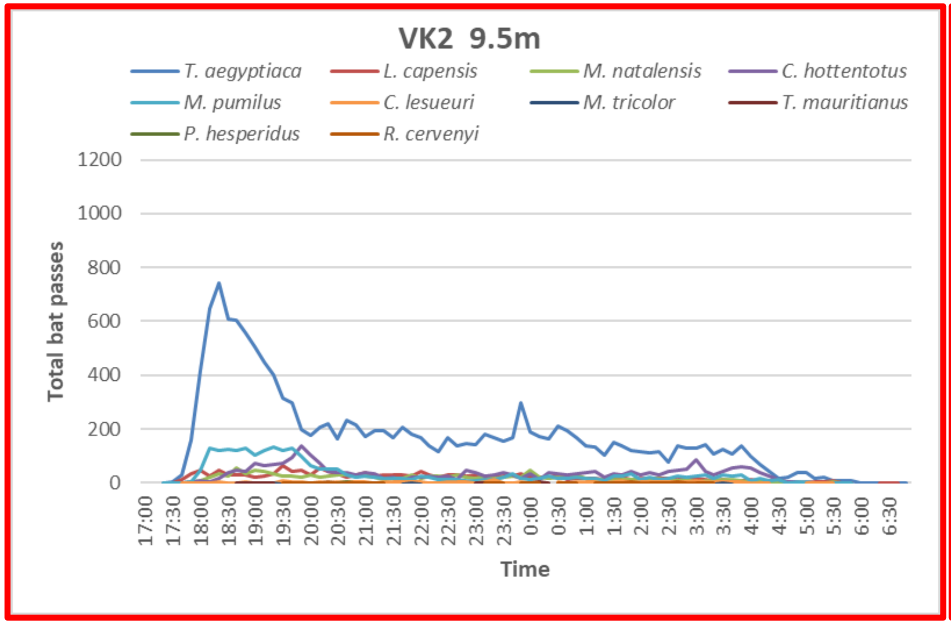


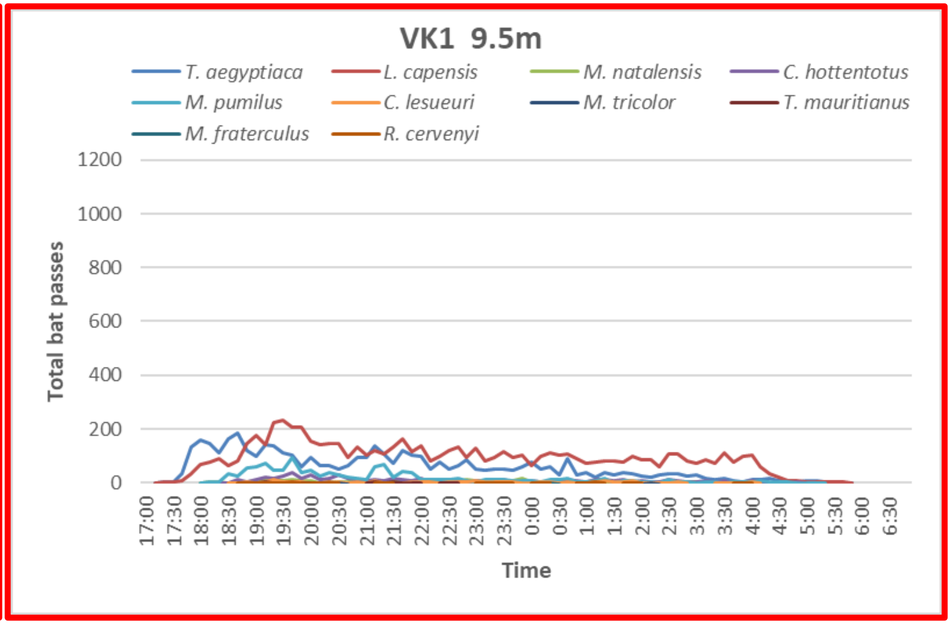
Figure 10 **Total bat passes recorded nightly at different heights at each of the Verkykerskop WEF cluster bat monitoring stations. The Groothoek WEF microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8) are outlined in dashed red**

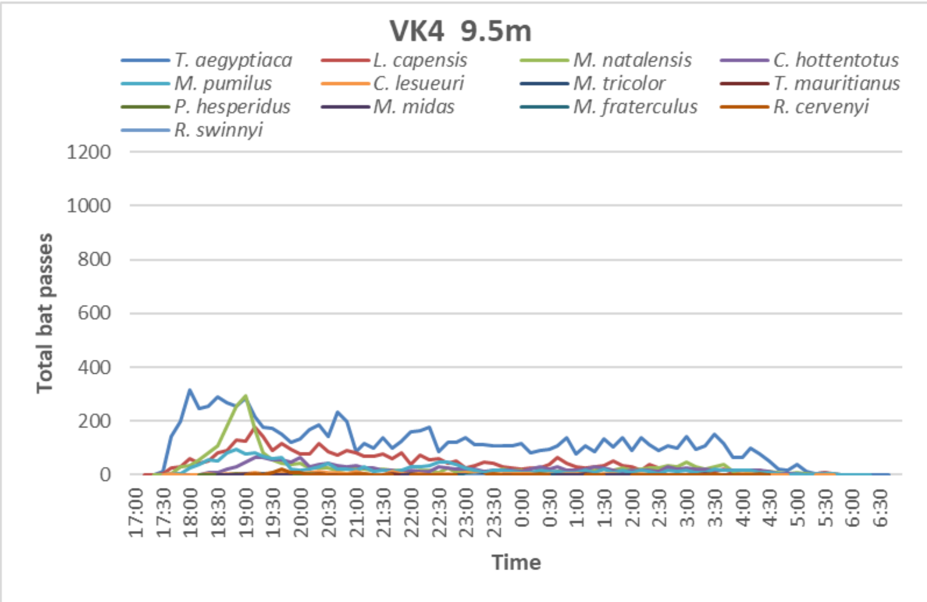
6.7 Key bat activity times

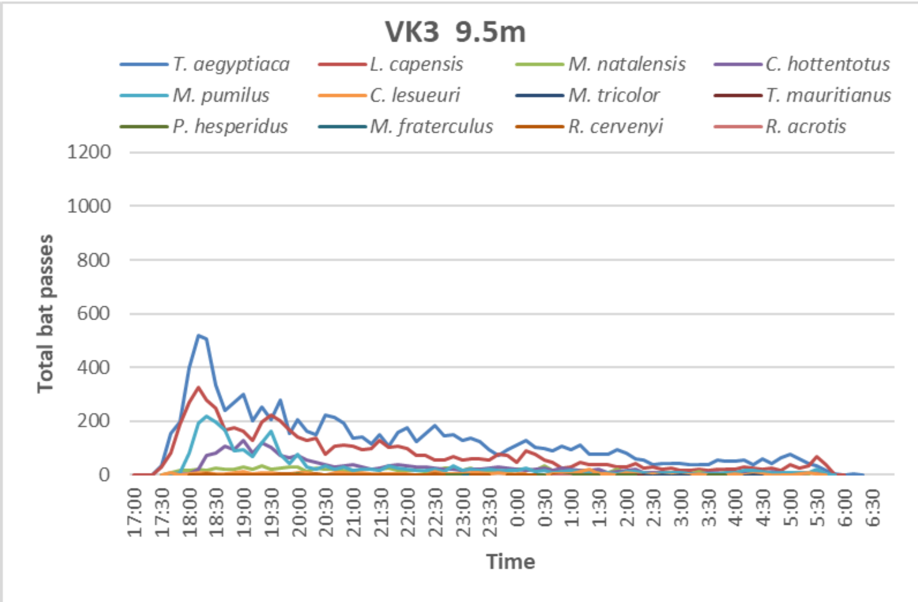
At VK1, VK2, and VK8 (mainly VK8-2), a distinct pattern in nightly activity was evident, especially from Egyptian Free-tailed Bats and Cape Serotines (**Figure 11**). From sunset, there was a sudden increase in the activity of Egyptian Free-tailed Bats until circa (ca.) 19:30, whilst Cape Serotine activity gradually increased or was more delayed and only began to decline later into the evening at around 20:00/20:30 and Little Free-tailed Bat emerged roughly 30 minutes later. From then, appreciable activity was recorded until ca. 04:30, whereafter activity declined by sunrise. The activity of species such as the Natal Long-fingered Bat, Little Free-tailed Bat, and Lesueur's Wing-gland Bat, was recorded most often during the first 1-3 hours after sunset before declining.

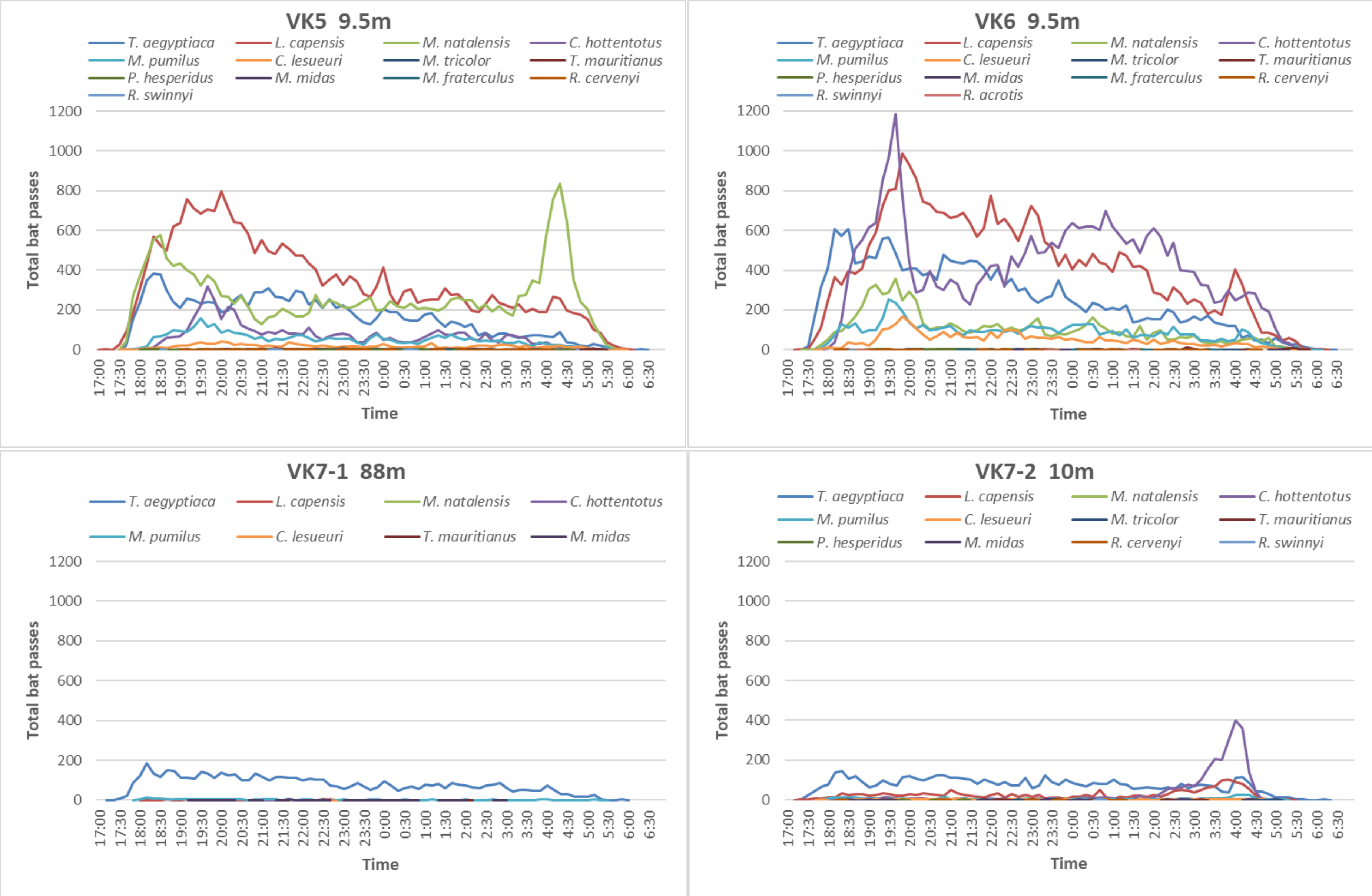
Due to their protracted night-time activity, Egyptian Free-tailed Bats and to a lesser degree Cape Serotines, will be at risk of fatality from turbines throughout the night whenever favourable weather, insects, and possibly other (e.g. lunar) conditions prevail. In contrast, species like Natal Long-fingered Bat will likely be at greatest risk of fatality for 1-3 hours after sunset, and in some areas (near roosts) for 1-3 hours before sunrise. Again, taxon-specific differences such as these should be taken into consideration if/when fatality mitigation measures are implemented. These trends were observed throughout the various seasons, only differing in relation to the time of sunset and sunrise (**Appendix 3**).

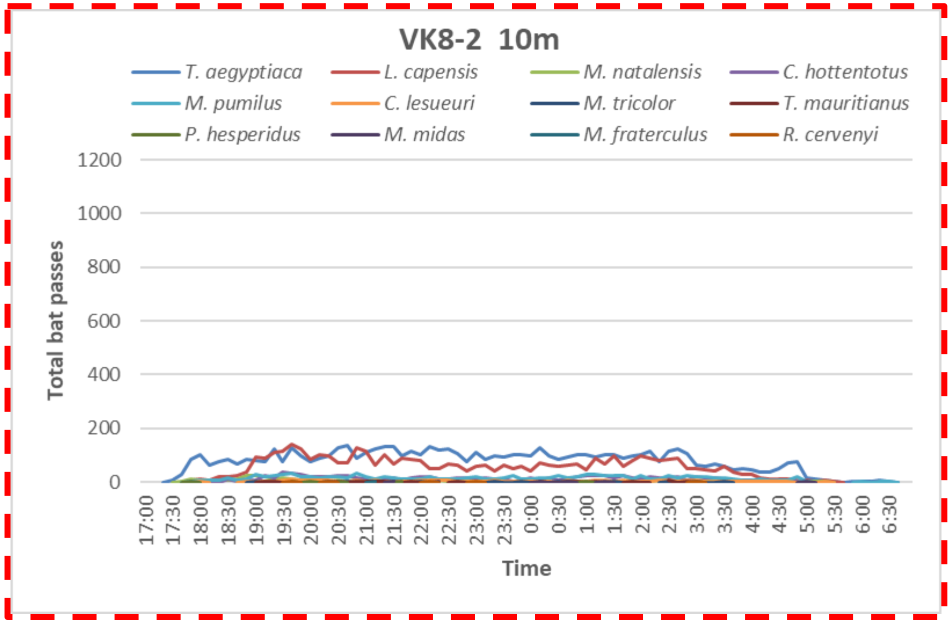

VK2 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
R. cervenyi
Total bat passes
Time


VK1 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
M. fraterculus
R. cervenyi
Total bat passes
Time


VK4 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
Total bat passes
Time


VK3 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. fraterculus
R. cervenyi
R. acrotis
Total bat passes
Time


VK5 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
Total bat passes
Time
VK6 9.5m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Total bat passes
Time
VK7-1 88m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
T. mauritianus
M. midas
Total bat passes
Time
VK7-2 10m
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
R. cervenyi
R. swinnyi
Total bat passes
Time



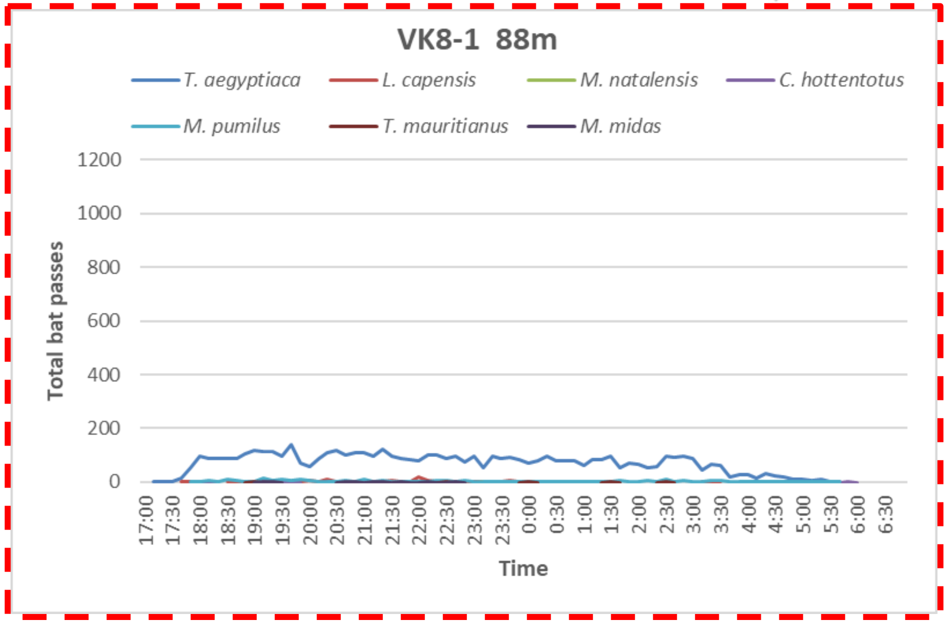


Figure 11 **Night-time activity of bat species recorded at each of the Verkykerskop WEF cluster bat monitoring stations. The Groothoek microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8) are outlined in dashed red**

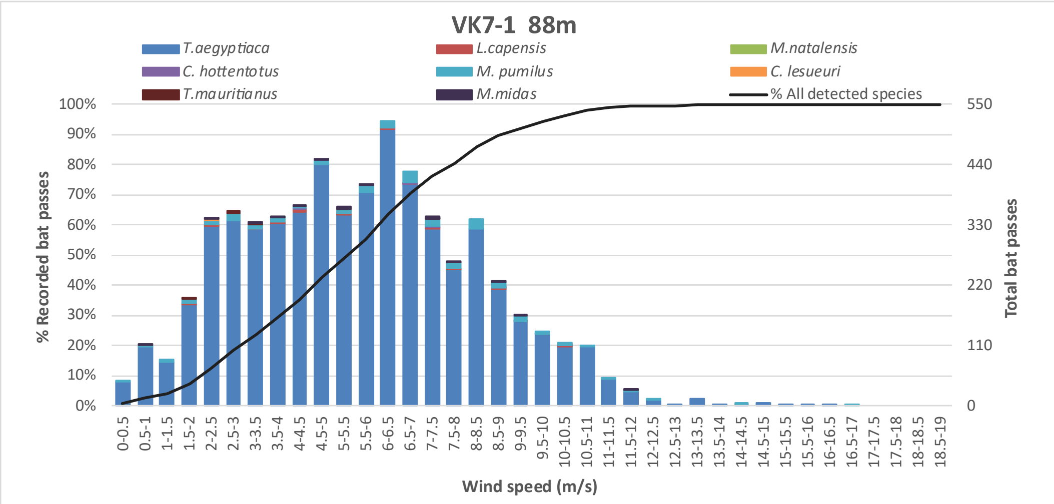
6.8 Bat activity in relation to weather

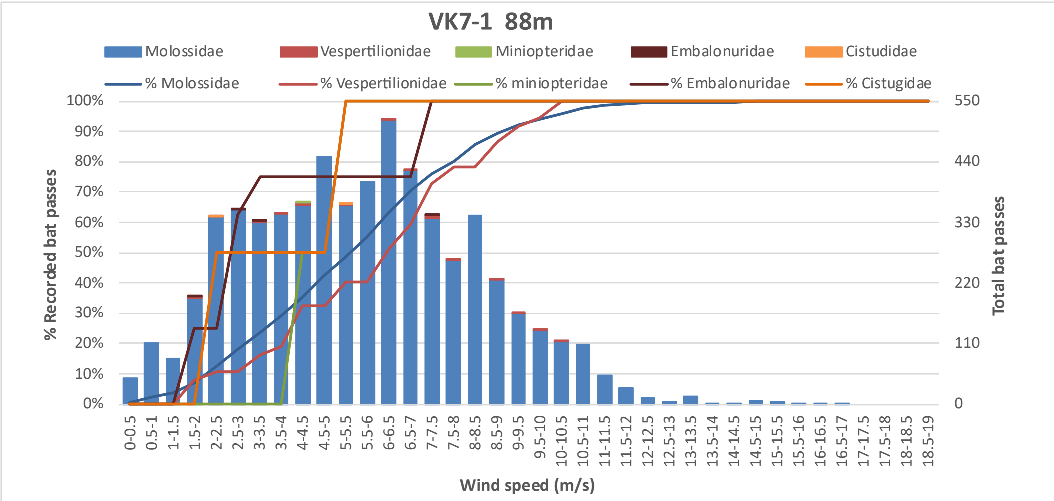
The cumulative and percentage bat passes recorded during different wind speeds in rotor sweep height were extrapolated from data measured at 80 m and 100 m and are shown in **Figure 12**. Similarly, cumulative and percentage bat passes recorded in rotor sweep height were compared to different atmospheric temperatures and are shown in **Figure 13**. Note, however, that temperature data were only available from 10 m above ground level. Based on the data from 10 m, most (>95% of) bat activity in rotor sweep height was recorded during temperatures above 9 and below 22°C (**Figure 13**). Miniopteridae species seemed to be more active during cooler temperatures (most activity between 8 to 18°C), while Verspertilionidae species were more active in warmer temperatures (between 12 to 21°C).

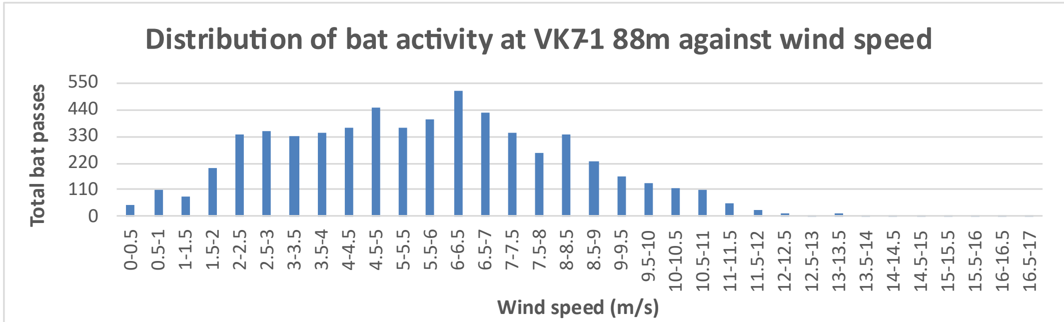
In 2023/24 at 88 m a.g.l. (**Figure 12**) approximately:

- 50% of bat activity was recorded during wind speeds below 5 m/s.
- 60% of bat activity was recorded during wind speeds below 5.5 m/s.
- 70% of bat activity was recorded during wind speeds below 6.5 m/s.
- 80% of bat activity was recorded during wind speeds below 7 m/s.
- 90% of bat activity was recorded during wind speeds below 8.5 m/s.
- 100% of bat activity was recorded during wind speeds below 12 m/s.

The results indicate that half of the time, bats were active onsite during wind speeds stronger than 5 m/s at 80-100 m a.g.l. If the bat fatality threshold is exceeded during operation, only 50% of activity of all bat species onsite would be protected below a cut-in wind speed of 5 m/s at 88 m a.g.l. should turbine curtailment be implemented. The calculation of bat fatality thresholds (as described by MacEwan *et al.* 2018) is dependent, inter alia, on the final (constructed) layout of the turbines.


VK7-1 88m
T.aegyptiaca
L.capensis
M.natalensis
C. hottentotus
M. pumilus
C. lesueuri
T.mauritianus
M.midas
% All detected species
% Recorded bat passes
Total bat passes
Wind speed (m/s)


VK7-1 88m
Molossidae
Vespertilionidae
Miniopteridae
Embalonuridae
Cistudidae
% Molossidae
% Vespertilionidae
% miniopteridae
% Embalonuridae
% Cistugidae
% Recorded bat passes
Total bat passes
Wind speed (m/s)


Distribution of bat activity at VK7-1 88m against wind speed
Total bat passes
Wind speed (m/s)

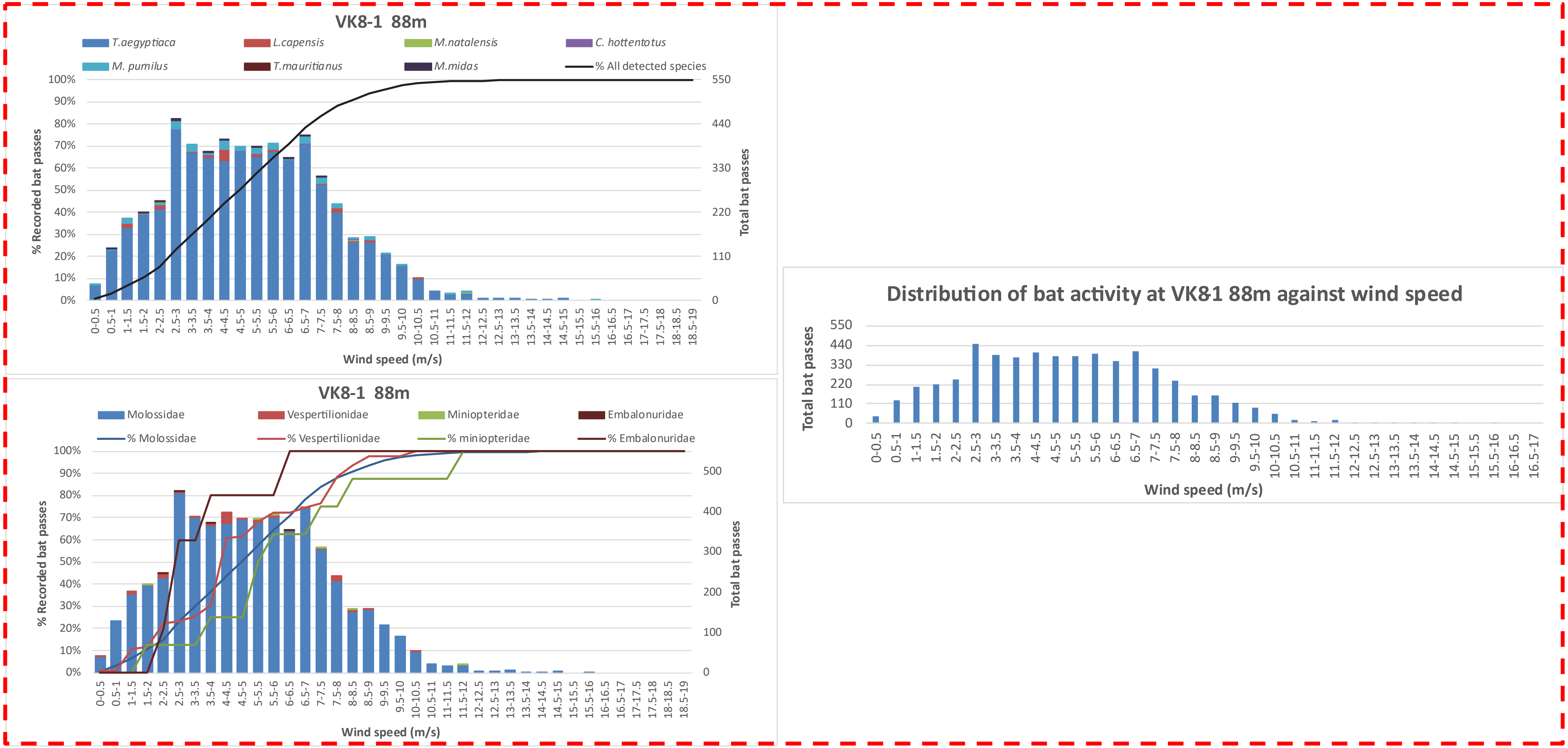
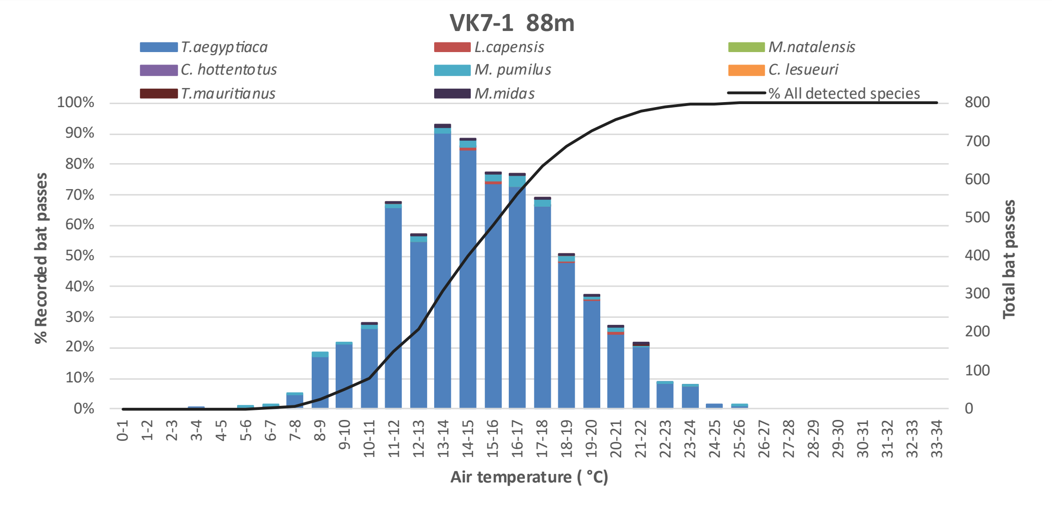
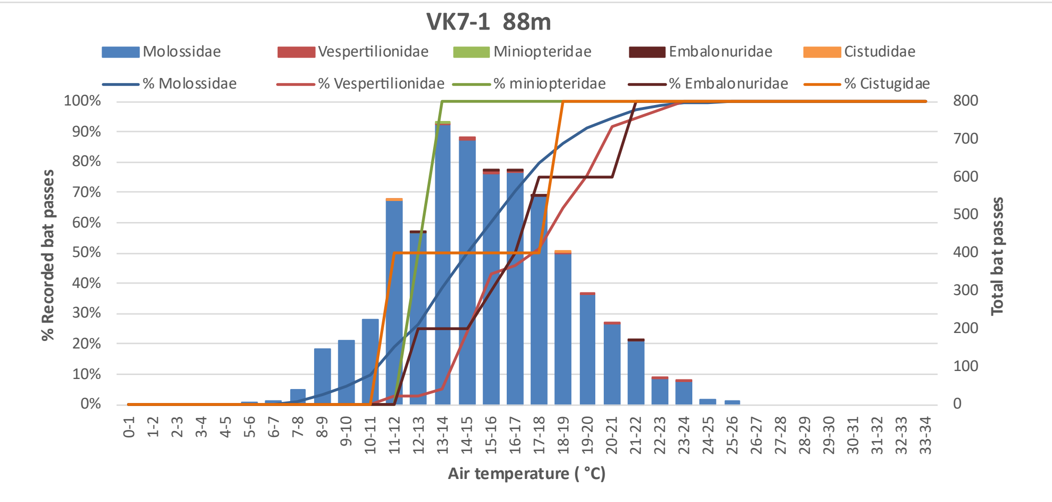
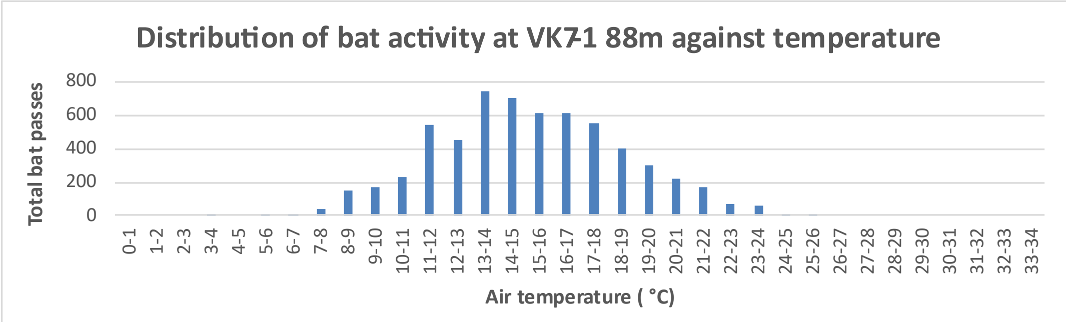


Figure 12 Relationship between bat activity at 88 m and wind speed extrapolated from 100 m and 80 m data. The closest microphone to Groothoek on a met. mast (VK8-1) is outlined in dashed red


VK7-1 88m
T.aegyptiaca
L.capensis
M.natalensis
C. hottentotus
M. pumilus
C. lesueuri
T.mauritianus
M.midas
% All detected species
% Recorded bat passes
Total bat passes
Air temperature (°C)


VK7-1 88m
Molossidae
Vespertilionidae
Miniopteridae
Embalonuridae
Cistudidae
% Molossidae
% Vespertilionidae
% miniopteridae
% Embalonuridae
% Cistugidae
% Recorded bat passes
Total bat passes
Air temperature (°C)


Distribution of bat activity at VK7-1 88m against temperature
Total bat passes
Air temperature (°C)

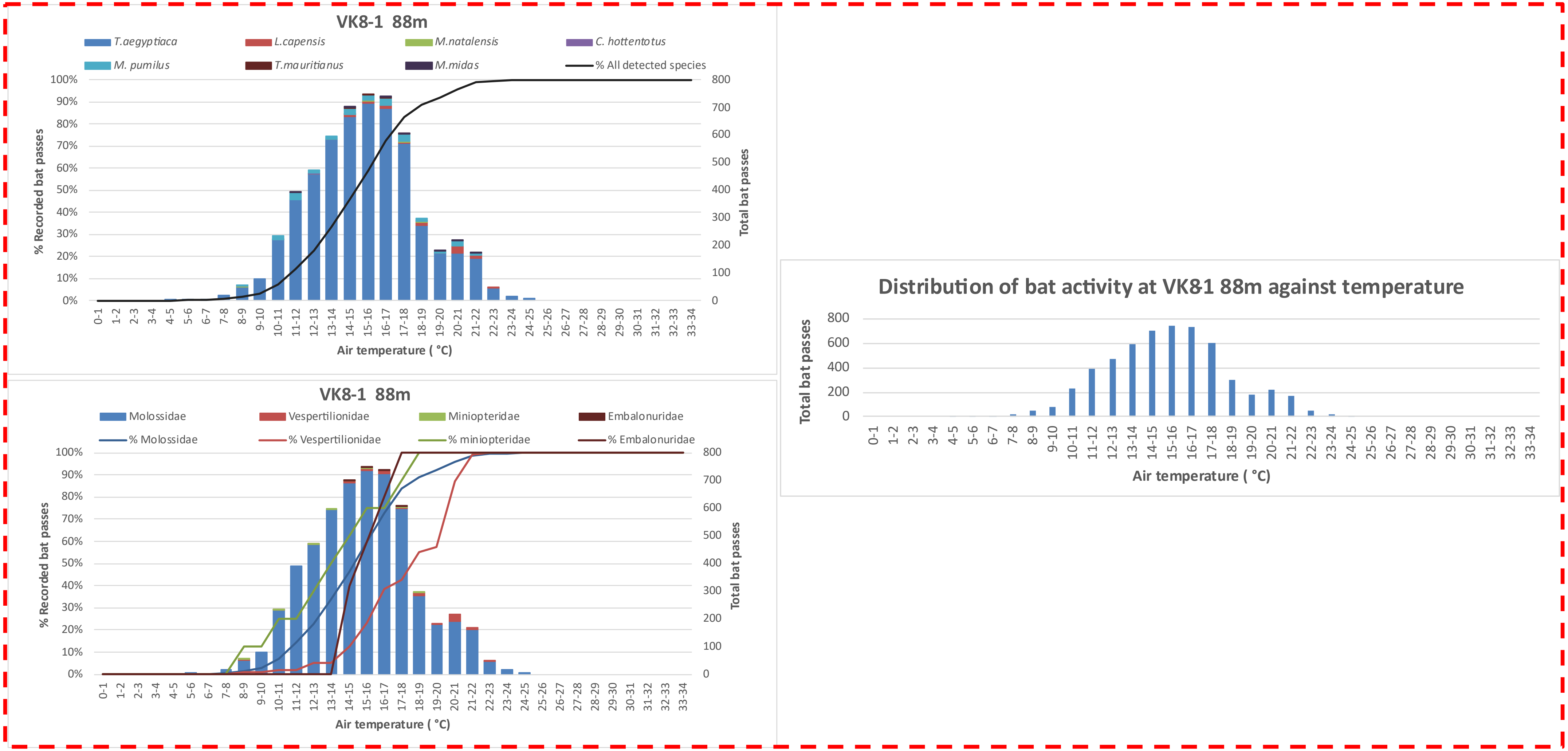


Figure 13 **Relationship between bat activity at 88 m and temperature at 10 m a.g.l. The closest microphone to Groothoek on a met. mast (VK8-1) is outlined in dashed red**

7. Bat Sensitivity Map

Described in **Table 3** and shown in **Figure 14**, is the relative sensitivity (i.e., the conservation importance for bats) of the different local land-cover classes and features, and the recommended buffers around these, as recommended in the South African guidelines on bat monitoring for proposed wind farms (MacEwan *et al.* 2020a) and based on our professional judgement.

High Bat Sensitive Areas include:

- Confirmed roosts with a 500 m buffer around these, based on evidence of bat roosting activity and suitable roosting habitat for certain cavity/roof-roosting bat species in identified buildings onsite, and the minimum 500 m buffer recommendation in the MacEwan *et al*. (2020a) guidelines for a small roost of Least Concern bats and/or Low fatality risk bats.
- Potential roosts with a 200 m buffer around these, based on the strong possibility that occupied and abandoned dwellings may provide suitable roosting habitat for certain cavity/roof-roosting bat species, and the minimum 200 m buffer recommendation in the MacEwan *et al*. (2020a) guidelines for any potentially important bat features.
- Significant natural rocky terrain including cliff faces, overhangs, cavities, crevices, and/or exfoliating rock, and a 200 m buffer extending downslope from these, based on: i) the possibility that these may provide roosting habitat for the cave-, cavity-, and crevice-roosting bat species that have been listed for the study area; ii) the minimum 200 m buffer recommendation in the MacEwan *et al.* (2020a) guidelines for any potentially important bat features; and iii) the generally higher levels of bat activity recorded by IWS at monitoring stations at lower elevations, compared to those at higher elevations.
- Natural and artificial hydrological features including rivers, dams, pans, and certain herbaceous wetlands, and a 500 m buffer around the large dam and river onsite, and 200 m buffer around all other hydrological features, based on: i) the known importance of surface water resources for bats (Serra-Cobo *et al.* 2000; Akasaka *et al*. 2009; Hagen and Sabo 2012; Sirami *et al*. 2013); ii) the minimum 200 m buffer recommendation in the best practice guidelines by MacEwan *et al.* (2020a) for known and potential bat important features; and iii) the recorded high activity of bats at monitoring stations VK5 and VK6 and the anticipated high activity of bats at the dam and along the river between these two locations.

Medium–**High** Bat Sensitive Areas include:

- Patches of indigenous and exotic woody vegetation, based on the known importance of trees for clutter and clutter-edge foraging, tree-roosting, and fruit-eating bat species. Dense stands of woody vegetation were assigned a 200 m buffer, based on the minimum 200 m buffer recommendation in the best practice guidelines by MacEwan *et al*. (2020a) for known and potential bat important features.

Medium Bat Sensitive Areas include:

- A 2.5 km buffer around the VK5 and VK6 monitoring stations, where a cave and other significant roosts are suspected, and exceptionally high levels of bat activity were recorded.

In addition to the identified local sensitivities, according to the spatial data and other information sources that were consulted by IWS, seven protected areas are situated within only 10 km of the proposed Verkykerskop WEF Cluster site (**Figure 15**).

Of these, the nearest include the:

- Upper Wilge National Protected Environment, which comprises a collection of land parcels located near the southern tip and up to 30 km south-west of the site.
- Ncandu Private Forest and Grassland Reserve ca. 1.6 km to the east
- Ncandu Nature Reserve ca. 5 km north-east.
- Normadien Protected Environment located ca. 4 km and up to 20 km to the south-east.
- Ora Nature Reserve ca. 5 km to the south-east.
- Kiepersol Protected Environment ca. 9 km to the north-east.
- uMsonti Private Nature Reserve ca. 6 km to the east.

Many other formal and informal protected and conservation areas occur within a 50 km radius of the Cluster site (**Figure 3**). **Bats which should be conserved within these protected areas could potentially be impacted in various ways by the proposed Verkykerskop WEF Cluster and, therefore, a 0-2.5 km High and 2.5-5 km Medium sensitivity buffer has been assigned around each of the seven closest protected areas (Figure 15**Figure 14**).**

The sensitivity mapping should be interpreted as follows:

- **High** Bat Sensitive Areas represent **No-Go** areas for the construction of WEF infrastructure especially turbines, substations, buildings, construction camps, laydown areas, and possible quarries (to avoid disturbing key bat roosting, foraging, and/or commuting habitat, and to avoid high bat fatalities in these areas where high bat activity is anticipated). No turbine, including its full rotor swept area and a 2 m pressure buffer around this, should occur in High sensitive areas. Consequently, turbines should be located a minimum of one blade length plus 2 m away from High sensitive areas. Construction of linear infrastructure such as roads and underground powerlines and cabling is only permissible in High Bat Sensitive Areas if this will not result in destruction or disturbance of bat roosts.
- **Medium-High** Bat Sensitive Areas represent areas where the construction of infrastructure and other disturbances should be avoided *where possible* (to avoid areas where bat activity is likely to be concentrated). No turbine towers should be positioned in Medium-High sensitive areas (to limit turbine encroachment into dense woody vegetation, which may be utilized by tree-roosting and/or clutter- and clutter-edge foraging bats).
- In the 2.5 km **Medium** Bat Sensitive buffers around VK5 and VK6, where a cave and other significant roosts are suspected, and exceptionally high levels of bat activity were recorded, all turbines will require bat fatality mitigation.
- Disturbances (e.g. light pollution) in **Low** Bat Sensitive Areas should be minimized.

IWS agrees with the "High" overall sensitivity rating of the three WEF sites comprising the Verkykerskop Cluster as per the national Screening Tool. This is not only due to the presence of various hydrological features and croplands onsite, but due to the collective presence of local rocky terrain, hydrological features, woody vegetation, confirmed and potential bat roosts in buildings and other locations, and nearby protected areas – as well as the onsite recorded above-average activity and diversity of bats including several Species of Conservation Concern.

Table 3 Sensitivity and buffering of local land-cover classes and features, and nearby protected areas

LOCAL LAND-COVER CLASSES AND FEATURES			BUFFER	
Type	**Name**	**Sensitivity**	**Sensitivity**	**Size**
Bat roost in building	Confirmed	HIGH	HIGH	500 m
Bat roost in building	Potential	HIGH	HIGH	200 m
Natural Waterbodies	Major rivers	HIGH	HIGH	500 m
Natural Waterbodies	Wetlands	HIGH	HIGH	200 m
Natural Waterbodies	Drainage lines	HIGH	HIGH	200 m
Artificial Waterbodies	Artificial dams	HIGH	HIGH	200 m
Feature	Cliffs and rocky outcrops	HIGH	HIGH	200 m downslope
Wooded Areas	Tree clumps	MEDIUM–HIGH	MEDIUM–HIGH	200 m for dense stands
Bat Station	VK5 and VK6 - where a cave roost is suspected, and high bat activity was recorded	MEDIUM	MEDIUM	2.5 km
NEARBY PROTECTED AREAS			**BUFFER**	
Type	**Name**	**Sensitivity**	**Sensitivity**	**Size**
Protected Environment	Upper Wilge Protected Environment	HIGH	HIGH	2.5 km
			MEDIUM	2.5-5 km
Forest Nature Reserve	Ncandu Private Forest and Grassland Reserve	HIGH	HIGH	2.5 km
			MEDIUM	2.5-5 km
Nature Reserve	Ncandu Nature Reserve	HIGH	HIGH	2.5 km
			MEDIUM	2.5-5 km
Nature Reserve	uMsonti Private Nature Reserve	HIGH	HIGH	2.5 km
			MEDIUM	2.5-5 km
Protected Environment	Kiepersol Protected Environment	HIGH	HIGH	2.5 km
			MEDIUM	2.5-5 km
Nature Reserve	Ora Nature Reserve	HIGH	HIGH	2.5 km
			MEDIUM	2.5-5 km
Protected Environment	Normandien Protected Environment	HIGH	HIGH	2.5 km
			MEDIUM	2.5-5 km

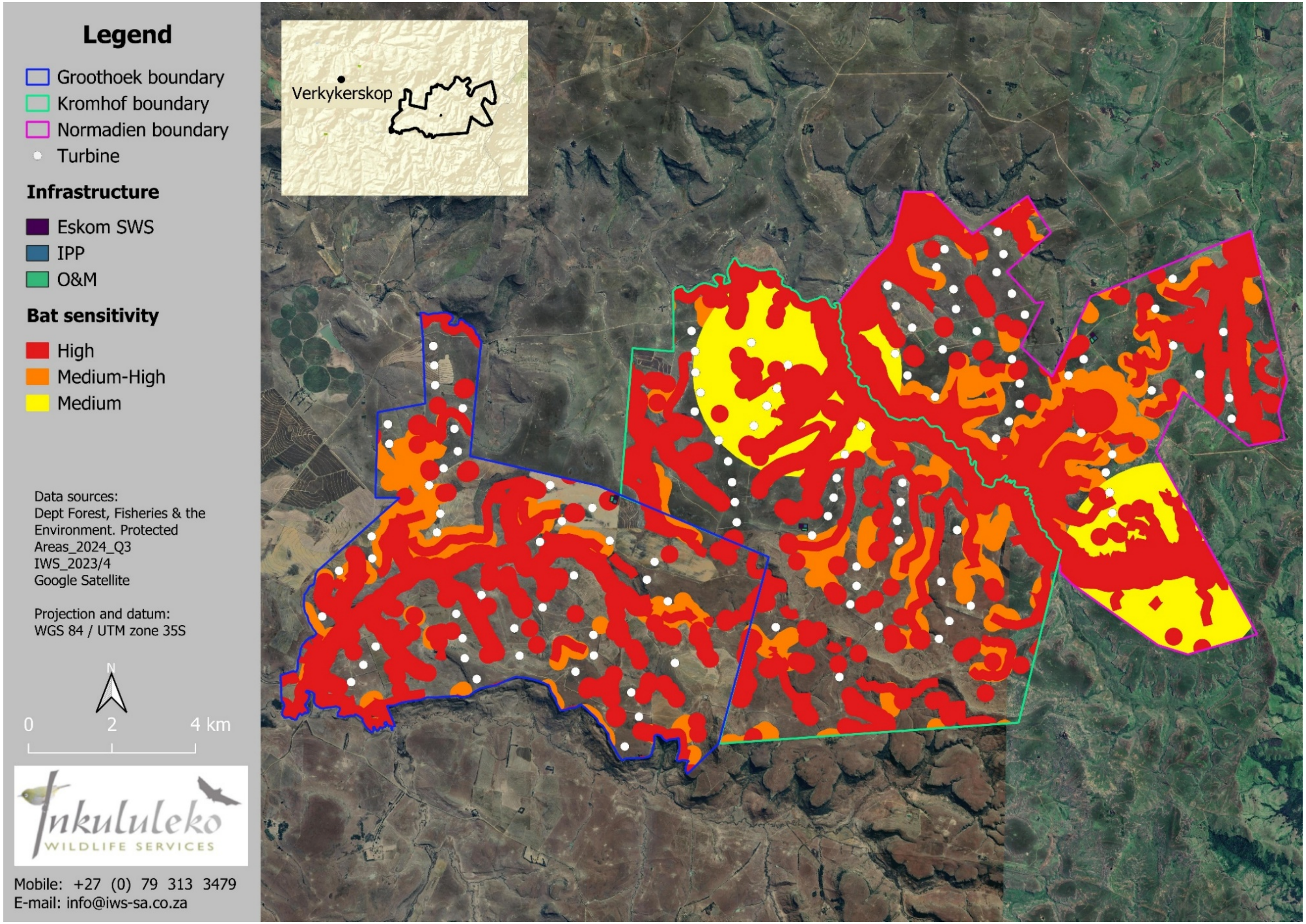


Figure 14 **Bat sensitivity map for the proposed Verkykerskop wind energy facility cluster site – EXCLUDING the buffers around nearby protected areas**

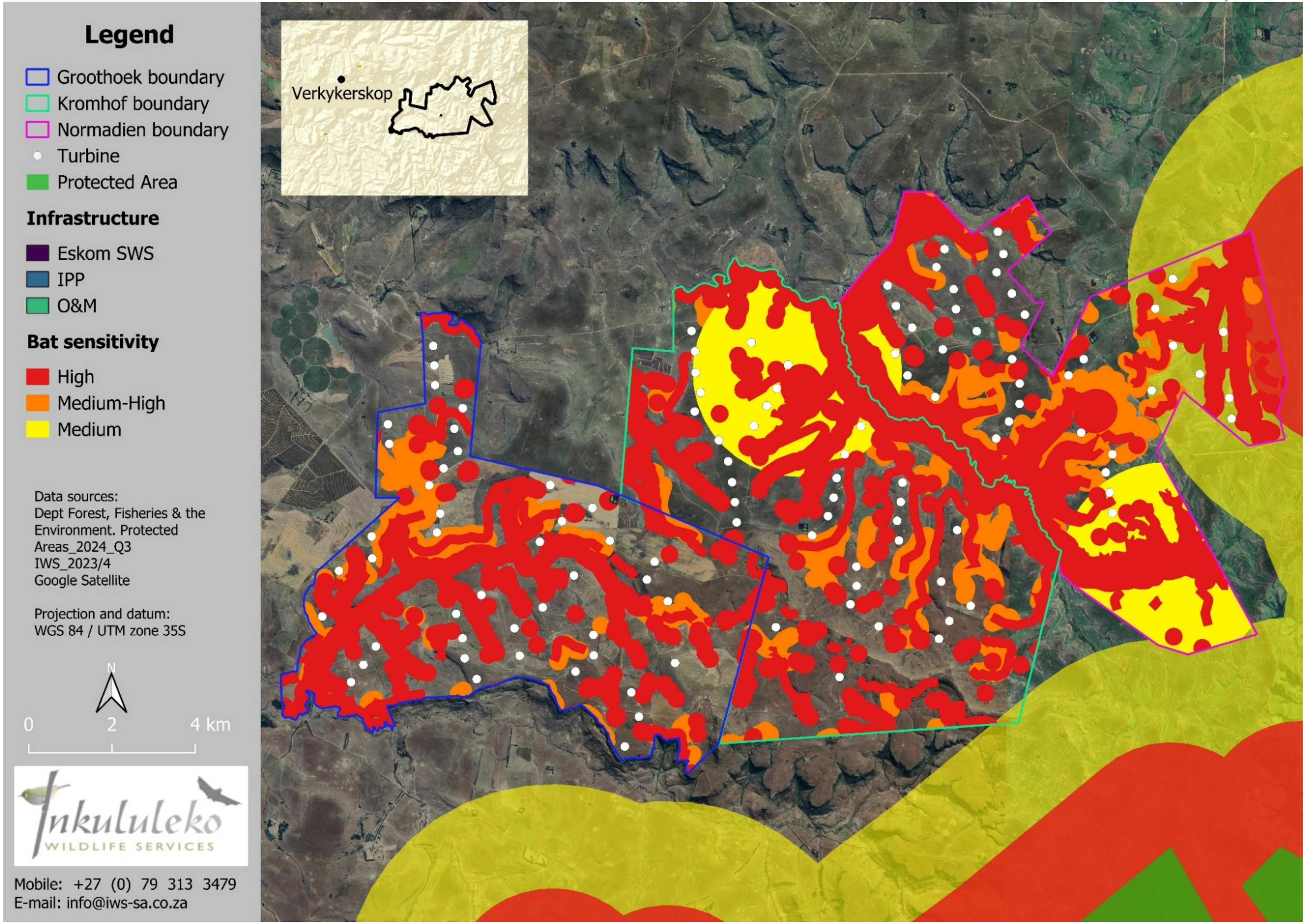


Figure 15 **Bat sensitivity map for the proposed Verkykerskop wind energy facility cluster site – including the buffers around nearby protected areas**

8. Bat Impact Assessment and Recommended Mitigation

8.1 Current impacts

Within the study area, bats have been negatively and positively impacted by anthropogenic activities. Commercial cultivation of maize, livestock farming, and human settlement especially in nearby towns, have in places reduced or modified grassland and other natural habitats where a higher diversity of bat species was potentially supported. Certain bat species, however, have likely benefitted from predation of crop pests in the cultivated fields, or roosting in buildings and other infrastructure (such as bridges, culverts). Roof-roosting bat species such as the Cape Serotine have also, however, likely been subject to eviction or persecution by people. Light pollution has possibly benefited certain bat species, but adversely impacted others (especially cavity-roosting species). Invasive and other alien trees have replaced natural grassland in various places but can provide roosting habitat for tree-roosting bat species, and foraging habitat for clutter- and clutter-edge foraging bat species. Widespread generalist species (such as the Egyptian Free-tailed Bat and Cape Serotine) are more likely to have benefitted from anthropogenic activities than rarer specialist bat taxa.

8.2 Potential impacts without and with mitigation

Presented in **Table 4** to **Table 6** is the assessment of each potential impact on bats, their habitats, or ecosystem services, without and with recommended impact mitigation measures. The cumulative impact assessment is presented in **Table 7**.

Without mitigation, the proposed Groothoek WEF may have a potential Very High impact in terms of bat fatalities from their collision with turbines, and a High impact on bat roosts, bat foraging habitat, and bat ecosystem services. **With diligent mitigation as recommended in this report, the WEF is expected to have a Moderate impact in terms of bat fatalities, bat foraging habitat, and bat eco-services, and a Low impact on bat roosts.** A discussion of each potential impact including recommended impact mitigation measures, follows.

8.2.1. Roost disturbance or destruction

During construction of the proposed WEF, bat roosts (roosting bats and/or roost sites) in buildings, rocky outcrops, and/or woody vegetation, could be disturbed or destroyed (e.g., from vegetation clearing, demolishment of old buildings, blasting, excavation works, human activity, and noise) if overlooked and/or not adequately avoided. Given the presence of multiple confirmed and potential roosts on site, this potential impact was rated with **High** significance, without mitigation (**Table 4**; **Table 6**).

<u>Recommended mitigation:</u>

To reduce mainly the potential magnitude and probability of this impact to overall **Low** significance, the following is recommended:

- **Avoid High sensitive areas**, in particular, buildings with confirmed roosts, and potential roosts in other buildings, rocky outcrops, and dense woody vegetation, and the prescribed buffers around these.
- **Avoid developing turbines in Medium-High sensitive areas,** where woody vegetation may be utilized by tree-roosting bats.
- **Avoid blasting within 2 km of a confirmed roost.**
- **Minimise artificial light at night** (excluding compulsory civil aviation lighting) – especially high-intensity, steady-burning, sodium vapour, quartz, halogen, and other bright lights at substations, offices, and turbines (to avoid disturbing roosts of certain sensitive bat species). All non-aviation lights

should be hooded downward and directed to minimise horizontal and skyward illumination. Where possible, solar-powered motion-sensitive lights should be used.

- **Consult a Bat Specialist if a bat roost is encountered** during any phase of the WEF, and refrain from disturbing the roost until appropriate advice has been obtained.

8.2.2. Destruction, degradation, and fragmentation of and displacement from foraging habitat

Construction of the WEF will cause widespread destruction, degradation, and fragmentation of threatened grassland and other natural terrestrial habitats, which support insect populations that the predominant aerial-foraging insectivorous bat species prey upon. Without careful planning, there could during construction also be destruction or disturbance of drainage lines and wetland areas, which currently provide bats with essential drinking water, concentrated insect prey, and/or which may represent important beacons or pathways for bat navigation and commuting (Serra-Cobo *et al*. 2000; Salata 2012; Sirami *et al.* 2013). Furthermore, during operation, certain bats may be displaced from foraging areas if they avoid the WEF (e.g. due to light pollution, obstruction to movement, or a reduction in insect prey) or suffer fatality from collision with turbines. This impact was rated with **High** significance in the absence of mitigation (**Table 4**; **Table 6**).

<u>Recommended mitigation:</u>

To reduce mainly the extent and magnitude of this impact to overall **Moderate** significance, the following is recommended:

- **Avoid High sensitive areas**, in particular, prominent streams, dams and other hydrological features, and the prescribed buffers around these.
- **Avoid developing turbines in Medium-High sensitive areas** where woody vegetation may be utilized by clutter and clutter-edge foraging insectivorous bats, and possibly also fruit bats.
- **Minimise the length and breadth of proposed roads** to thus minimise the loss and fragmentation of terrestrial (bat foraging) habitat.
- **Minimize the number of proposed turbines** to potentially reduce the extent of the road network and the overall extent of the wind farm and thus, the extent of terrestrial habitat loss and possible displacement of bats.
- **Minimise the degradation of terrestrial habitat** by implementing and maintaining effective dust, stormwater, erosion, sediment, and invasive alien plant control measures.
- **Minimise artificial light at night** (excluding compulsory civil aviation lighting) – especially high-intensity, steady-burning, sodium vapour, quartz, halogen, and other bright lights at substations, offices, and turbines (to avoid disturbing roosts of certain sensitive bat species). All non-aviation lights should be hooded downward and directed to minimise horizontal and skyward illumination. Where possible, solar-powered motion-sensitive lights should be used.
- **Rehabilitate disturbed terrestrial habitats** by comprehensively and diligently implementing effective rehabilitation measures based on consultation with an appropriate vegetation specialist.

8.2.3. Bat fatalities from collision with turbines, and potential population declines

During operation of the WEF, there will be inevitable fatality of bats from their collision with turbines and possibly to some extent, from barotrauma. If the fatality rate of impacted species exceeds their rate of successful reproduction and survival, population declines will occur.

This inevitable impact was rated with **Very High** significance considering: i) the large size of the proposed turbines; ii) that seven of the 14 bat species recorded onsite have a High risk of collision with turbines, and two species have a Medium-High fatality risk; iii) that overall bat activity on site was above-average for the Drakensberg Grasslands ecoregion; and iv) particularly high bat activity was recorded at the VK5 and VK6 monitoring locations (**Table 5**).

Recommended mitigation:

To reduce mainly the magnitude and extent of this impact to overall **Moderate** significance, the following is recommended:

- **Avoid High sensitive areas**, including all bat significant features and the buffers around these. No turbine, including its full rotor swept area and a 2 m pressure buffer around this, should occur in High sensitive areas.
- **Avoid Medium-High sensitive areas where possible**. No turbine towers should be positioned in woody vegetation, especially dense stands where bat activity may be concentrated.
- **Minimise artificial light at night** (excluding compulsory civil aviation lighting) – especially high-intensity, steady-burning, sodium vapour, quartz, halogen, and other bright lights at substations, offices, and turbines (to avoid disturbing roosts of certain sensitive bat species). All non-aviation lights should be hooded downward and directed to minimise horizontal and skyward illumination. Where possible, solar-powered motion-sensitive lights should be used.
- **Monitor bat fatalities as soon as the first turbine starts spinning** – as per the latest SABAA guideline for this (Aronson *et al*. 2020 or later) and the latest (2023 or later) IFC Good Practice Handbook on post-construction bird and bat fatality monitoring for onshore WEFs in emerging market countries. At the very least, bat fatality monitoring should be conducted during the WEF's first two years of operation, and then every fifth year thereafter. The monitoring and data analysis are to be conducted to a high standard so that there is confidence in the estimated numbers of actual bat fatalities.
- **Conduct passive monitoring of live bat activity (at least on the VK8 met. mast)** as soon as the first turbine starts spinning and whenever bat fatality monitoring is performed during the WEF's operation. This will allow for comparison of operational bat activity levels with pre-construction bat activity levels and operational bat fatalities, and it will help to assess the efficacy of any implemented bat fatality mitigation measures.
- **Mitigate bat fatalities adaptively** by consulting the latest SABAA guideline for this (MacEwan *et al.* 2018 or later), and the best available relevant scientific information. Taxon-specific differences should be taken into consideration if/when fatality mitigation measures are implemented. The calculation of bat fatality thresholds (as described by MacEwan *et al.* 2018) is dependent, inter alia, on the final (constructed) layout of turbines. **Adequate financial provision should be made to permit effective monitoring, management, and mitigation of bat fatalities throughout the life of the WEF.**
- **Forward all (live and fatality) bat monitoring data** to the database recommended by the South African Bat Assessment Association (SABAA) to expand the scientific knowledge base for more informed decision making and mitigation.

8.2.4. Decline or loss of bat ecosystem services

If bat populations in the study area start declining because of roost disturbance, loss of and/or displacement from foraging habitat, and/or high bat fatalities, the ecosystem services that the bats provide will be impacted. Local bat eco-services possibly include population control of maize pests and various other insect species. The plant pollination, seed dispersal, and habitat regeneration services provided by fruit bats could be impacted if the WEF causes fatalities of fruit bats – which might not reside but could commute through the area. Without mitigation, a potential decline or loss of these services was rated with **High** significance (**Table 5**).

Recommended mitigation:

This potential impact could be reduced to overall **Moderate** significance by implementing all **mitigation measures** that have been prescribed for potential bat roost disturbance, terrestrial habitat loss and possible displacement of bats, and bat fatalities from collision with turbines, and possible population declines.

8.2.5. Cumulative impact

According to the latest (2024 Quarter 4) Renewable Energy EIA Applications data from the Department of Fisheries, Forestry, and the Environment (DFFE; https://egis.environment.gov.za/), only one other WEF has been proposed within a 50 km radius of the Verkykerskop WEF cluster site (**Figure 17**). The proposed Newcastle Wind Power 2 WEF (up to 200 MW; DFFE Ref: 14/12/16/3/3/2/2213) located ~38 km to the north-east of the cluster appears to have been refused. As such, the cumulative impacts of WEFs in the area are currently limited to the three proposed WEFs that make up the Verkykerskop cluster.

Without very diligent monitoring and mitigation of bat fatalities and other impacts (e.g. roost disturbance) at all three WEFs comprising the Verkykerskop cluster, their potential cumulative impact on bat habitats, populations, and ecosystem services was rated with **High** significance. Only with proper bat fatality monitoring and adaptive management of bat fatalities using turbine curtailment and other secondary mitigation measures, may the cumulative impact of these WEFs on bats be reduced to **Moderate** significance (**Table 7**).

9. Conclusion

Under the current 43-turbine layout for the Groothoek WEF, as shown in **Figure 16**, **10 turbines are positioned in areas where their rotor sweep will encroach on Medium-High sensitive areas. Where possible, these 10 turbines should be shifted slightly to avoid encroachment on Medium-High sensitive areas.**

Going forward, the Client is strongly advised to carefully ensure that there is adequate financial planning and provision for high standard operational bat fatality and activity monitoring, and bat fatality mitigation in the form of blanket or smart turbine curtailment or bat deterrents - should the need for this arise.

All bat impact mitigation measures recommended in this report must, so far as applicable, be followed and included in the Wind farm's Environmental Management Programme (EMPr).

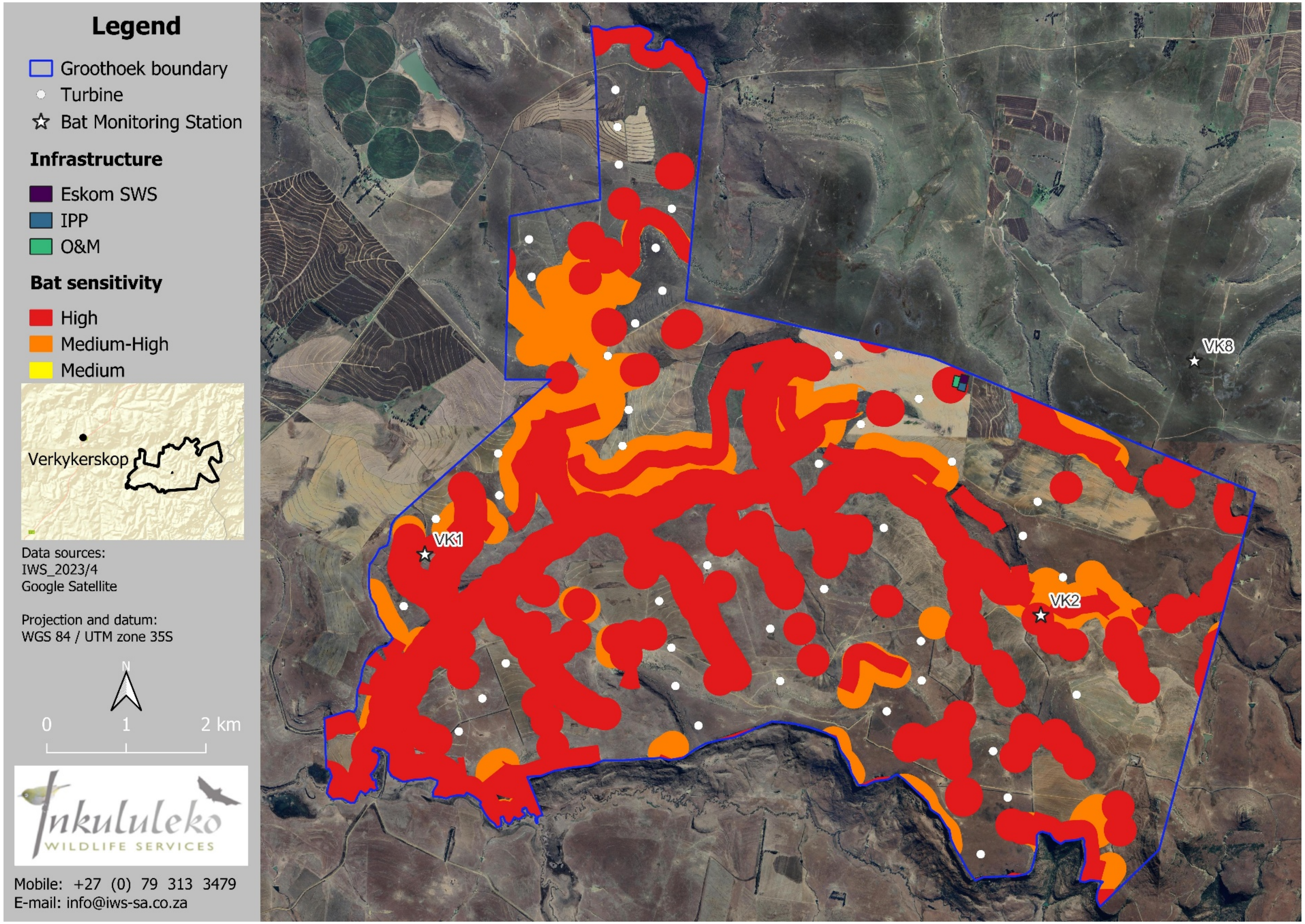


Figure 16 **Bat sensitivity ratings and the proposed layout of the Groothoek WEF**

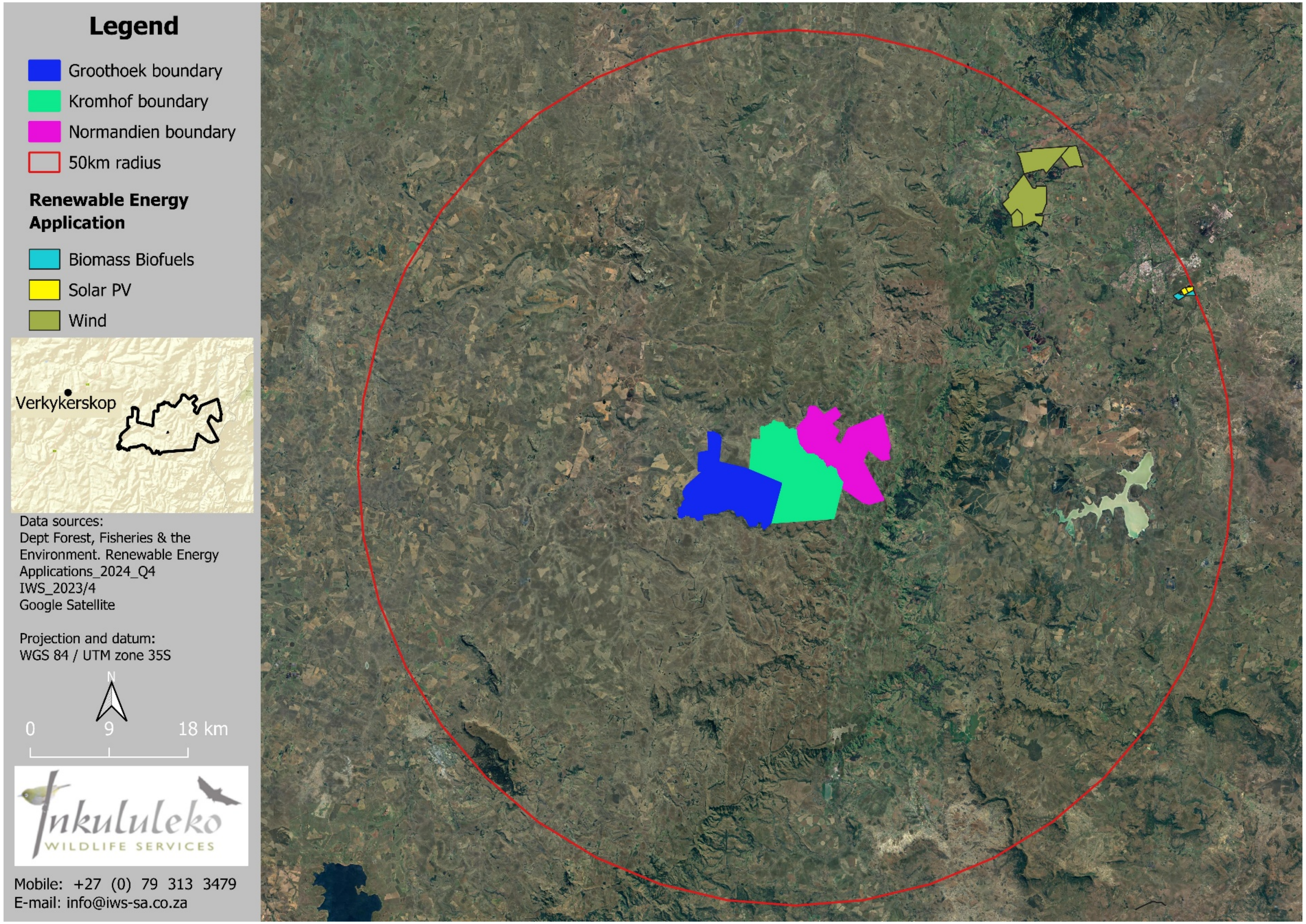


Figure 17 **Renewable energy development applications within 50 km of the proposed Verkykerskop WEF cluster**

Table 4 Assessment of potential impacts during construction

CONSTRUCTION												
Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Bat roosts	Disturbance of bat roosts	Construction	Negative	Moderate	5	3	3	5	4	64	N4
					Significance	N4 - High						
Impact 2:	Bat habitat	Terrestrial habitat loss, and possible displacement of bats	Construction	Negative	Moderate	4	2	3	4	5	65	N4
					Significance	N4 - High						
						Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating
						3	2	3	4	2	24	N2
						N2 - Low						
						2	1	3	3	5	45	N3
						N3 - Moderate						

Table 5 Assessment of potential impacts during operation

OPERATIONAL												
Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation						
						(M+	E+	R+	D)x	P=	S	
Impact 1:	Bat fatalities	Bat fatalities from collision with turbines, and possible population declines	Operational	Negative	Low	5	3	5	4	5	85	N5
					Significance	N5 - Very High						
Impact 2:	Ecosystem services	If high bat fatalities lead to declines in certain species populations, the ecosystem services that these populations provide will be compromised.	Operational	Negative	Moderate	5	3	3	4	5	75	N4
					Significance	N4 - High						
						Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	
						3	2	3	4	5	60	N3
						N3 - Moderate						
						2	3	3	4	3	36	N3
						N3 - Moderate						

Table 6 Assessment of potential impacts during decommissioning

DECOMISSIONING													
Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							
						(M+	E+	R+	D)x	P=	S		
Impact 1:	Bat roosts	Disturbance of bat roosts	Construction	Negative	Moderate	5	3	3	5	4	64	N4
					Significance	N4 - High							
Impact 2:	Bat habitat	Terrestrial habitat loss, and possible displacement of bats	Construction	Negative	Moderate	4	2	3	4	5	65	N4
					Significance	N4 - High							

Post-Mitigation						
(M+	E+	R+	D)x	P=	S	
3	2	3	4	2	24	N2
N2 - Low						
2	1	3	3	3	27	N2
N2 - Low						

Table 7 Cumulative impact assessment

CUMULATIVE												
Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation						
						(M+	E+	R+	D)x	P=	S	
Impact 1:	Other WEFs	Cumulative impact of renewable energy developments in the area	Cumulative	Negative	Low	3	3	5	5	4	64	N4
					Significance	N4 - High						

Post-Mitigation						
(M+	E+	R+	D)x	P=	S	
2	3	3	4	3	36	N3
N3 - Moderate						

10. References

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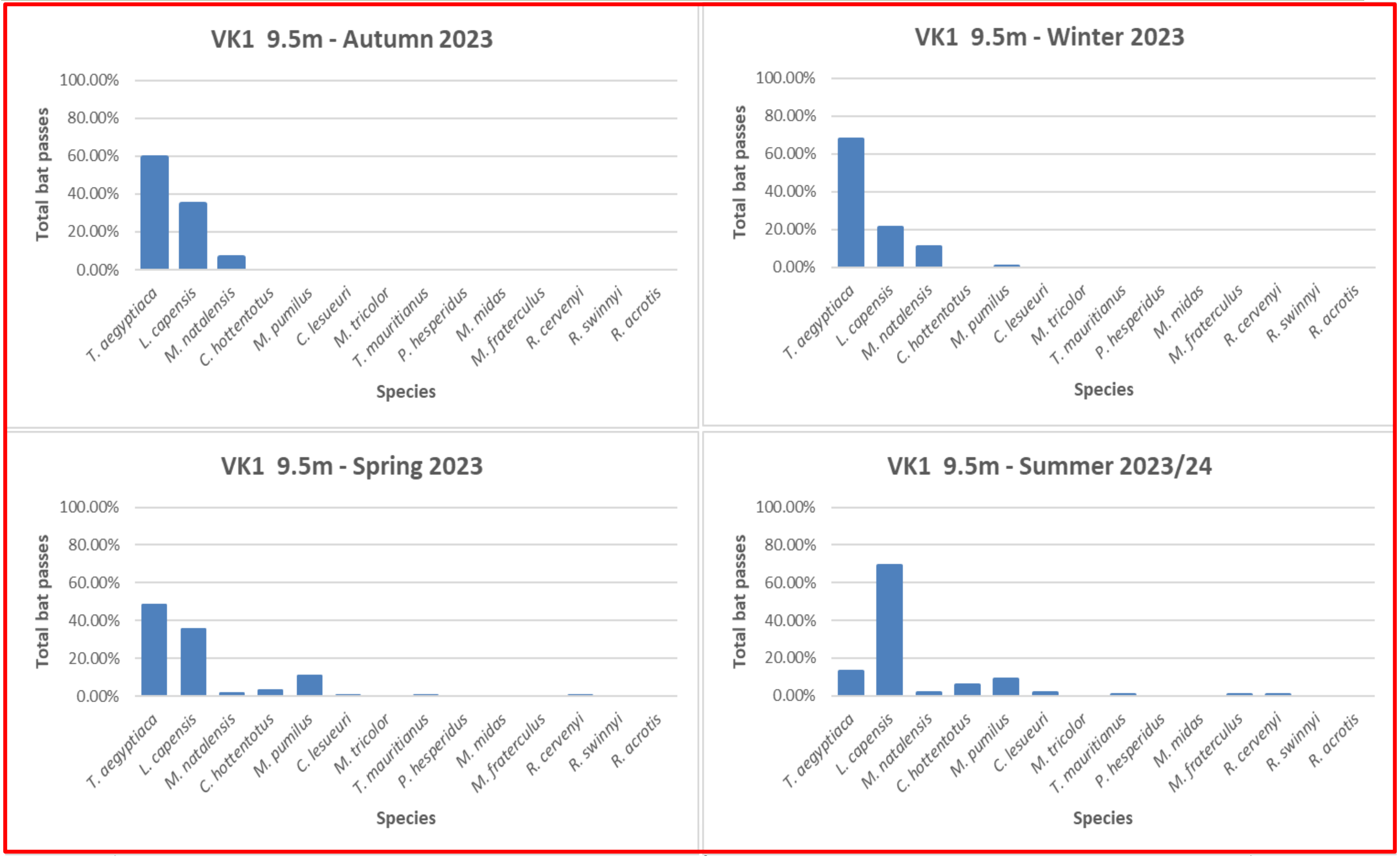
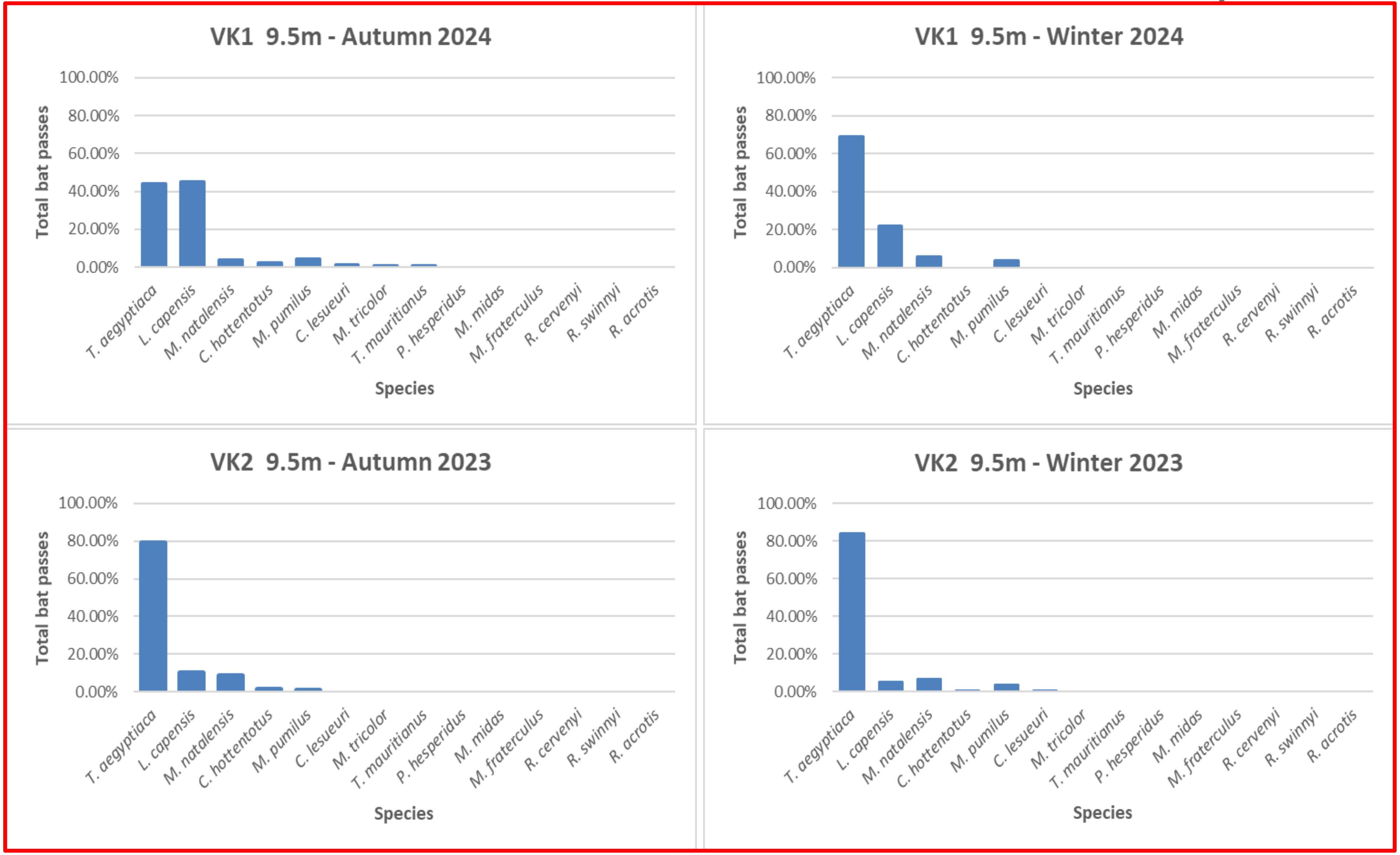
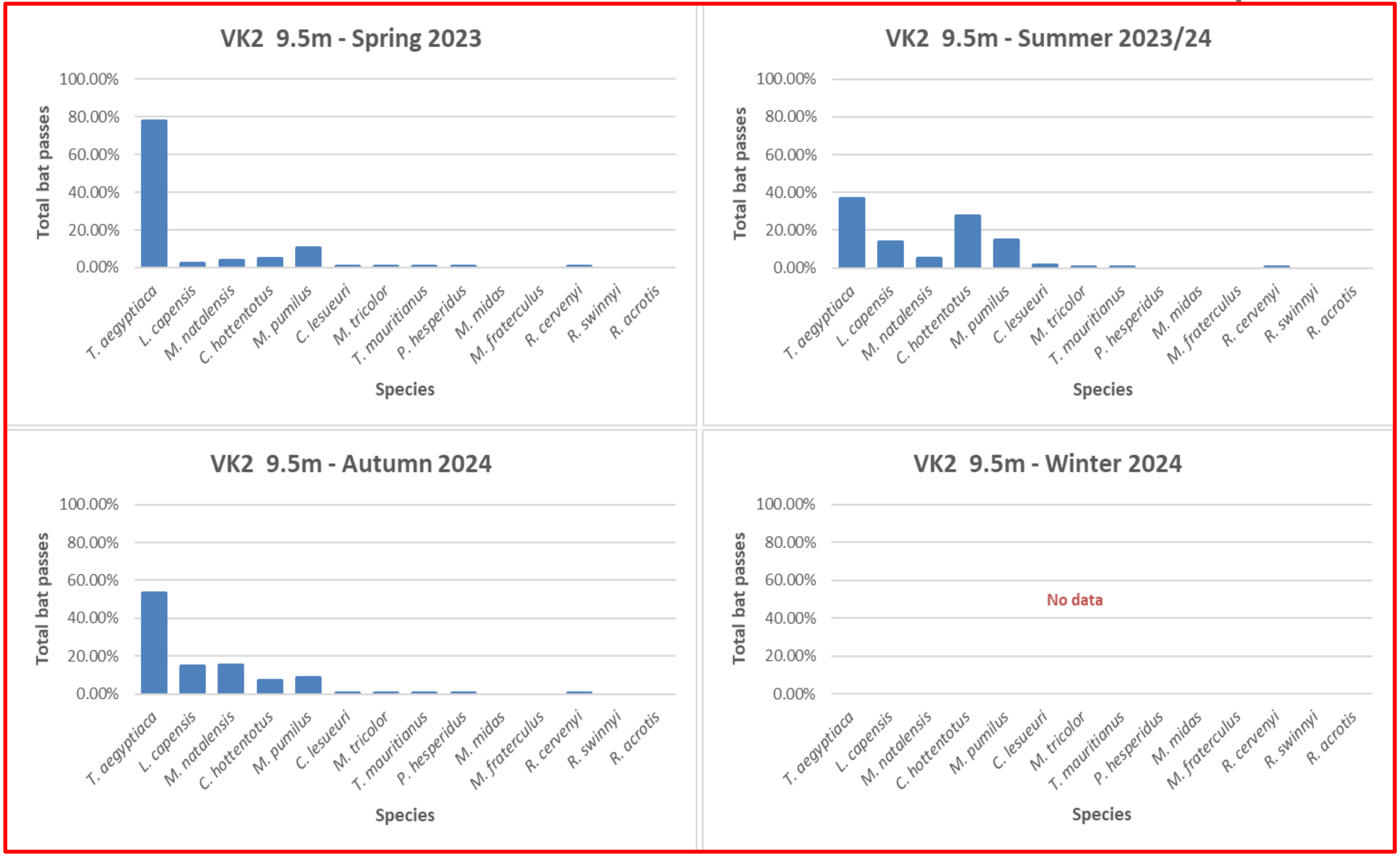
11. Appendix 1: Bat Species Composition at Each Monitoring Location and Height - Per Season




VK1 9.5m - Autumn 2024
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species
VK1 9.5m - Winter 2024
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species
VK2 9.5m - Autumn 2023
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species
VK2 9.5m - Winter 2023
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species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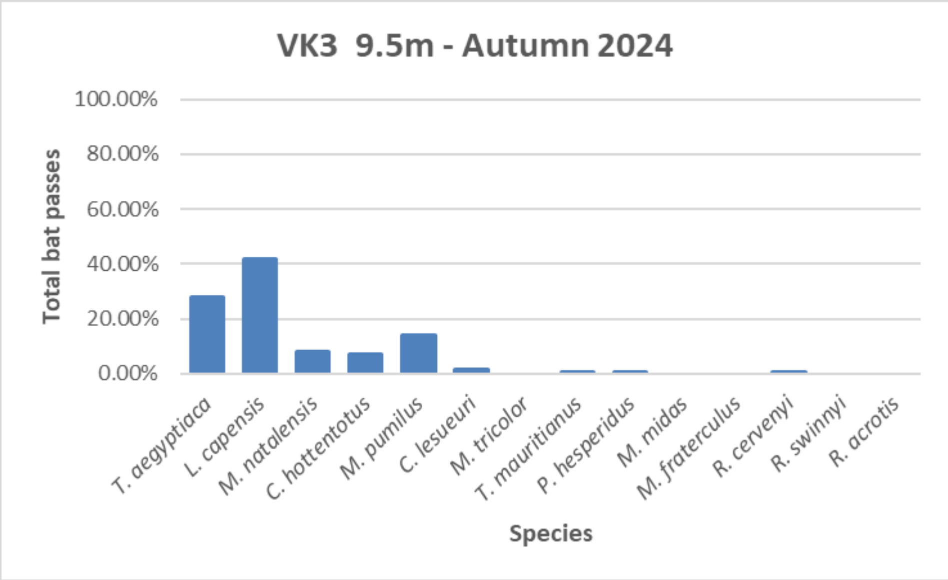
VK2 9.5m - Summer 2023/24
VK2 9.5m - Autumn 2024
VK2 9.5m - Winter 2024
No data
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK3 9.5m - Autumn 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK3 9.5m - Winter 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
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M. fraterculus
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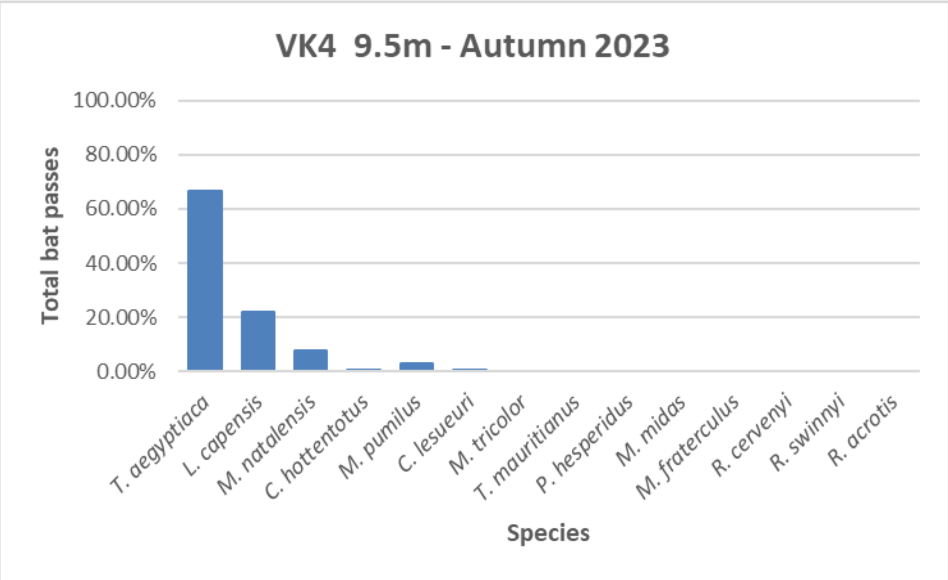
R. swinnyi
R. acrotis
Species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Total bat passes
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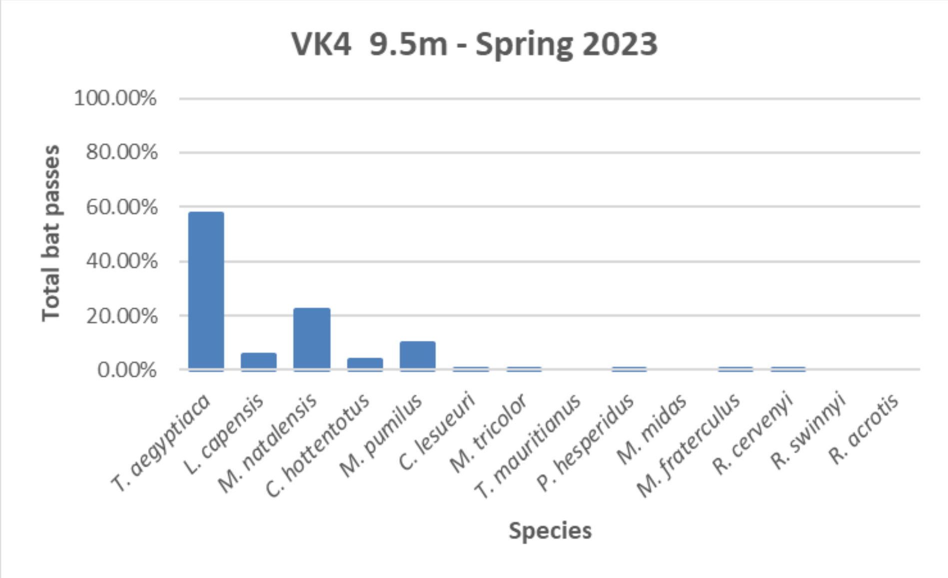
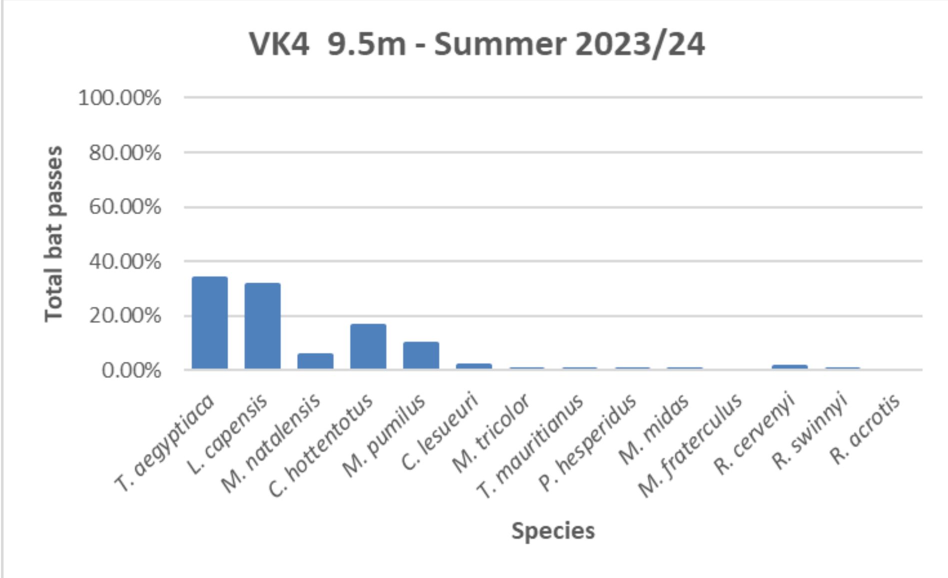
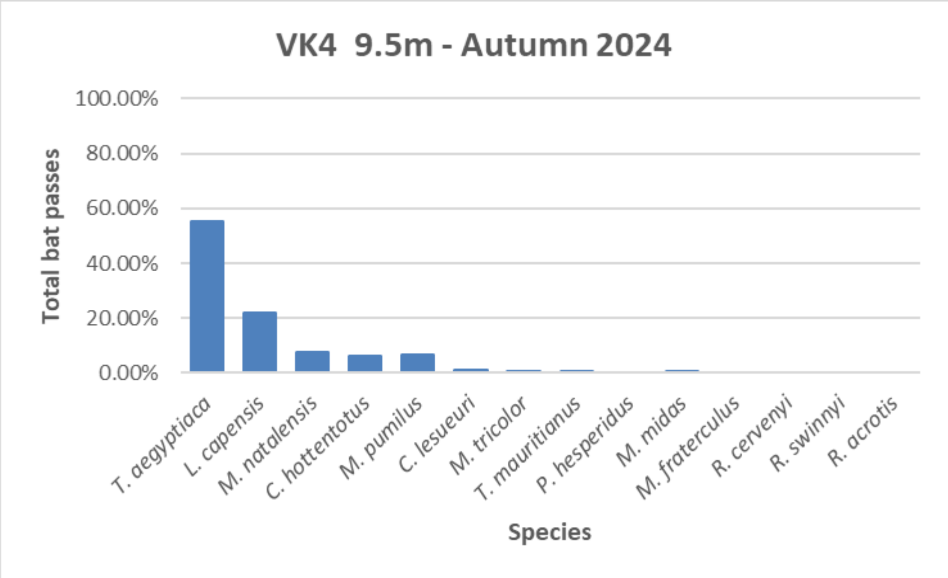
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK4 9.5m - Winter 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK4 9.5m - Spring 2023
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK4 9.5m - Summer 2023/24
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK4 9.5m - Autumn 2024
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
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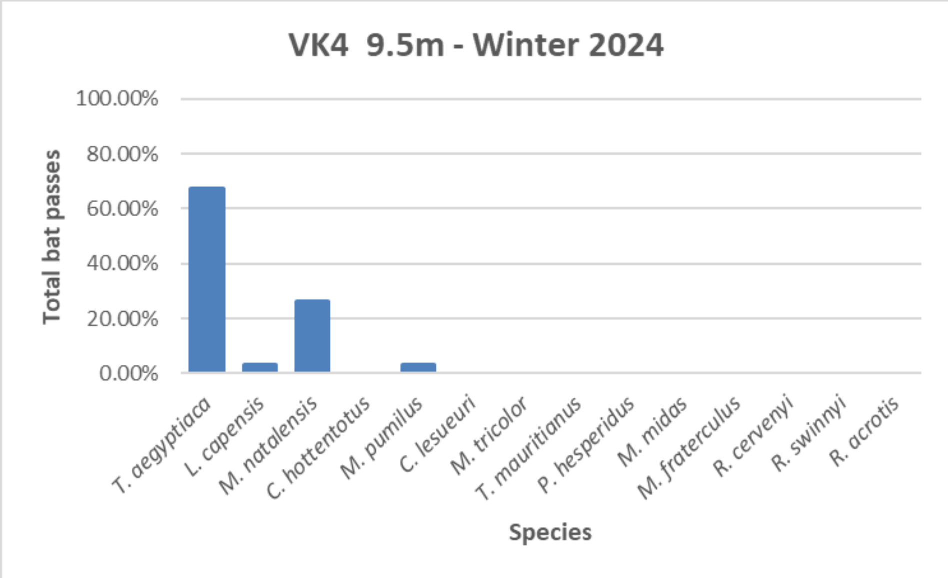
R. swinnyi
R. acrotis
Species


VK4 9.5m - Winter 2024
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
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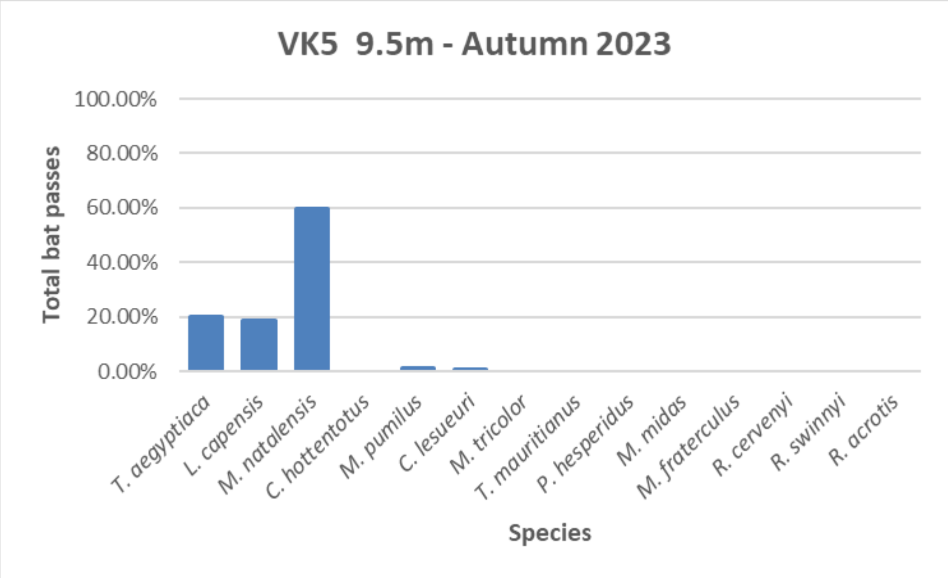
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species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100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
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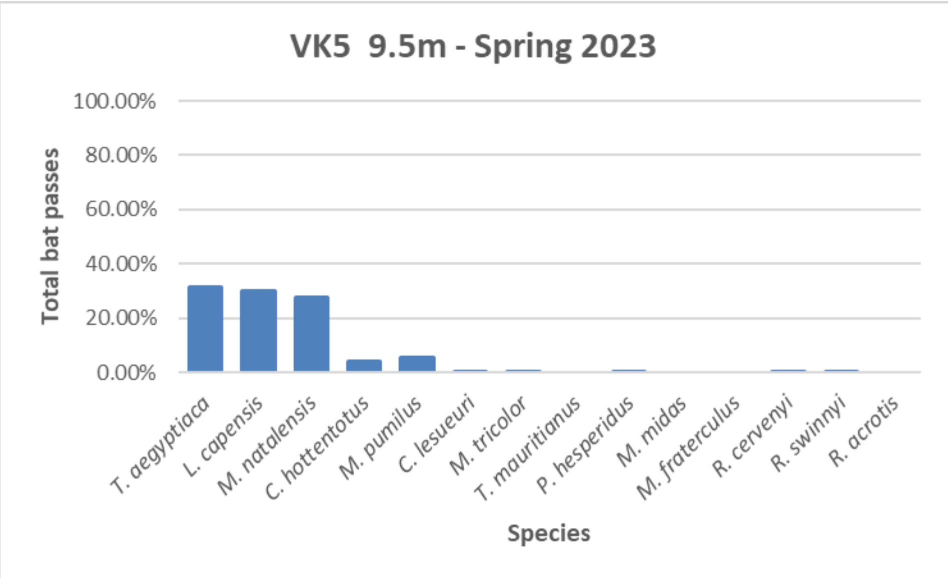
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK5 9.5m - Winter 2023
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species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100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
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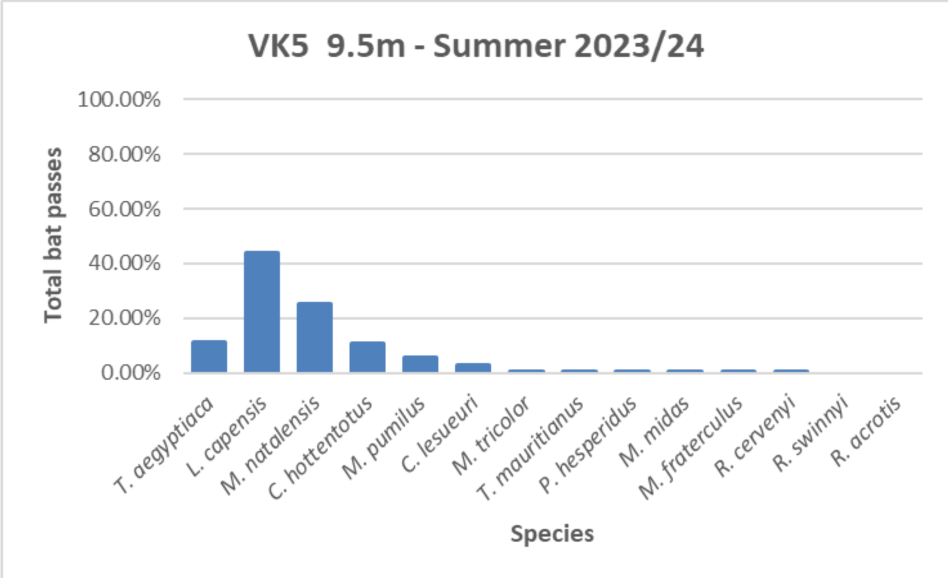
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK5 9.5m - Summer 2023/24
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Total bat passes
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
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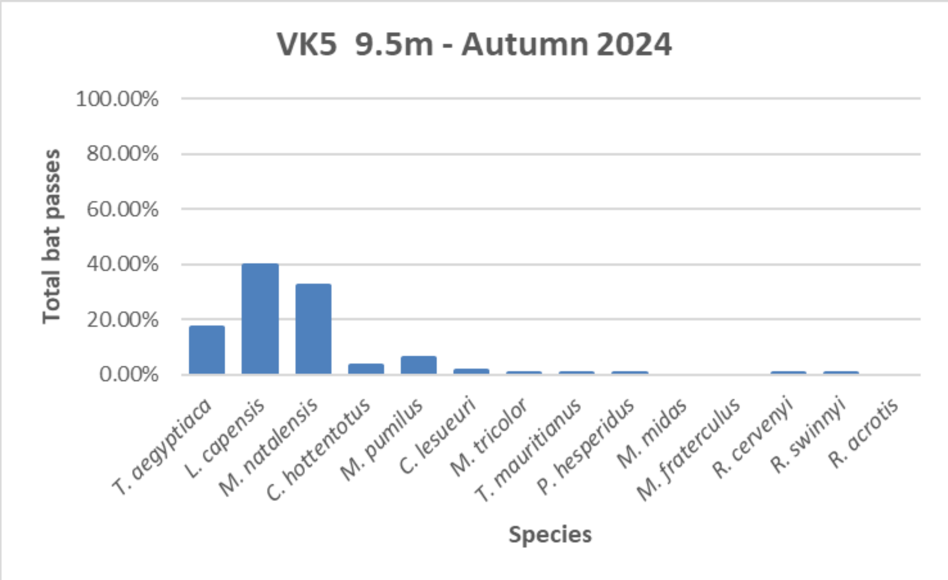
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK5 9.5m - Autumn 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK5 9.5m - Winter 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
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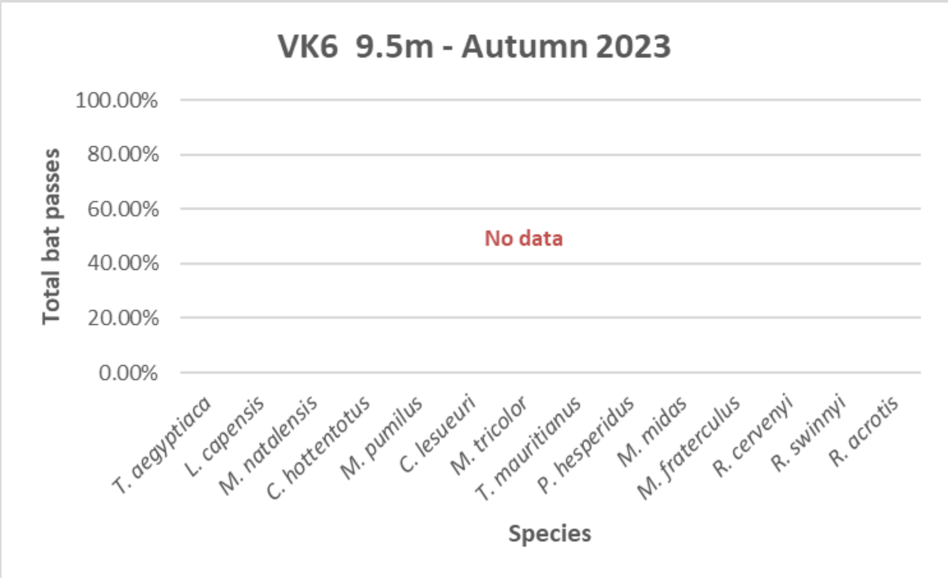
R. acrotis
Species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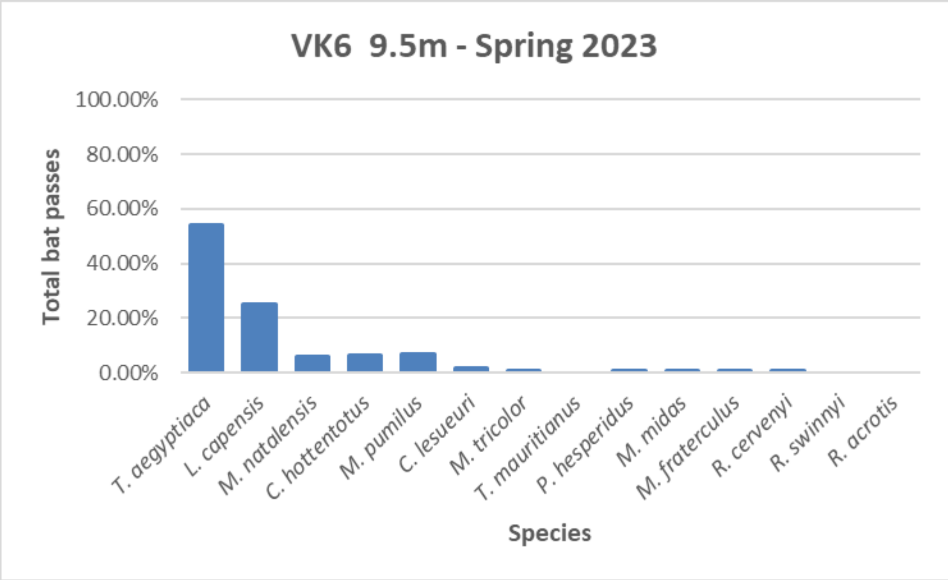
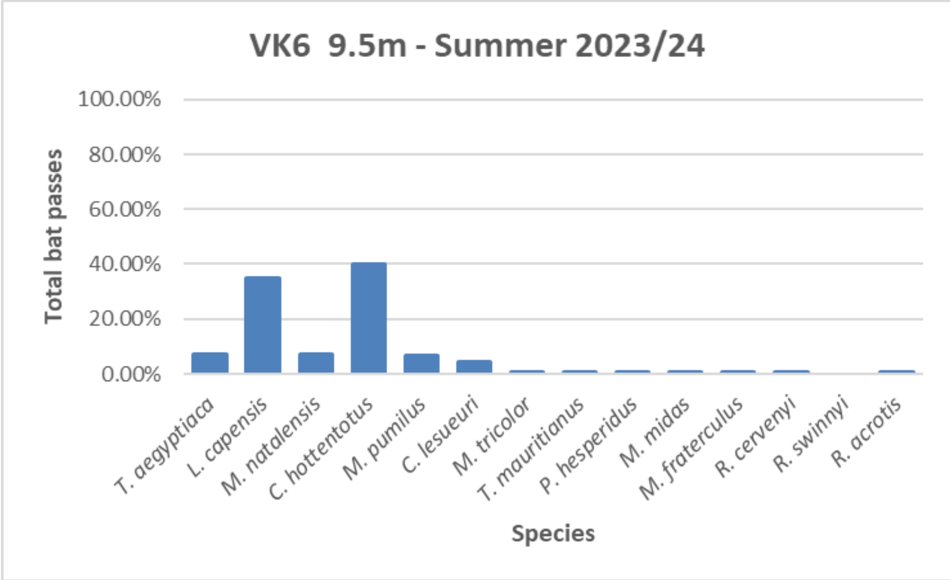
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
No data
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK6 9.5m - Winter 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK6 9.5m - Spring 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK6 9.5m - Summer 2023/24
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
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P. hesperidus
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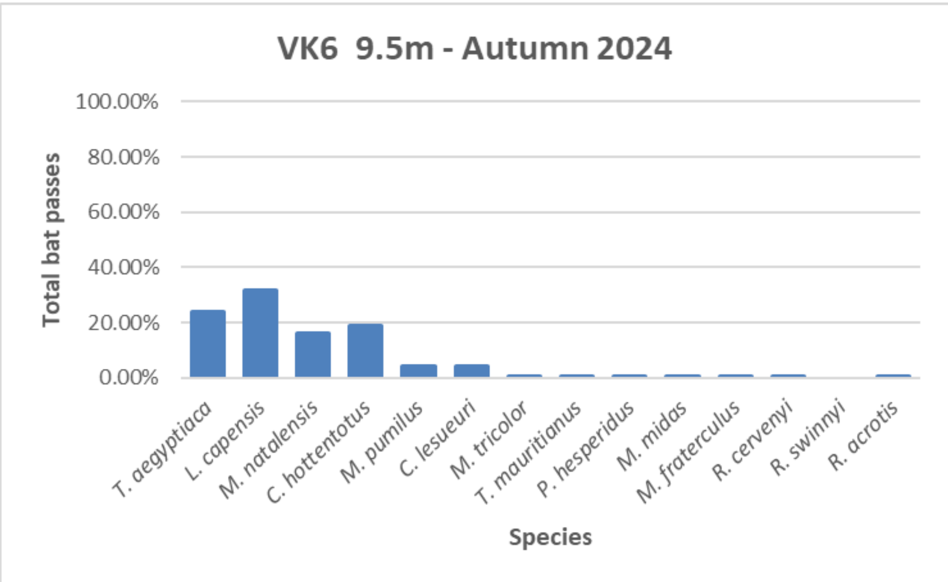
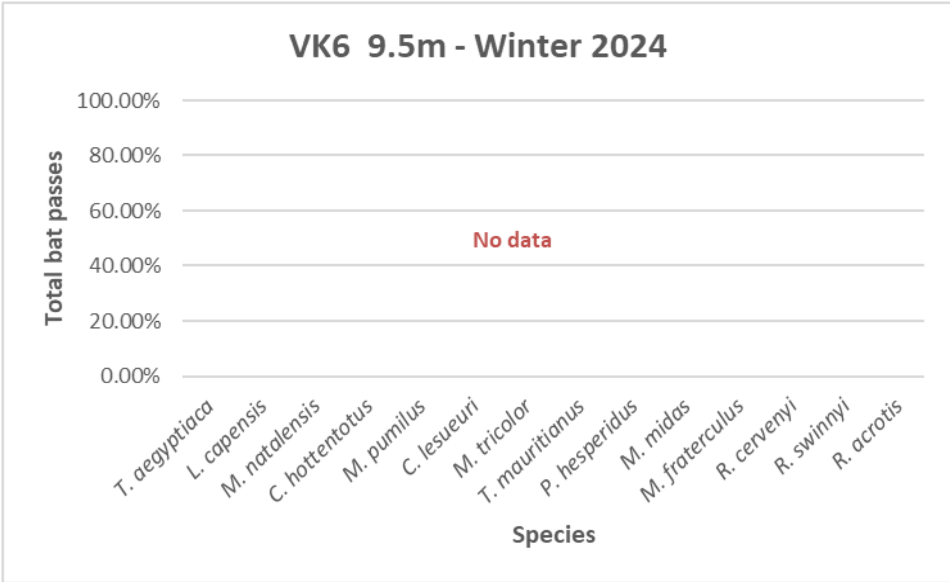
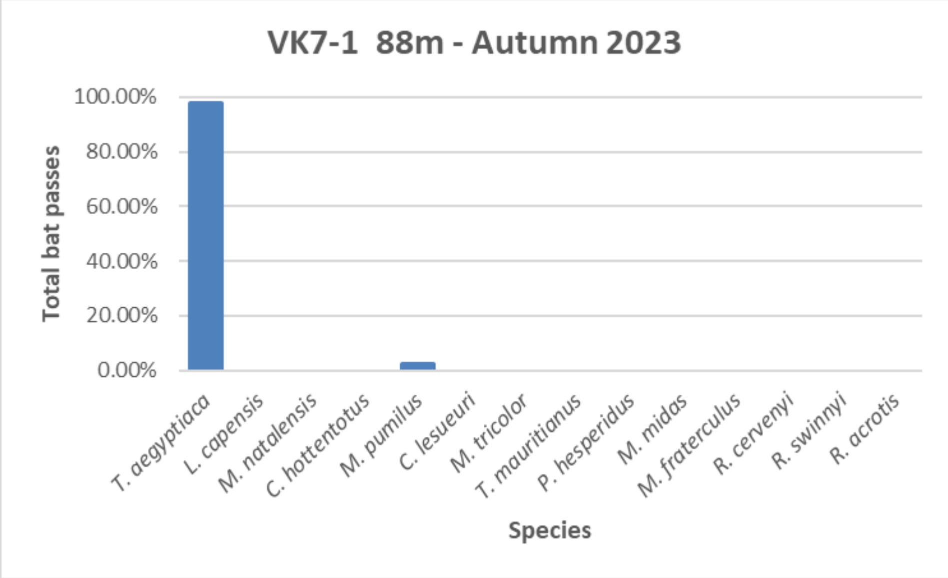
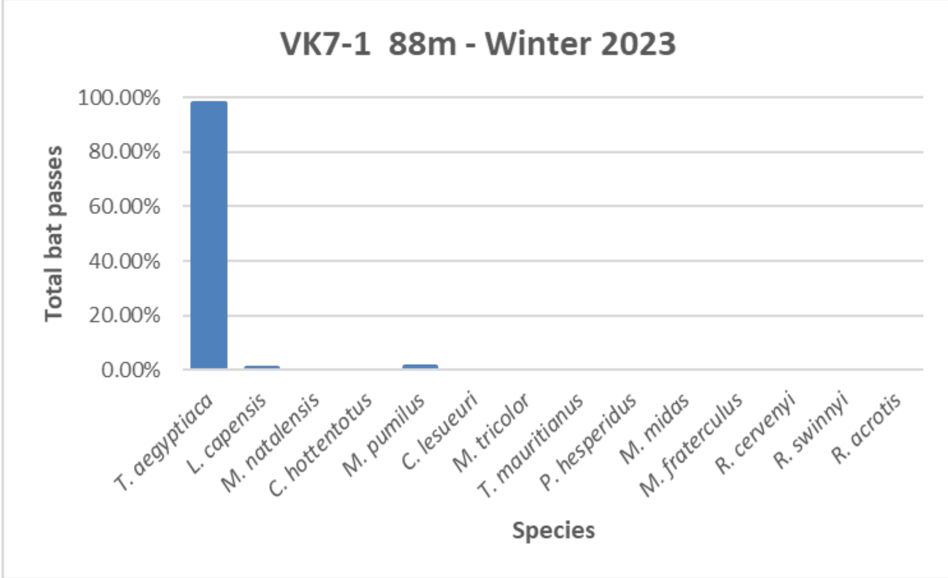
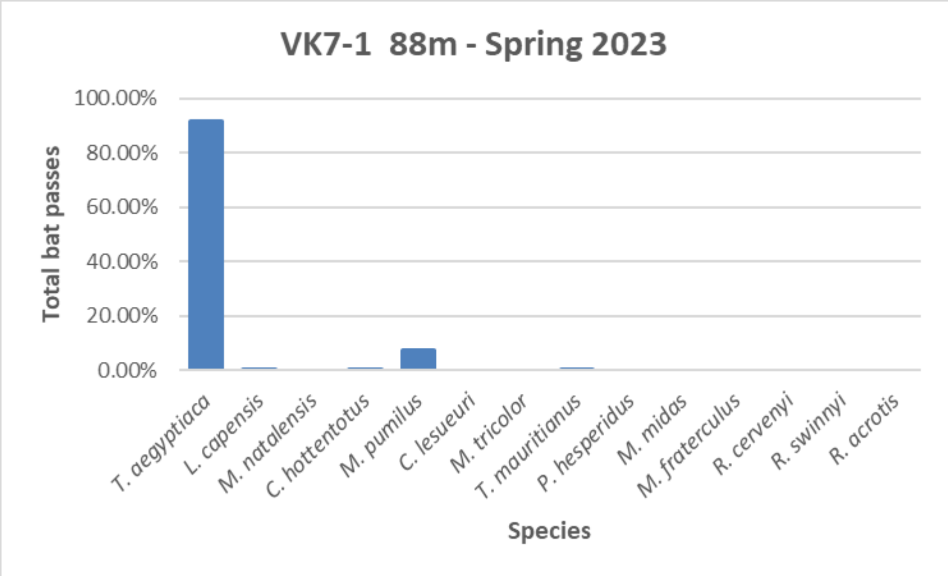
R. acrotis
Species

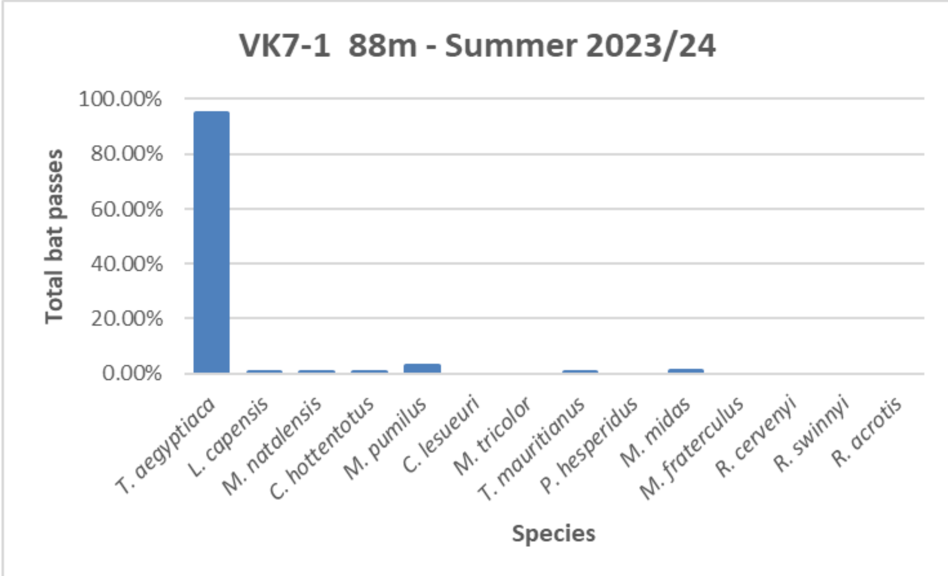

VK6 9.5m - Autumn 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

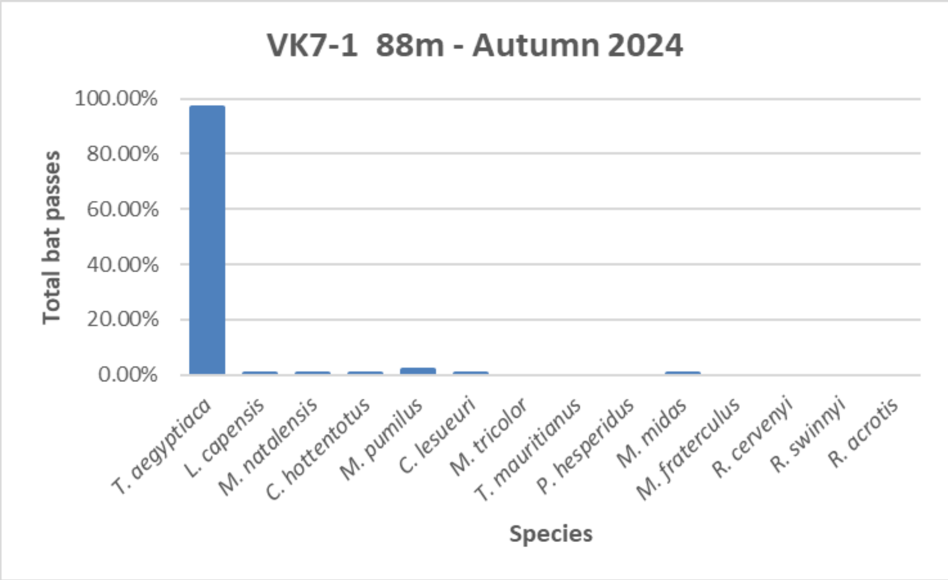

VK6 9.5m - Winter 2024
Total bat passes
100.00%
80.00%
60.00%
No data
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

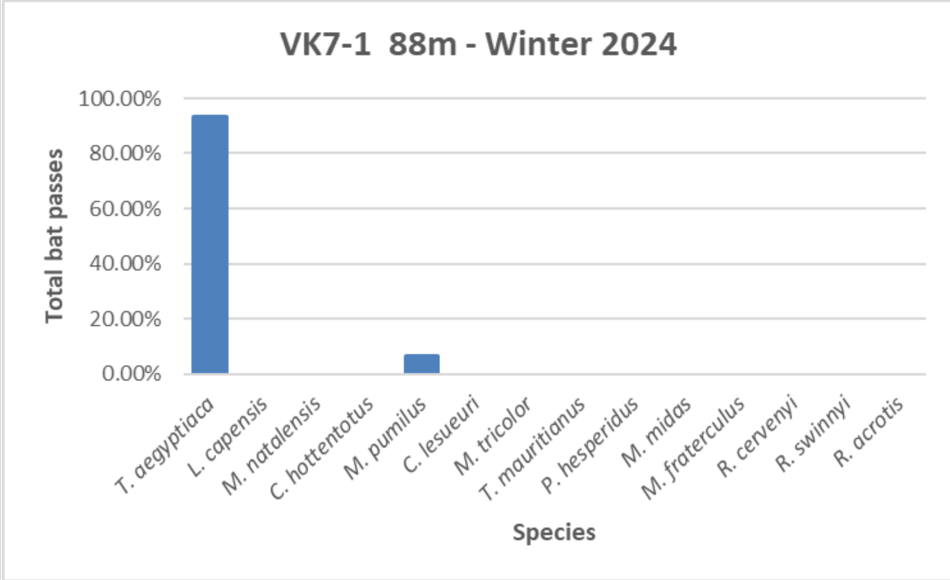

VK7-1 88m - Autumn 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

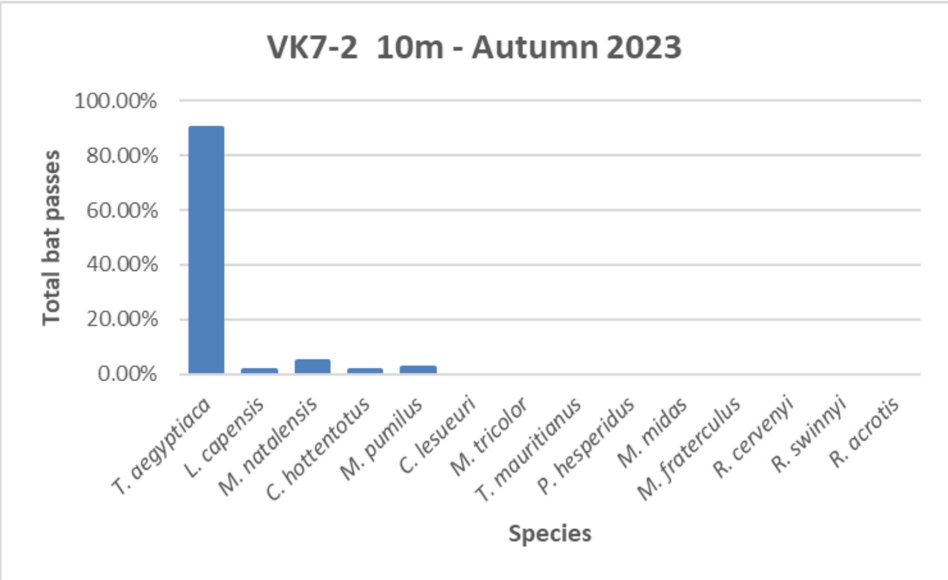

VK7-1 88m - Winter 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

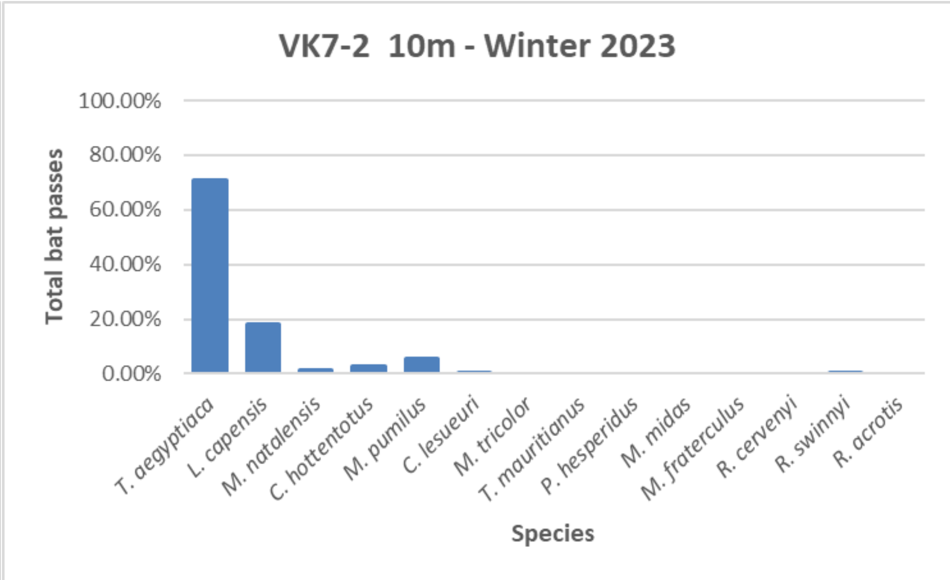

VK7-1 88m - Spring 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

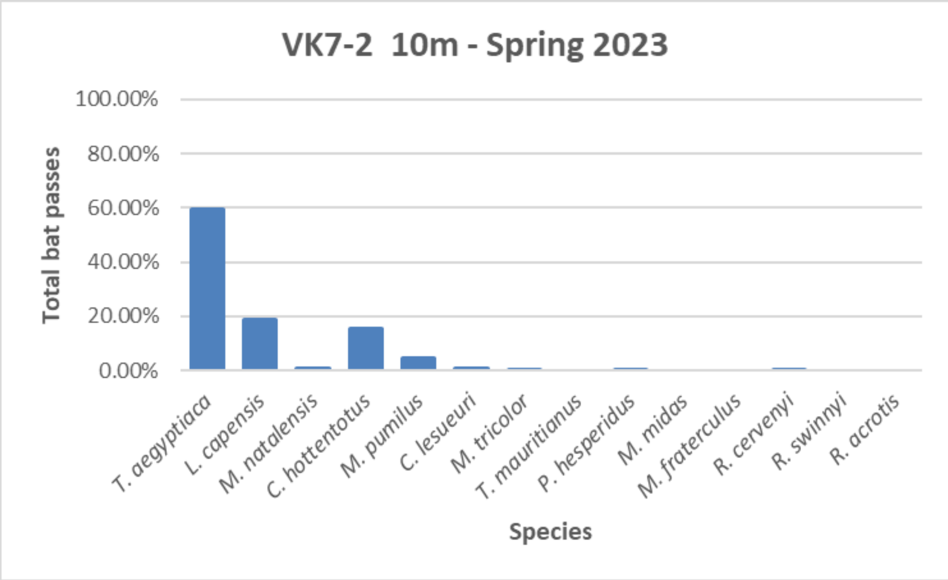

VK7-1 88m - Summer 2023/24
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

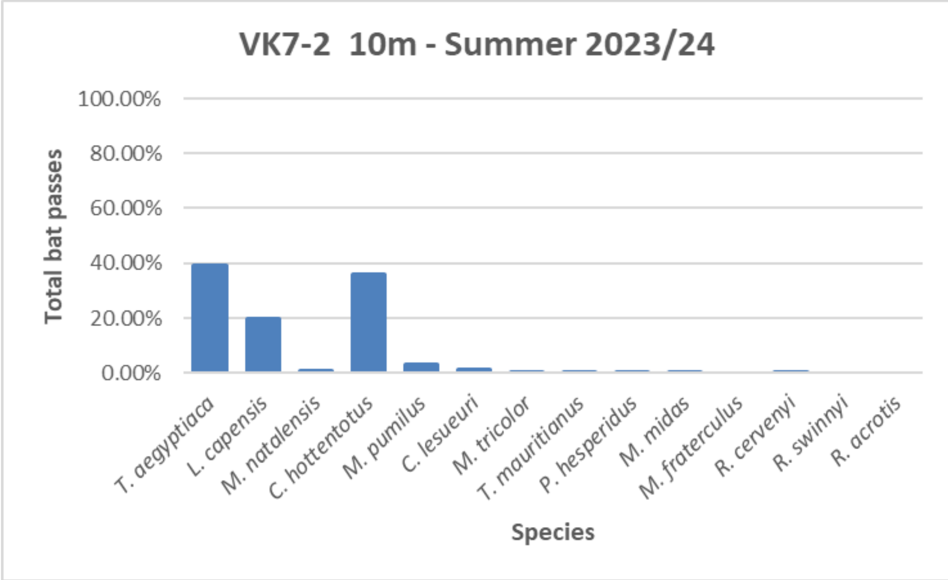

VK7-1 88m - Autumn 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

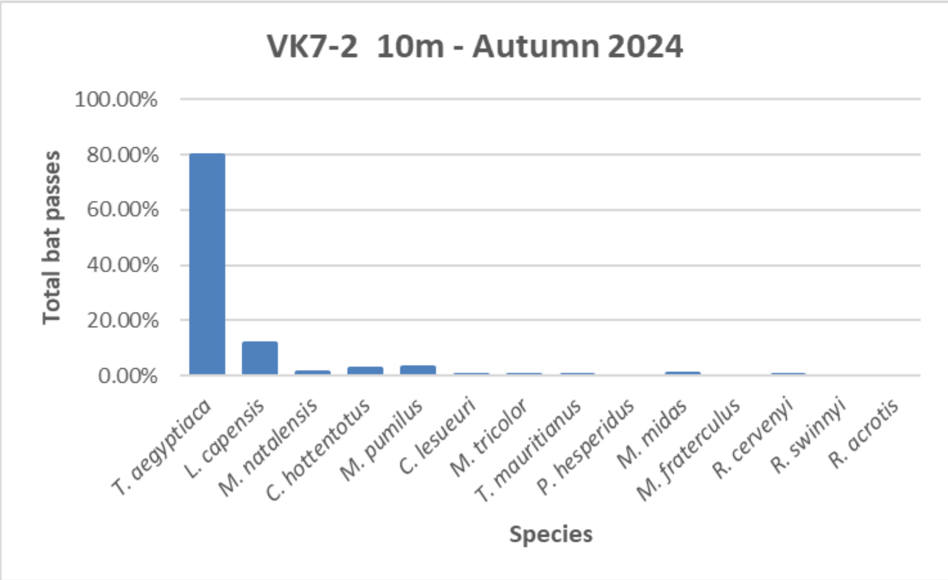

VK7-1 88m - Winter 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

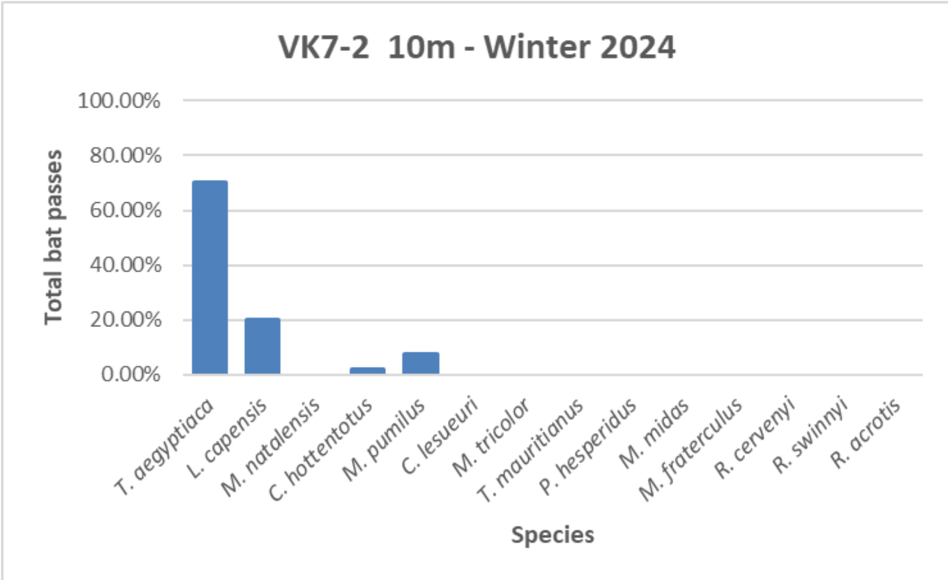

VK7-2 10m - Autumn 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

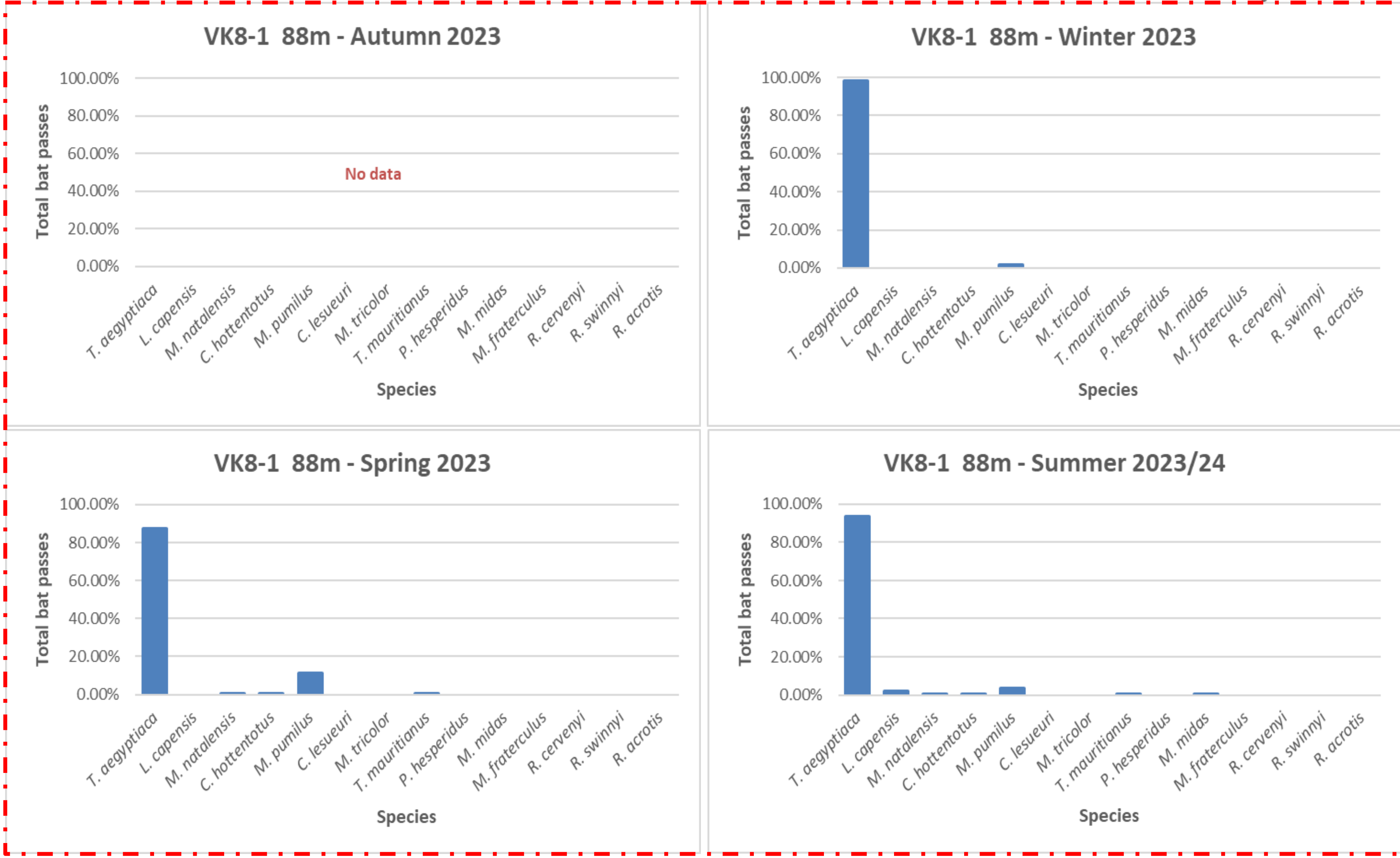

VK7-2 10m - Winter 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

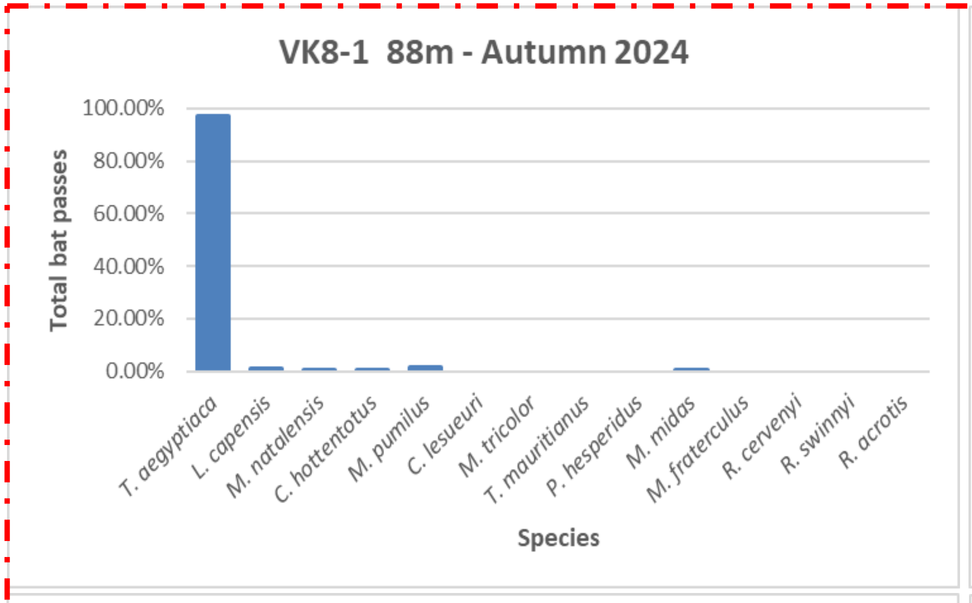

VK7-2 10m - Spring 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

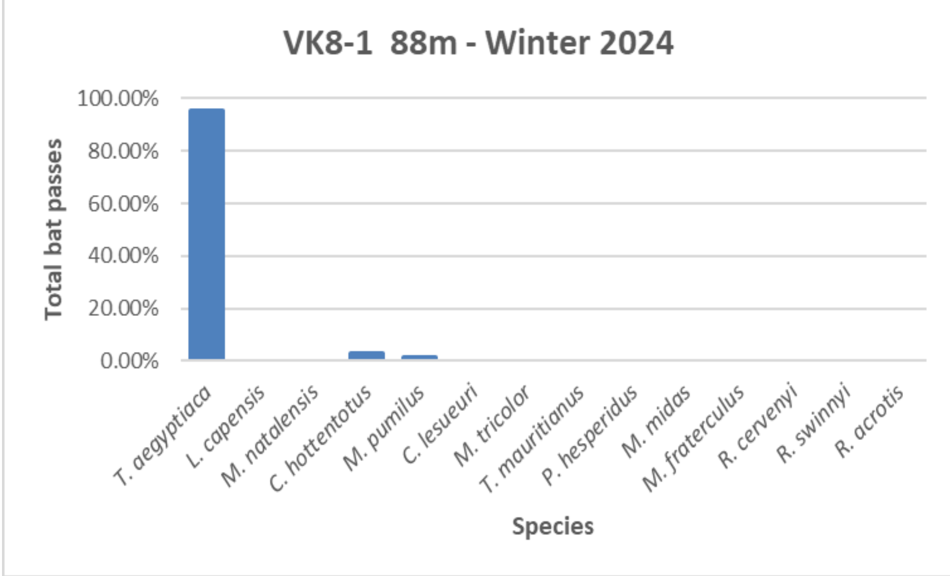

VK7-2 10m - Summer 2023/24
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

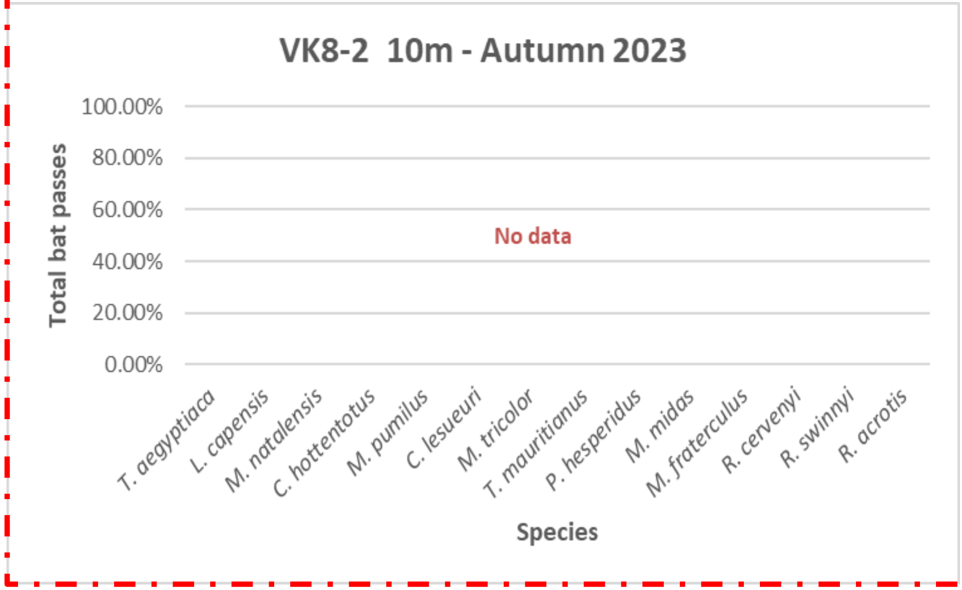

VK7-2 10m - Autumn 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

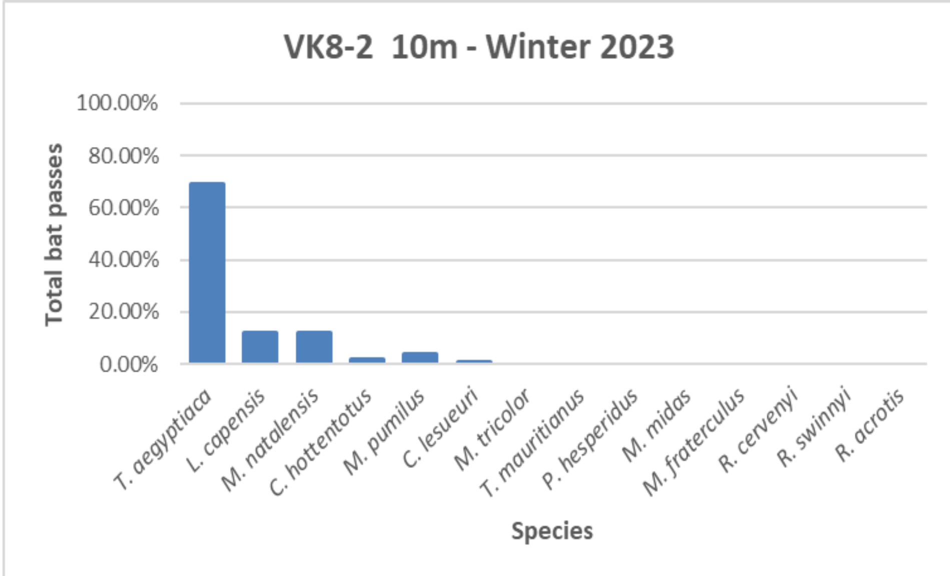

VK7-2 10m - Winter 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK8-1 88m - Autumn 2023
Total bat passes
Species
No data
VK8-1 88m - Winter 2023
VK8-1 88m - Spring 2023
VK8-1 88m - Summer 2023/24
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis


VK8-1 88m - Autumn 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK8-1 88m - Winter 2024
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK8-2 10m - Autumn 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
No data
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species


VK8-2 10m - Winter 2023
Total bat passes
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. swinnyi
R. acrotis
Species

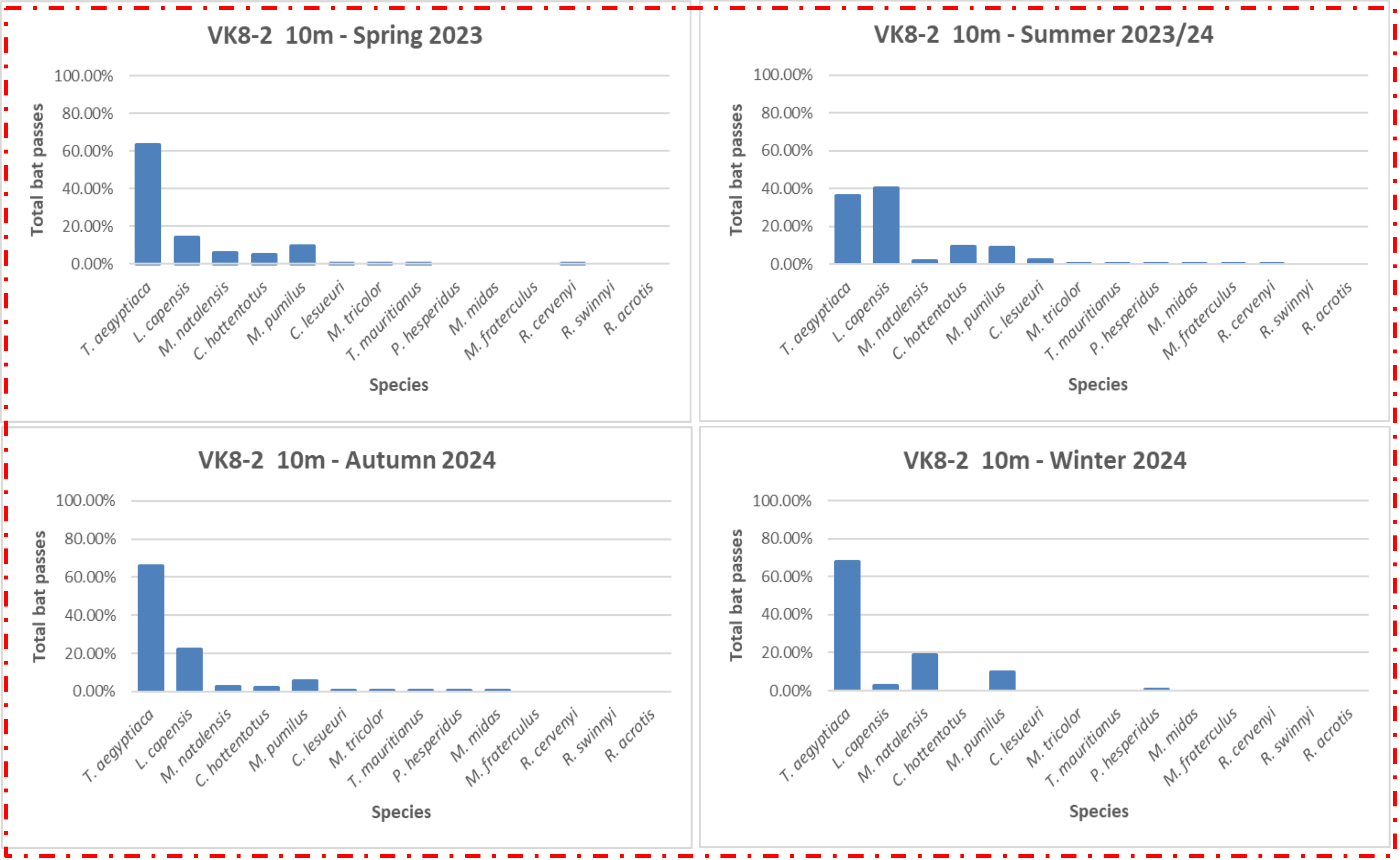
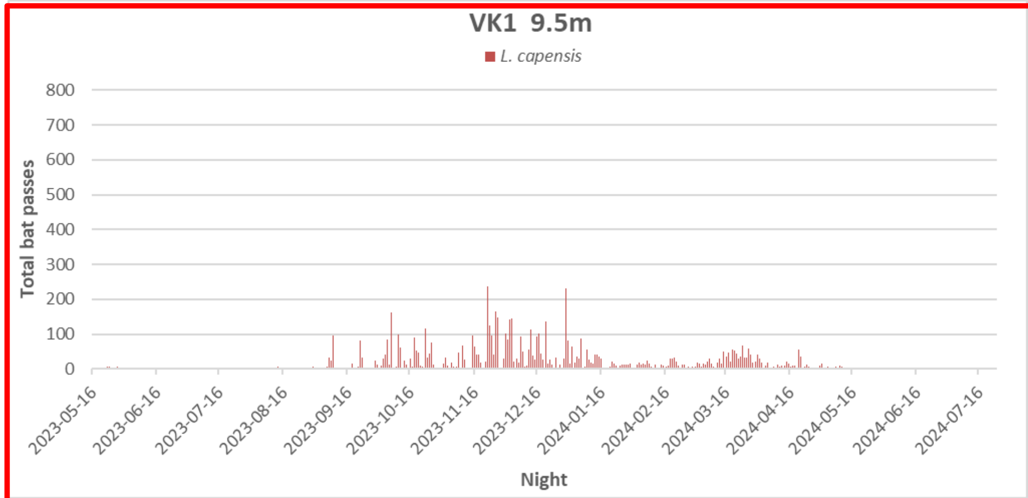
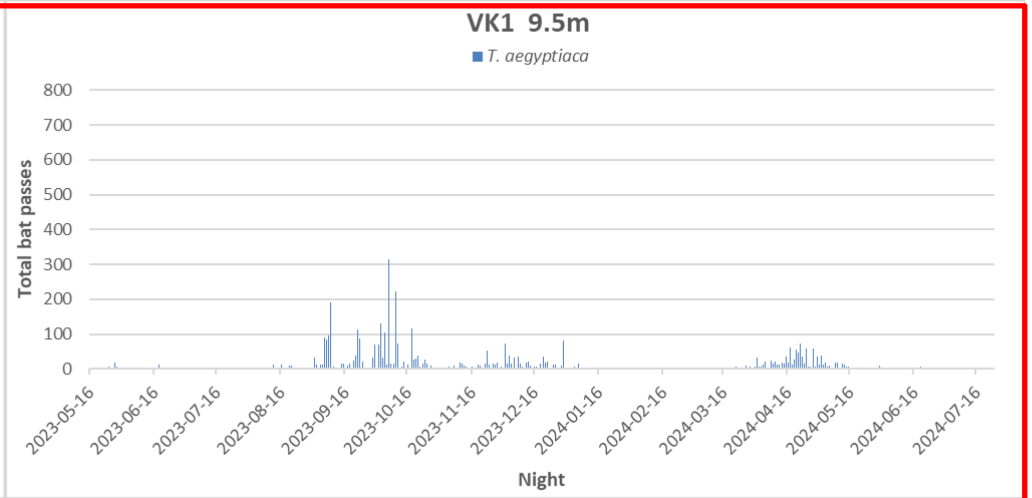
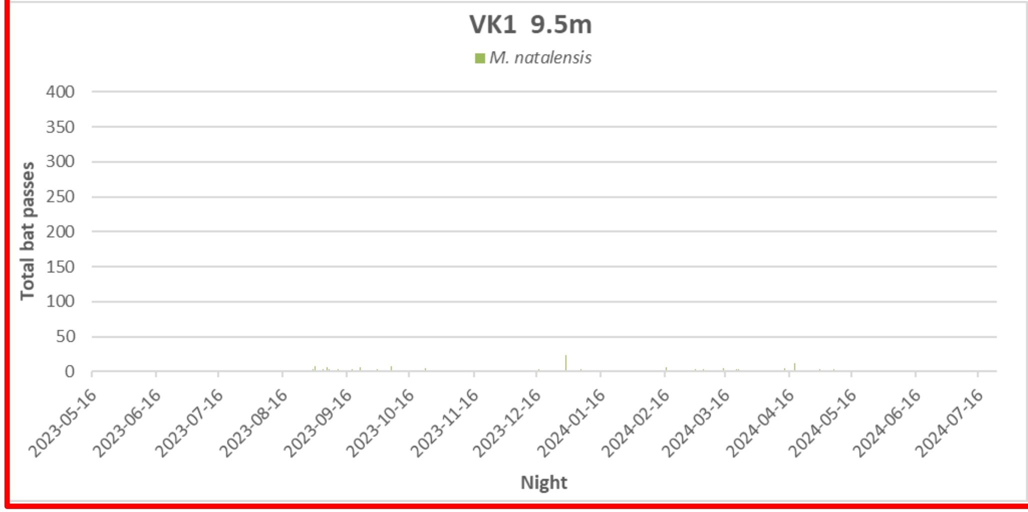


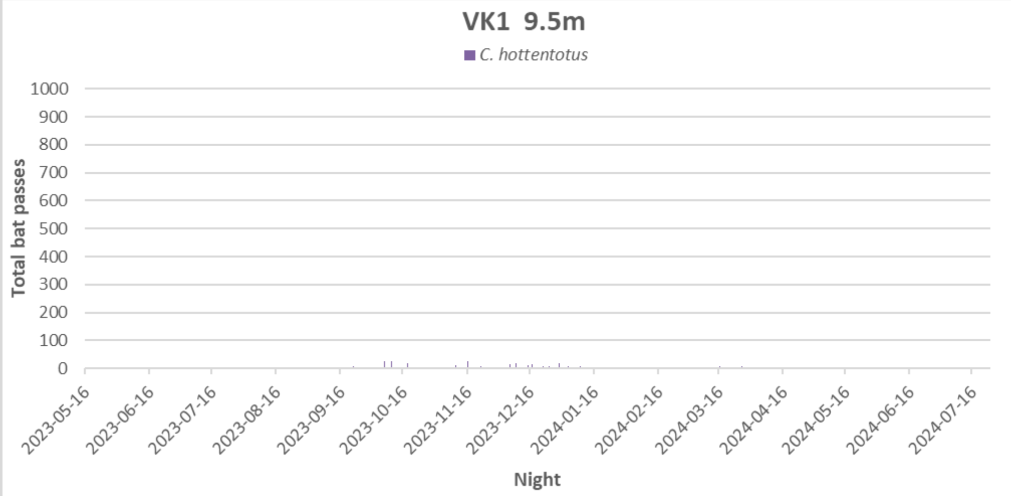
Figure 18 Species composition of bat calls recorded at each monitoring location and height – per season. The Groothoek microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8) are outlined in dashed red

12. Appendix 2: Nights When the Activity of Each Bat Species Peaked at Each Monitoring Location and Height

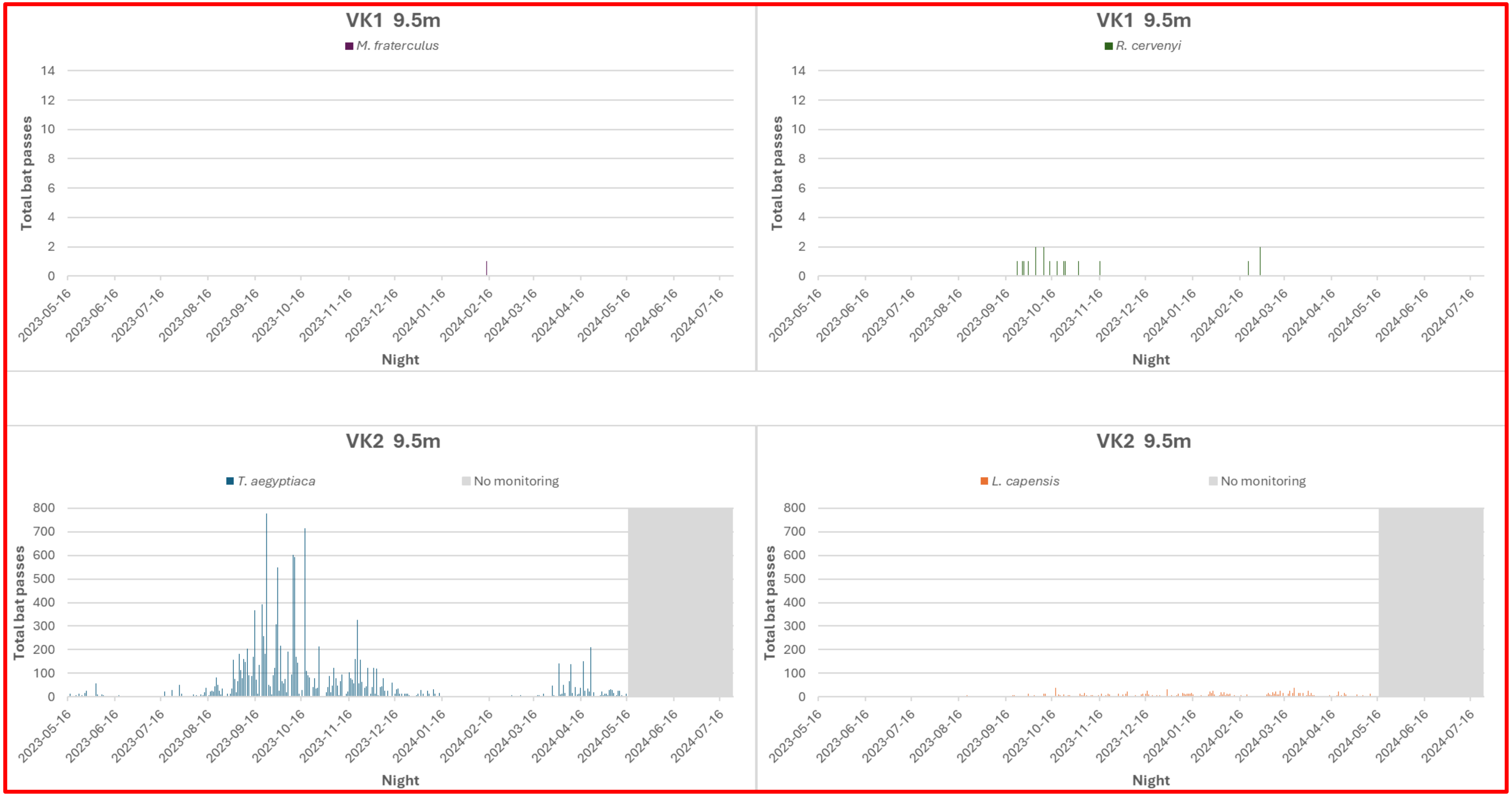


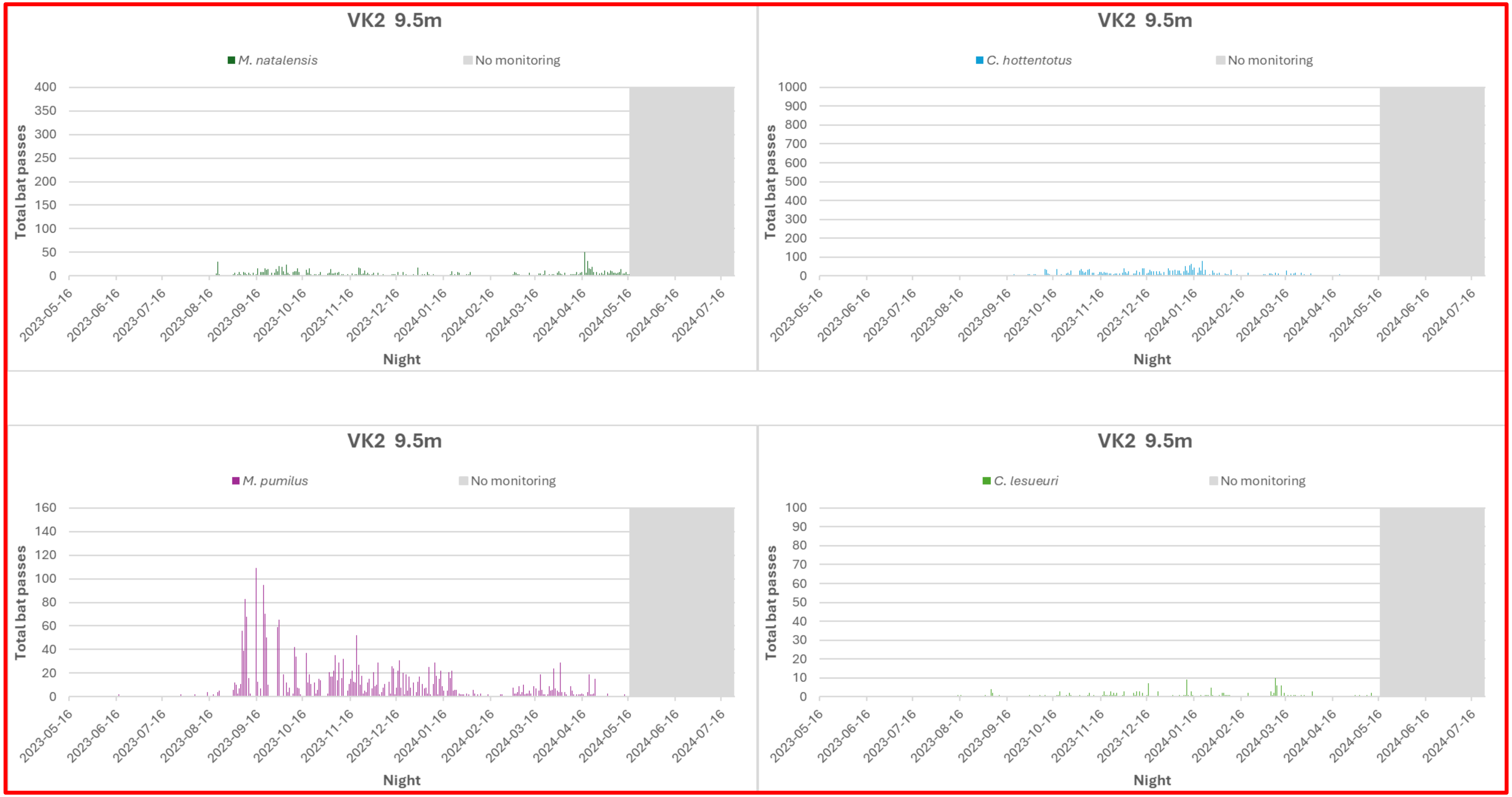




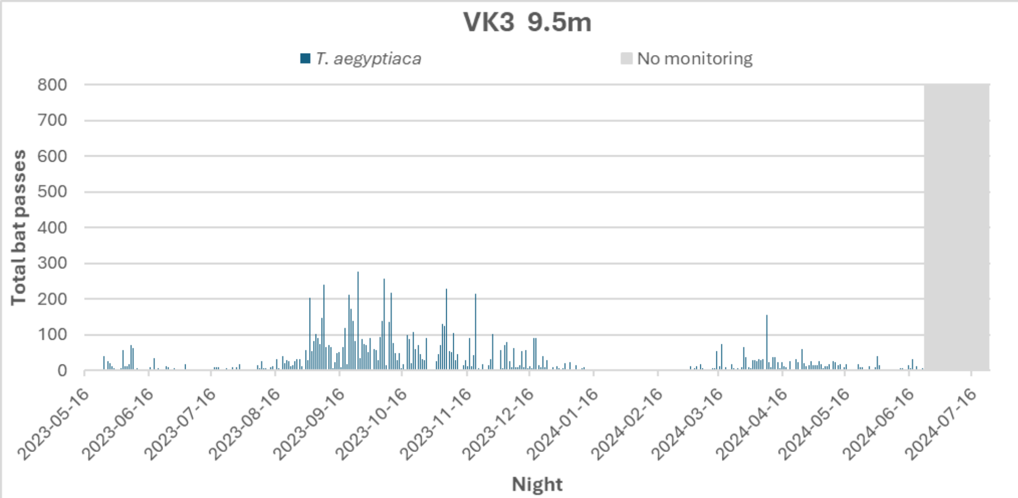


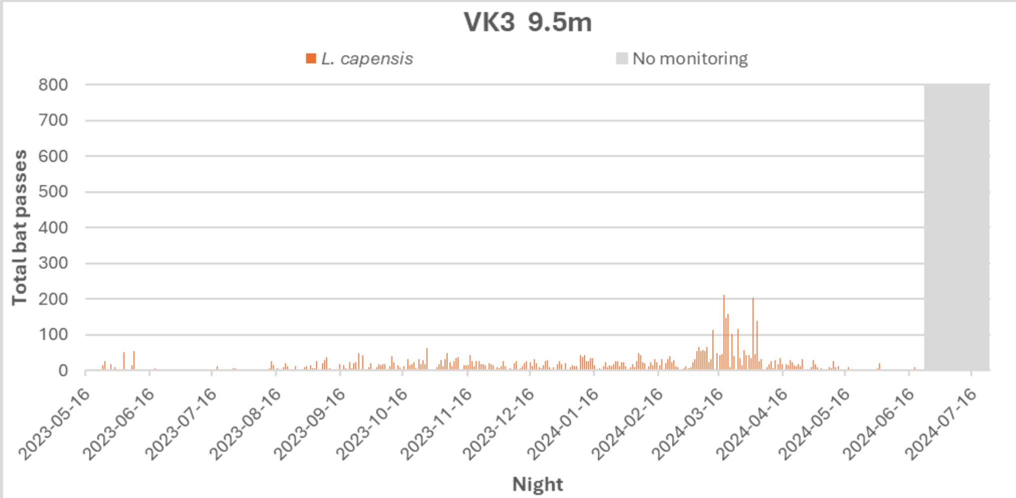

VK1 9.5m
M. pumilus
Total bat passes
Night
VK1 9.5m
C. lesueuri
Total bat passes
Night
VK1 9.5m
M. tricolor
Total bat passes
Night
VK1 9.5m
T. mauritianus
Total bat passes
Night

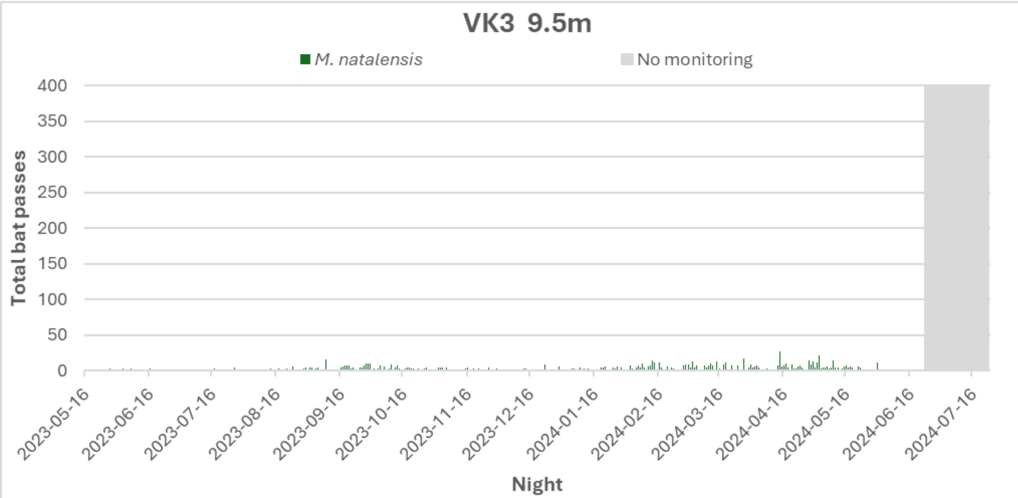

VK1 9.5m
M. fraterculus
Total bat passes
Night
VK1 9.5m
R. cervenyi
Total bat passes
Night
VK2 9.5m
T. aegyptiaca
No monitoring
Total bat passes
Night
VK2 9.5m
L. capensis
No monitoring
Total bat passes
Night

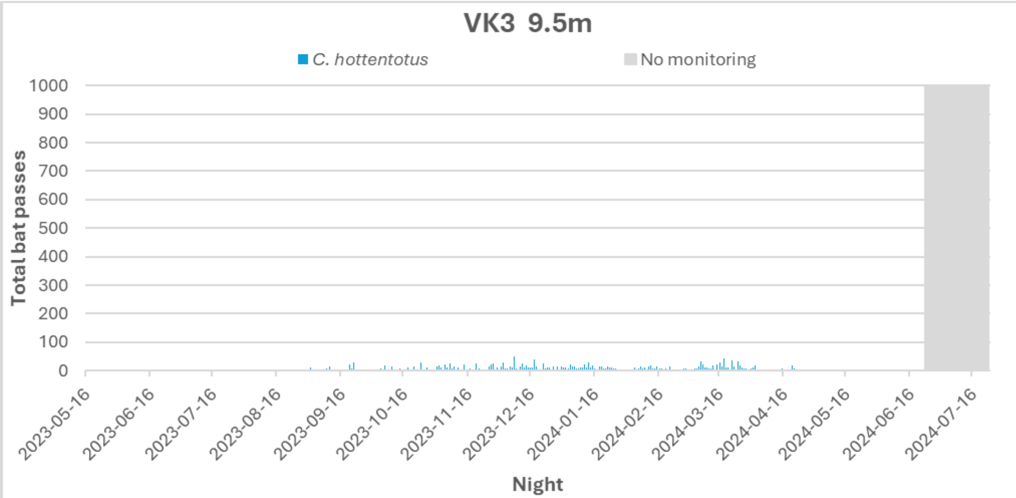

VK2 9.5m
M. natalensis
No monitoring
Total bat passes
Night
VK2 9.5m
C. hottentotus
No monitoring
Total bat passes
Night
VK2 9.5m
M. pumilus
No monitoring
Total bat passes
Night
VK2 9.5m
C. lesueuri
No monitoring
Total bat passes
Night

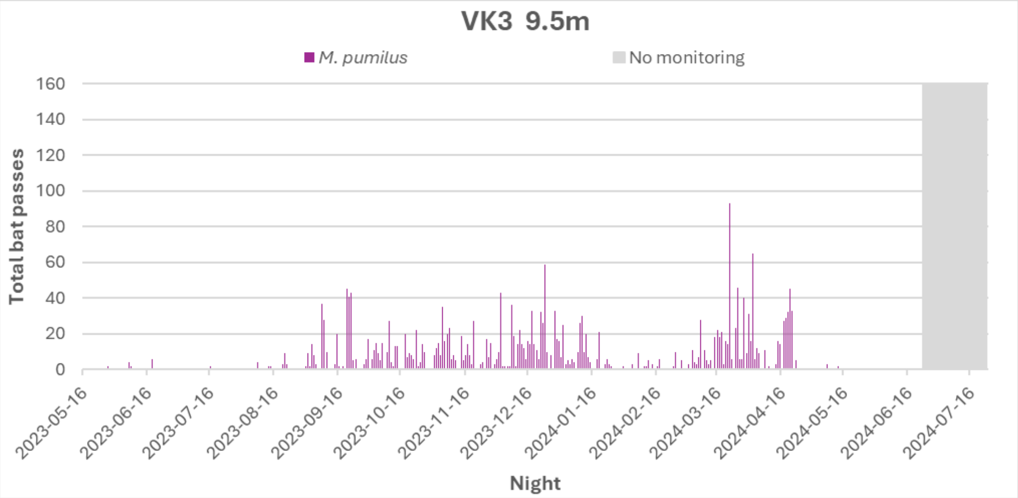

VK2 9.5m
M. tricolor
No monitoring
Total bat passes
14
12
10
8
6
4
2
0
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night
VK2 9.5m
T. mauritianus
No monitoring
Total bat passes
Night
VK2 9.5m
P. hesperidus
No monitoring
Total bat passes
Night
VK2 9.5m
R. cervenyi
No monitoring
Total bat passes
Night

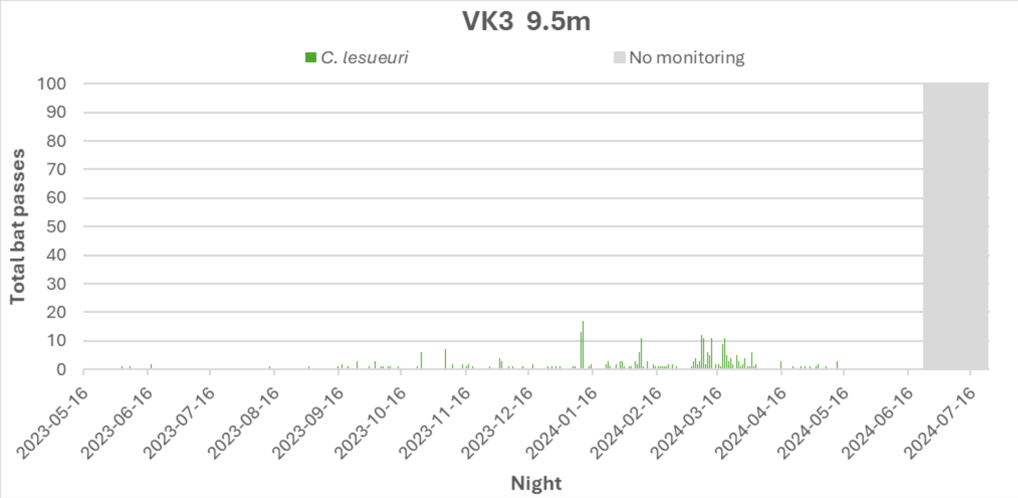

VK3 9.5m
T. aegyptiaca
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

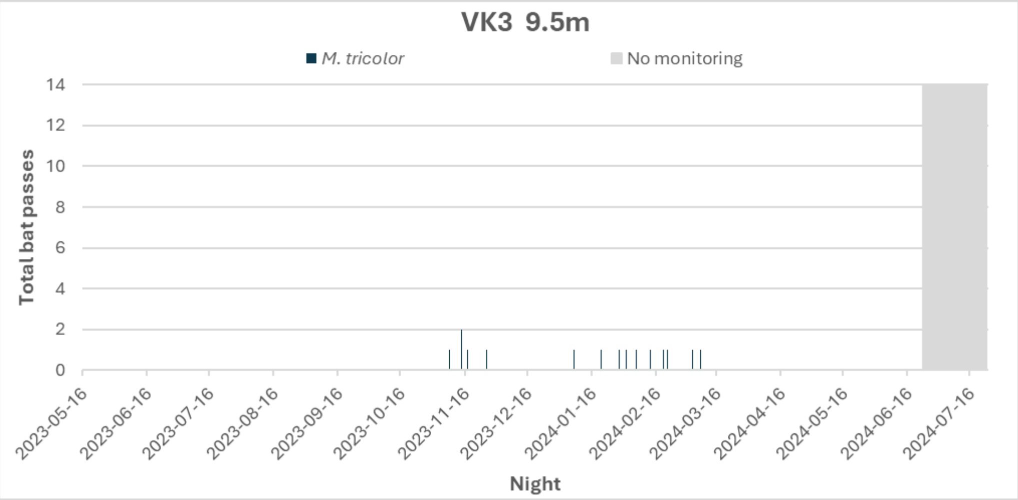

VK3 9.5m
L. capensis
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

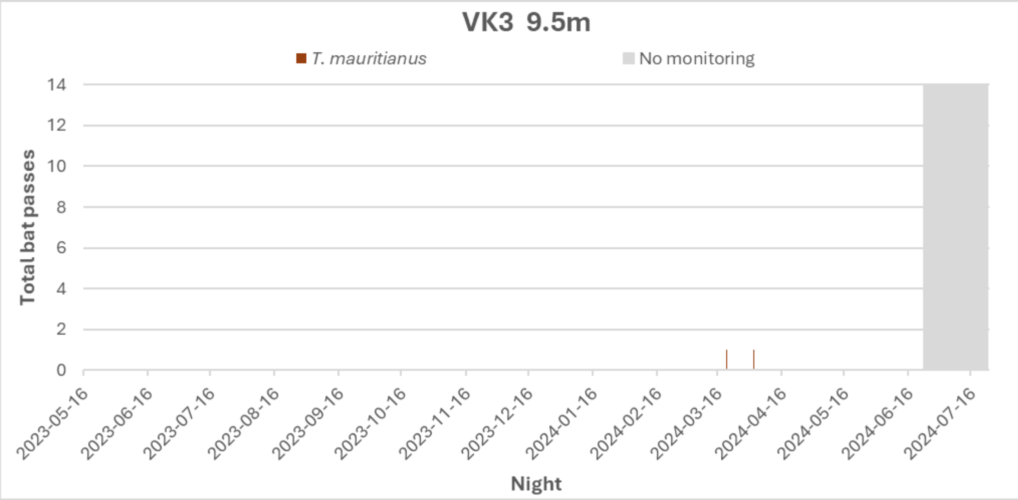

VK3 9.5m
M. natalensis
No monitoring
Total bat passes
0
50
100
150
200
250
300
350
400
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

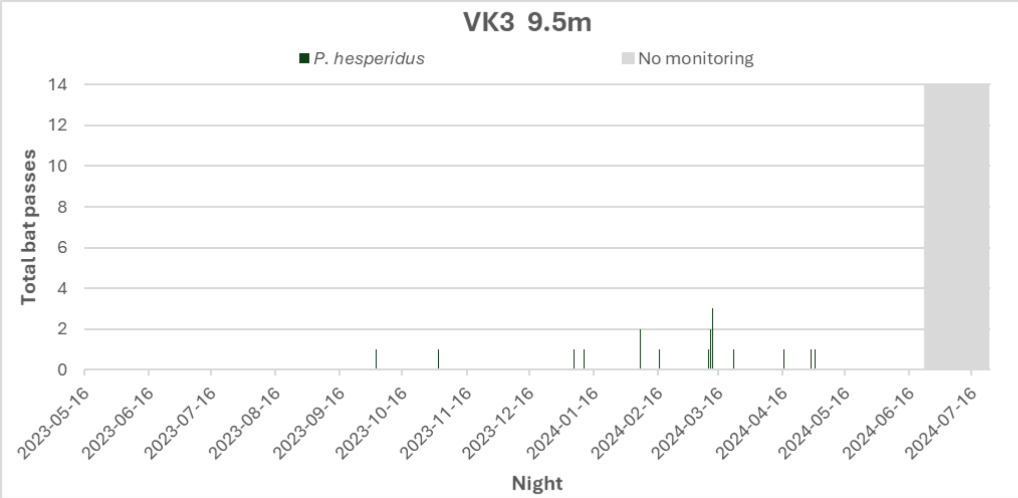

VK3 9.5m
C. hottentotus
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
900
1000
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

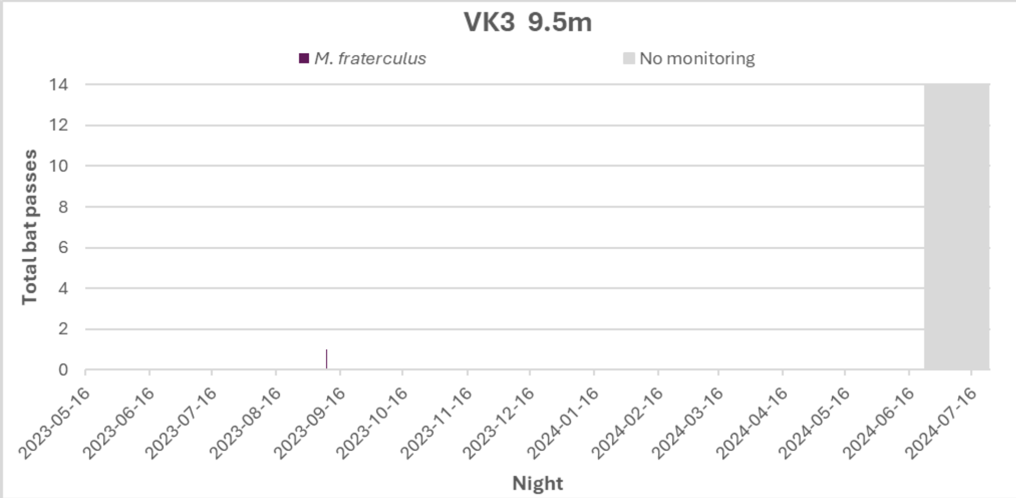

VK3 9.5m
M. pumilus
No monitoring
Total bat passes
Night


VK3 9.5m
C. lesueuri
No monitoring
Total bat passes
Night


VK3 9.5m
M. tricolor
No monitoring
Total bat passes
Night


VK3 9.5m
T. mauritianus
No monitoring
Total bat passes
Night


VK3 9.5m
P. hesperidus
No monitoring
Total bat passes
0
2
4
6
8
10
12
14
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night


VK3 9.5m
M. fraterculus
No monitoring
Total bat passes
0
2
4
6
8
10
12
14
2023-05-16
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2023-07-16
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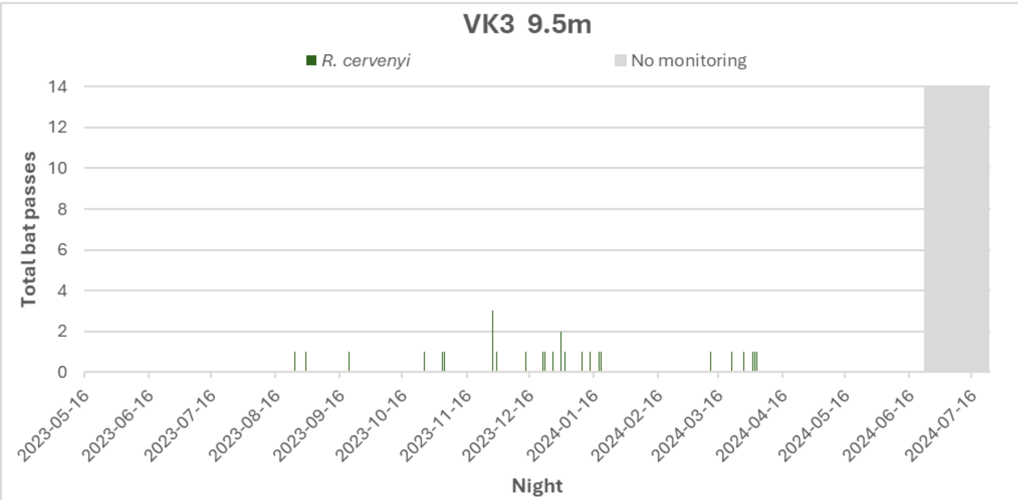
Night


VK3 9.5m
R. cervenyi
No monitoring
Total bat passes
0
2
4
6
8
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2023-05-16
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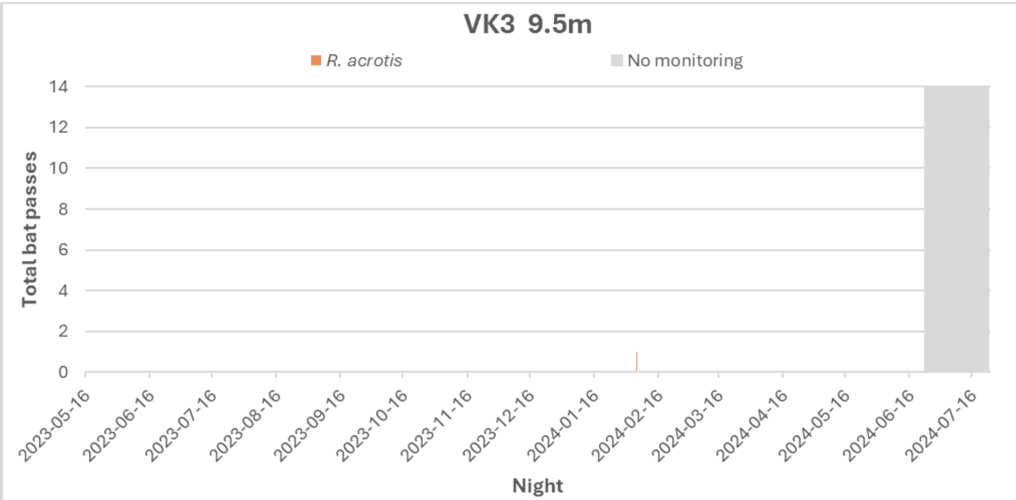
Night


VK3 9.5m
R. acrotis
No monitoring
Total bat passes
0
2
4
6
8
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12
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2023-05-16
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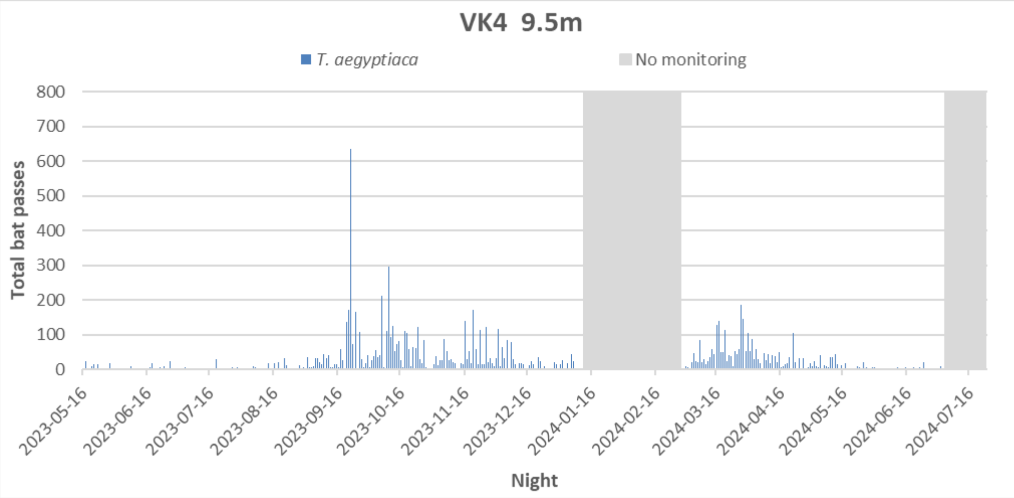
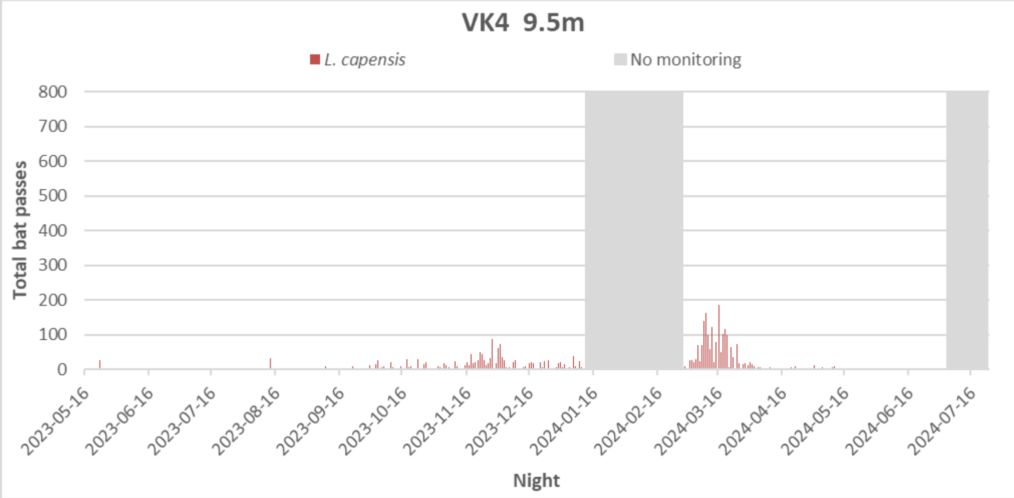
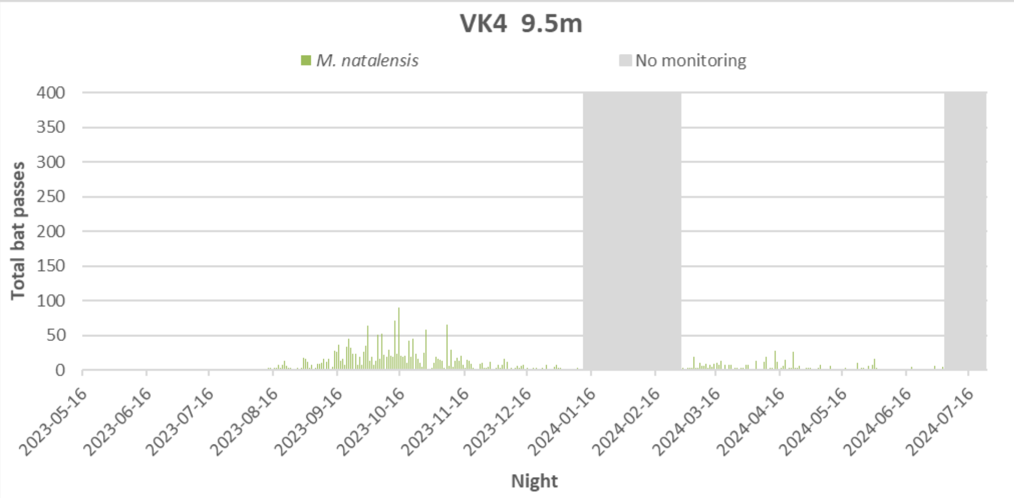
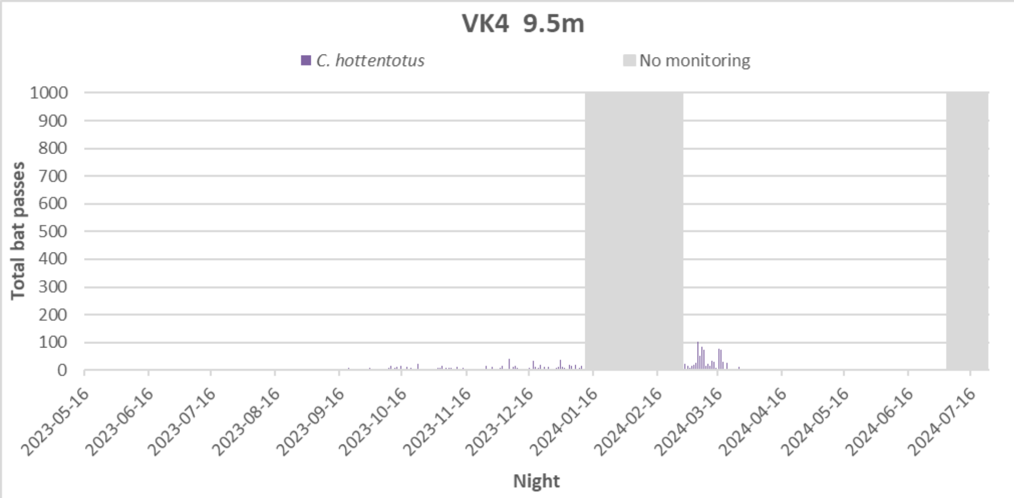
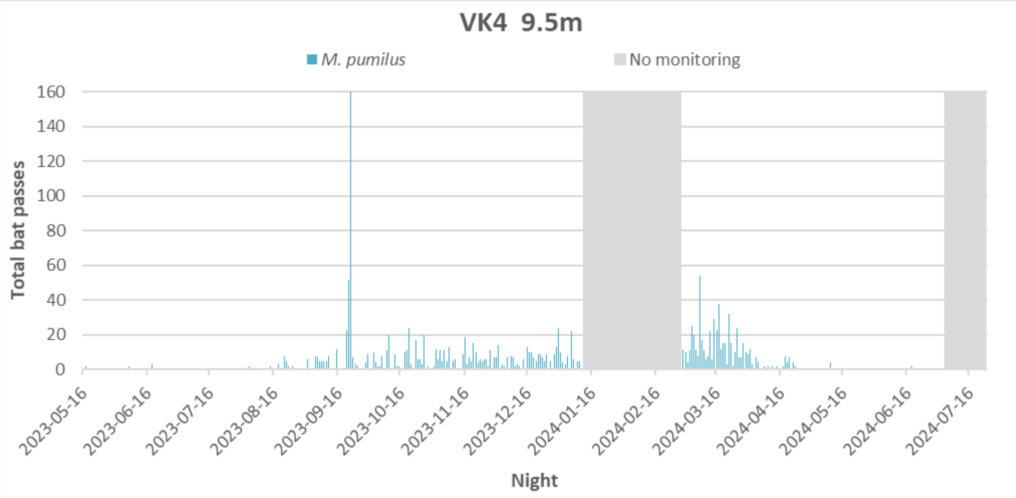
Night

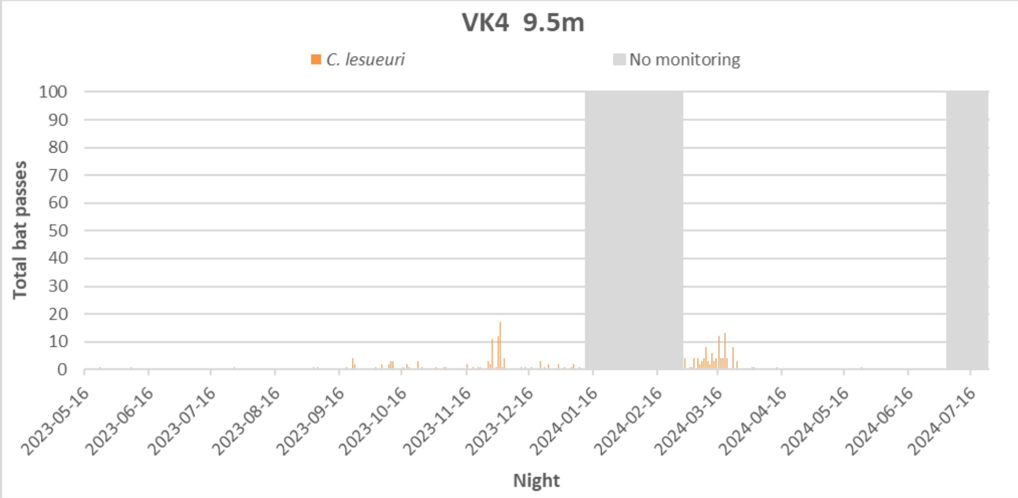

VK4 9.5m
T. aegyptiaca
No monitoring
Total bat passes
Night

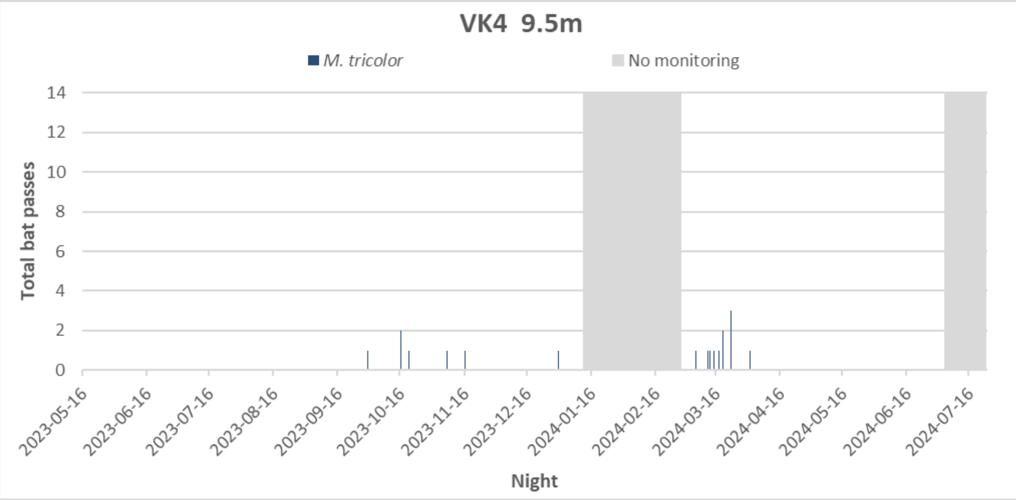

VK4 9.5m
L. capensis
No monitoring
Total bat passes
Night

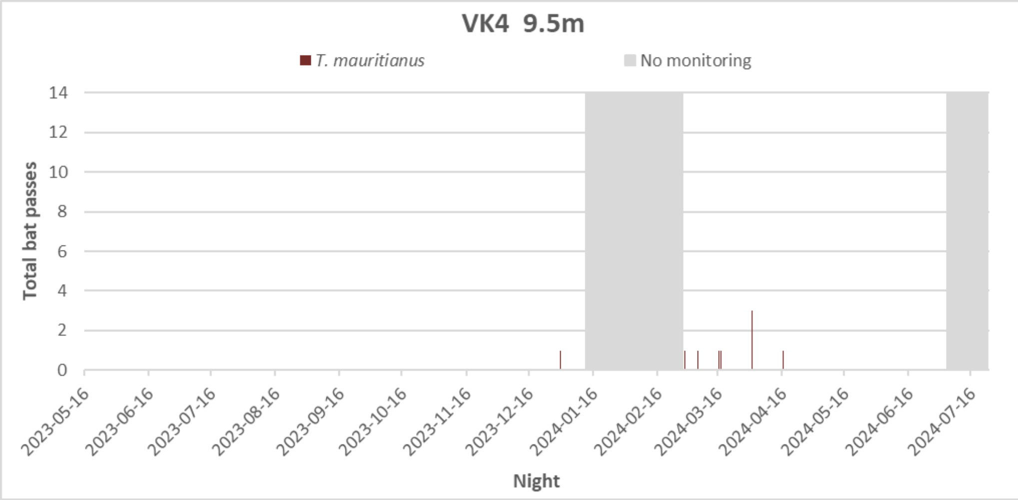

VK4 9.5m
M. natalensis
No monitoring
Total bat passes
Night

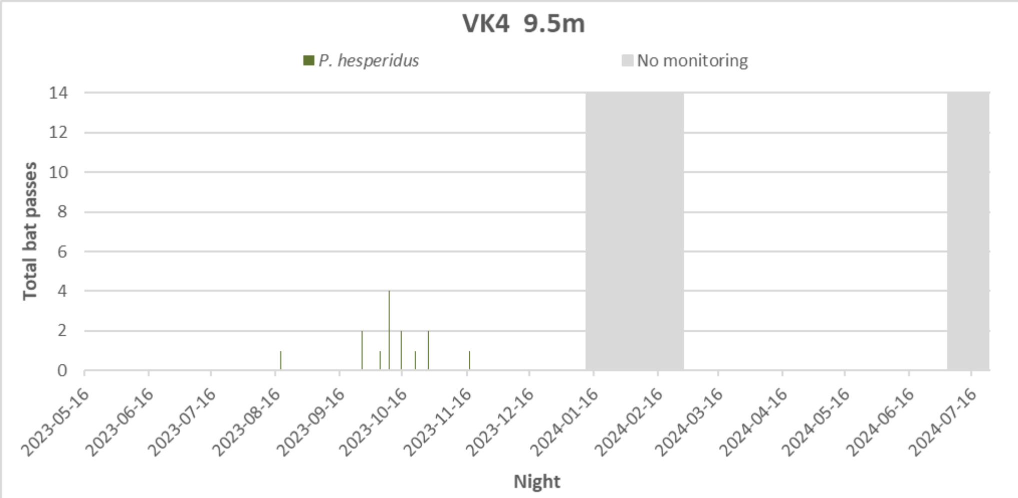

VK4 9.5m
C. hottentotus
No monitoring
Total bat passes
Night

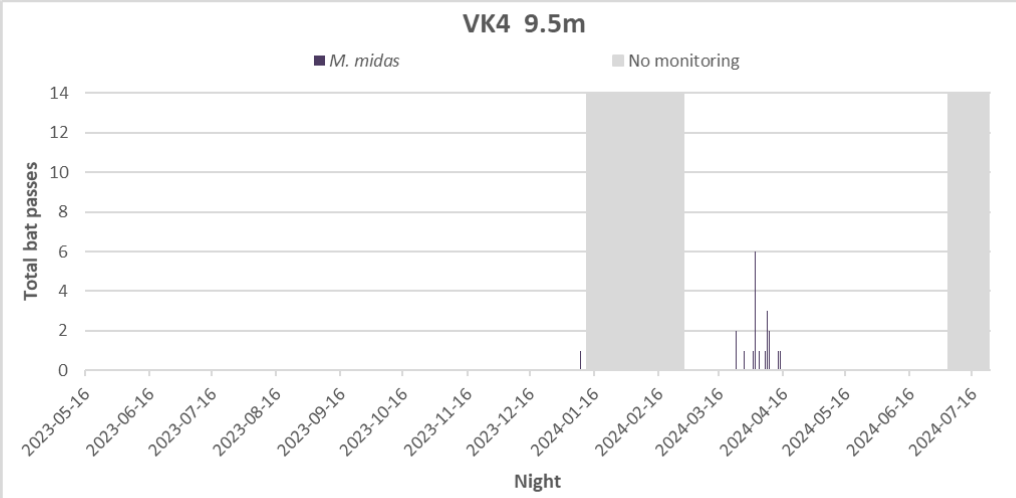

VK4 9.5m
M. pumilus
No monitoring
Total bat passes
Night

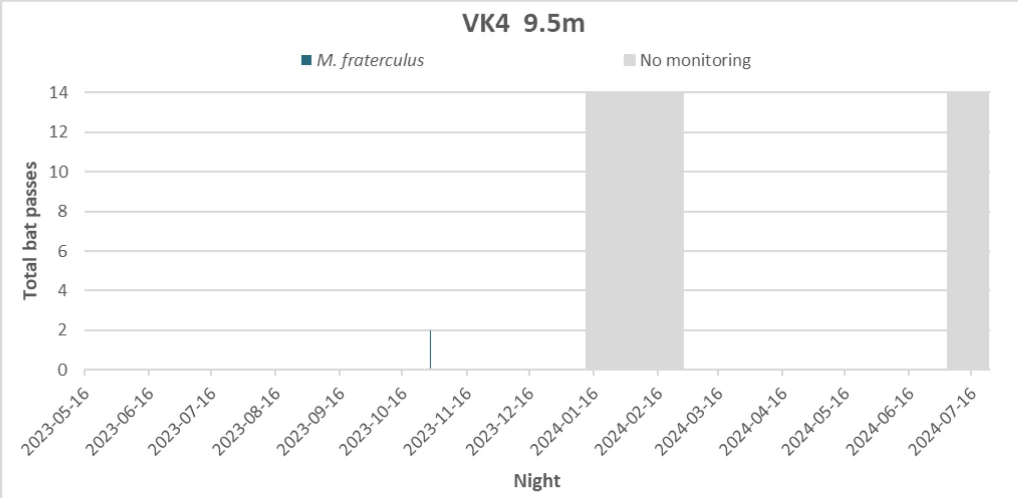

VK4 9.5m
C. lesueuri
No monitoring
Total bat passes
Night

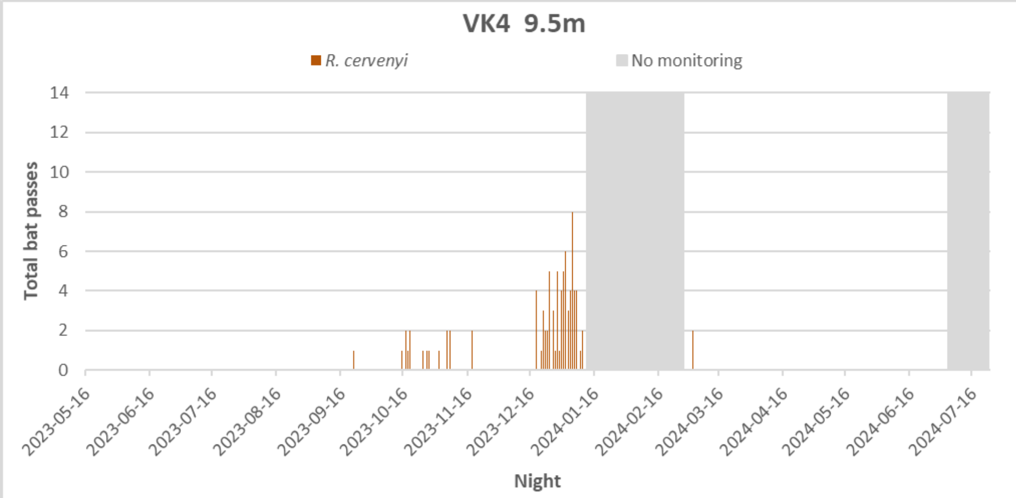

VK4 9.5m
M. tricolor
No monitoring
Total bat passes
Night

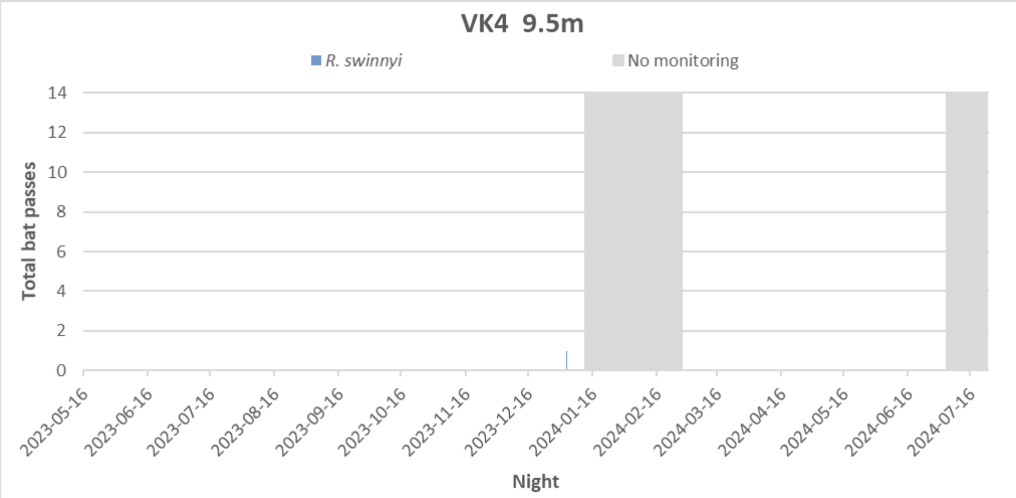

VK4 9.5m
T. mauritianus
No monitoring
Total bat passes
Night

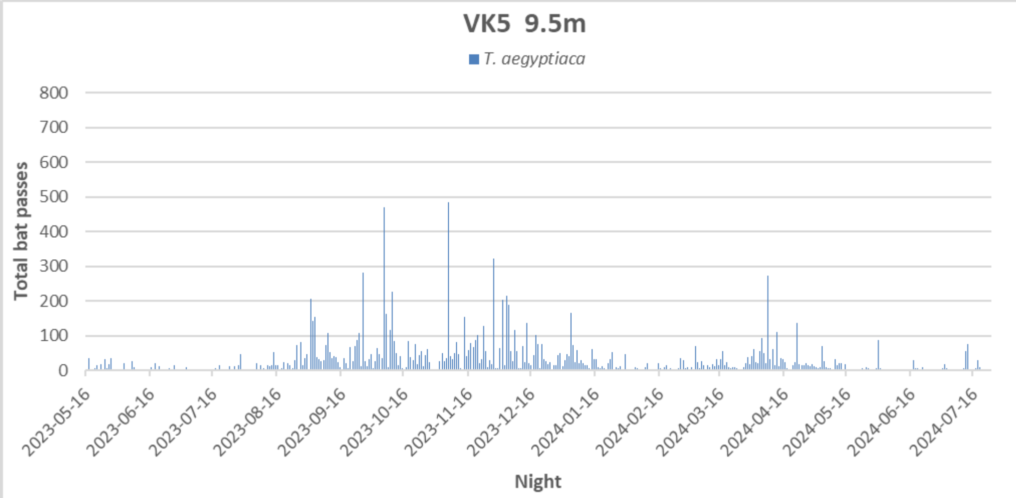

VK4 9.5m
P. hesperidus
No monitoring
Total bat passes
Night

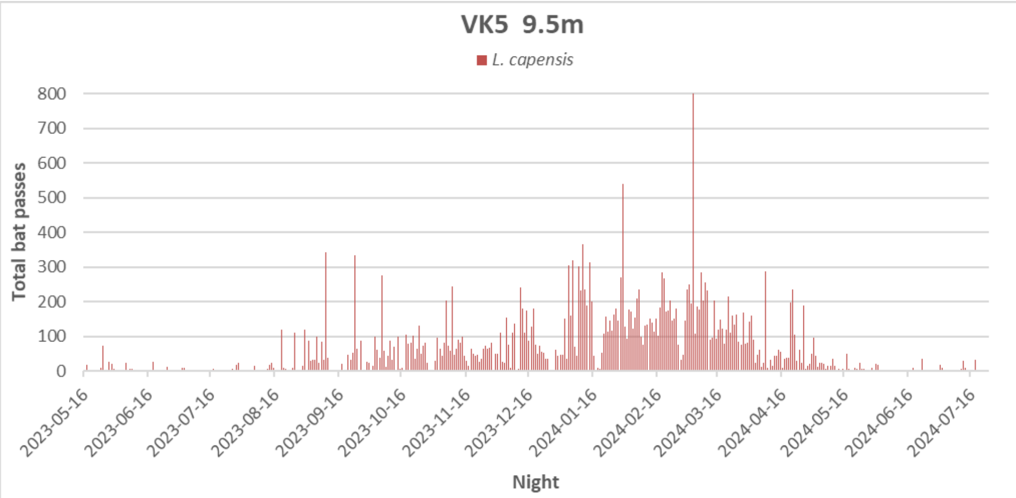

VK4 9.5m
M. midas
No monitoring
Total bat passes
Night

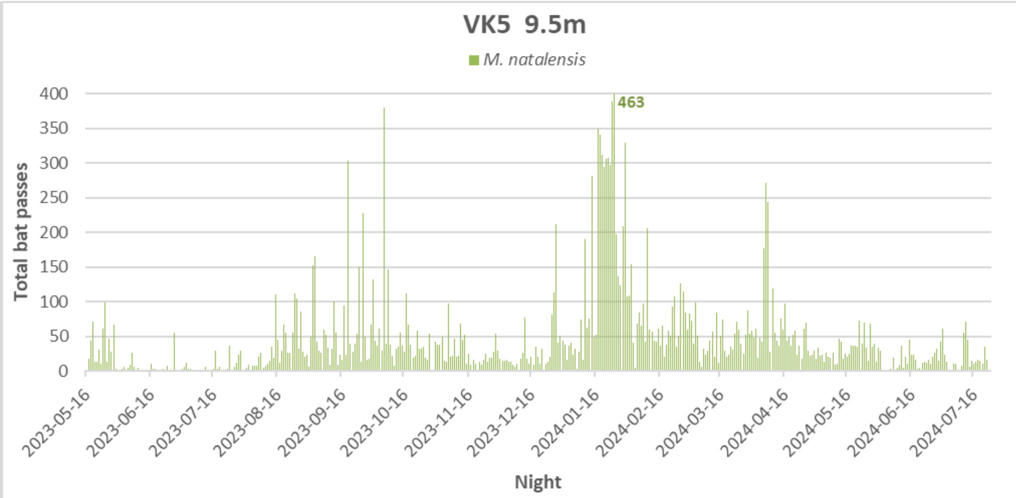

VK4 9.5m
M. fraterculus
No monitoring
Total bat passes
Night

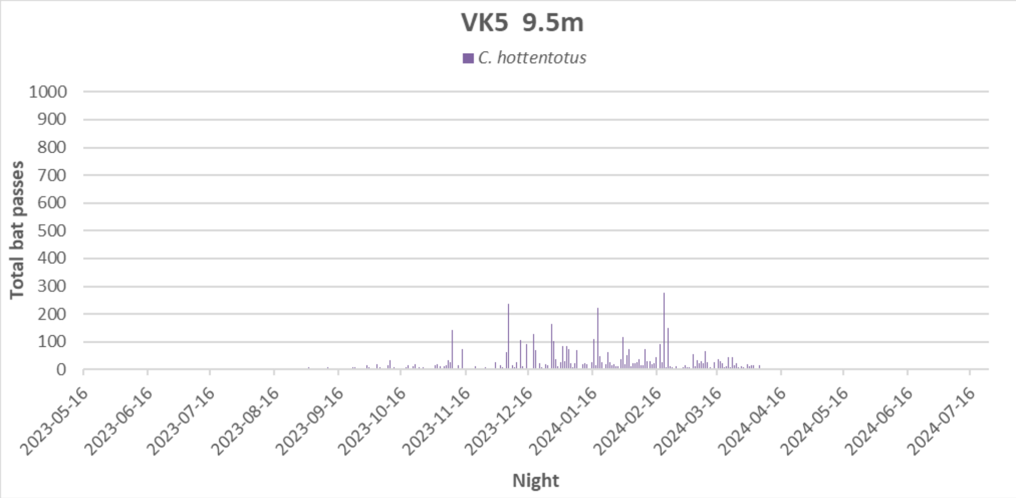

VK4 9.5m
R. cervenyi
No monitoring
Total bat passes
Night

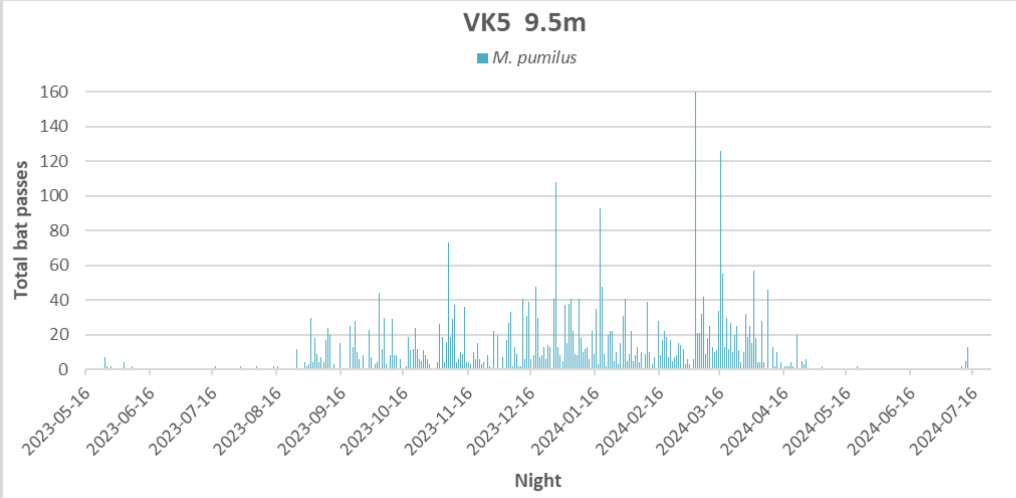

VK4 9.5m
R. swinnyi
No monitoring
Total bat passes
Night

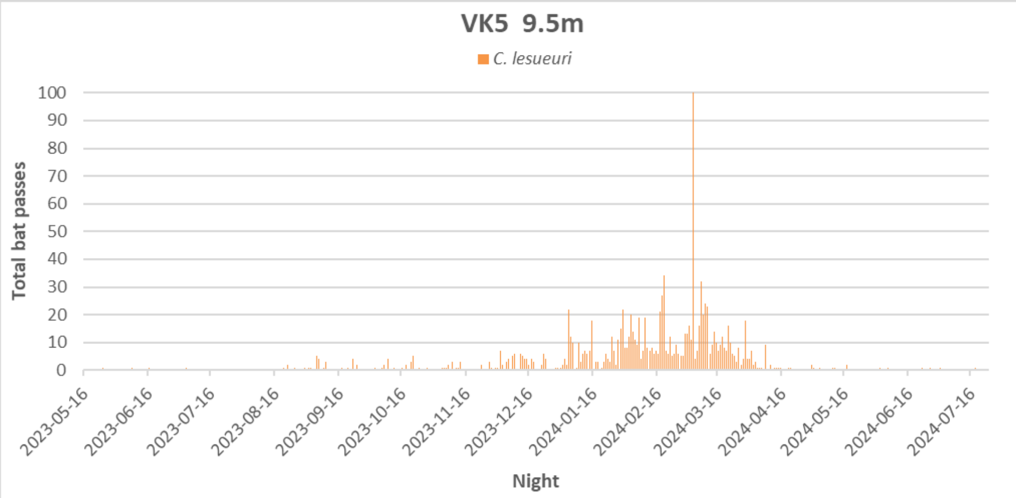

VK5 9.5m
T. aegyptiaca
Total bat passes
Night

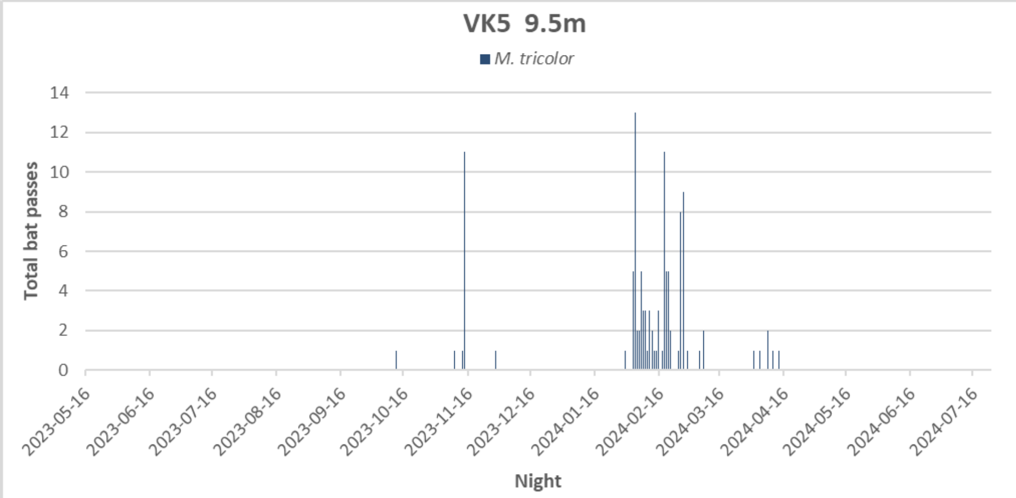

VK5 9.5m
L. capensis
Total bat passes
Night

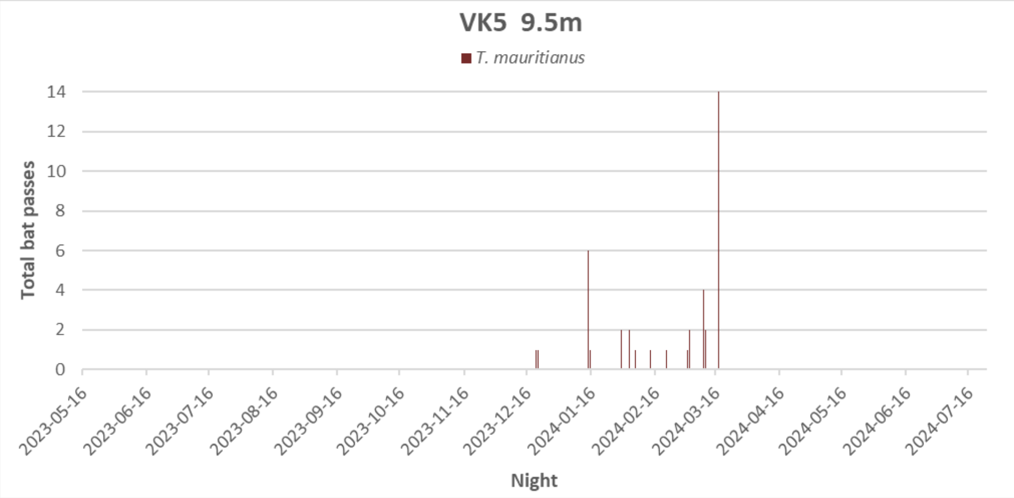

VK5 9.5m
M. natalensis
463
Total bat passes
Night


VK5 9.5m
C. hottentotus
Total bat passes
Night


VK5 9.5m
M. pumilus
Total bat passes
Night


VK5 9.5m
C. lesueuri
Total bat passes
Night


VK5 9.5m
M. tricolor
Total bat passes
Night


VK5 9.5m
T. mauritianus
Total bat passes
Night
14
12
10
8
6
4
2
0
2023-05-16
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2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
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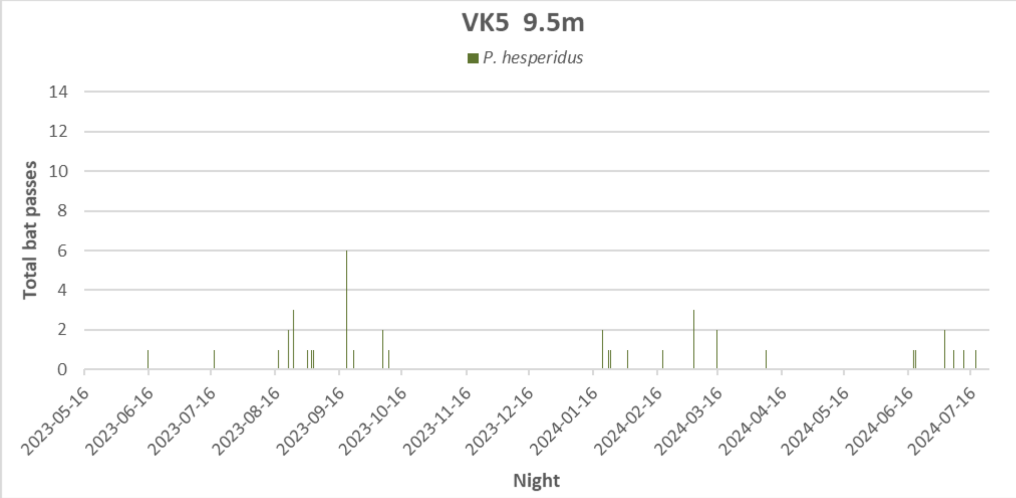
2024-07-16


VK5 9.5m
P. hesperidus
Total bat passes
Night
14
12
10
8
6
4
2
0
2023-05-16
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2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
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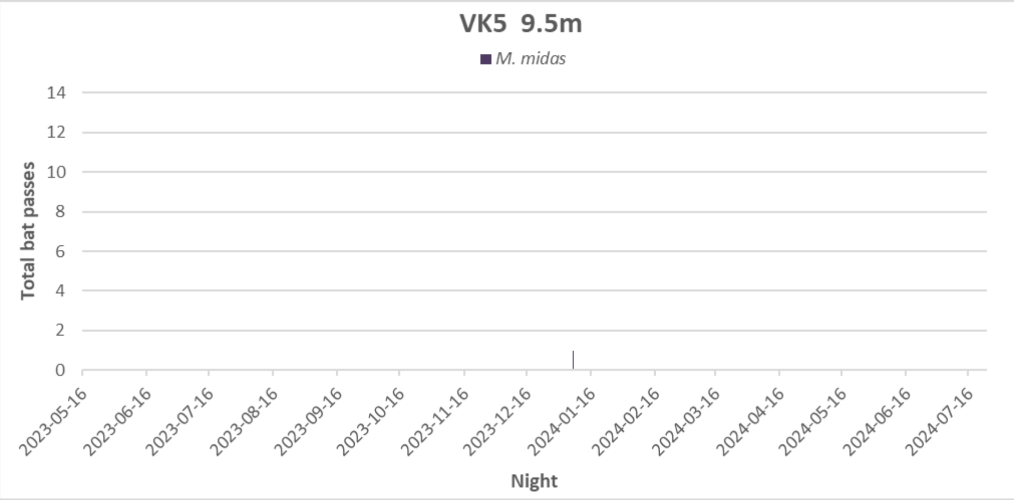
VK5 9.5m
M. midas
Total bat passes
Night
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12
10
8
6
4
2
0
2023-05-16
2023-06-16
2023-07-16
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2023-09-16
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2023-11-16
2023-12-16
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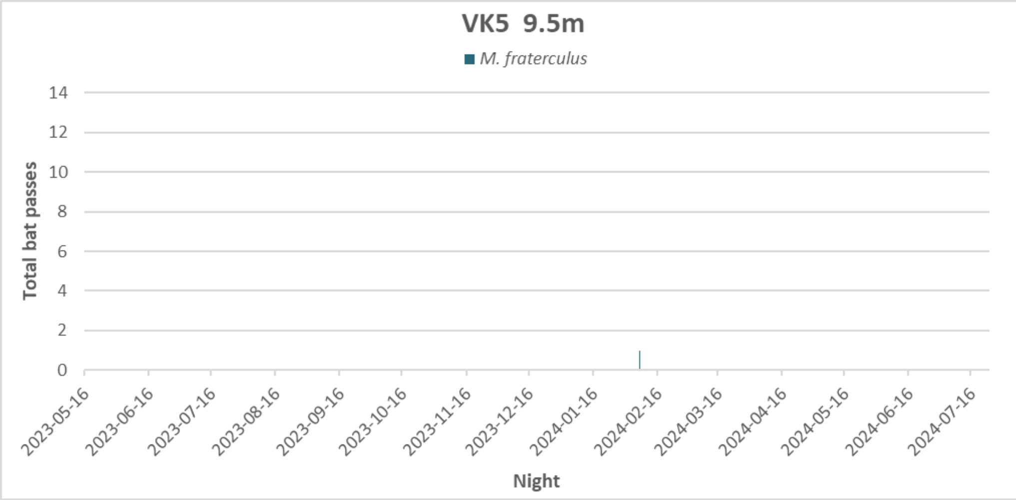
VK5 9.5m
M. fraterculus
Total bat passes
Night
14
12
10
8
6
4
2
0
2023-05-16
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2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
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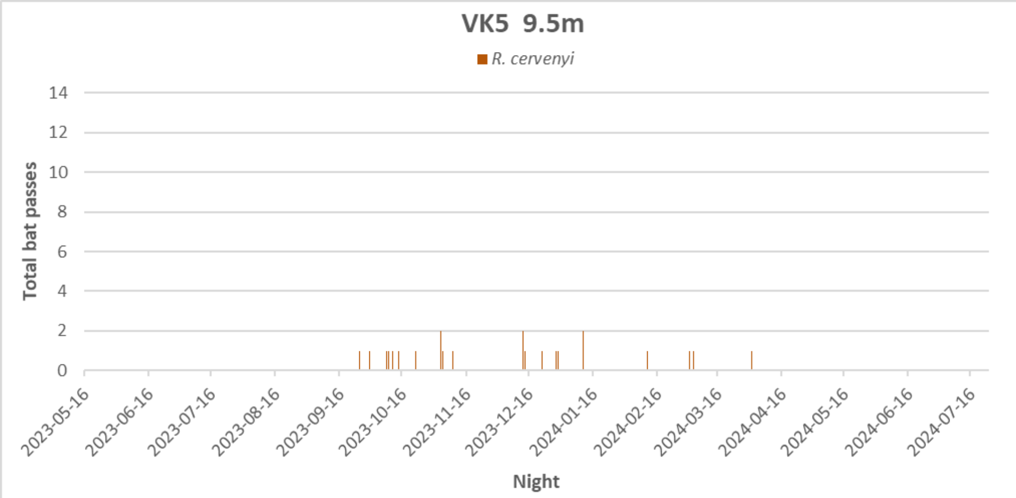
VK5 9.5m
R. cervenyi
Total bat passes
0
2
4
6
8
10
12
14
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
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2023-11-16
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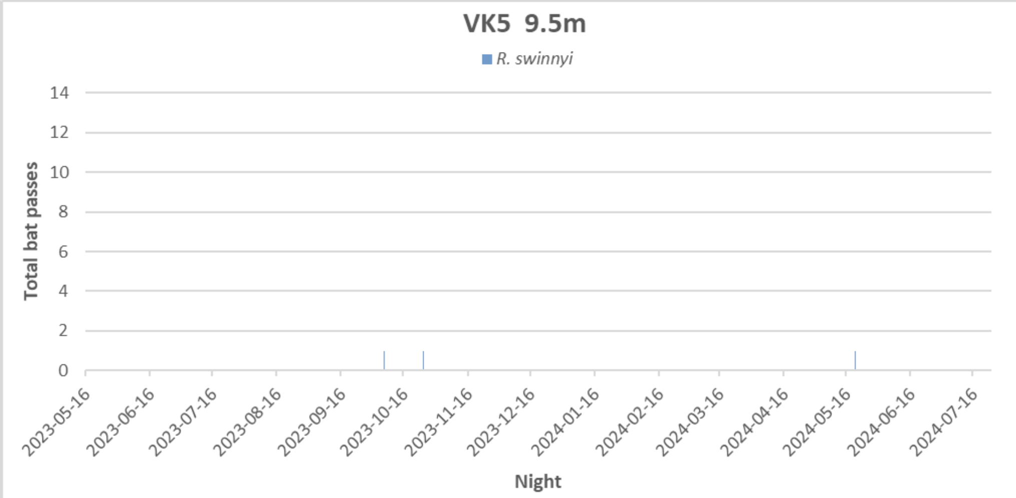
Night


VK5 9.5m
R. swinnyi
Total bat passes
0
2
4
6
8
10
12
14
2023-05-16
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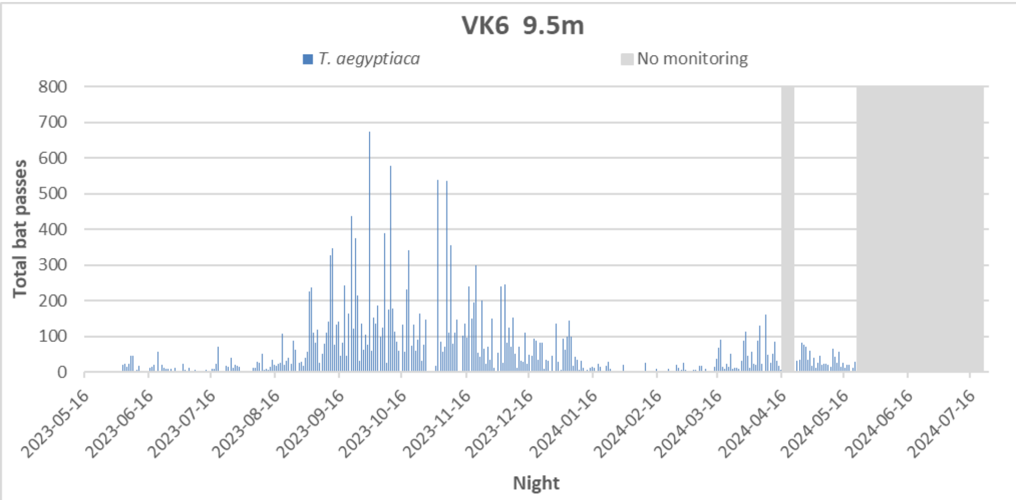
Night


VK6 9.5m
T. aegyptiaca
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
2023-05-16
2023-06-16
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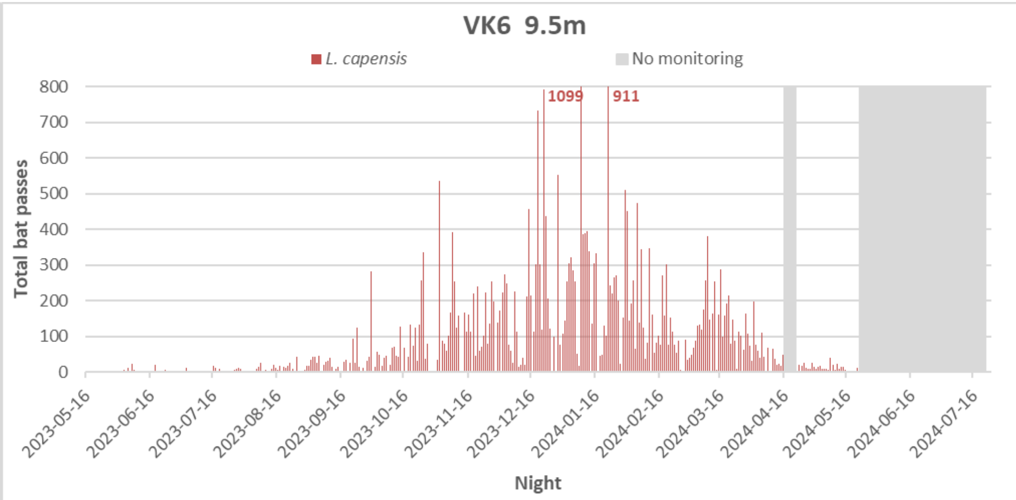
VK6 9.5m
L. capensis
No monitoring
1099
911
Total bat passes
0
100
200
300
400
500
600
700
800
2023-05-16
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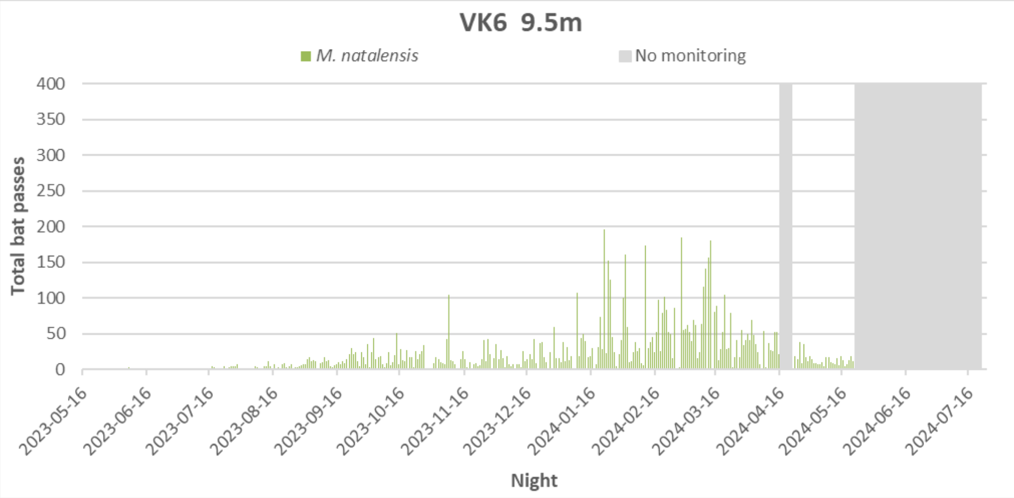
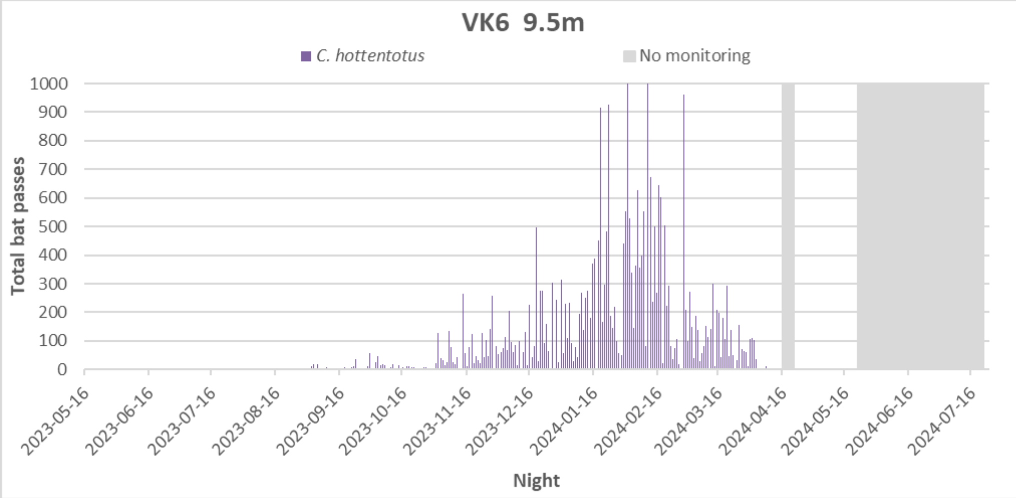
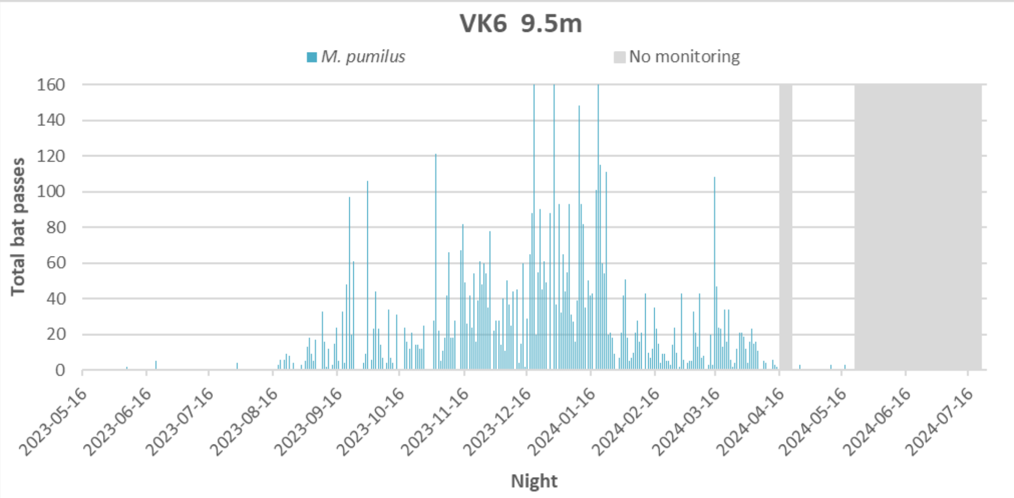
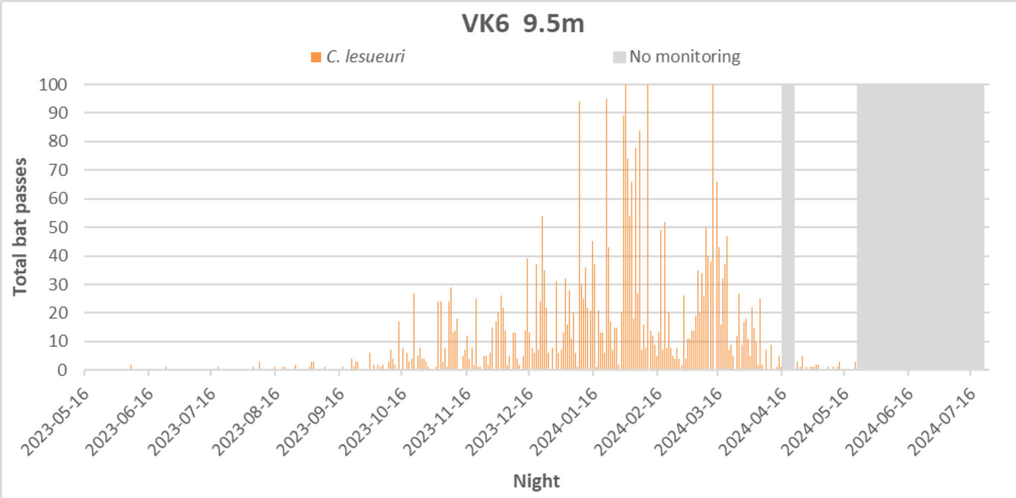
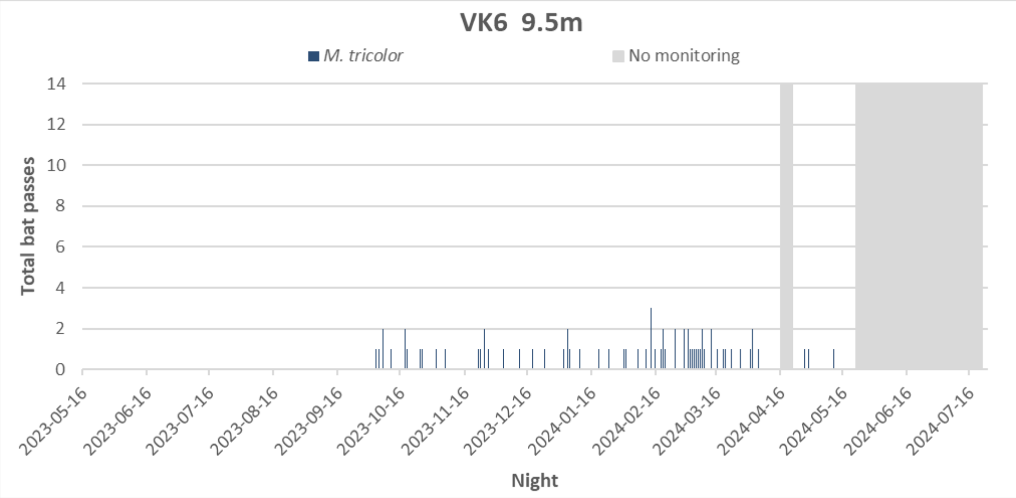
Night

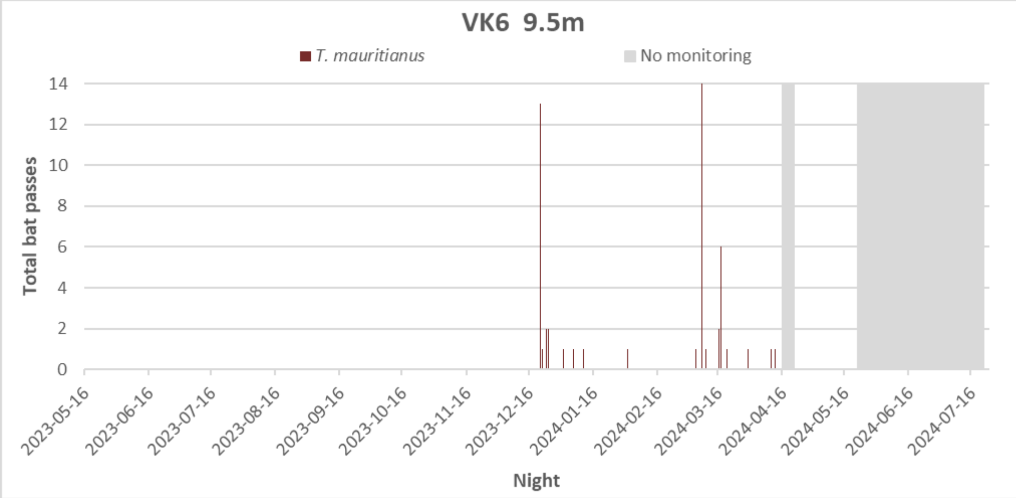

VK6 9.5m
M. natalensis
No monitoring
Total bat passes
Night

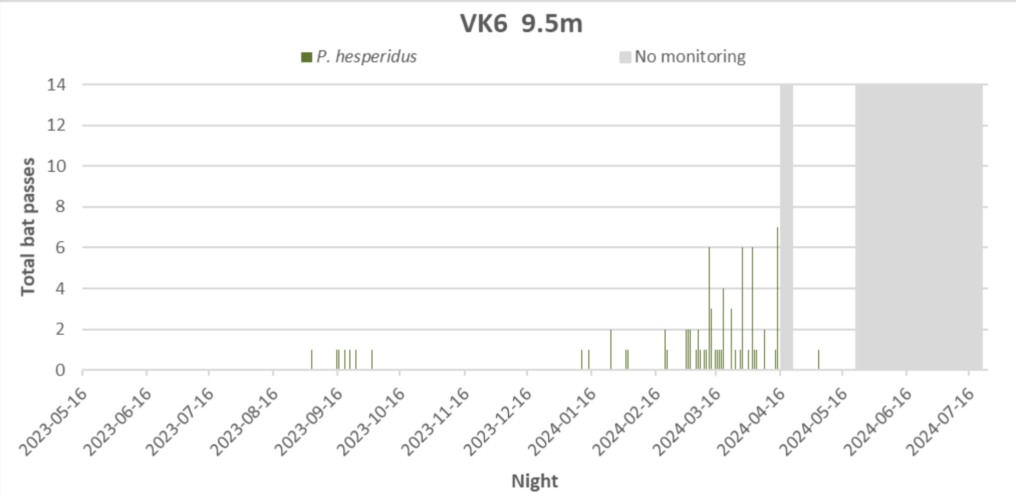

VK6 9.5m
C. hottentotus
No monitoring
Total bat passes
Night

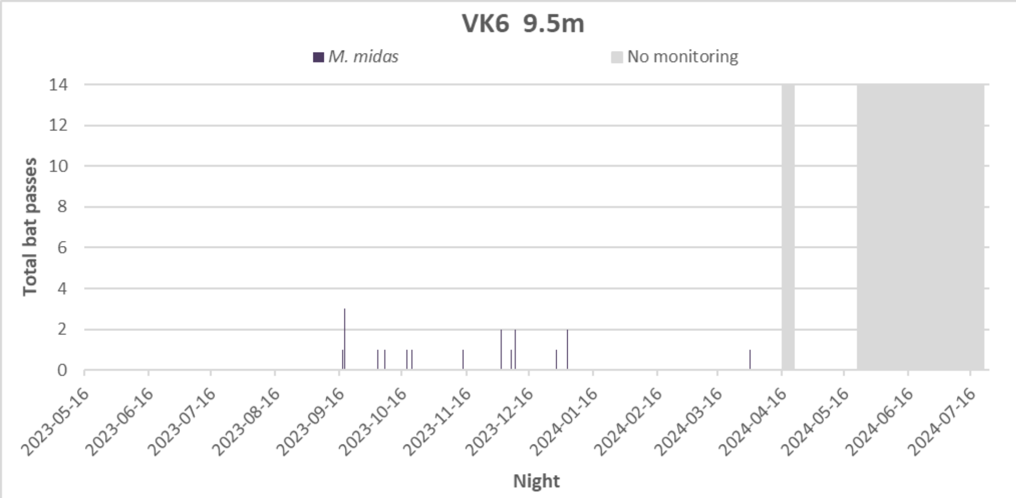

VK6 9.5m
M. pumilus
No monitoring
Total bat passes
Night

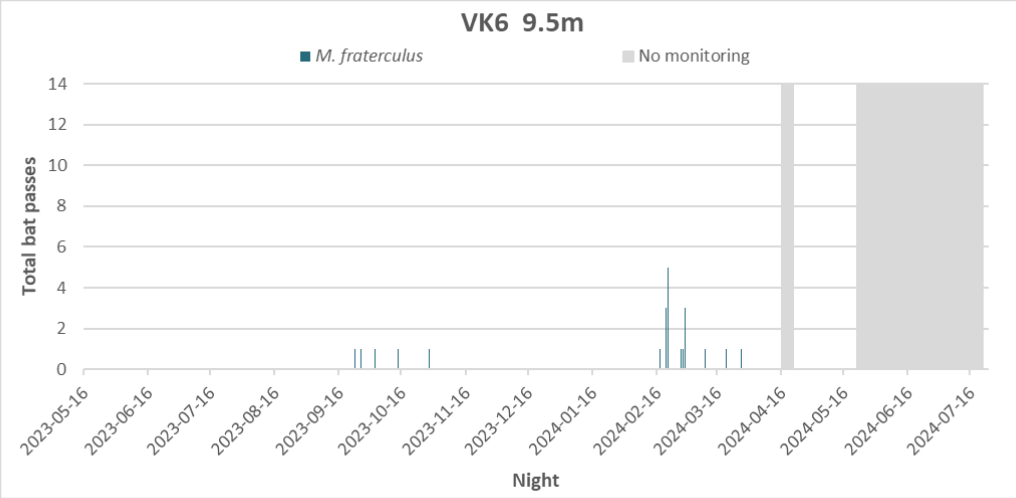

VK6 9.5m
C. lesueuri
No monitoring
Total bat passes
Night


VK6 9.5m
M. tricolor
No monitoring
Total bat passes
Night


VK6 9.5m
T. mauritianus
No monitoring
Total bat passes
Night


VK6 9.5m
P. hesperidus
No monitoring
Total bat passes
Night


VK6 9.5m
M. midas
No monitoring
Total bat passes
Night


VK6 9.5m
M. fraterculus
No monitoring
Total bat passes
14
12
10
8
6
4
2
0
2023-05-16
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2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
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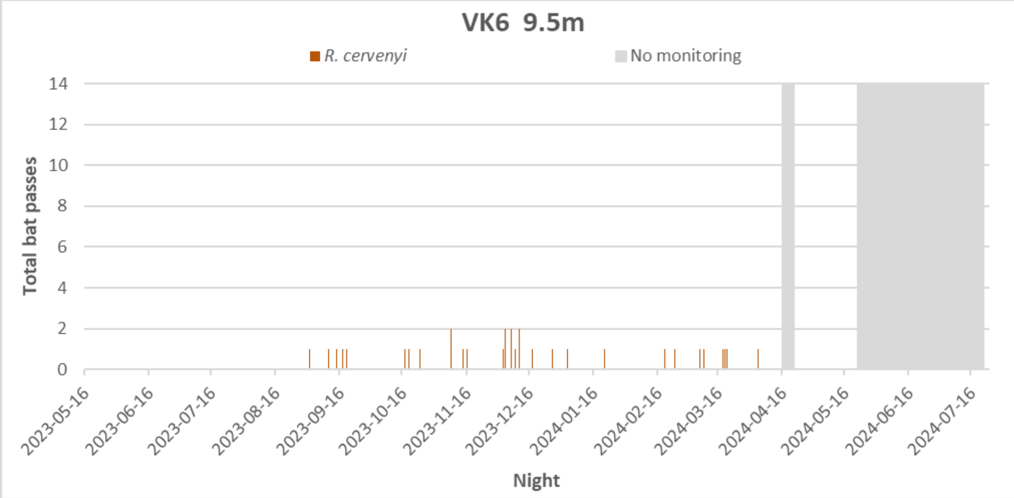
Night


VK6 9.5m
R. cervenyi
No monitoring
Total bat passes
14
12
10
8
6
4
2
0
2023-05-16
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2023-07-16
2023-08-16
2023-09-16
2023-10-16
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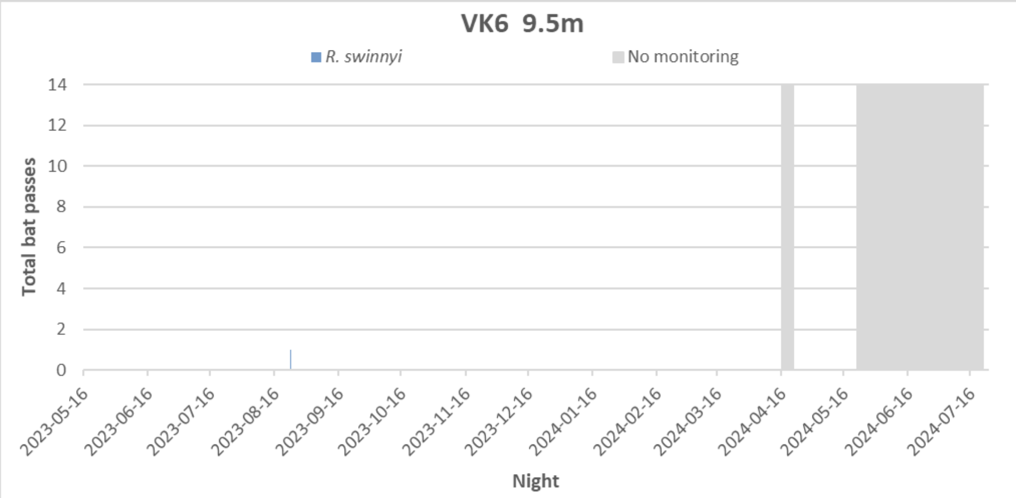
Night


VK6 9.5m
R. swinnyi
No monitoring
Total bat passes
14
12
10
8
6
4
2
0
2023-05-16
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2023-07-16
2023-08-16
2023-09-16
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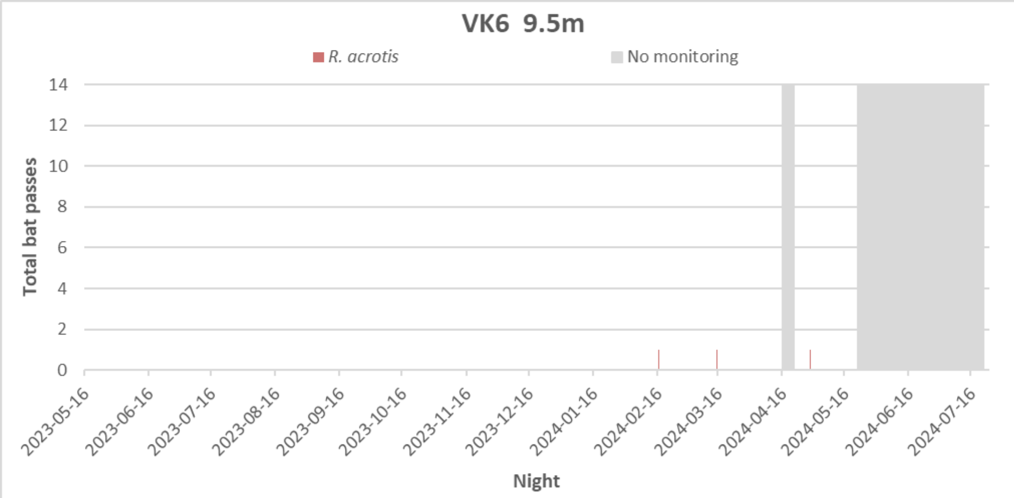
Night


VK6 9.5m
R. acrotis
No monitoring
Total bat passes
14
12
10
8
6
4
2
0
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
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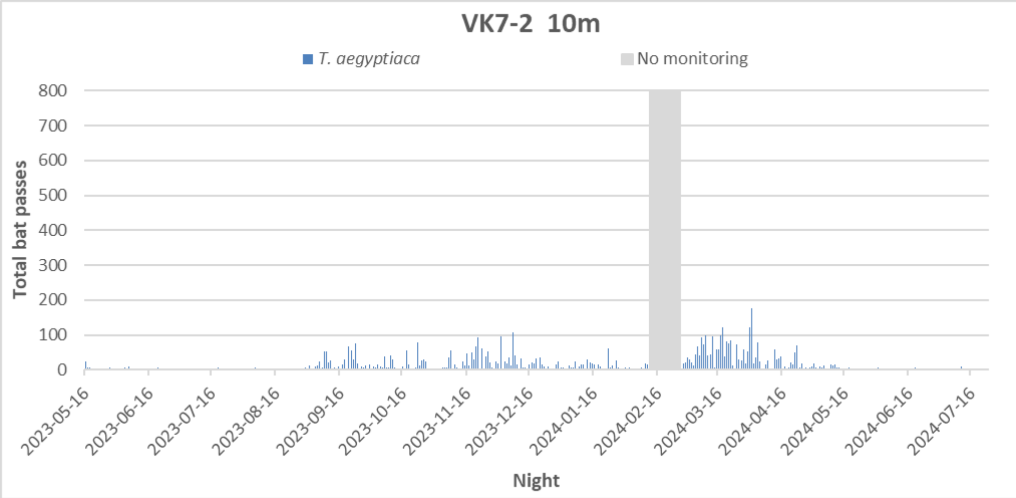
2024-07-16
Night


VK7-2 10m
T. aegyptiaca
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
2023-05-16
2023-06-16
2023-07-16
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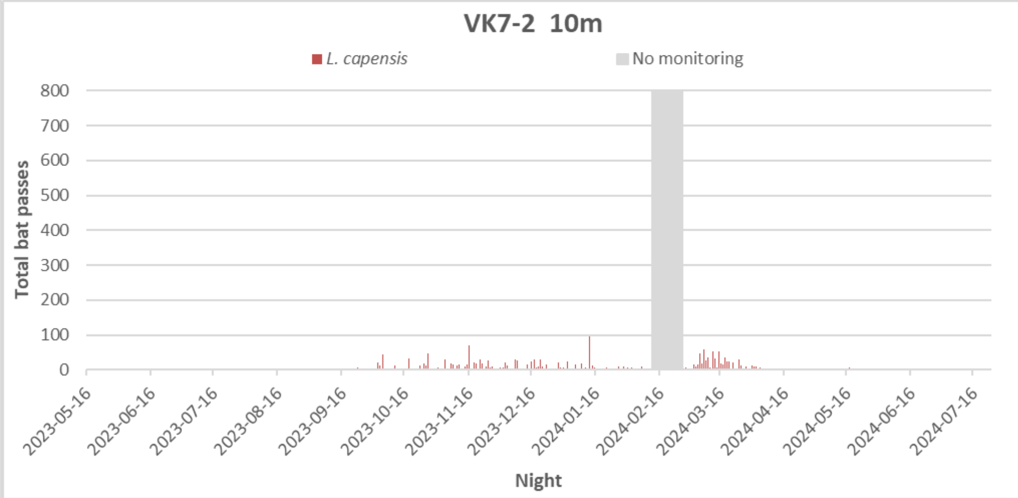
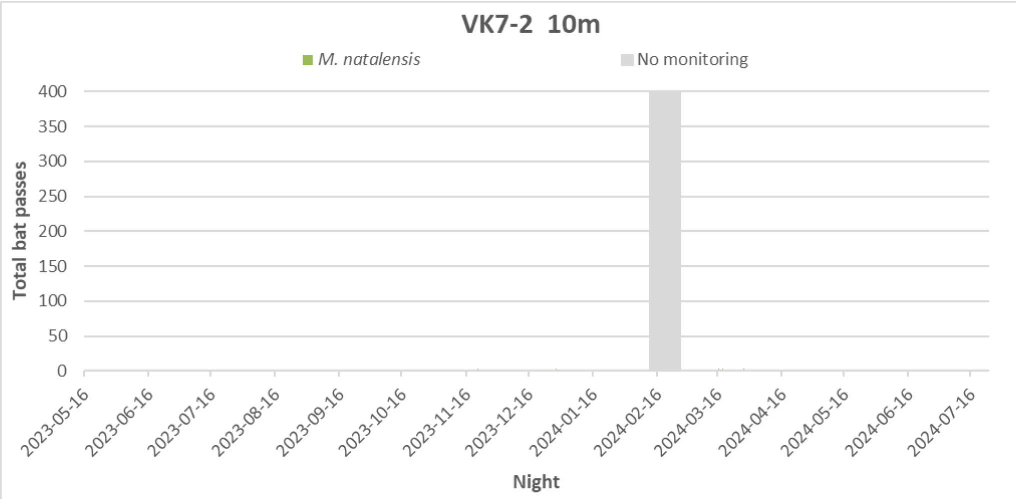
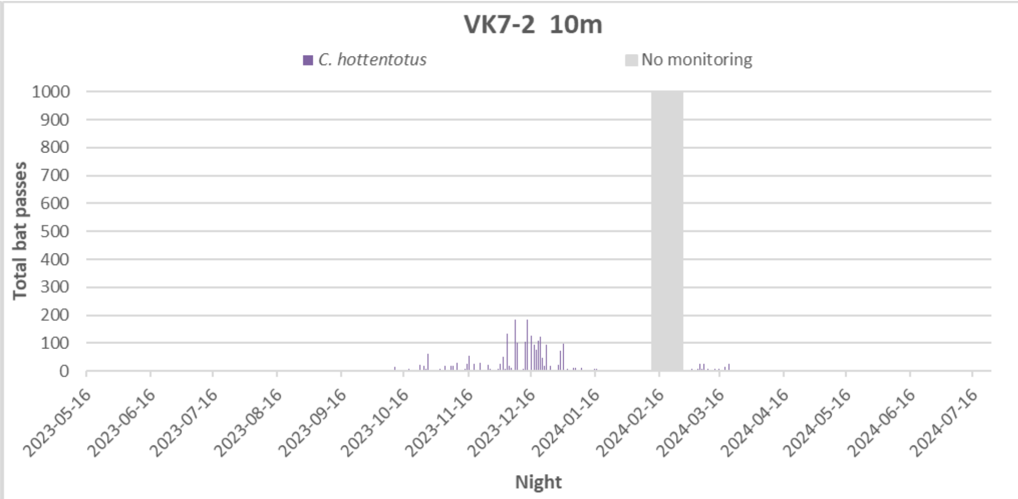
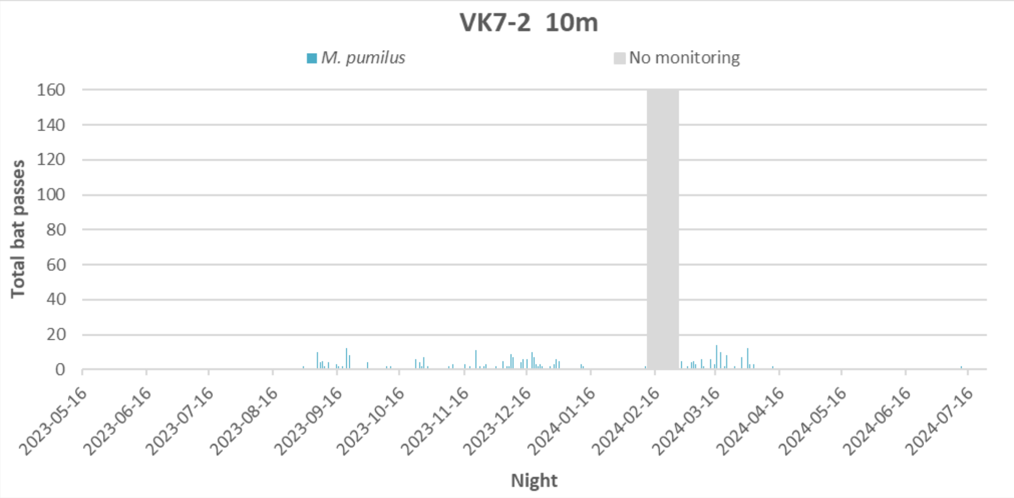
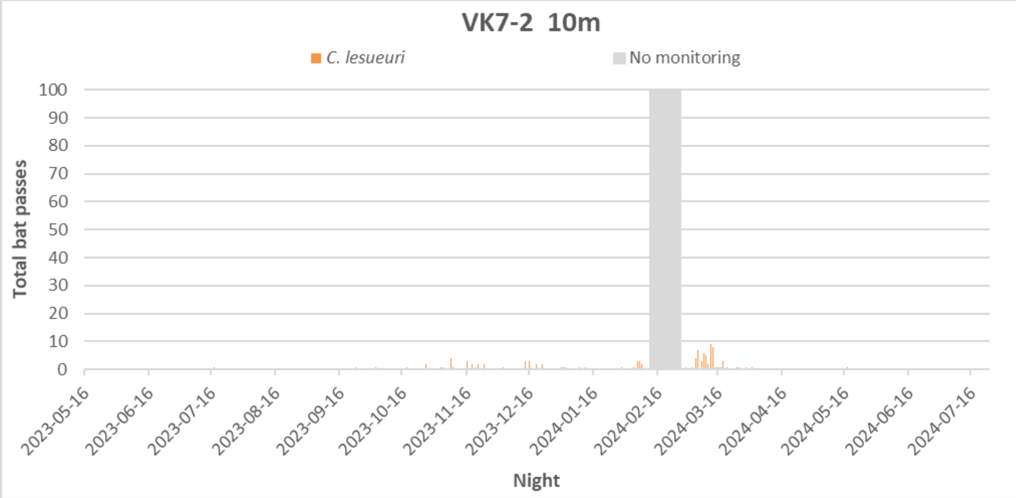
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

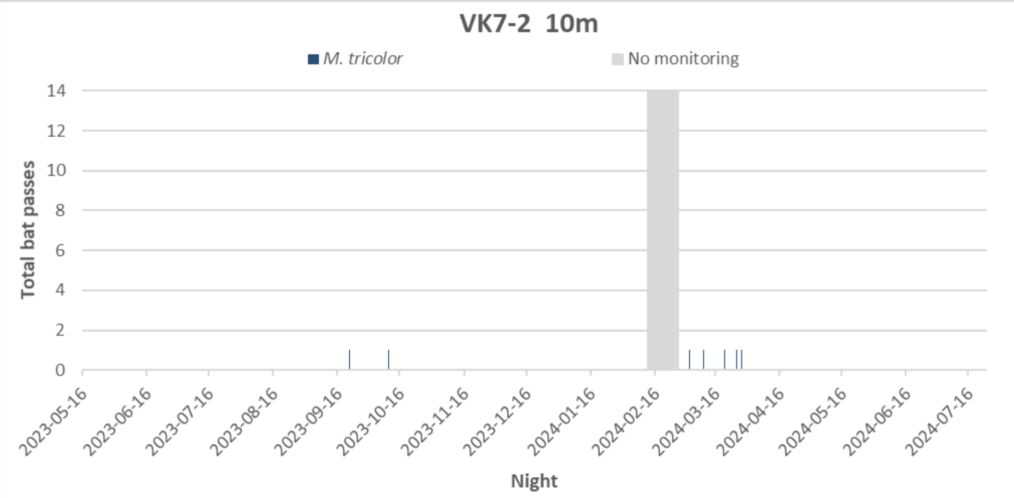

VK7-2 10m
L. capensis
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

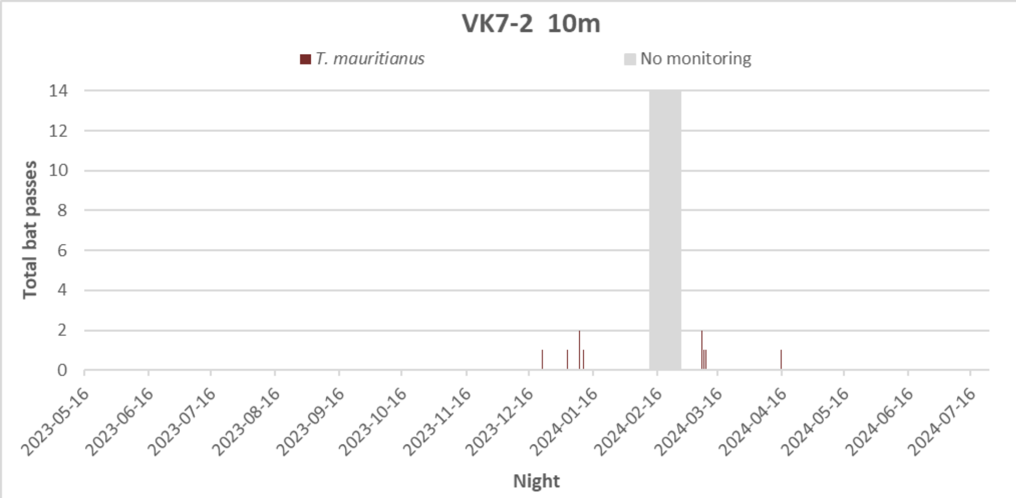

VK7-2 10m
M. natalensis
No monitoring
Total bat passes
0
50
100
150
200
250
300
350
400
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

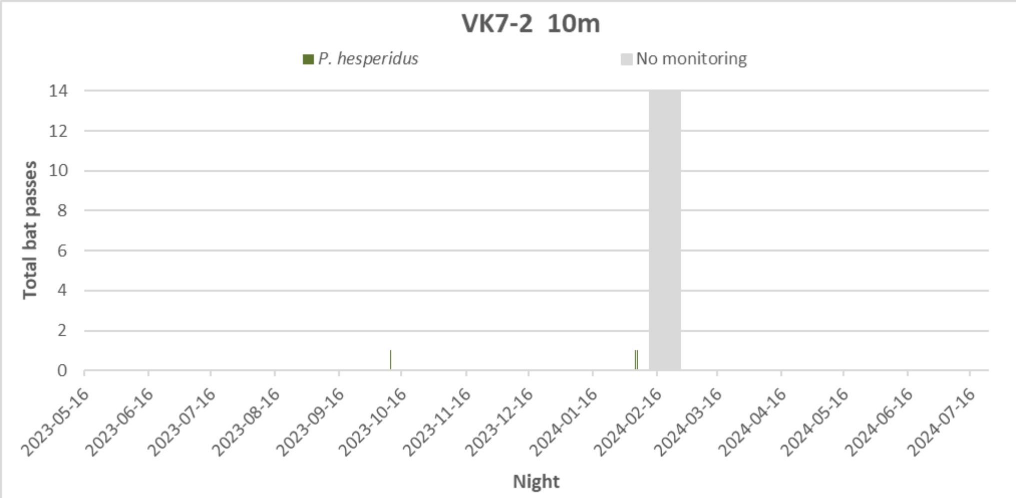

VK7-2 10m
C. hottentotus
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
900
1000
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

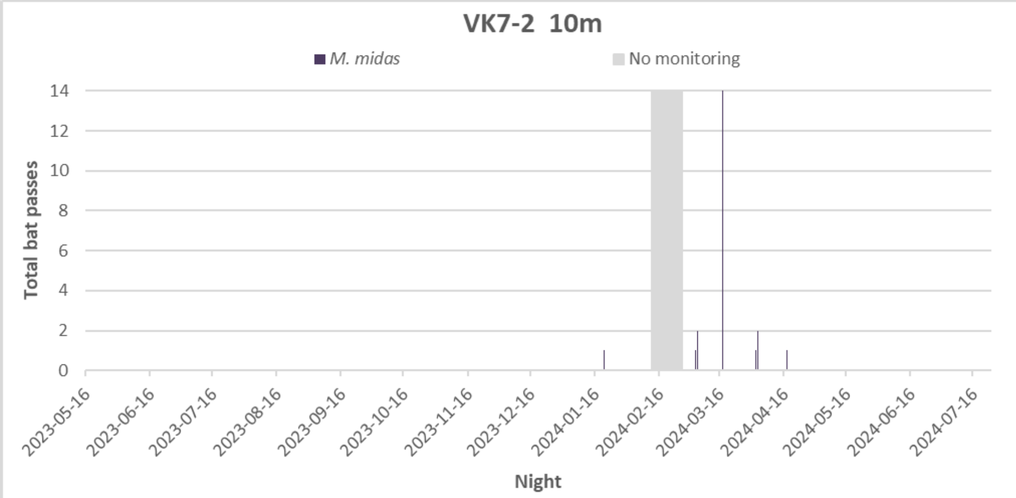

VK7-2 10m
M. pumilus
No monitoring
Total bat passes
Night

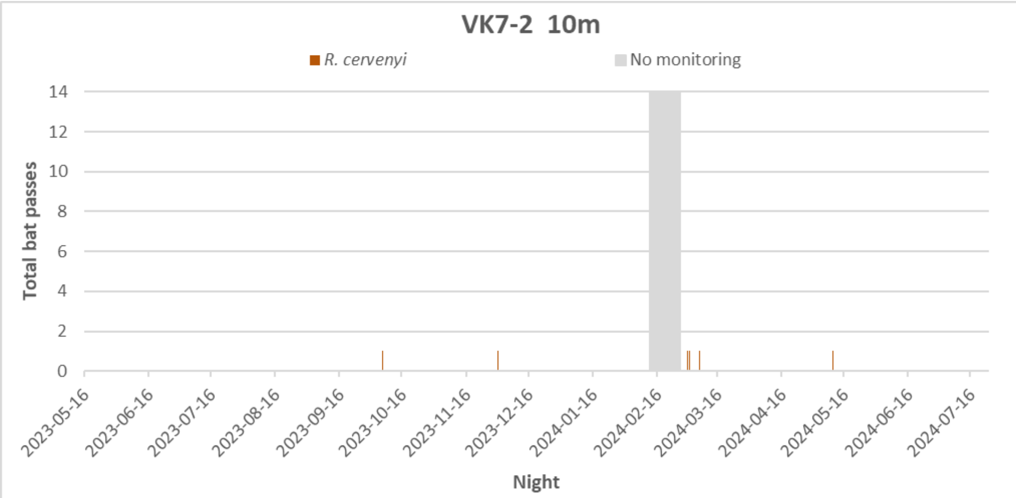

VK7-2 10m
C. lesueuri
No monitoring
Total bat passes
Night

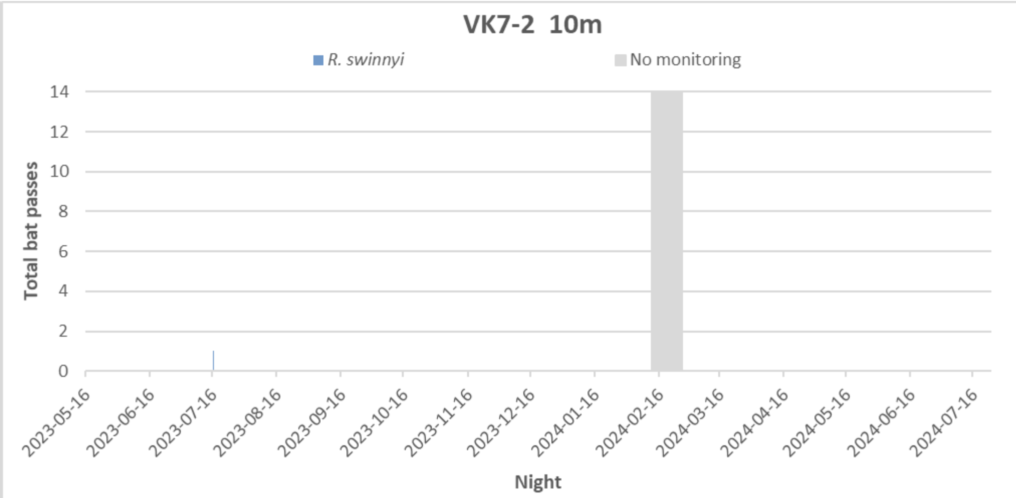

VK7-2 10m
M. tricolor
No monitoring
Total bat passes
Night

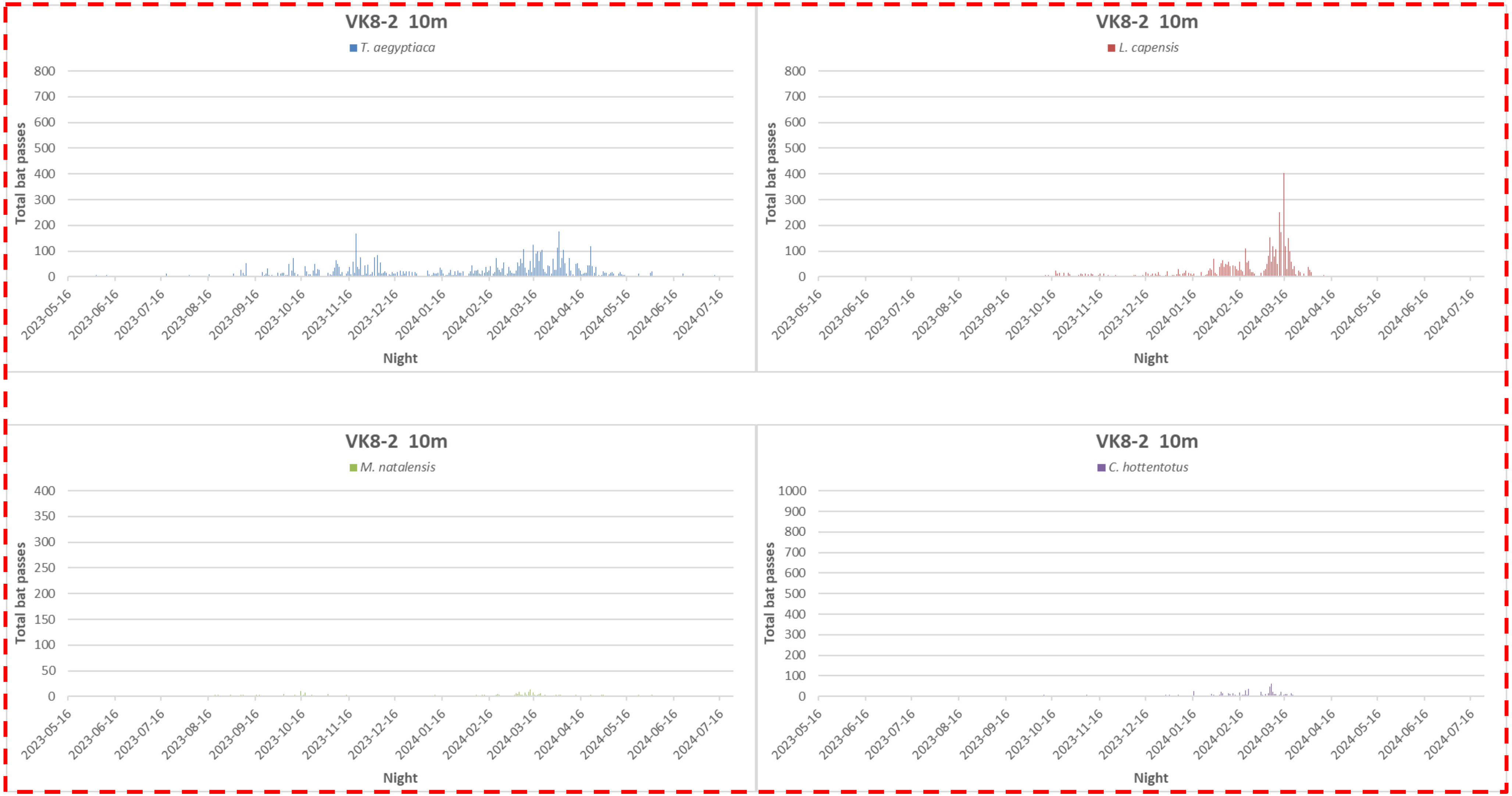

VK7-2 10m
T. mauritianus
No monitoring
Total bat passes
Night

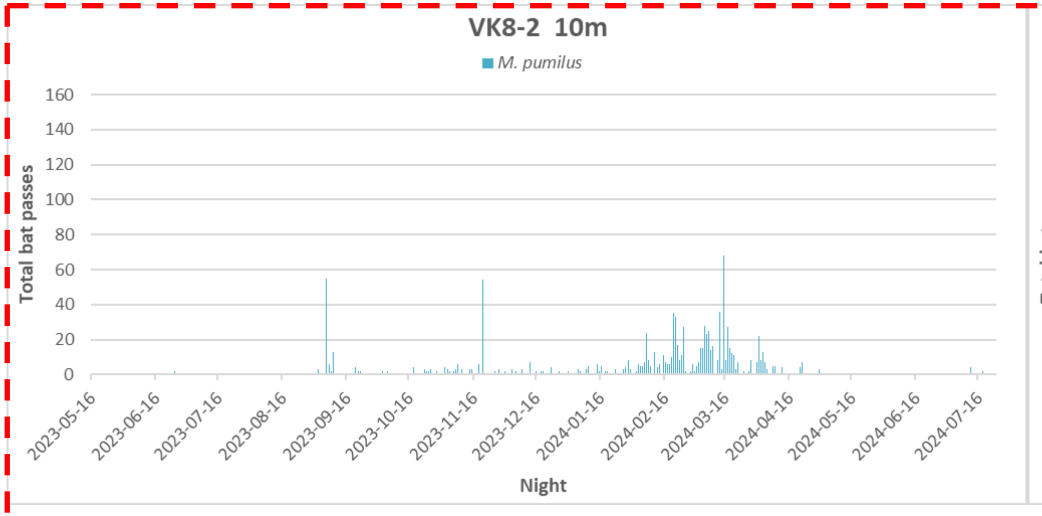

VK7-2 10m
P. hesperidus
No monitoring
Total bat passes
Night

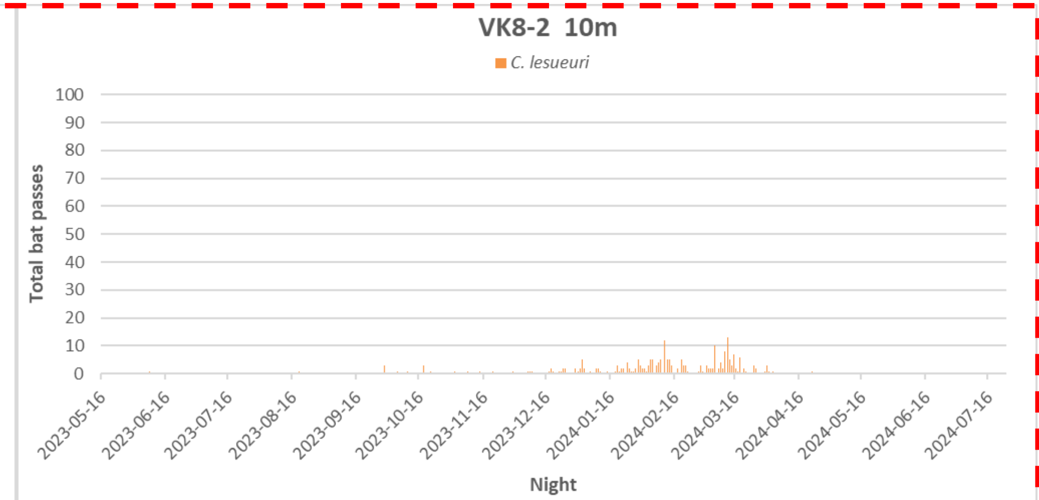

VK7-2 10m
M. midas
No monitoring
Total bat passes
Night

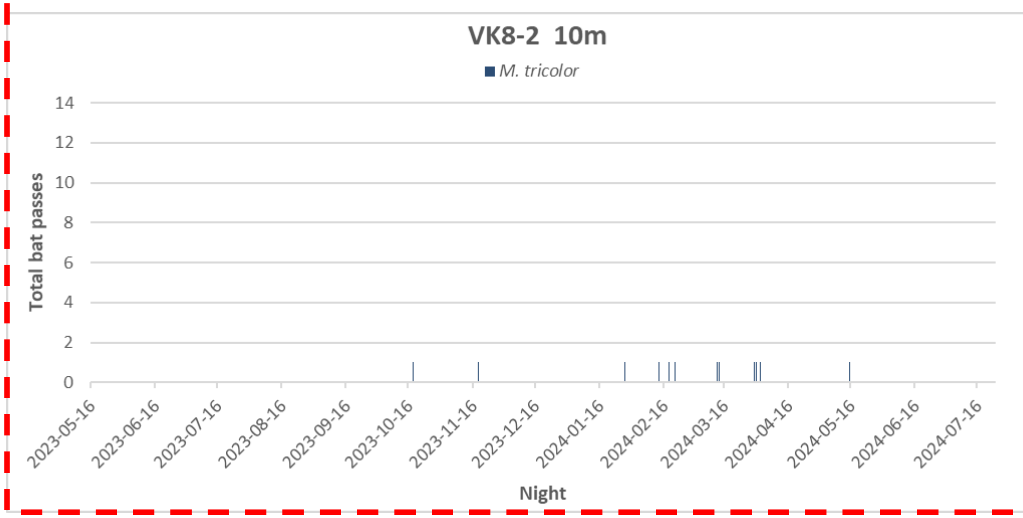

VK7-2 10m
R. cervenyi
No monitoring
Total bat passes
Night

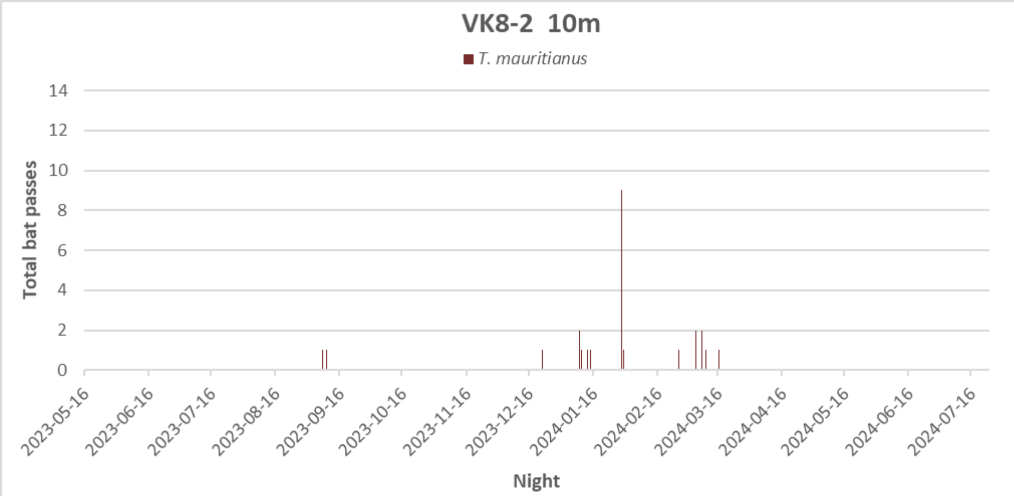

VK7-2 10m
R. swinnyi
No monitoring
Total bat passes
Night


VK8-2 10m
T. aegyptiaca
Total bat passes
Night
VK8-2 10m
L. capensis
Total bat passes
Night
VK8-2 10m
M. natalensis
Total bat passes
Night
VK8-2 10m
C. hottentotus
Total bat passes
Night

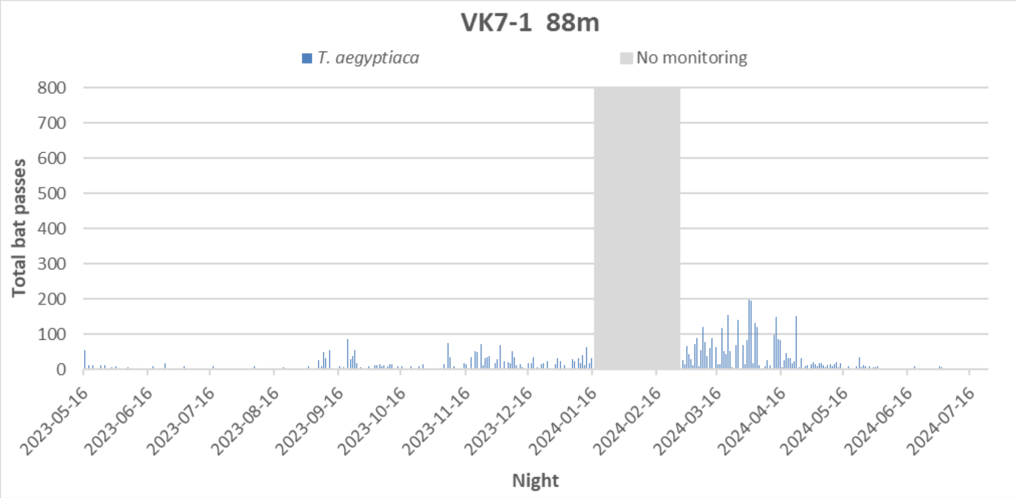

VK8-2 10m
M. pumilus
Total bat passes
Night

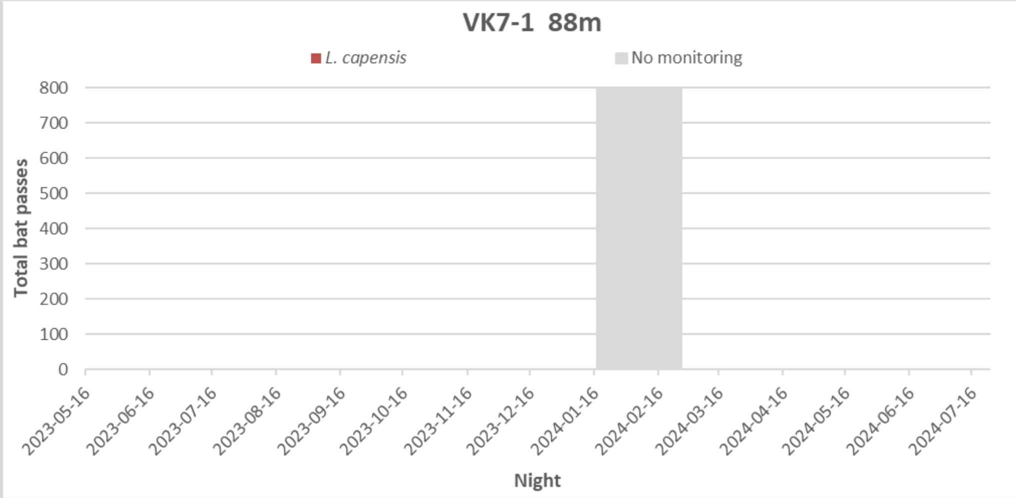

VK8-2 10m
C. lesueuri
Total bat passes
Night

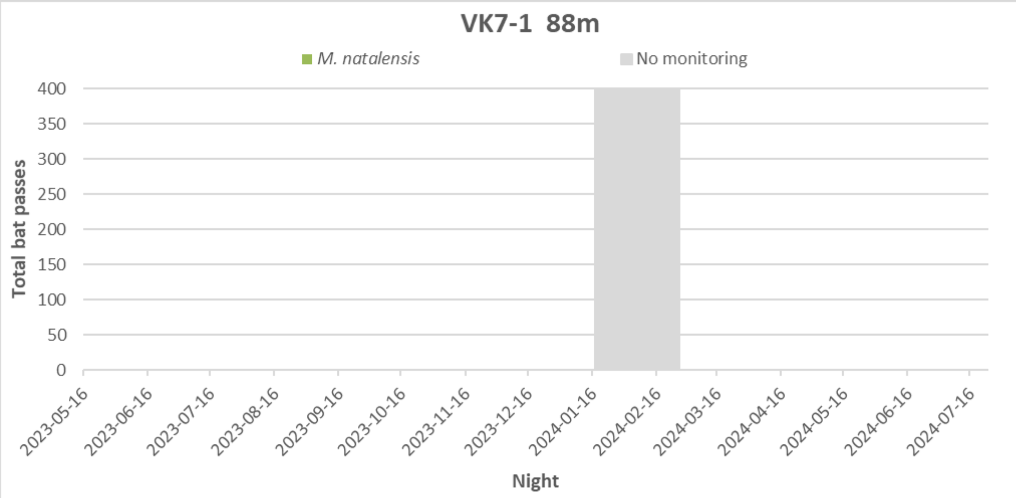

VK8-2 10m
M. tricolor
Total bat passes
Night

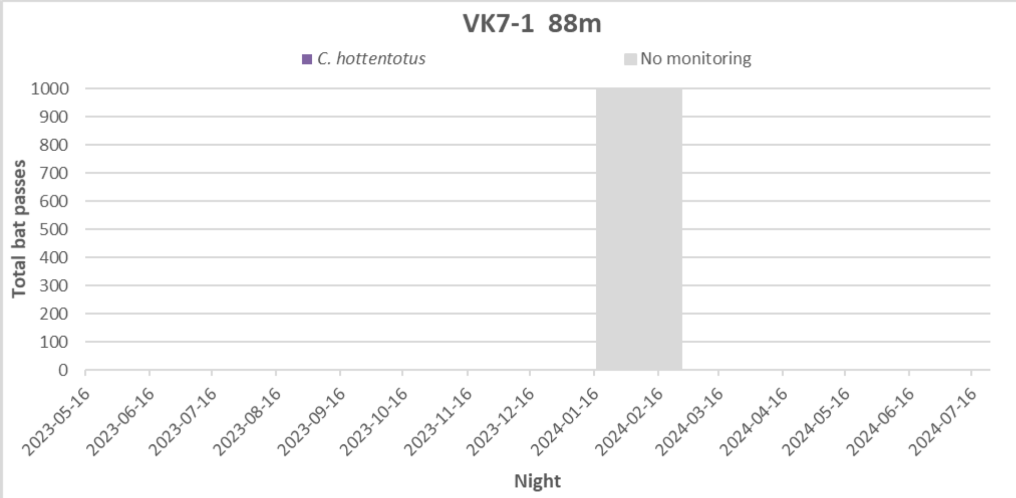

VK8-2 10m
T. mauritianus
Total bat passes
Night

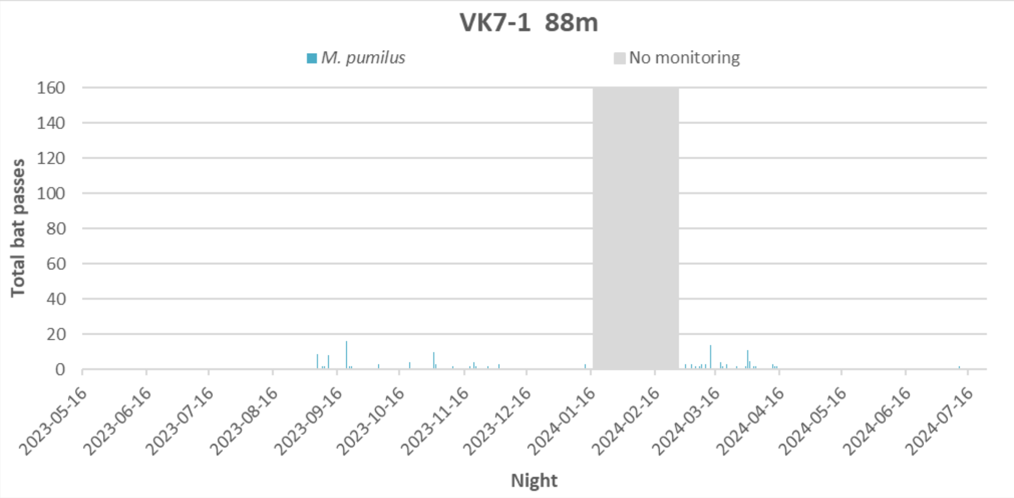

VK8-2 10m
P. hesperidus
VK8-2 10m
M. midas
VK8-2 10m
M. fraterculus
VK8-2 10m
R. cervenyi
Total bat passes
Night
0
2
4
6
8
10
12
14
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16

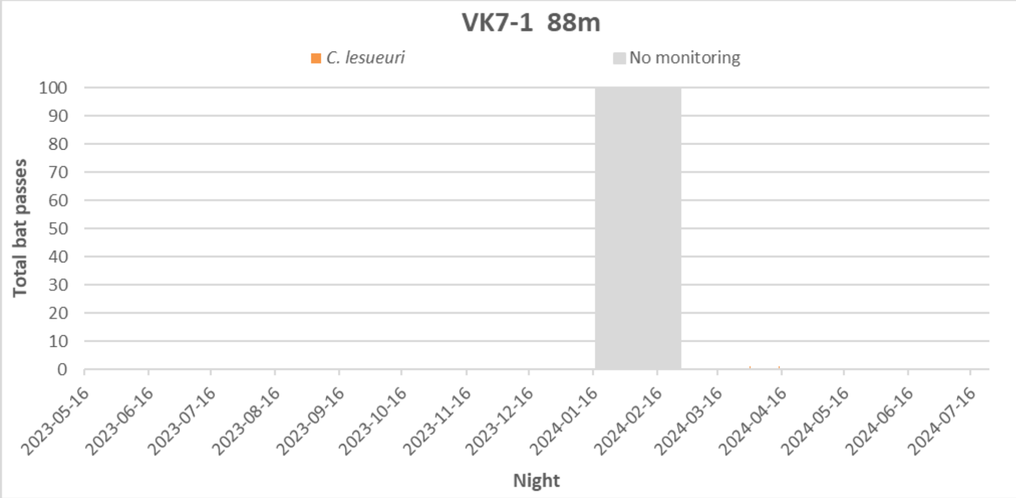

VK7-1 88m
T. aegyptiaca
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

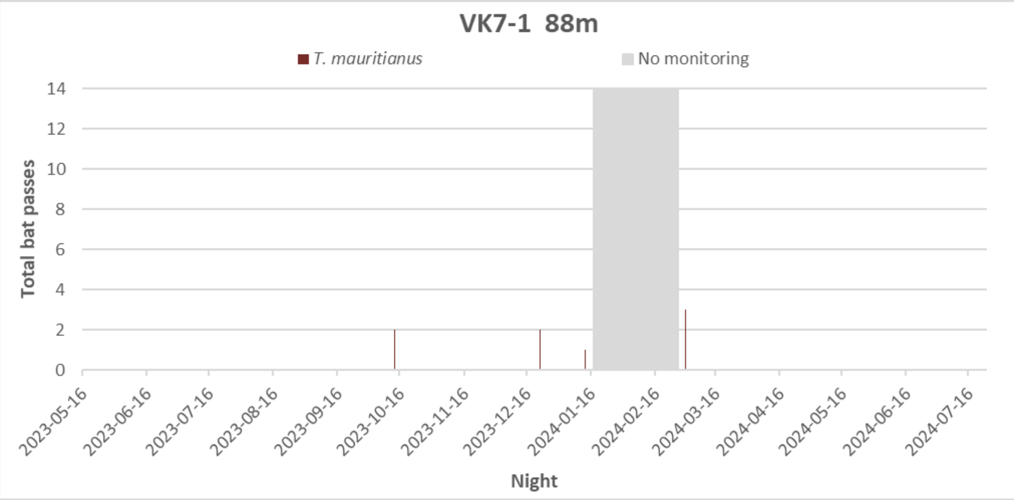

VK7-1 88m
L. capensis
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night

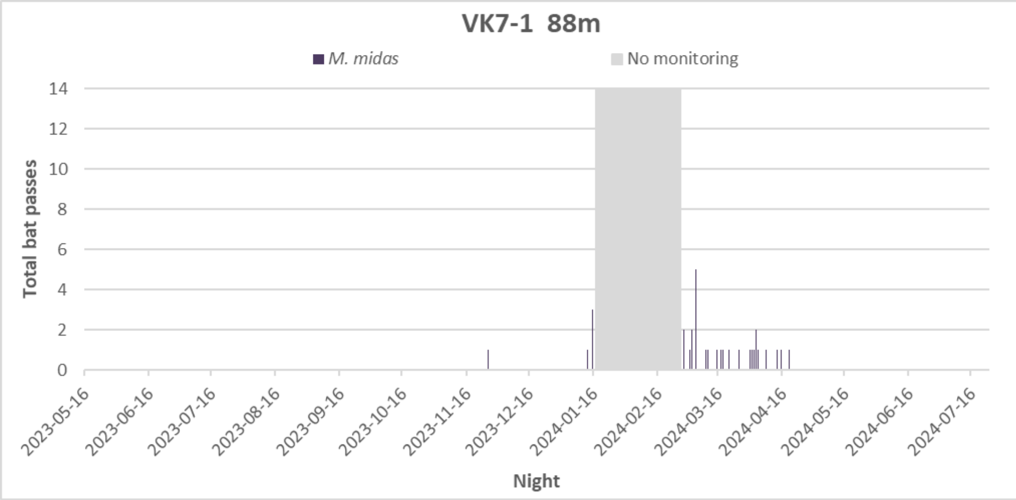

VK7-1 88m
M. natalensis
No monitoring
Total bat passes
0
50
100
150
200
250
300
350
400
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night


VK7-1 88m
C. hottentotus
No monitoring
Total bat passes
0
100
200
300
400
500
600
700
800
900
1000
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16
Night


VK7-1 88m
M. pumilus
No monitoring
Total bat passes
Night


VK7-1 88m
C. lesueuri
No monitoring
Total bat passes
Night


VK7-1 88m
T. mauritianus
No monitoring
Total bat passes
Night


VK7-1 88m
M. midas
No monitoring
Total bat passes
Night

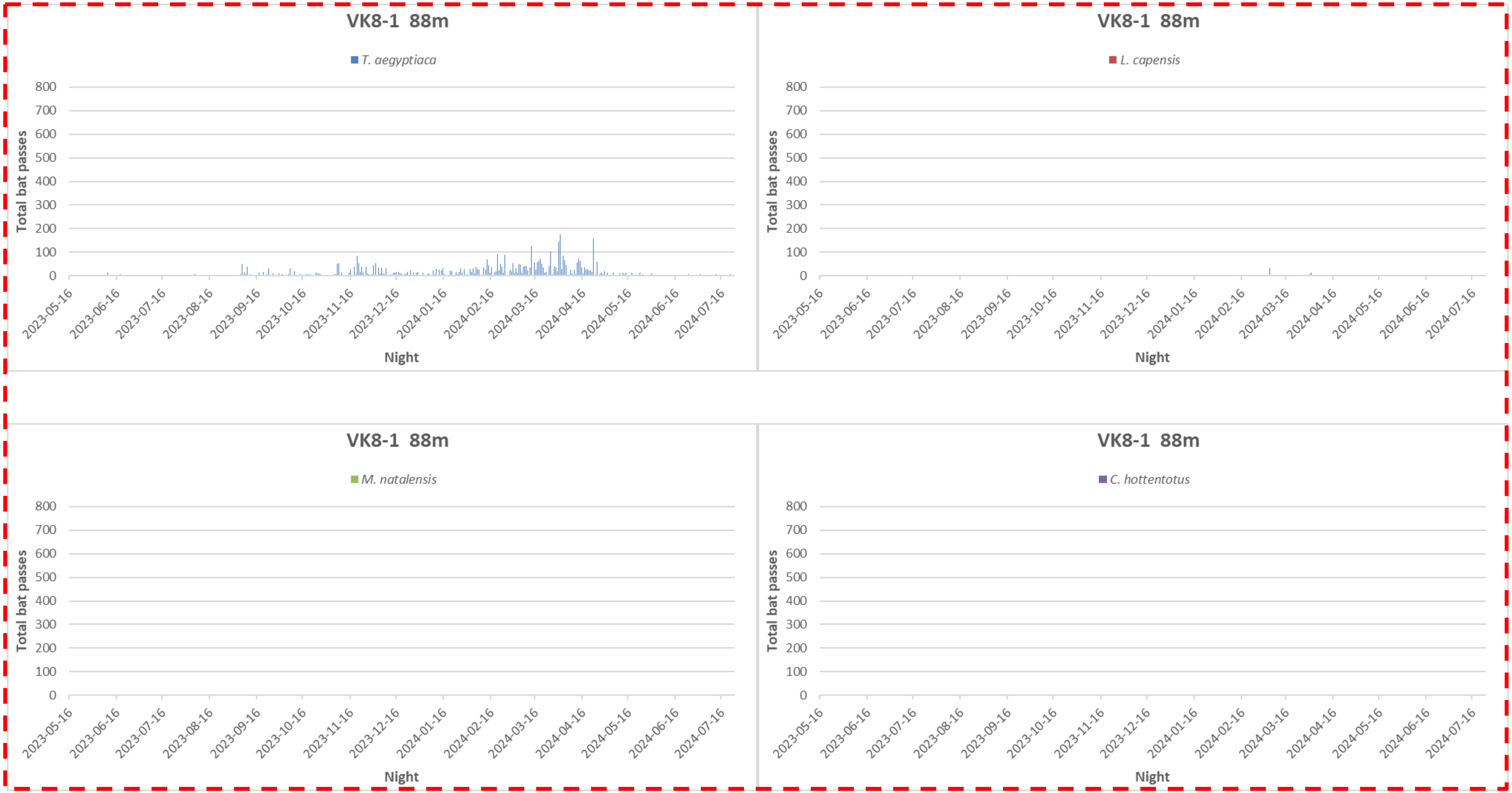
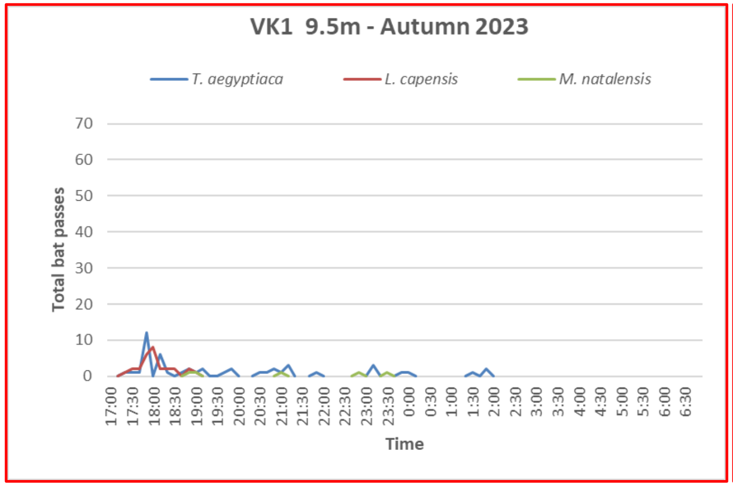
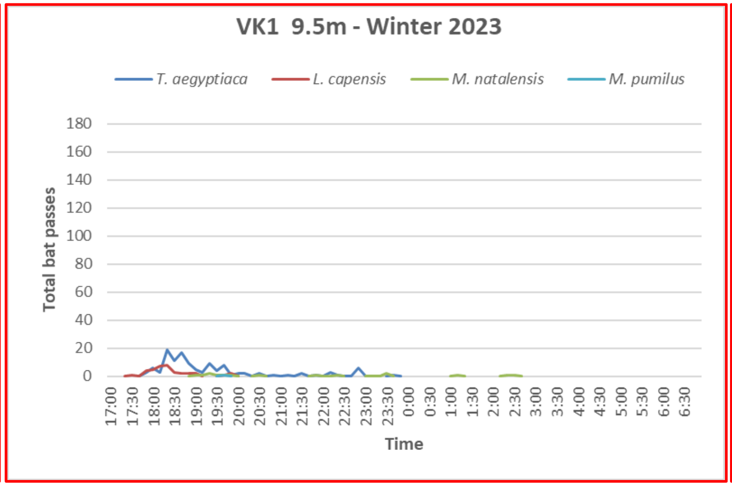
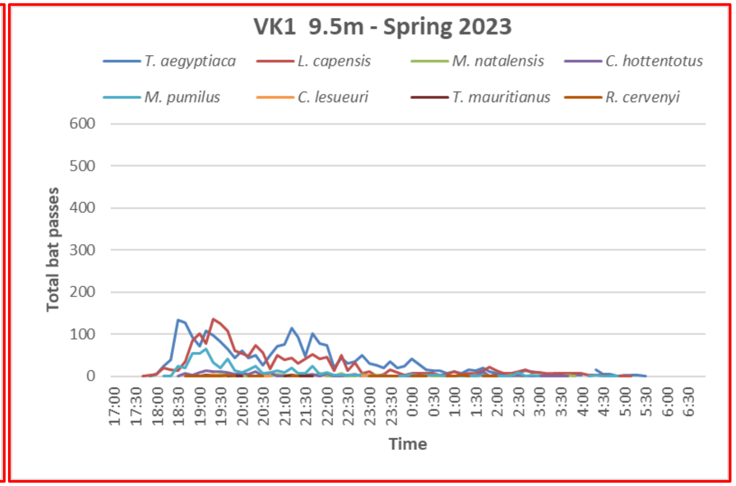

VK8-1 88m
T. aegyptiaca
Total bat passes
Night
VK8-1 88m
L. capensis
Total bat passes
Night
VK8-1 88m
M. natalensis
Total bat passes
Night
VK8-1 88m
C. hottentotus
Total bat passes
Night
0
100
200
300
400
500
600
700
800
2023-05-16
2023-06-16
2023-07-16
2023-08-16
2023-09-16
2023-10-16
2023-11-16
2023-12-16
2024-01-16
2024-02-16
2024-03-16
2024-04-16
2024-05-16
2024-06-16
2024-07-16

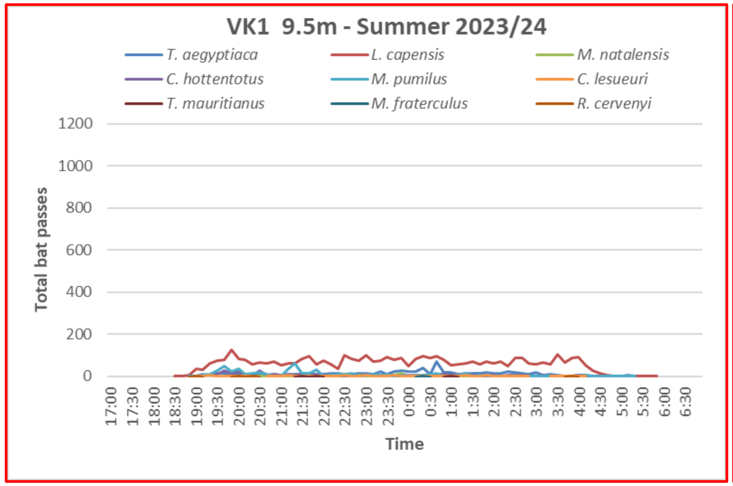
Figure 19 Total bat passes for each species recorded nightly at different heights at each of the Verkykerskop WEF cluster bat monitoring stations. The Groothoek WEF microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8) are outlined in dashed red

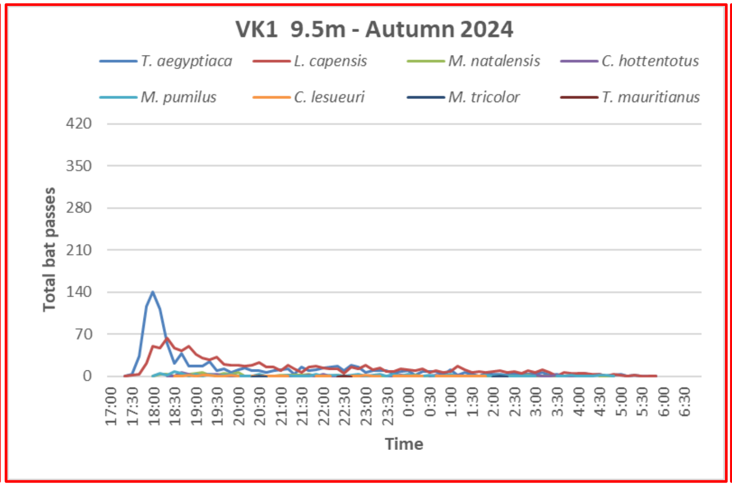
13. Appendix 3: Key Bat Activity Times - Per Season

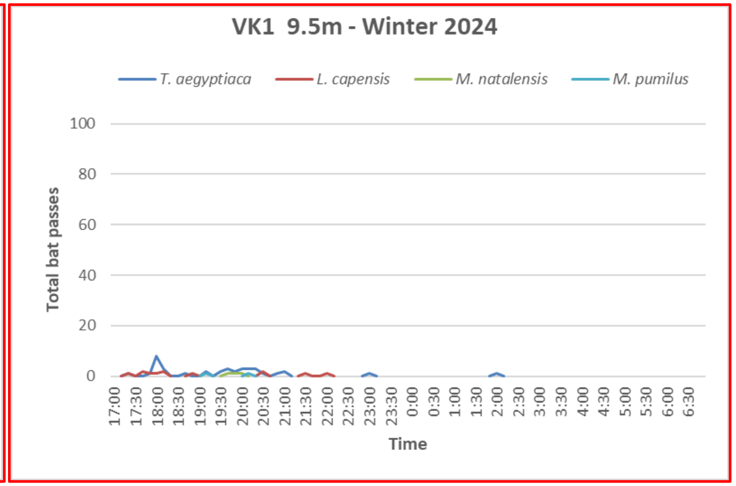


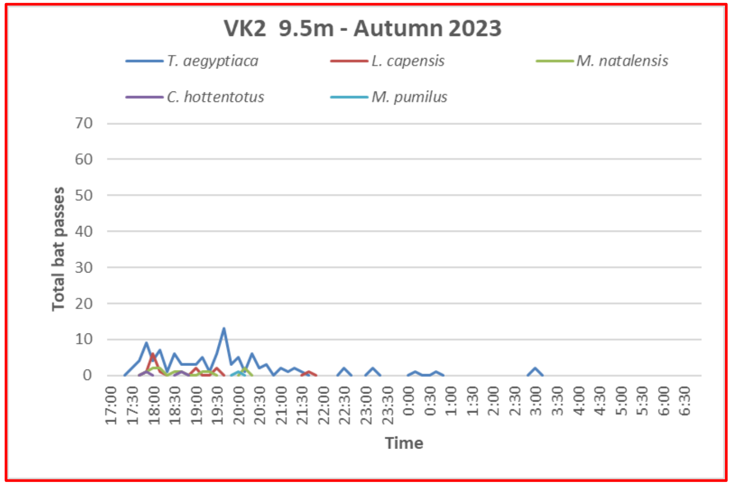


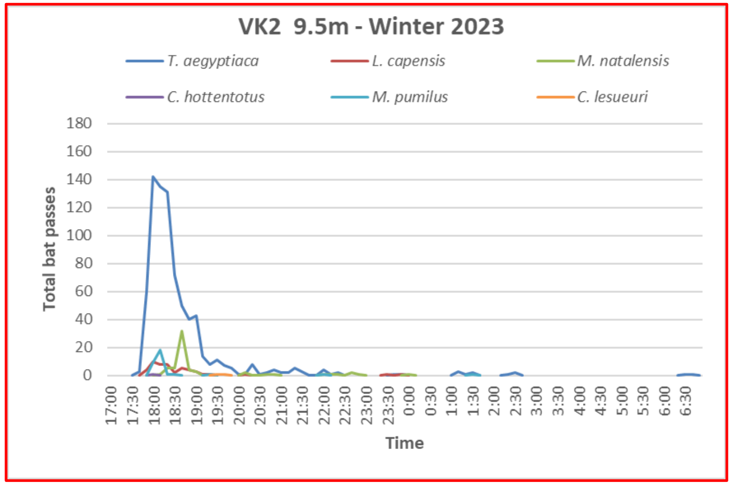


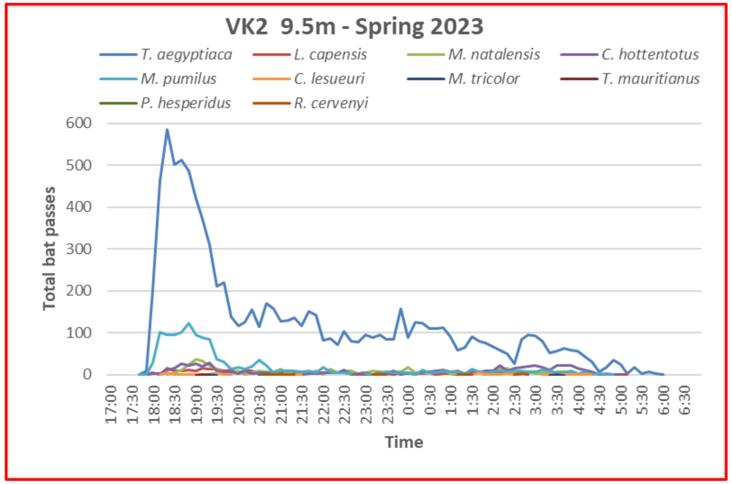


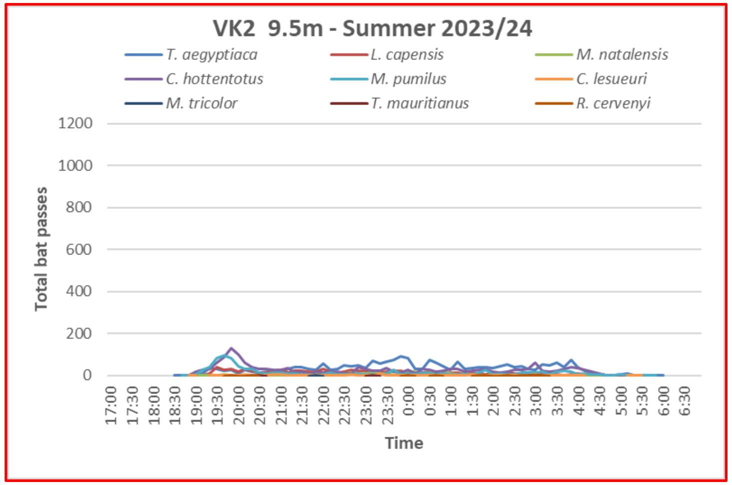


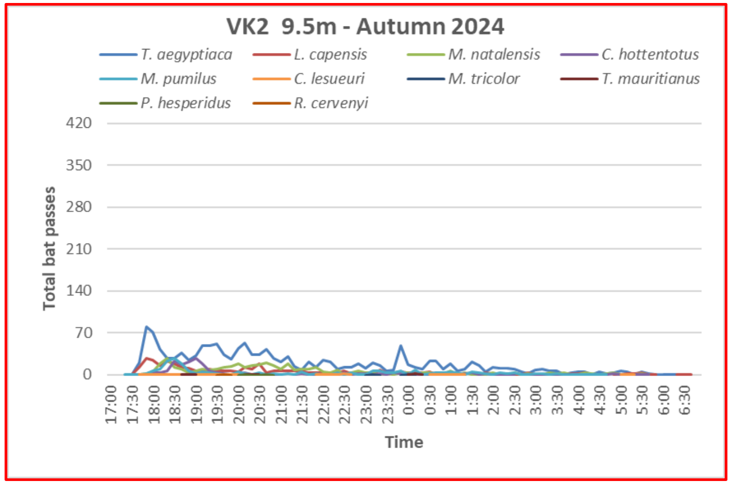


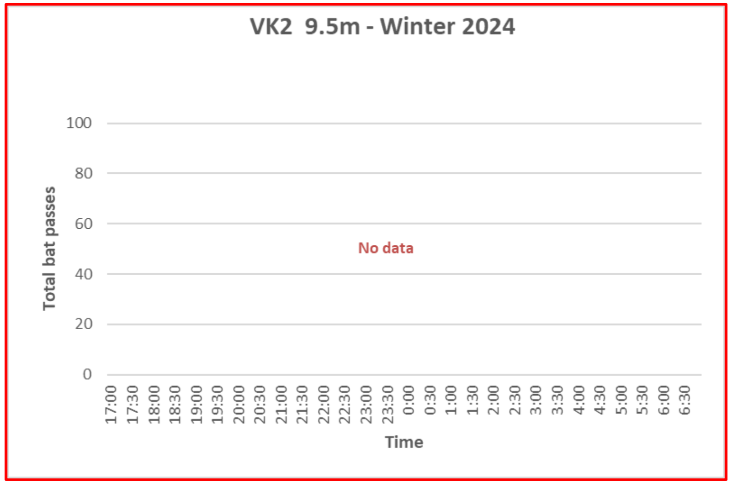

VK2 9.5m - Autumn 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
Total bat passes
Time

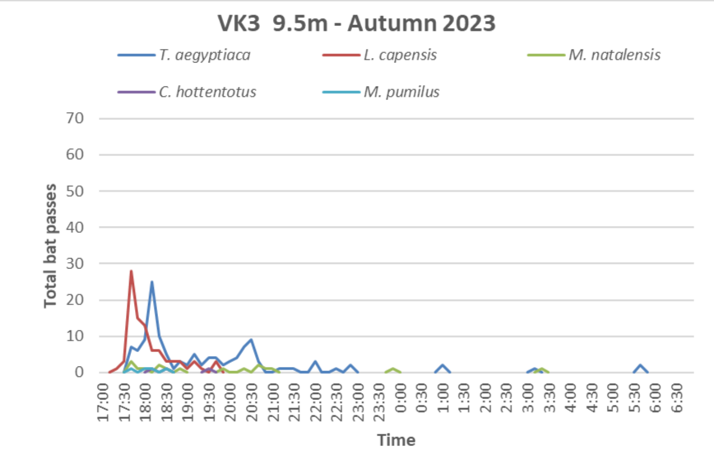

VK2 9.5m - Winter 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
Total bat passes
Time

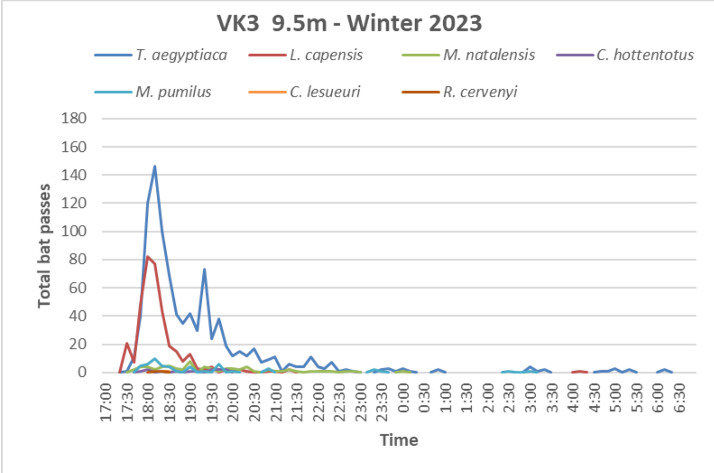

VK2 9.5m - Spring 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
R. cervenyi
Total bat passes
Time

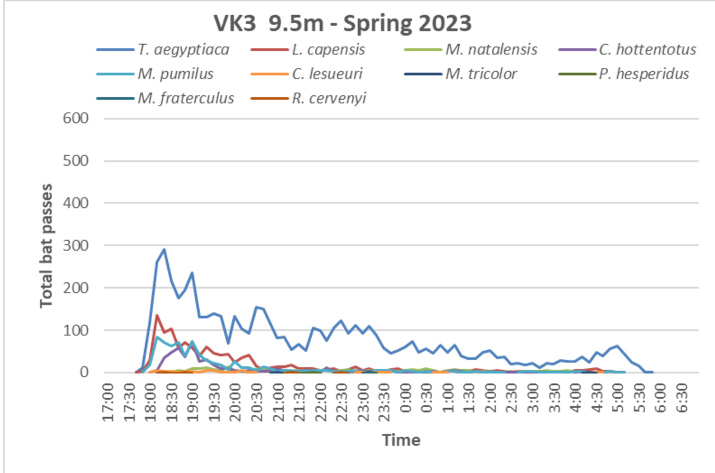

VK2 9.5m - Summer 2023/24
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
R. cervenyi
Total bat passes
Time

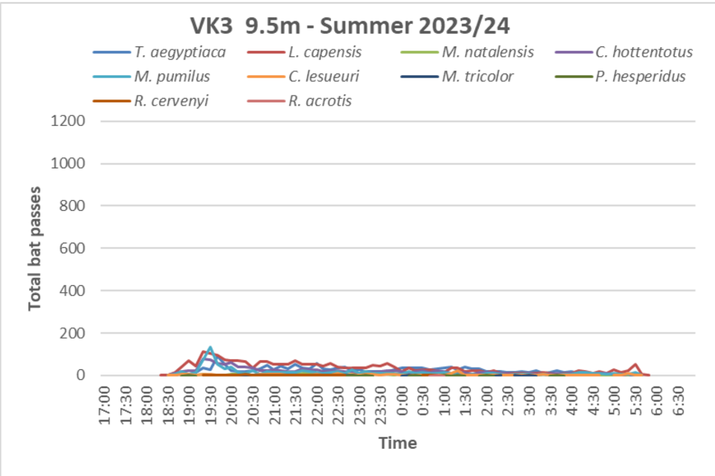

VK2 9.5m - Autumn 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
R. cervenyi
Total bat passes
Time

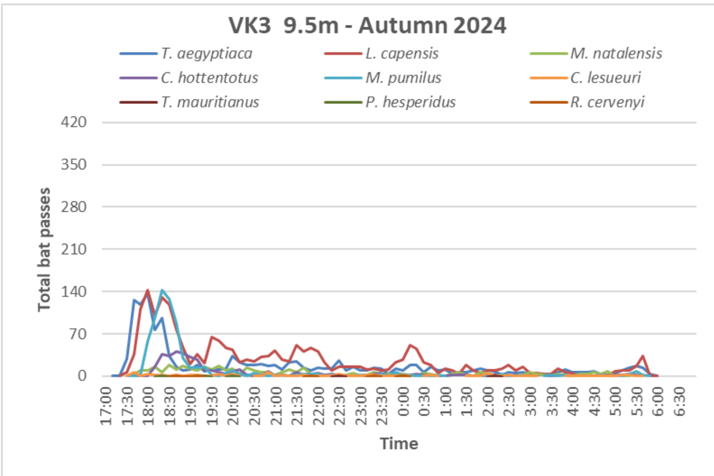

VK2 9.5m - Winter 2024
No data
Total bat passes
Time

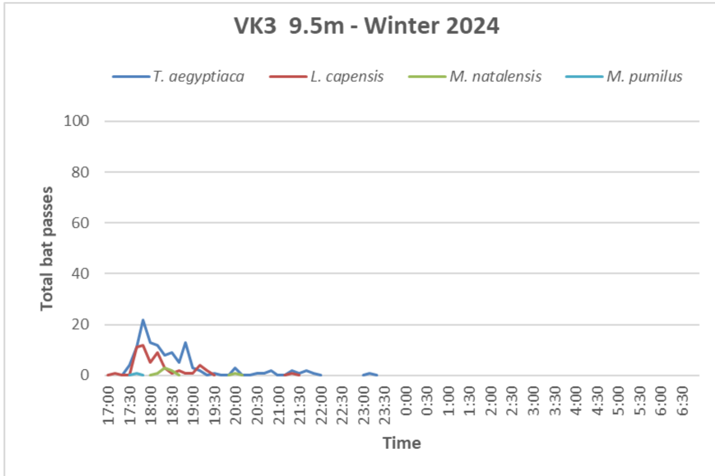

VK3 9.5m - Autumn 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
Total bat passes
Time

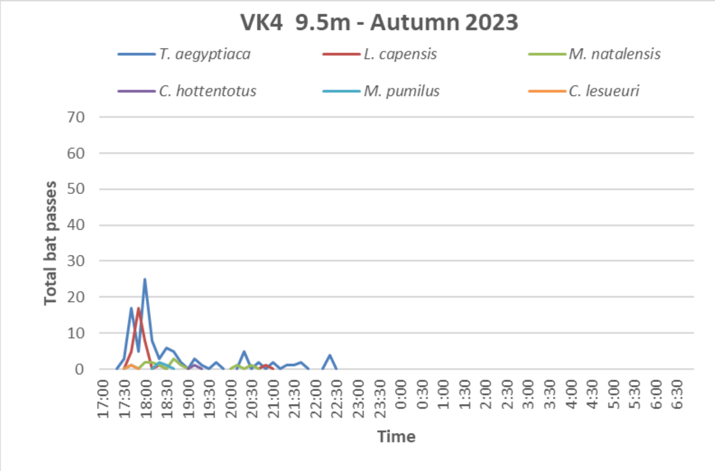

VK3 9.5m - Winter 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
R. cervenyi
Total bat passes
Time

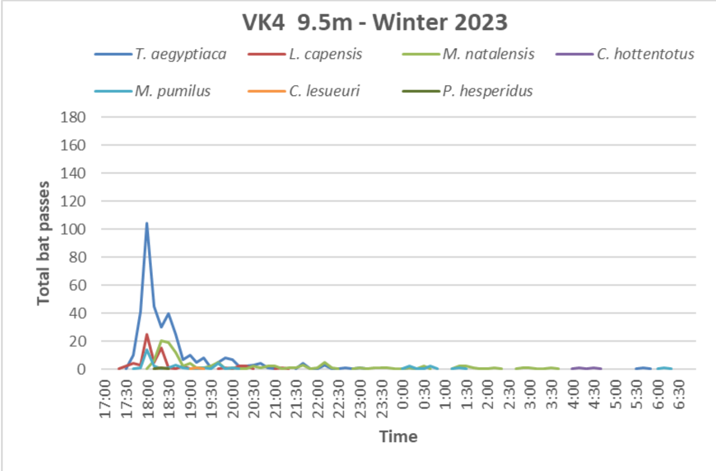

VK3 9.5m - Spring 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
P. hesperidus
M. fraterculus
R. cervenyi
Total bat passes
Time

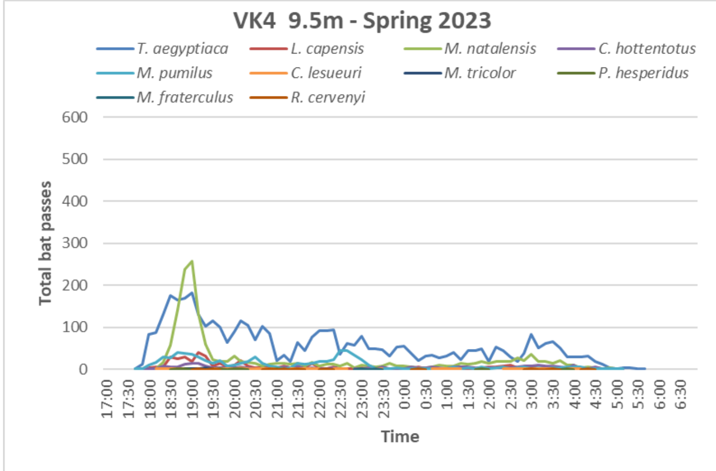

VK3 9.5m - Summer 2023/24
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
P. hesperidus
R. cervenyi
R. acrotis
Total bat passes
Time

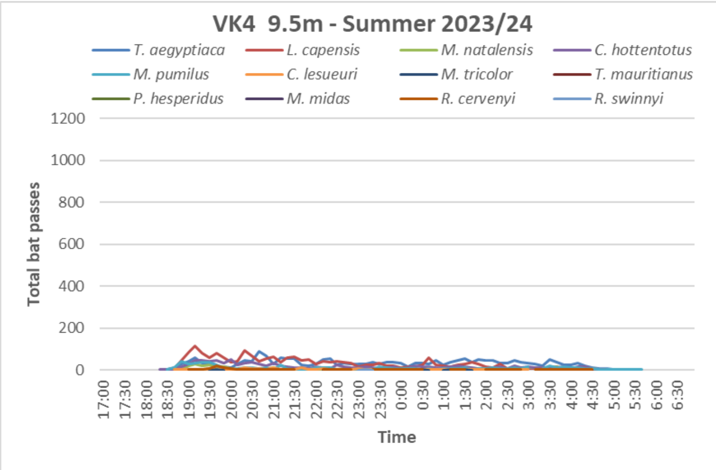

VK3 9.5m - Autumn 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
T. mauritianus
P. hesperidus
R. cervenyi
Total bat passes
Time

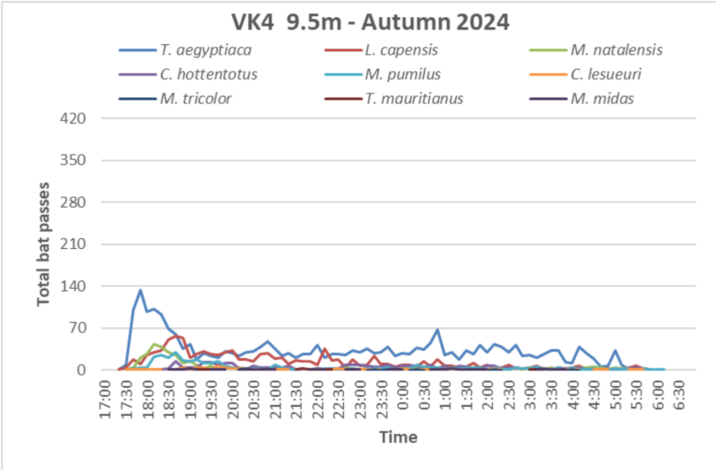

VK3 9.5m - Winter 2024
T. aegyptiaca
L. capensis
M. natalensis
M. pumilus
Total bat passes
Time

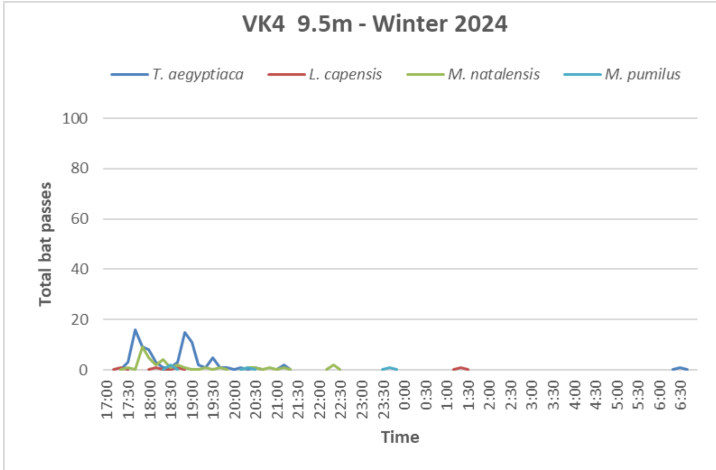

VK4 9.5m - Autumn 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
Total bat passes
0 10 20 30 40 50 60 70
Time

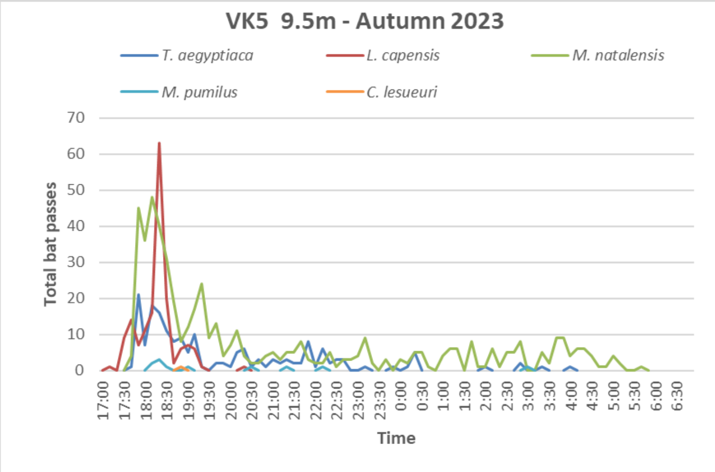

VK4 9.5m - Winter 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
P. hesperidus
Total bat passes
0 20 40 60 80 100 120 140 160 180
Time

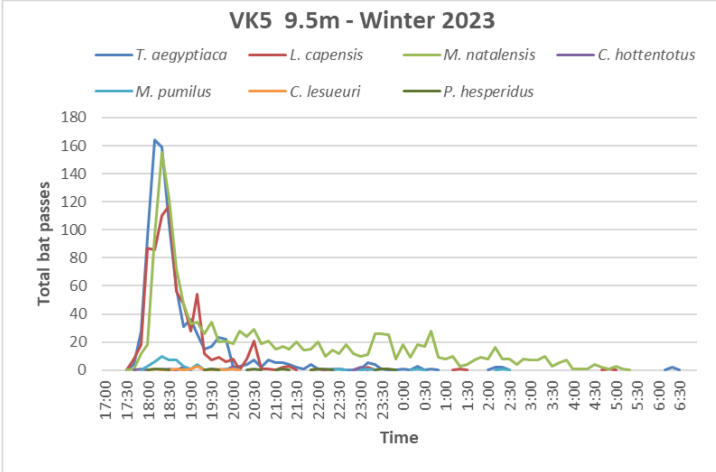

VK4 9.5m - Spring 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
P. hesperidus
M. fraterculus
R. cervenyi
Total bat passes
0 100 200 300 400 500 600
Time

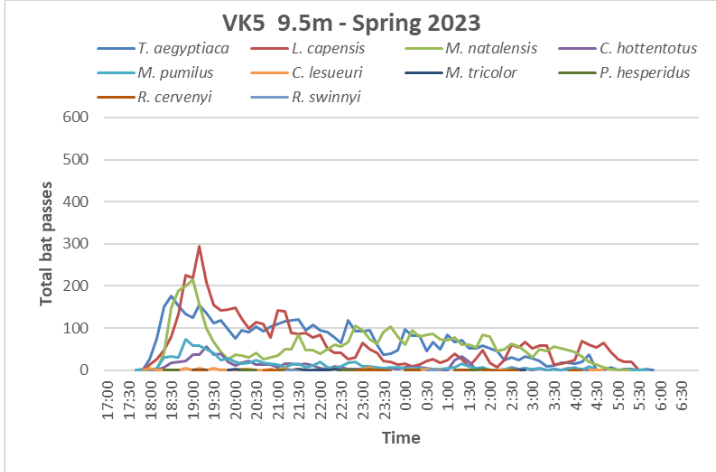

VK4 9.5m - Summer 2023/24
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
R. cervenyi
R. swinnyi
Total bat passes
0 200 400 600 800 1000 1200
Time

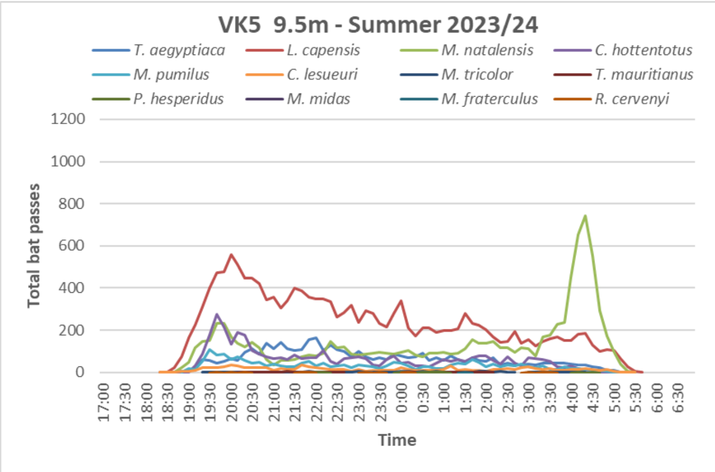

VK4 9.5m - Autumn 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
M. midas
Total bat passes
0 70 140 210 280 350 420
Time

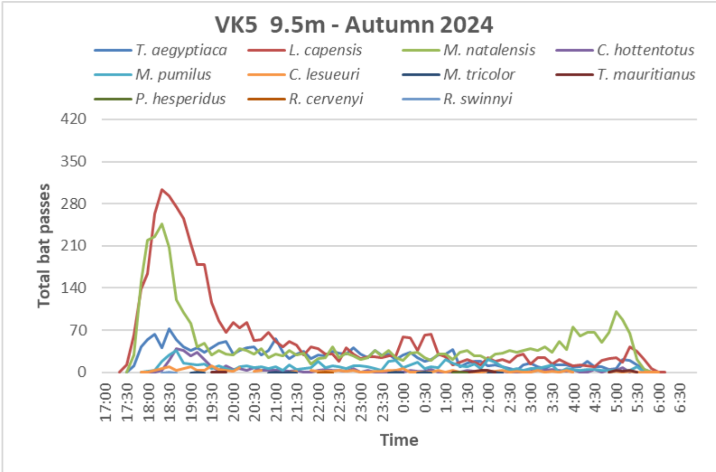

VK4 9.5m - Winter 2024
T. aegyptiaca
L. capensis
M. natalensis
M. pumilus
Total bat passes
0 20 40 60 80 100
Time

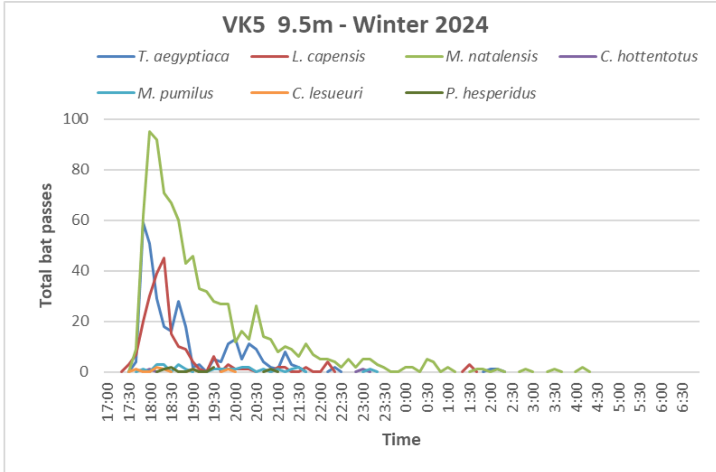

VK5 9.5m - Autumn 2023
T. aegyptiaca
L. capensis
M. natalensis
M. pumilus
C. lesueuri
Total bat passes
Time

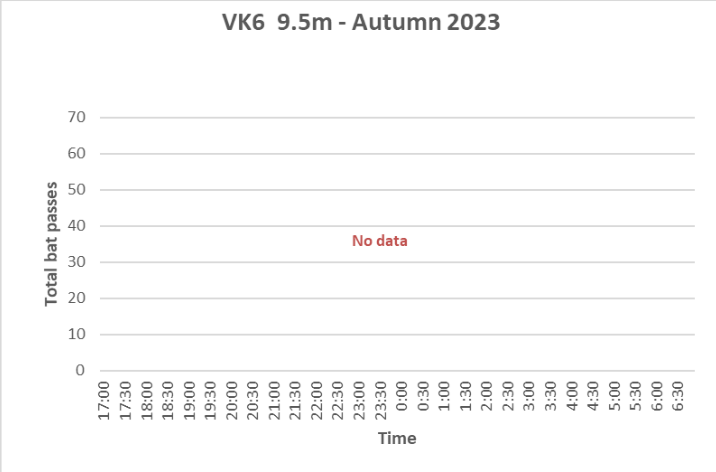

VK5 9.5m - Winter 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
P. hesperidus
Total bat passes
Time

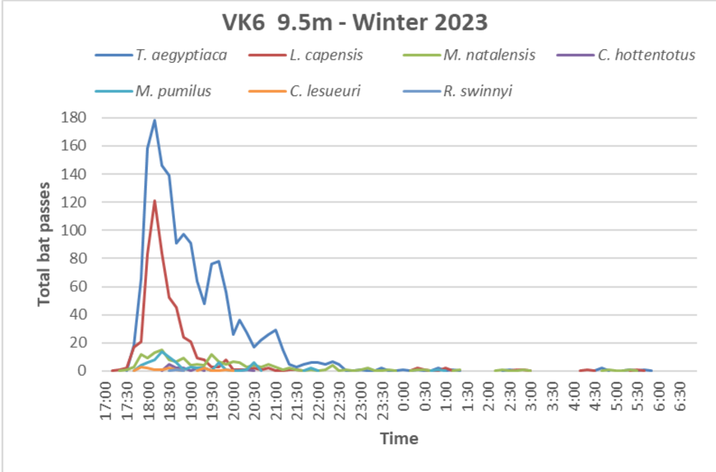

VK5 9.5m - Spring 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
P. hesperidus
R. cervenyi
R. swinnyi
Total bat passes
Time

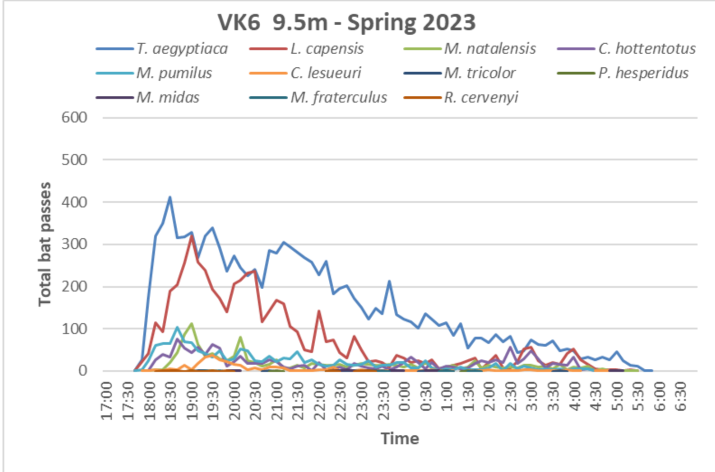

VK5 9.5m - Summer 2023/24
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
Total bat passes
Time

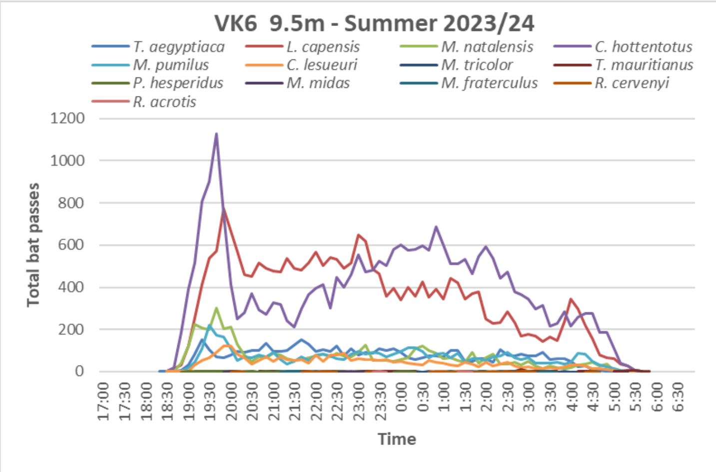

VK5 9.5m - Autumn 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
R. cervenyi
R. swinnyi
Total bat passes
Time

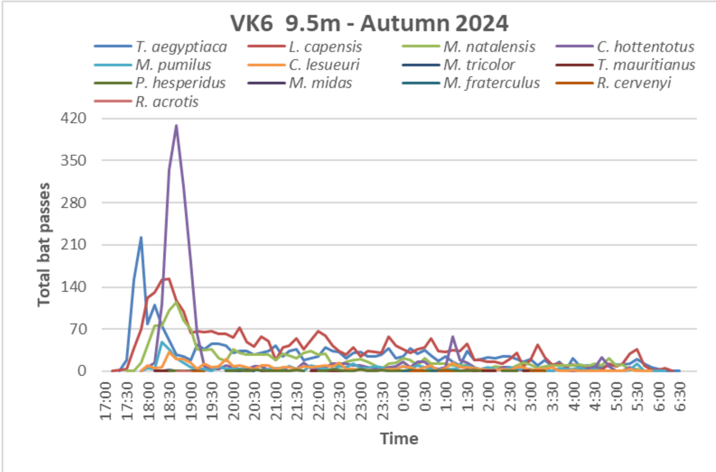

VK5 9.5m - Winter 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
P. hesperidus
Total bat passes
Time

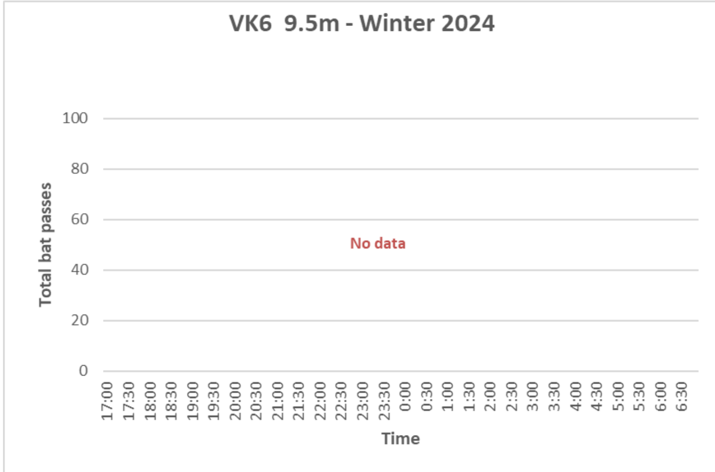

VK6 9.5m - Autumn 2023
No data
Total bat passes
Time

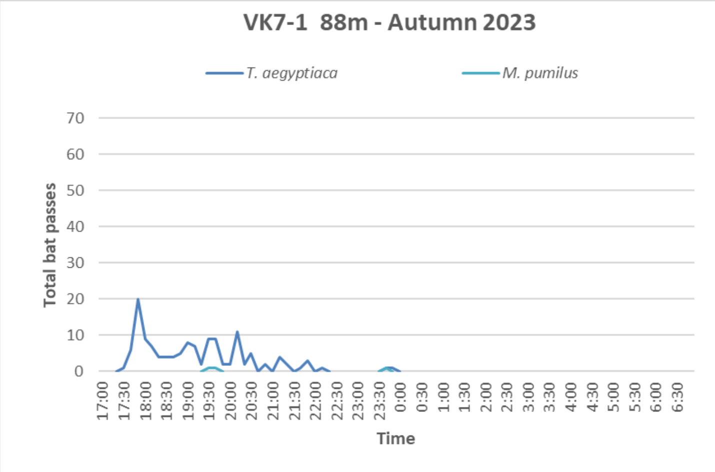

VK6 9.5m - Winter 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
R. swinnyi
Total bat passes
Time

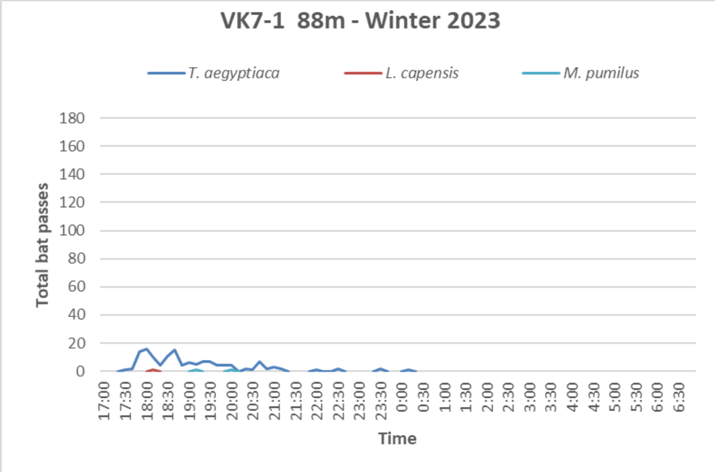

VK6 9.5m - Spring 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
Total bat passes
Time

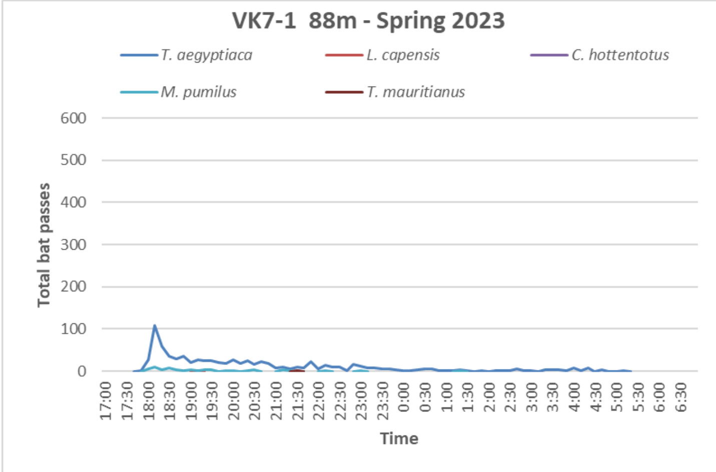

VK6 9.5m - Summer 2023/24
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. acrotis
Total bat passes
Time

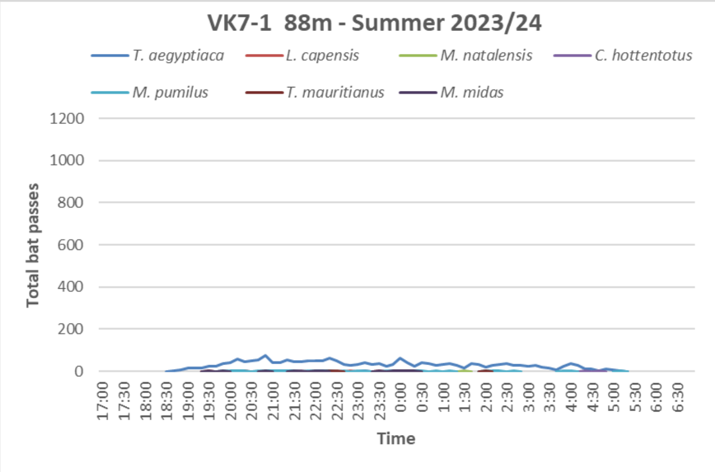

VK6 9.5m - Autumn 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
M. fraterculus
R. cervenyi
R. acrotis
Total bat passes
Time

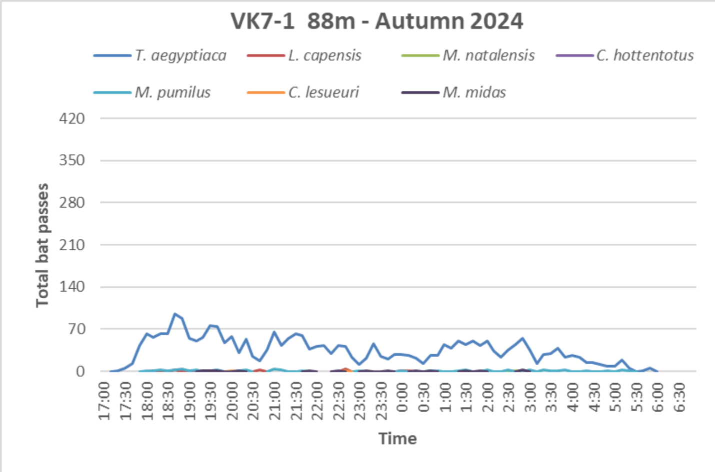

VK6 9.5m - Winter 2024
No data
Total bat passes
Time

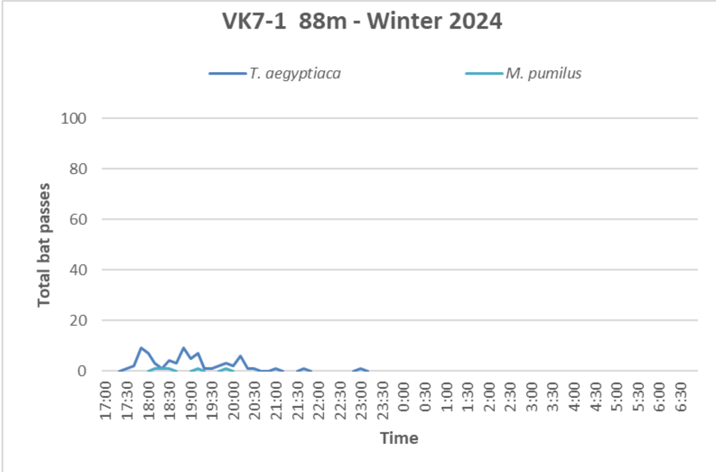

VK7-1 88m - Autumn 2023
T. aegyptiaca
M. pumilus
Total bat passes
Time

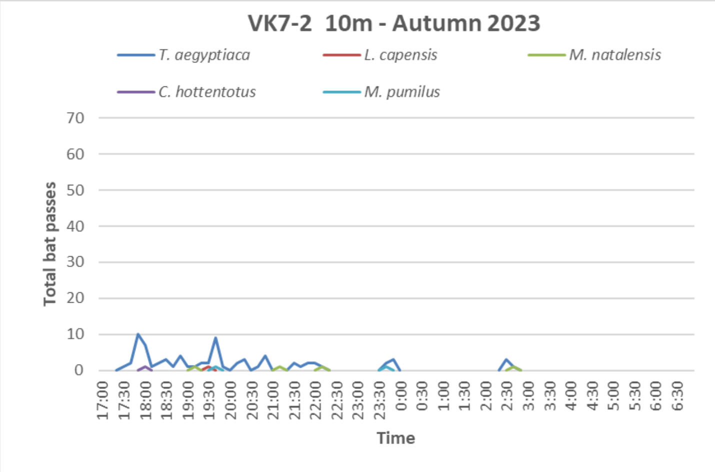

VK7-1 88m - Winter 2023
T. aegyptiaca
L. capensis
M. pumilus
Total bat passes
Time

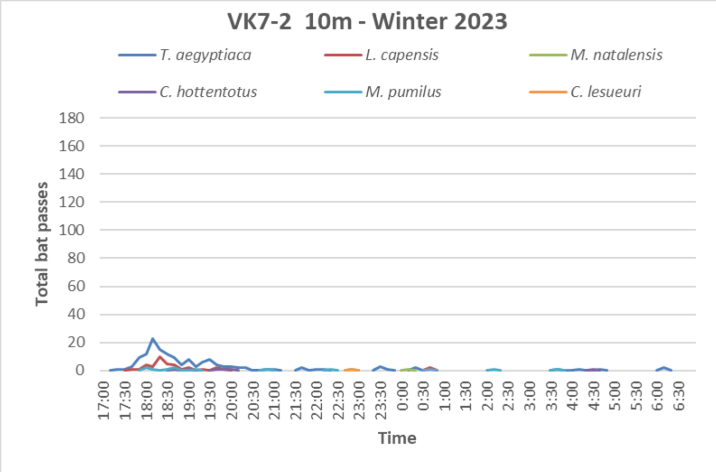

VK7-1 88m - Spring 2023
T. aegyptiaca
L. capensis
C. hottentotus
M. pumilus
T. mauritianus
Total bat passes
Time

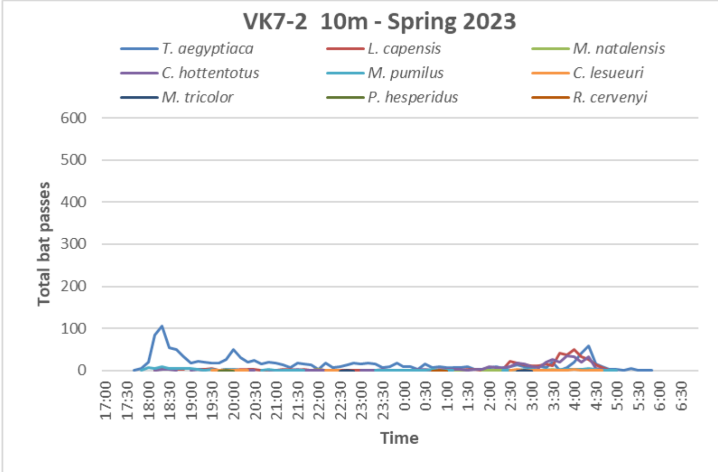

VK7-1 88m - Summer 2023/24
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
T. mauritianus
M. midas
Total bat passes
Time

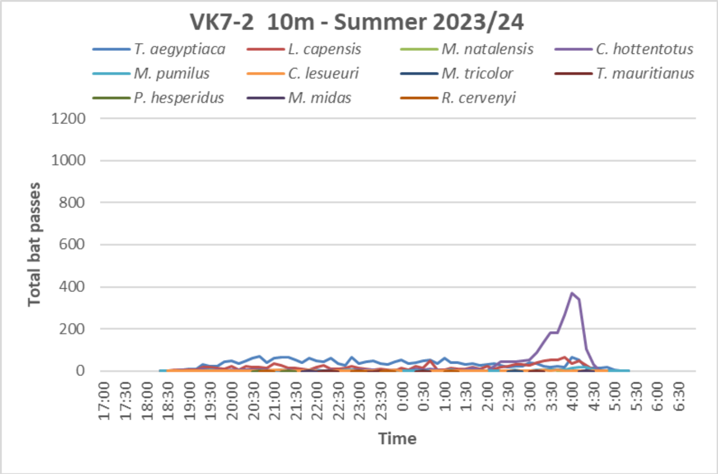

VK7-1 88m - Autumn 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. midas
Total bat passes
Time

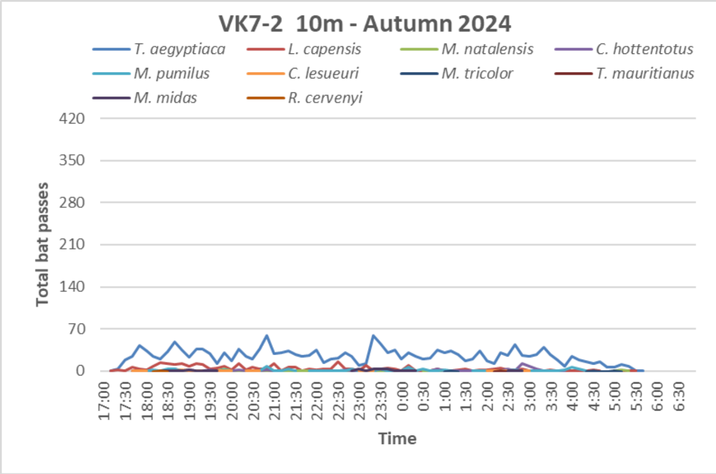

VK7-1 88m - Winter 2024
T. aegyptiaca
M. pumilus
Total bat passes
Time

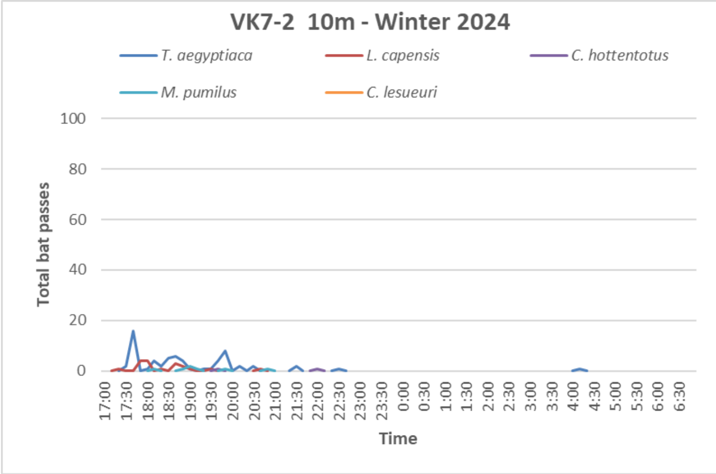

VK7-2 10m - Autumn 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
Total bat passes
Time

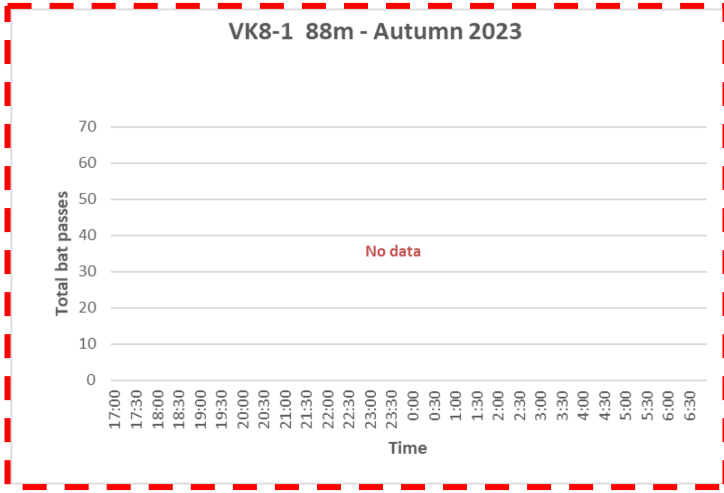

VK7-2 10m - Winter 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
Total bat passes
Time

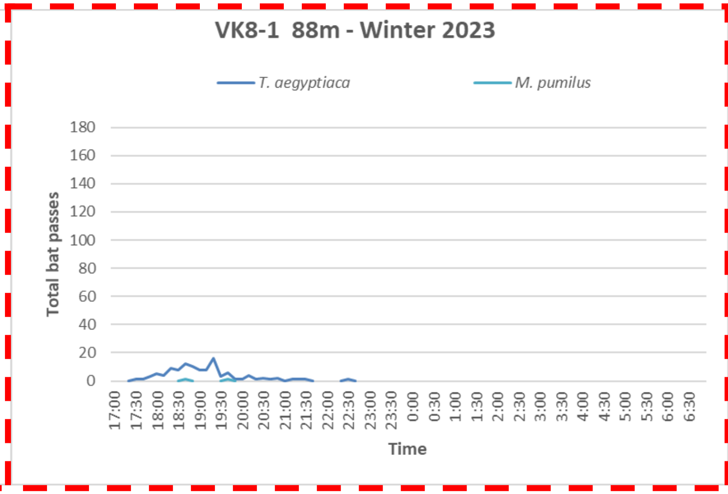

VK7-2 10m - Spring 2023
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
P. hesperidus
R. cervenyi
Total bat passes
Time

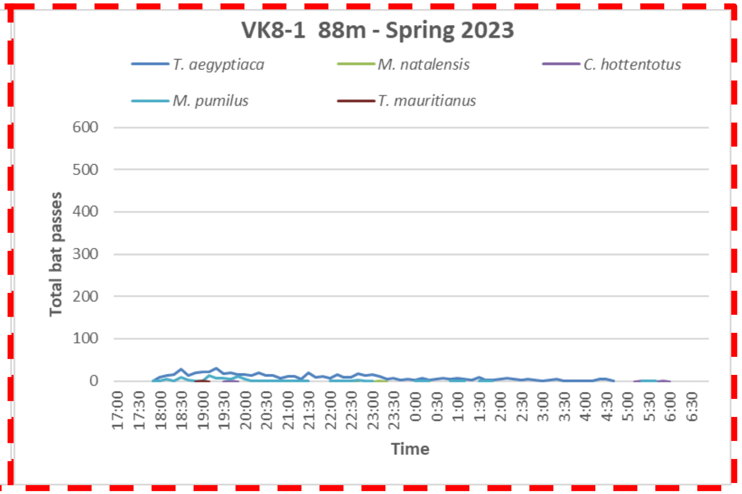

VK7-2 10m - Summer 2023/24
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
P. hesperidus
M. midas
R. cervenyi
Total bat passes
Time

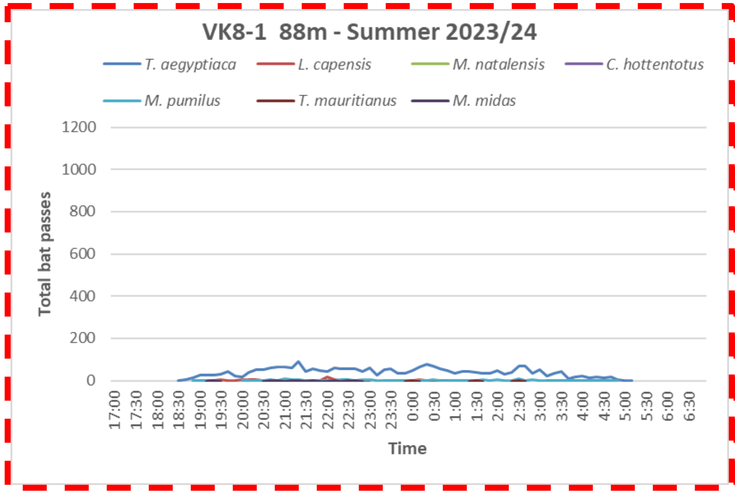

VK7-2 10m - Autumn 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
C. lesueuri
M. tricolor
T. mauritianus
M. midas
R. cervenyi
Total bat passes
Time

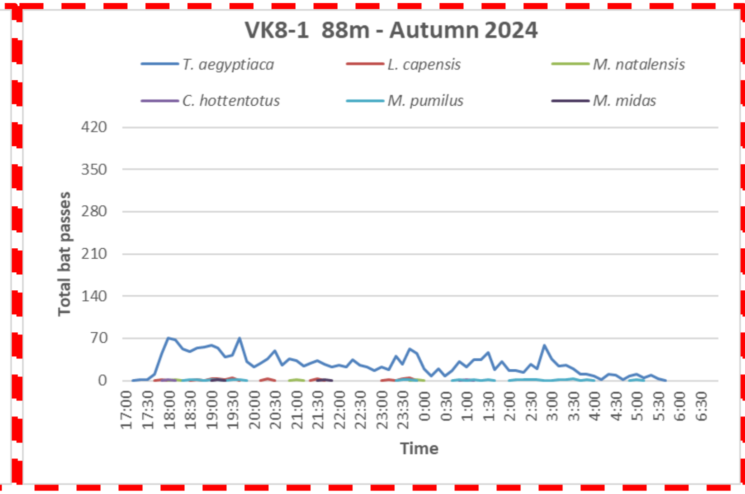

VK7-2 10m - Winter 2024
T. aegyptiaca
L. capensis
C. hottentotus
M. pumilus
C. lesueuri
Total bat passes
Time

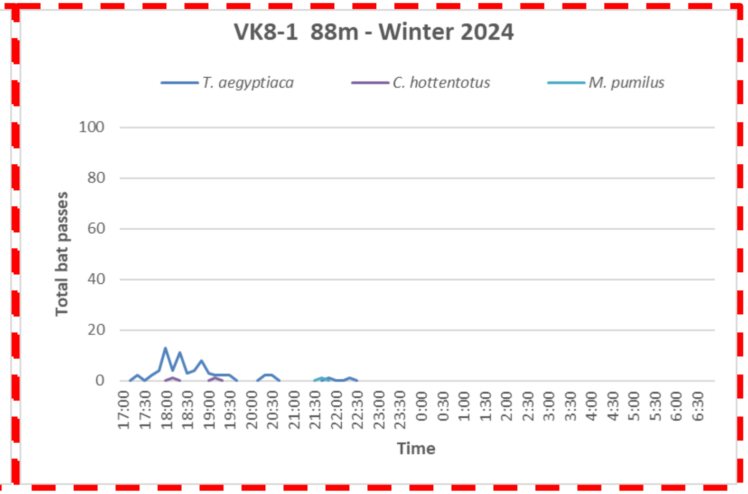

VK8-1 88m - Autumn 2023
No data
Total bat passes
Time


VK8-1 88m - Winter 2023
T. aegyptiaca
M. pumilus
Total bat passes
Time


VK8-1 88m - Spring 2023
T. aegyptiaca
M. natalensis
C. hottentotus
M. pumilus
T. mauritianus
Total bat passes
Time


VK8-1 88m - Summer 2023/24
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
T. mauritianus
M. midas
Total bat passes
Time


VK8-1 88m - Autumn 2024
T. aegyptiaca
L. capensis
M. natalensis
C. hottentotus
M. pumilus
M. midas
Total bat passes
Time


VK8-1 88m - Winter 2024
T. aegyptiaca
C. hottentotus
M. pumilus
Total bat passes
Time

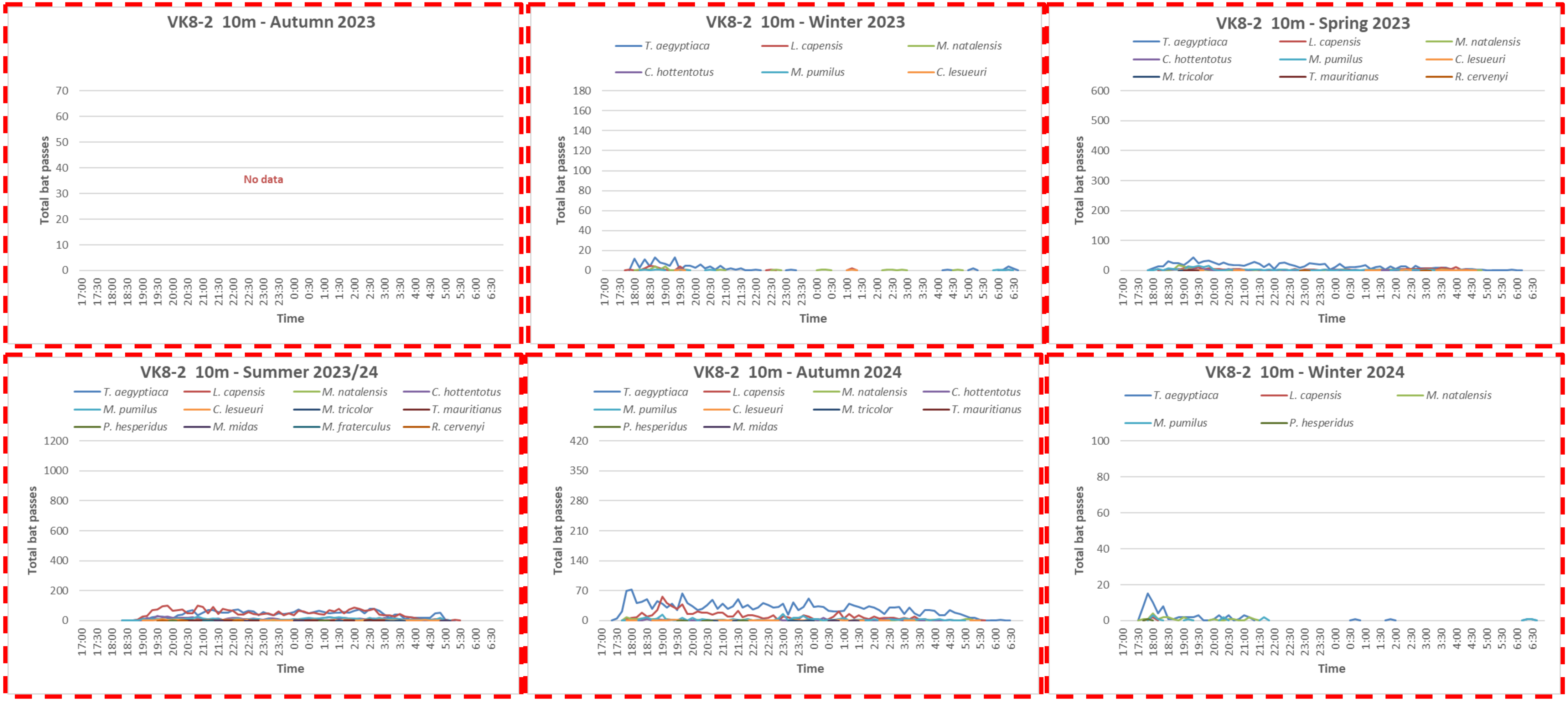


Figure 20 Night-time activity of bat species recorded at each of the Verkykerskop WEF cluster bat monitoring stations – per season. The Groothoek microphones (VK1, VK2) are outlined in solid red and the closest microphones from a met. mast (VK8) are outlined in dashed red

14. Appendix 4: CV of Dr Caroline Lötter

Name: **DR CAROLINE ANGELA LöTTER (NEÉ YETMAN)**

Name of Firm: Inkululeko Wildlife Services (Pty) Ltd
Position: Managing Director and Senior Zoologist
Date of Birth: 6 November 1979
Nationality: South African
Languages: English, Afrikaans

QUALIFICATIONS & PROFESSIONAL REGISTRATION

- PhD – Zoology (University of Pretoria: 2003-2011)
- MSc – African Mammalogy (University of Pretoria: 2002)
- BSc Hons – Zoology (University of Pretoria: 2001)
- BSc – Ecology (University of Pretoria: 1998-2000)
- Registered with SACNASP (no. 400182/09) as a Professional Natural Scientist in the field of Zoology

KEY EXPERIENCE

- **Specialist Assessments:**
  - Long-term bat monitoring at more than 70 wind farm sites in southern Africa, including field work, desktop research, report writing, and project management.
  - Surveys and impact assessments for the Square Kilometre Array project and several bat caves.
  - Baseline and impact assessments for fauna in general at over 100 sites in South Africa.
  - Biodiversity Management Plans for large South African mining complexes.
  - Specialist Giant Bullfrog assessments for more than 50 proposed development sites.

EMPLOYMENT EXPERIENCE

- **Inkululeko Wildlife Services, Johannesburg (June 2019 – present)**
  Position Title: Managing Director
  - Bat project management
  - Proposals
  - Desktop research
  - Field work
  - Reporting and report reviews
  - Analysis and reporting of data for peer-review publication
  - Co-author of South African pre-construction bat monitoring guidelines (MacEwan *et al*. 2020a)
  - Co-author of article on bat activity in South Africa and its implications for wind farm development (MacEwan *et al.* 2020b)

- **Natural Scientific Services, Johannesburg (November 2011 – April 2019)**
  Position Title: Senior Zoologist
  - Bat, faunal, and general biodiversity (i.e. faunal, flora, wetland and aquatic) project management
  - Proposals
  - Desktop research
  - Field work
  - Reporting and report reviews
  - Analysis and reporting of data for peer-review publication