12-Month Pre-construction Bat Environmental Impact Assessment (EIA)

For the proposed Camden I Wind Energy Facility (WEF)
Mpumalanga, South Africa

ANiMALiA

Compiled by

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For:	12-Month Pre-construction Bat Environmental Impact Assessment

Independence

Animalia Consultants (Pty) Ltd has no connection with the developer. Animalia Consultants (Pty) Ltd is not a subsidiary, legally or financially of the developer; remuneration for services by the developer in relation to this 12-month Pre-construction Bat Environmental Impact Assessment (EIA) Report is not linked to approval by decision-making authorities responsible for permitting this proposal and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project.

Applicable Legislation

Legislation dealing with biodiversity applies to bats and includes the following:
NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004 (ACT 10 OF 2004; Especially sections 2, 56 & 97).

The Act calls for the management and conservation of all biological diversity within South Africa. Bats constitute an important component of South African biodiversity and therefore all species receive attention, in addition to those listed as Threatened or Protected.

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Table i. Explanation of abbreviations used in this document

Abbreviation	Explanation
ACR	African Chiroptera Report
BESS	Battery Energy Storage System
DFFE	Department of Forestry, Fisheries & the Environment
DMRE	Department of Mineral Resources and Energy
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMPr	Environmental Management Plan report
GHAF	Green Hydrogen & Ammonia Facility
IRP	Integrated Resource Plan
MM	Meteorological ("Met") Mast
PV	Photo-voltaic (facility)
REC	Renewable Energy Complex
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SABAA	South African Bat Assessment Association
SEA	Strategic Environmental Assessment
ShM	Short Mast (passive bat detection system)
WEF	Wind Energy Facility

NEMA Requirements

The content of a specialist report is specified in the EIA Regulations GN R. 982, as amended (4 Dec 2014) Appendix 6. A specialist report prepared in terms of these Regulations must contain:

NEMA Requirement	Section/page in report
Details of the specialist who prepared the report, and the expertise of that specialist to compile a specialist report including a curriculum vitae.	**Separate Curriculum Vitae**
A declaration that the specialist is independent in a form as may be specified by the competent authority.	**Page 3**
An indication of the scope of, and the purpose for which, the report was prepared.	**Section 1**
An indication of the quality and age of the base data used for the specialist report.	**Sections 3; 4**
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	**Sections 4; 5**
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment.	**Section 3**
A description of the methodology adopted in preparing the report or carrying out the specialised process, inclusive of equipment and modelling used.	**Section 3**
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure.	**Section 5**
An identification of any areas to be avoided, including buffers.	**Section 4.5**
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	**Section 4.5**
A description of any assumptions made and any uncertainties or gaps in knowledge.	**Section 3.4**

A description of the findings and potential implications of such findings on the impact of the proposed activity, or activities.	**Sections 4; 7**
Any mitigation measures for inclusion in the EMPr.	**Section 6**
Any conditions for inclusion in the environmental authorisation.	**Sections 5; 6; 7**
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	**Section 5; 7**
A reasoned opinion whether the proposed activity or portions thereof should be authorised, and regarding the acceptability of the proposed activity or activities. And if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr.	**Sections 5; 6; 7**
A description of any consultation process that was undertaken during the course of preparing the specialist report.	**Sections 3**

1 OBJECTIVES AND TERMS OF REFERENCE FOR THE STUDY

The objectives and terms of reference for the impact assessment are to provide the following:

- A description of the baseline characteristics and conditions of the receiving environment (e.g., site and/or surrounding land uses including urban and agricultural areas).
- An evaluation of the predicted impacts of the project on the receiving environment.
- An assessment of the probability of each impact occurring, the reversibility of each impact and the level of confidence in each potential impact.
- Consideration and evaluation of the cumulative impacts in terms of the current and proposed activities in the area.
- Recommendations to avoid negative impacts, as well as feasible and practical mitigation, management and/or monitoring options to reduce negative impacts that can be included in the Environmental Management Programme.
- A reasoned opinion as to whether the proposed activity, or portions of the activity should be authorised.
- Presentation of the findings regarding bat species assemblage and abundance on the site.
- Findings regarding temporal distribution of bat activity (nightly, monthly and seasonally) throughout the year of study in order to detect peaks and troughs in activity.
- Development of long-term baseline data for use during operational monitoring.
- Identification of turbines requiring special attention with regards to bat monitoring during the operational phase.
- Details regarding the types of mitigation measures that are possible if bat mortality rates are found to be unacceptable, including the potential times/circumstances which may result in higher mortality rates.

2 INTRODUCTION

This document is the 12-month Pre-construction Bat Environmental Impact Assessment (EIA) Report for the proposed Camden I Wind Energy Facility completed by Animalia Consultants (Pty) Ltd.

Enertrag South Africa (Pty) Ltd is proposing the development of a commercial wind energy facility (WEF), along with the associated grid connections and infrastructure on a site located approximately 17km south-south-east of Ermelo and 200km east-south-east of Johannesburg, within the Msukaligwa Local Municipality of the Gert Sibande District Municipality, Mpumalanga Province. The below Table 2.1 gives the project description and summarises the infrastructure specifications for the developments. Figure 2.1 depicts the proposed WEF site boundary and current turbine layout.

Table 2.1. Project Summary - Camden I Wind Energy Facility (WEF)

Facility Name	Camden I Wind Energy Facility
Applicant	Camden I Wind Energy Facility (RF) Propriety Limited
Municipalities	Msukaligwa Local Municipality of the Gert Sibande District Municipality
Affected Farms[1]	o Portion 0 of Klipfontein Farm No. 442 o Portion 1 of Welgelegen Farm No. 322 o Portion 1 of Klipfontein Farm No. 442 o Portion 2 of Uitkomst Farm No. 292 o Portion 2 of Welgelegen Farm No. 322 o Portion 3 of Langverwatch Farm No. 293 o Portion 3 of Klipbank Farm No. 295 o Portion 3 of Klipfontein Farm No. 442 o Portion 10 of Uitkomst Farm No. 292 o Portion 14 of Mooiplaats Farm No. 290
Extent	6000 ha
Buildable area	Approximately 200 ha

[1] **Based on the current conceptual layout.**

Capacity	Up to 210MW
Number of turbines	Up to 37
Turbine hub height:	Up to 200m
Rotor Diameter:	Up to 200m
Foundation	Approximately 25m diameter x 4.5m deep – 2500m^3 concrete. Total clearance per turbine approximately 1ha.
Operations and Maintenance (O&M) building footprint:	Located in close proximity to the substation. Septic tanks with portable toilets Typical areas include: - Operations building – 20m x 10m = 200m^2 - Workshop – 15m x 10m = 150m^2 Stores - 15m x 10m = 150m^2
Construction camp laydown	Typical area 100m x 50m = 5000m^2. Sewage: Septic tanks and portable toilets
Temporary laydown or staging area:	Typical area 220m x 100m = 22000m². Laydown area could increase to 30000m² for concrete towers, should they be required.
Cement batching plant (temporary):	Gravel and sand will be stored in separate heaps whilst the cement will be contained in a silo. The footprint will be around 0.5ha. Maximum height of the silo will be 20m.
Internal Roads:	Width of internal road – Between 5m and 6m, this can be increased to 8m on bends. Length of internal road – Approximately 60km.
Cables:	The medium voltage collector system will comprise of cables up to and include 33kV that run underground, except where a technical assessment suggest that overhead lines are required, in the facility connecting the turbines to the onsite substation.
Independent Power Producer (IPP) site substation and battery energy storage system (BESS):	Total footprint will be up to 10ha in extent. The substation will consist of a high voltage substation yard to allow for multiple (up to) 400kV feeder bays and transformers, control building, telecommunication infrastructure, access roads, etc. The associated BESS storage capacity will be up to 200MW/800MWh with up to four hours of storage. It is proposed that Lithium Battery Technologies, such as Lithium Iron Phosphate, Lithium Nickel Manganese Cobalt oxides or Vanadium Redox flow technologies will be considered as the preferred battery technology. The main components of the BESS include the batteries, power conversion system and transformer which will all be stored in various rows of containers.

This energy facility is proposed in response to the identified objectives of the national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes. It is the developer's intention to bid the Camden I WEF under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme or any similar procurement programme under the IRP, with the aim of evacuating the generated power into the national grid. Third party off-take is also considered, where feasible. This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP), with the Camden I Wind Energy Facility set to inject up to 210MW into the national grid.

Figure 2.1. Layout of the proposed Camden I WEF: Turbine layout (white circles).

2.1 The Bats of South Africa

Bats form part of the Order Chiroptera and are the second largest group of mammals after rodents. They are the only mammals to have developed true powered flight and have undergone various skeletal changes to accommodate this. The forelimbs are elongated, whereas the hind limbs are compact and light, thereby reducing the total body weight. This unique wing profile allows for the manipulation of wing camber and shape, exploiting functions such as agility and manoeuvrability. This adaption surpasses the static design of the bird wings in function and enables bats to utilise a wide variety of food sources, including, but not limited to, a large diversity of insects (Neuweiler 2000). Species-based facial features may differ considerably as a result of differing lifestyles, particularly in relation to various feeding and echolocation navigation strategies. Most South African bats are insectivorous and are capable of consuming vast quantities of insects on a nightly basis (Taylor 2000, Tuttle and Hensley 2001) however, they have also been found to feed on amphibians, fruit, nectar and other invertebrates. As a result, insectivorous bats are the predominant predators of nocturnal flying insects in South Africa and contribute greatly to the suppression of these numbers. Their prey also includes agricultural pests such as moths and vectors for diseases such as mosquitoes (Rautenbach 1982, Taylor 2000).

Urban development and agricultural practices have contributed to the deterioration of bat populations on a global scale. Public participation and funding of bat conservation are often hindered by negative public perceptions and unawareness of the ecological importance of bats. Some species choose to roost in domestic residences, causing disturbance and thereby decreasing any esteem that bats may have established. Other species may occur in large communities in buildings, posing as a potential health hazard to residents in addition to their nuisance value. Unfortunately, the negative association with bats obscures their importance as an essential component of ecological systems and their value as natural pest control agents, which actually serves as an advantage to humans.

Many species of bats roost in large communities and congregate in small areas. Therefore, any major disturbances within and around the roosting areas may adversely impact individuals of different communities concurrently (Hester and Grenier 2005). Secondly, nativity rates of bats are much lower than those of most other small mammals. This is because, for the most part, only one or two pups are born per female per annum. Under natural circumstances, a population's numbers may accumulate over long periods of time. This is due to the longevity of up to 30 years (O'Shea *et al*. 2003) and the relatively low predation of bats when compared to other small mammals. However, bat populations are not able to adequately recover after mass mortalities and major roost disturbances.

2.2 Bats and Wind Turbines

Although most bats are highly capable of advanced navigation through the use of echolocation and excellent sight, they are still at risk of physical impact with the blades of wind turbines. The corpses of bats have been found in close proximity to wind turbines and, in a case-study conducted by Johnson *et al*. (2003), were found to be directly related to collisions. The incident of bat fatalities for migrating species has been found to be directly related to turbine height, increasing exponentially with altitude, as this disrupts the migratory flight paths (Howe *et al*. 2002, Barclay *et al*. 2007). Although the number of fatalities of migrating species increased with turbine height, this correlation was not found for increased rotor sweep (Howe *et al*. 2002, Barclay *et al*. 2007). In the USA it was hypothesized that migrating bats may navigate without the use of echolocation, rather using vision as their main sense for long distance orientation (Johnson *et al*. 2003, Barclay *et al*. 2007). Despite the high incidence of deaths caused by direct impact with the blades, most bat mortalities have been found to be caused by barotrauma (Baerwald *et al*. 2008). This is a condition where low air pressure found around the moving blades of wind turbines causes the lungs of a bat to collapse, resulting in fatal internal haemorrhaging (Kunz *et al*. 2007). Baerwald *et al*. (2008) found that 90% of bat fatalities around wind turbines involved internal haemorrhaging consistent with barotrauma.

Three factors need to be present for most South African bats to be prevalent in an area: availability of roosting space, food (insects/arthropods or fruit), and accessible open water sources. However, the dependency of a bat on each of these factors is subject to the species, its behaviour and ecology. Nevertheless, bat activity, abundance and diversity are likely to be higher in areas supporting all three above-mentioned factors. Although bats are predominately found roosting and foraging in areas near trees, rocky outcrops, human dwellings and water; in conditions where valleys are foggy, warmer air is drawn to hilltops through thermal inversion which may result in increased concentrations of insects and consequently bats at hilltops, where wind turbines are often placed (Kunz *et al*. 2007). Some studies (Horn *et al*. 2008) suggest that bats may be attracted to the large turbine structure as roosting spaces or that swarms of insects may get trapped in low pressure air pockets around turbines, also encouraging the presence of bats. The presence of lights on wind turbines has also been identified as a possible cause for increased bat fatalities for non-cave roosting species. This is thought to be due to increased insect activity and subsequent increased foraging activity of bats (Johnson *et al*. 2003). Clearings around wind turbines, in previously forested areas, may also improve conditions for insects, thereby attracting bats to the area. The swishing sound of turbine blades has also been proposed as a possible source for disorientation in bats (Kunz *et al*. 2007). Electromagnetic fields generated by the turbine may additionally affect bats which are sensitive to magnetic fields (Kunz *et al*. 2007). It could also be hypothesized, from personal observations that the echolocation capabilities of bats are designed to locate smaller insect prey or avoid stationary objects, and may not be primarily focused on the detection of unnatural objects moving sideways across the flight path.

South African operational monitoring studies currently point to South African bats being just as vulnerable to mortality from turbines as international studies have previously indicated. The main species of concern are *Laephotis capensis*, *Tadarida aegyptiaca* and *Miniopterus natalensis,* on this site and in general. They will be discussed in depth in this report (Section 4.3).

Whatever the reason for bat fatalities in relation to wind turbines, it is clearly a significant ecological problem which requires attention. Most bat species only reproduce once per year, bearing one young per female, thus their numbers are slow to recover from mass mortalities. It is very difficult to assess the true number of bat deaths in relation to wind turbines, due to carcasses being removed from sites through predation, the rate of which differs from site to site as a result of habitat type, species of predator and their numbers (Howe *et al*. 2002, Johnson *et al*. 2003). Various mitigation measures are being researched and experimented with globally. The implementation of curtailment processes, where the turbine cut-in speed is raised to a higher wind speed, has been proven to be the most effective mitigation measure currently. This relies on the principle that the prey of bats will not be found in areas of strong winds and more energy is required for the bats to fly under these conditions anyways. The impact on bats foraging in the area will be higher when uncurtailed turbine blades are left to turn slowly in low wind speeds; it is a misperception that faster turning blades present a higher mortality risk.

A cautionary tale regarding the cumulative impacts that wind energy is able to exert on bat populations is provided through the case study of the hoary bat (*Lasiurus cinereus*). This bat is a common, migratory species across much of the Americas and is currently listed as Least Concern (Gonzalez *et al*. 2016). However, it is also the most frequently encountered victim of fatality around turbine stands in North America. Using population modelling, it has been calculated that hoary bats could decline by as much as 90% over the next 50 years, assuming static population growth rates, and allowing for the current expansion of the wind energy industry in the United States and Canada (Frick *et al*. 2017). There has been an urgent call to curb hoary bat deaths on account of wind farms before the risk of extinction escalates.

It is important from both a conservation and an ecological standpoint to maintain the abundance of even our common species, since these common species fulfil significant ecological roles of insect predation due to their high numbers. Especially given the scale of wind energy prospecting occurring in South Africa currently.

3 METHODOLOGY

3.1 Literature-based and On-site Inspections

The site is evaluated by comparing the amount of surface rock (possible roosting space), topography (influencing surface rock in most cases), vegetation (possible roosting spaces and foraging sites), climate (can influence insect numbers and availability of fruit), and presence of surface water (influences insects and acts as a source of drinking water) to identify bat species that may be impacted by wind turbines. These comparisons are done principally by briefly studying the geographic literature of each site, available satellite imagery and by ground-truthing with site visits. The probability of occurrence based on the above-mentioned factors are estimated for the species both expected and confirmed on site as well as the larger surrounding area.

3.2 Active & Passive Monitoring

Several site visits were made to the Camden I REC between August 2020 and October 2021 to ground truth bat sensitivity features and habitats delineated in the bat sensitivity constraints map, and to collect passive data from bat detection systems. A summary of the fieldwork and equipment specifications is provided below in Table 3.1.

Passive bat detection systems (Figure 3.1) were set up on a meteorological mast with microphones at 10m, 55m and 110m (Met1). Additionally, 3 short mast bat detection systems were also set up, with microphones at 7m (referred to as C1-ShM1 – C1-ShM3). These systems were set to gather bat activity data every night for 12 months to form part of the long-term pre-construction monitoring and inform the EIA study.

The data is analysed by classifying (as near to species level as possible) and counting positive bat passes detected by the systems. A bat pass is defined as a sequence of ≥1 echolocation calls where the duration of each pulse is ≥2ms (one echolocation call can consist of numerous pulses). A new bat pass is identified by a >1 000ms period between pulses. These bat passes are summed into hourly intervals which are used to calculate nocturnal distribution patterns over time. Times of sunset and sunrise are automatically adjusted with the time of year. Nightly bat totals over time are useful for displaying abrupt peaks in activity on specific nights or short time periods, and to visually represent the spread of bat activity over the monitoring period. This assists in developing mitigation schedules, as required.

The data from the four passive systems is fully analysed and discussed in Section 4.7

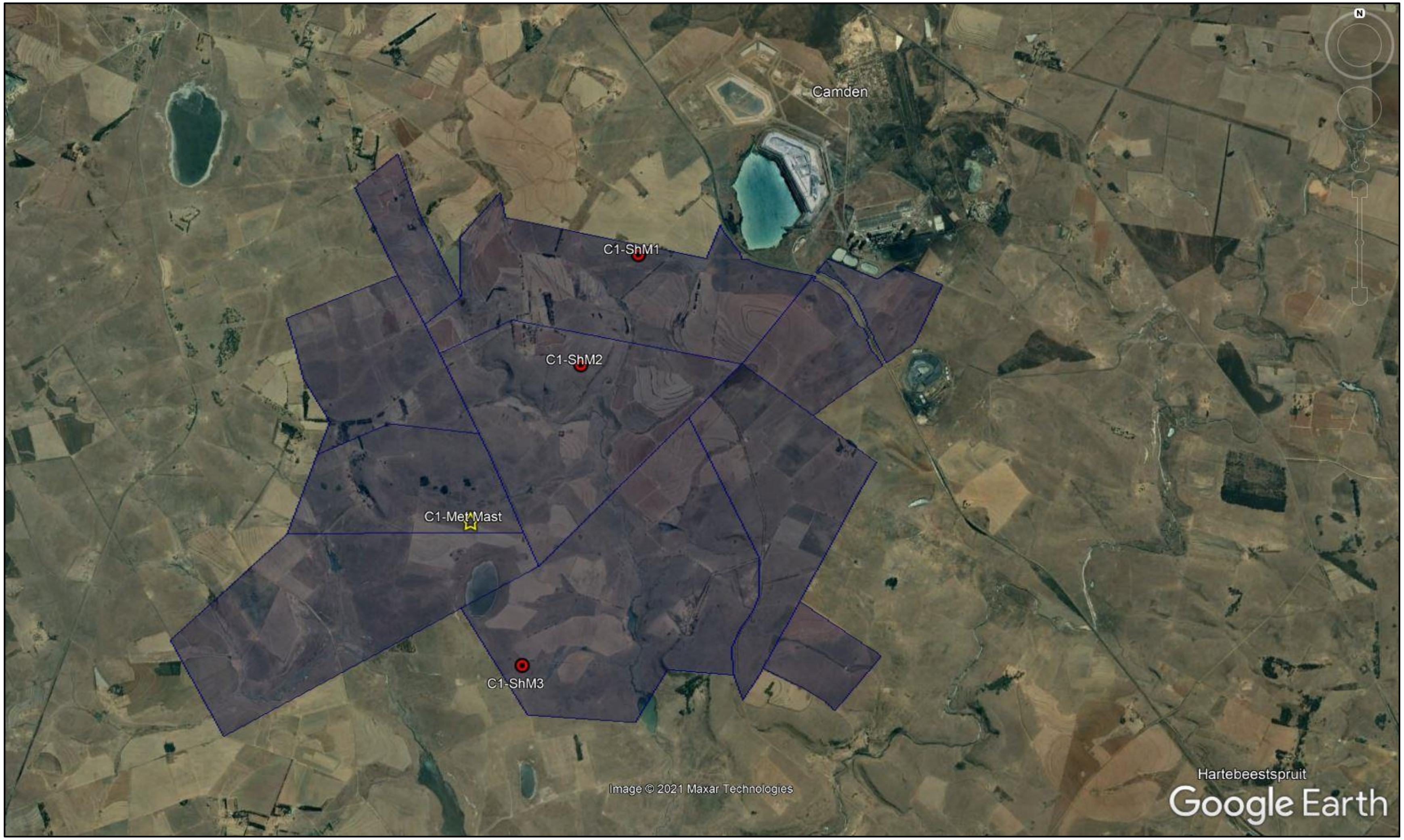

Figure 3.1. Positions of the passive bat detection systems on site. The three Short Mast systems, C1-ShM1, C1-ShM2 and C1-ShM3 are shown (red circles), as well as the location of the Meteorological Mast (Met1) system (yellow star).

Table 3.1 Equipment setup and site visit information.

Site visit dates	First visit	12 – 14 August 2020
	Second visit	13 – 15 November 2020
	Third visit	20 – 23 February 2021
	Fourth visit	11 – 14 June 2021
	Fifth visit	1 – 4 October 2021
Met mast passive bat detection systems	**Quantity on site**	1 (“Met1”)
	Microphone heights	10m, 55m, 110m
	Coordinates	Met1: (-26.66288 30.02358)
Short mast passive bat detection systems	**Quantity on site**	3
	Microphone height	7m
	Coordinates	Short Mast 1 “C1-ShM1” (-26.62371 30.05088) Short Mast 2 “C1-ShM2” (-26.63987 30.04156) Short Mast 3 “C1-ShM3” (-26.68391 30.03206)
Replacements/ Repairs/ Comments	**First visit**	The passive systems were installed with mounted microphones angled 30° downwards
	Second visit	110m microphone did not have power – charge controller not functional. Charge controller from 10m system was moved to 110m to prioritise this system. The faulty part was replaced several weeks later by a subcontractor
	Third visit	C1-ShM2 microphone was replaced due to low sensitivity
	Fourth visit	None
	Fifth visit	None
Type of passive bat detector		SM4 BAT
Recording schedule		Each detector was set to operate in continuous trigger mode from dusk each evening until dawn (times were automatically adjusted in relation to latitude, longitude and season).
Trigger threshold		>16KHz, -18dB
Trigger window (time of recording after trigger ceased)		1 000ms (1 second)

Microphone gain setting	12dB
Compression	W4V-8
Single memory card size (each system uses 4 cards)	64GB
Battery size	17Ah; 12V
Solar panel output	10 Watts
Solar charge regulator	6 - 8 Amp with low voltage/deep discharge protection
Other methods	Terrain was investigated during the day for habitat observations.

3.3 Bat Sensitivity Mapping

Google Earth satellite imagery and verifications during site visits were used to spatially demarcate areas of the site with high and medium sensitivities relating to bat species ecology and habitat preferences. The map considers man-made structures and habitat alterations (such as dams), as well as natural terrain features that are likely to offer roosting and foraging opportunities for bat species found in the broader site area. With regards to hydrology features, distinction has been made between permanent and seasonal water sources. Clumps of trees (as opposed to scattered or single trees) offer significantly better roosting and foraging habitat on this site; they have received priority during sensitivity mapping.

3.4 Assumptions and Limitations

As with any environmental study, there are certain assumptions and limitations that exist around the current knowledge we possess regarding bats and their behaviour, movements and distribution. Some important points are discussed briefly below:

- Distribution maps of South African bat species still require further refinement, thus the bat species proposed to occur on the site (and not detected in the area yet) should be considered precautionary. If a species has a distribution marginal to the site, it was assumed to occur in the area.

- The migratory paths of bats are largely unknown, thus some uncertainty in this regard will remain until the end of operational monitoring of at least 2 years. Based on the currently available data from the pre-construction monitoring, there is nothing to date that indicates that the site is located in a migratory path.

- The sensitivity map is based partially on satellite imagery and from detailed site visits, although given the large extent of the site, there is always the possibility that what has been mapped may differ slightly to what is on the ground.

4 RESULTS AND DISCUSSION

4.1 Land Use, Vegetation, Climate and Topography

The proposed Camden I WEF falls within the Grassland Biome, and the Mesic Highveld Grassland Bioregion. The vegetation units found on site include Amersfoort Highveld Clay Grassland, Eastern Highveld Grassland and Eastern Temperate Freshwater Wetlands (Figure 4.1, Mucina & Rutherford 2012). The general geology for these vegetation units on site includes dolerite and arenite formations, which are not prone to cave formation suitable for roosting bats. Land use type is predominantly agricultural in nature and consists of grazing for livestock and ploughed soil for mixed crops.

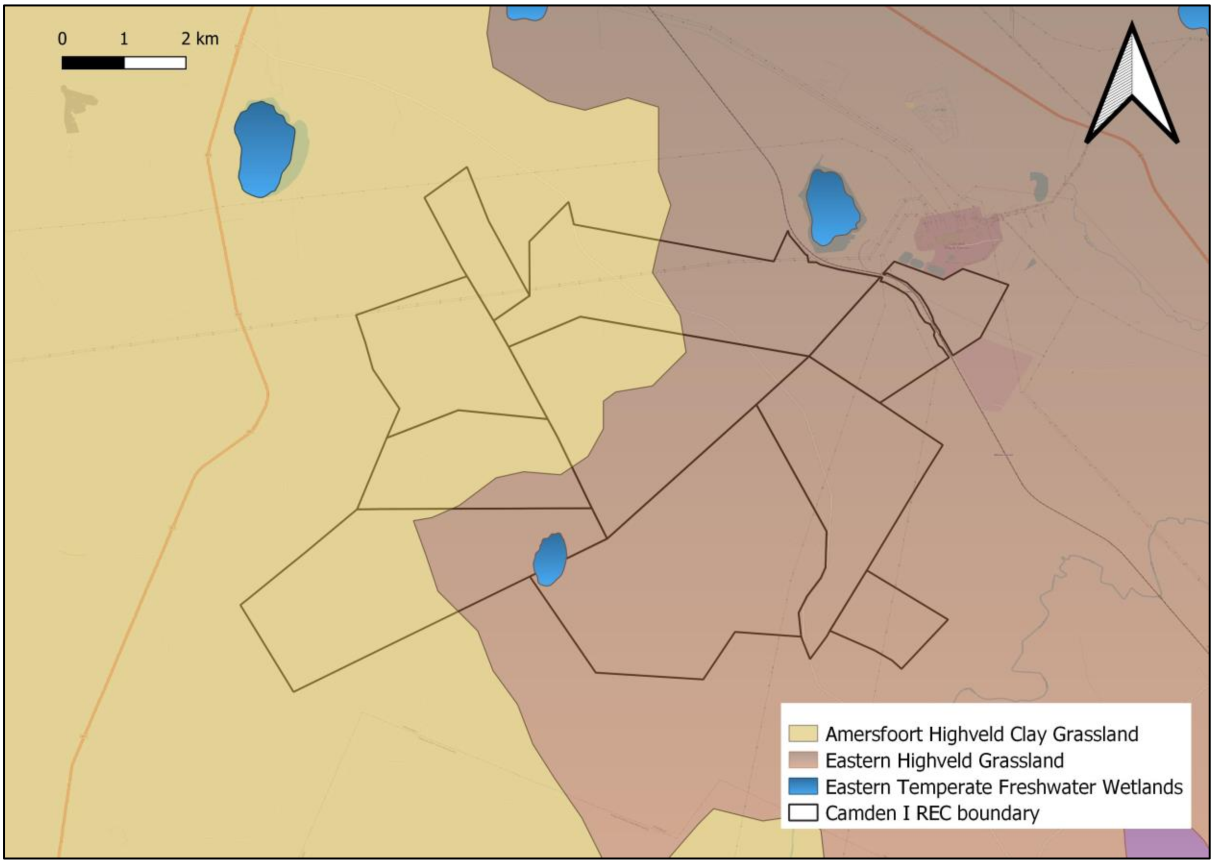

Figure 4.1. Vegetation units present on the proposed Camden I REC (Mucina & Rutherford 2012).

4.1.1 Amersfoort Highveld Clay Grassland

This vegetation unit covers slightly less than half of the Camden I WEF site area, to the north and west. It is typified by an often severely grazed *Themeda triandra* sward of short closed grassland cover. Dolerite outcrops may occur in places scattered among undulating grassland plains. There is a high incidence of frost in the area, with the winters being typically cold, and the summers mild. Annual rainfall ranges between 620 – 830mm while mean annual temperature is 14°C. Amersfoort Highveld Clay Grassland is considered to be vulnerable, and is readily invaded by alien species such as silver and black wattle (*Acacia* spp.) and *Salix babylonica* in the drainage areas (Mucina & Rutherford 2006).

4.1.2 Eastern Highveld Grassland

The Eastern Highveld Grassland vegetation unit is present on the Camden I WEF to the east and south of site, and consists of slight to moderate undulating plains of short dense grassland cover. Important taxa include *Aristida*, *Digitaria*, *Eragrostis*, *Themeda* and *Tristachya*. Some rocky outcrops may occur, with associated sour grasses and certain woody species. There is a strongly seasonal rainfall pattern; precipitation ranges from 650 – 900mm per annum, predominantly in the summer. Very limited areas of this vegetation unit are currently conserved in statutory reserves and overall, the unit is endangered (Mucina & Rutherford 2006).

4.1.3 Eastern Temperate Freshwater Wetlands

This vegetation unit is limited on site, but one such area does occur in the south-west. The unit is typified by temporary or permanent water bodies filled by predominantly summer rainfall supporting aquatic and hygrophilous vegetation. These wetlands are primarily a grassland phenomenon and plant structure and diversity is dependent on the length of time that water remains present in the vleis or pans. Numerous species of megagraminoids and aquatic herbs form part of the important taxa found within the Eastern Temperate Freshwater Wetlands (Mucina & Rutherford 2006).

4.2 **Currently Confirmed, Previously Recorded and Literature-based Species Probability of Occurrence**

Table 4.1 below indicates the species of bat which have been confirmed to occur on site, those unconfirmed species which may potentially occur on site, as well as those occurring in the broader area of the site based on literature review. For each species, the risk of impact by wind energy infrastructure was assigned by MacEwan *et al*. (2020) based on their distributions, altitudes at which they fly, and foraging ecology.

Table 4.1. Species currently confirmed on site, previously recorded in the area, or potentially occurring. Roosting and foraging habitats in the study area, conservation status and risk of impact are also briefly described per species (Monadjem *et al*. 2020).

Species	Common name	Occurrence in area*	Conservation status (SANBI & EWT, 2016)	Possible roosting habitat on site	Possible foraging habitat utilised on site	Risk of impact (MacEwan *et al.* 2020 for wind)
Tadarida aegyptiaca	**Egyptian free-tailed bat**	Confirmed on site	Least Concern (2016 Regional Listing)	Hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of habitats.	High
Mops midas	**Midas free-tailed bat**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of habitats.	High
Mops (Chaerephon) pumilus	**Little free-tailed bat**	Confirmed on site	Least Concern (2016 Regional Listing)	Hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of habitats.	High
Laephotis (Neoromicia) capensis	**Cape serotine**	Confirmed on site	Least Concern (2016 Regional Listing)	Roosts in the roofs of houses and buildings, and also under the bark of trees.	It appears to tolerate a wide range of environmental conditions from arid semi-desert areas to montane grasslands, forests, and savannahs. Predominantly a medium height clutter edge forager on site.	High

Laephotis zuluensis	**Zulu serotine**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and possibly roofs of buildings.	Predominantly a medium height clutter edge forager on site.	Medium – High
Laephotis nanus	**Banana bat**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and in the folded leaves of banana trees in the larger area.	Predominantly a medium height clutter edge forager on site.	Medium – High
Pipistrellus hesperidus	**Dusky pipistrelle**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and possibly roofs of buildings.	Prefers vegetation edges and clutter with open water sources.	Medium – High
Miniopterus natalensis	**Natal long-fingered bat**	Confirmed on site	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area, may also take residence in suitable hollows such as culverts under roads.	Clutter-edge forager. May forage in more open terrain during suitable weather.	High
Miniopterus fraterculus	**Lesser long-fingered bat**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Clutter-edge forager. May forage in more open terrain during suitable weather.	High
Eptesicus hottentotus	**Long-tailed serotine**	Confirmed on site	Least Concern (2016 Regional Listing)	It is a crevice dweller roosting in rock crevices in the larger area, as well as other crevices in buildings.	It generally seems to prefer woodland habitats, and forages on the clutter edge. But may still forage over open terrain occasionally.	Medium – High
Myotis tricolor	**Temmink's myotis**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area, may also take residence in suitable hollows such as culverts under roads.	Clutter-edge forager. May forage in more open terrain during suitable weather.	Medium – High
Rhinolophus blasii	**Blasius's horseshoe bat**	Confirmed in 100km radius	Near Threatened (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low

Rhinolophus clivosus	**Geoffroy's horseshoe bat**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low
Rhinolophus swinnyi	**Swinny's horseshoe bat**	Confirmed in 100km radius	Vulnerable (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low
Rhinolophus simulator	**Bushveld horseshoe bat**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low
Scotophilus dinganii	**Yellow-bellied house bat**	Confirmed on site	Least Concern (2016 Regional Listing)	Roofs of buildings and other suitable hollows.	Clutter-edge forager. May forage in more open terrain during suitable weather.	High
Cloeotis percivali	**Percival's short-eared trident bat**	Confirmed in 100km radius	Endangered (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low
Epomophorus wahlbergi	**Wahlberg's epauletted fruit bat**	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts in dense foliage of large, leafy trees in the larger area, and may travel several kilometres each night to reach fruiting trees.	Feeds on fruit, nectar, pollen and flowers. If and where available on or near site.	High
Eidolon helvum	**African straw-coloured fruit bat**	Possible as migrant	Least Concern (2016 Regional Listing) (Globally Near threatened)	Non-breeding migrant with sparse scattered records.	Feeds on fruit, nectar, pollen and flowers, if and where available on site.	High

*Occurrence of species records based on ACR 2020**,** Monadjem *et al*. 2020 and confirmed presence detected through passive data methods

4.3 Ecology of bat species that may be impacted the most by the Camden I WEF

There are several bat species in the vicinity of the site that occur commonly in the area. Some of these species are of special importance based on their likelihood of being impacted by the proposed WEF, due to high abundances and certain behavioural traits. They have also been dominating records of fatalities at wind energy facilities in South Africa. The relevant species are discussed below.

4.3.1 Tadarida aegyptiaca

The Egyptian free-tailed bat, *Tadarida aegyptiaca*, is a Least Concern species (SANBI Red List 2016) as it has a wide distribution and high abundance throughout South Africa, and is part of the free-tailed bat family (Molossidae). It occurs from the Western Cape of South Africa, north through to Namibia and southern Angola; and through Zimbabwe to central and northern Mozambique (Monadjem *et al*. 2020). This species is protected by national legislation in South Africa (ACR 2020).

Egyptian free-tailed bats roost communally in small (dozens) to medium-sized (hundreds) groups in caves, rock crevices, under exfoliating rocks, in hollow trees and behind the bark of dead trees. It has also adapted to roosting in buildings, in the roofs of houses in particular (Monadjem *et al*. 2020). Thus, man-made structures and large trees on the site would be important roosts for this species.

Tadarida aegyptiaca forages over a wide range of habitats, flying above the vegetation canopy. It appears that the vegetation has little influence on foraging behaviour as the species forages over desert, semi-arid scrub, savannah, grassland and agricultural lands. Its presence is strongly associated with permanent water bodies due to concentrated densities of insect prey (Monadjem *et al*. 2020).

After a gestation of four months, a single pup is born, usually in November or December, when females give birth once a year. In males, spermatogenesis occurs from February to July and mating occurs in August. Maternity colonies are apparently established by females in November.

The Egyptian free-tailed bat is considered to have a high risk of fatality on wind energy facilities due to turbine collisions (MacEwan *et al.* 2020). Due to the high abundance and widespread distribution of this species, high mortality rates due to wind turbines would be a cause for concern as these species have more significant ecological roles than the rarer bat species, and are currently displaying moderate to high numbers of mortalities at nearby operating wind farms.

4.3.2 Laephotis capensis

Laephotis capensis is commonly called the Cape serotine (formerly *Neoromicia capensis*) and has a conservation status of Least Concern (SANBI Red List 2016) as it is found in high numbers and is widespread over much of Sub-Saharan Africa. High mortality rates of this species due to wind turbines would be a cause for concern precisely because of its abundance. As such, it has a more significant role to play within local ecosystems than the rarer bat species, since they can consume large numbers of nocturnal insects.

The Cape serotine roosts individually or in small groups of two to three bats in a variety of shelters, such as under the bark of trees, at the base of aloe leaves, and under the roofs of houses. They will use most man-made structures as day roosts which can be found throughout the site and surrounding areas (Monadjem *et al*. 2020). They do not undertake migrations and thus are considered residents of the site.

Mating takes place from the end of March until the beginning of April. Spermatozoa are stored in the uterine horns of the female from April until August, when ovulation and fertilisation occur. They give birth to twins during late October and November, but single pups, triplets and quadruplets have also been recorded (van der Merwe 1994 and Lynch 1989).

They are tolerant of a wide range of environmental conditions as they survive and prosper across arid and semi-arid areas to montane grasslands, forests, and savannas; indicating that they may occupy several habitat types across the site, and are amenable towards habitat changes. They are however clutter-edge foragers, meaning they prefer to hunt on the edge of vegetation clutter, but can occasionally forage in open spaces. They are thought to have a medium to high likelihood of fatality due to wind turbines (MacEwan *et al.* 2020) and are currently displaying moderate to high numbers of mortalities at operational wind farms in South Africa.

4.3.3 Miniopterus natalensis

Miniopterus natalensis, commonly referred to as the Natal long-fingered bat, occurs widely across the country but mostly within the southern and eastern regions, and is listed as Least Concern (Monadjem *et al*. 2020). This bat is a cave-dependent species and identification of suitable roosting sites may be more important in determining its presence in an area than the presence of surrounding vegetation. It occurs in large numbers when roosting in caves with approximately 260 000 bats observed making seasonal use of the De Hoop Guano Cave in the Western Cape, South Africa. Culverts and mines have also been observed as roosting sites for either single bats or small colonies. Separate roosting sites are used for winter hibernation activities and summer maternity behaviour, with the winter hibernacula generally occurring at higher altitudes in more temperate areas and the summer hibernacula occurring at lower altitudes in warmer areas of the country (Monadjem *et al*. 2020).

Mating and fertilisation usually occur during March and April and is followed by a period of delayed implantation until July/August. Birth of a single pup usually occurs between October and December as the females congregate at maternity roosts (Monadjem *et al.* 2020 & van de Merwe 1979).

The Natal long-fingered bat undertakes short migratory journeys between hibernaculum and maternity roosts. Due to this migratory behaviour, they are considered to be at high risk of fatality from wind turbines if a wind farm is placed within a migratory path (MacEwan *et al.* 2020). The mass movement of bats during migratory periods could result in mass casualties if wind turbines are positioned over a mass migratory route and such turbines are not effectively mitigated. Very little is known about the migratory behaviour and paths of *M. natalensis* in South Africa with migration distances exceeding 150 kilometres. Based on the available data from the pre-construction monitoring, there is nothing to date that indicates that the site is located in a migratory path.

A study by Vincent *et al.* (2011) on the activity and foraging habitats of Miniopteridae found that the individual home ranges of lactating females were significantly larger than that of pregnant females. It was also found that the bats predominately made use of urban areas (54%) followed by open areas (19.8%), woodlands (15.5%) orchards and parks (9.1%) and water bodies (1.5%) when selecting habitats. Foraging areas were also investigated with the majority again occurring in urban areas (46%), however a lot of foraging also occurred in woodland areas (22%), crop and vineyard areas (8%), pastures, meadows and scrubland (4%) and water bodies (4%).

MacEwan *et al.* (2020) advises that *M. natalensis* faces a medium to high risk of fatality due to wind turbines. This evaluation was based on broad ecological features and excluded migratory information. The species is currently displaying low to moderate numbers of mortalities at operational wind farms in South Africa.

4.3.4 Relation between Bat Activity and Weather Conditions

Several sources of literature describe how numerous bat species are influenced by weather conditions (O'Farrell *et al.* 1967, Rachwald 1992, Arnett *et al*. 2010). Weather may influence bats in terms of lowering activity, changing the time of emergence and flight duration. It is also important to note that environmental factors are never isolated and therefore a combination of these factors can have synergistic or otherwise contradictory influences on bat activity. For example, a combination of high temperatures and low wind speeds will be more favourable to bat activity than low temperatures and low wind speed, whereas low temperature and high wind speed will be the least favourable for bats. Below are short descriptions of how wind speed, temperature and barometric pressure influences bat activity.

If it is found during operation that the wind farm is causing unsustainable numbers of bat fatalities, an analysis can be performed to determine the wind speed and temperature range within which 80% of bat passes were detected. The results of such an analysis may be used, if necessary, to inform mitigation measures for turbines based on conserving 80% of detected bat passes. This is keeping in mind the synergistic or otherwise contradictory effects that the combination of wind speeds and temperatures can have on bat activity.

4.3.4.1 Wind speed

The bat species that have been identified as being at risk by to wind energy, show reduced activity in windy conditions. Strong winds have been found to suppress flight activity in bats by making flight difficult (O'Farrell *et al.* 1967). Several studies at proposed and operating wind facilities in the United States have documented discernibly lower bat activity during 'high' wind speeds (Arnett *et al*. 2010).

Wind speed and direction also affect availability of insect prey, as insects on the wing often accumulate on the lee side of wind breaks such as tree lines (Peng *et al.* 1992). At edges exposed to wind, flight activity of insects, and therefore bats, may be suppressed while at edges to the lee side of wind, bat activity may be greater.

4.3.4.2 Temperature

Flight activity of bats generally increases with temperature. Flights are of shorter duration on cooler nights and extended on warmer nights. Rachwald (1992) noted that distinct peaks of activity disappeared in warm weather such that activity was mostly continuous through the night. During nights of low temperatures bats intensified foraging shortly after sunset (Corbet and Harris 1991).

Peng (1991) found that many families of aerial dipteran insects (flies) preferred warm conditions for flight. A preference among insects for warm conditions has been reported by many authors suggesting that temperature is an important regulator of bat activity, through its effects on insect prey availability.

4.4 Conservation and protected areas, known sensitivities and caves/roosts within 100km of the site

There is only a single conservation area within 100km of Camden I WEF, namely the RAMSAR-recognised Seekoeivlei Nature Reserve of approximately 4 300 ha on the outer extent of the 100km boundary (see Figure 4.2). This has no bearing on the current site and will not be discussed further.

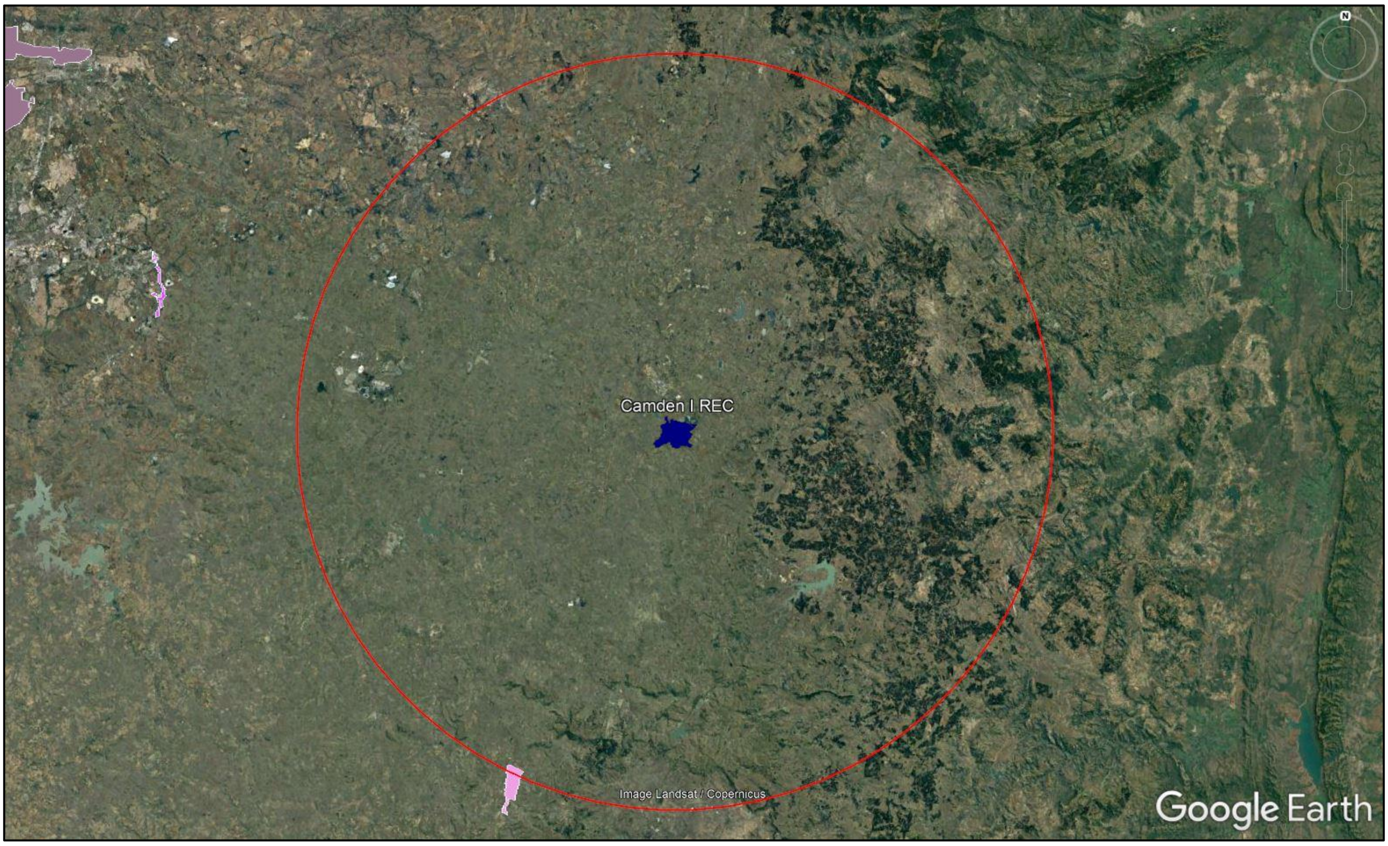

Figure 4.2. Protected areas within a radius of approximately 100km (red line) around the Camden I WEF site (DEA, 2021).

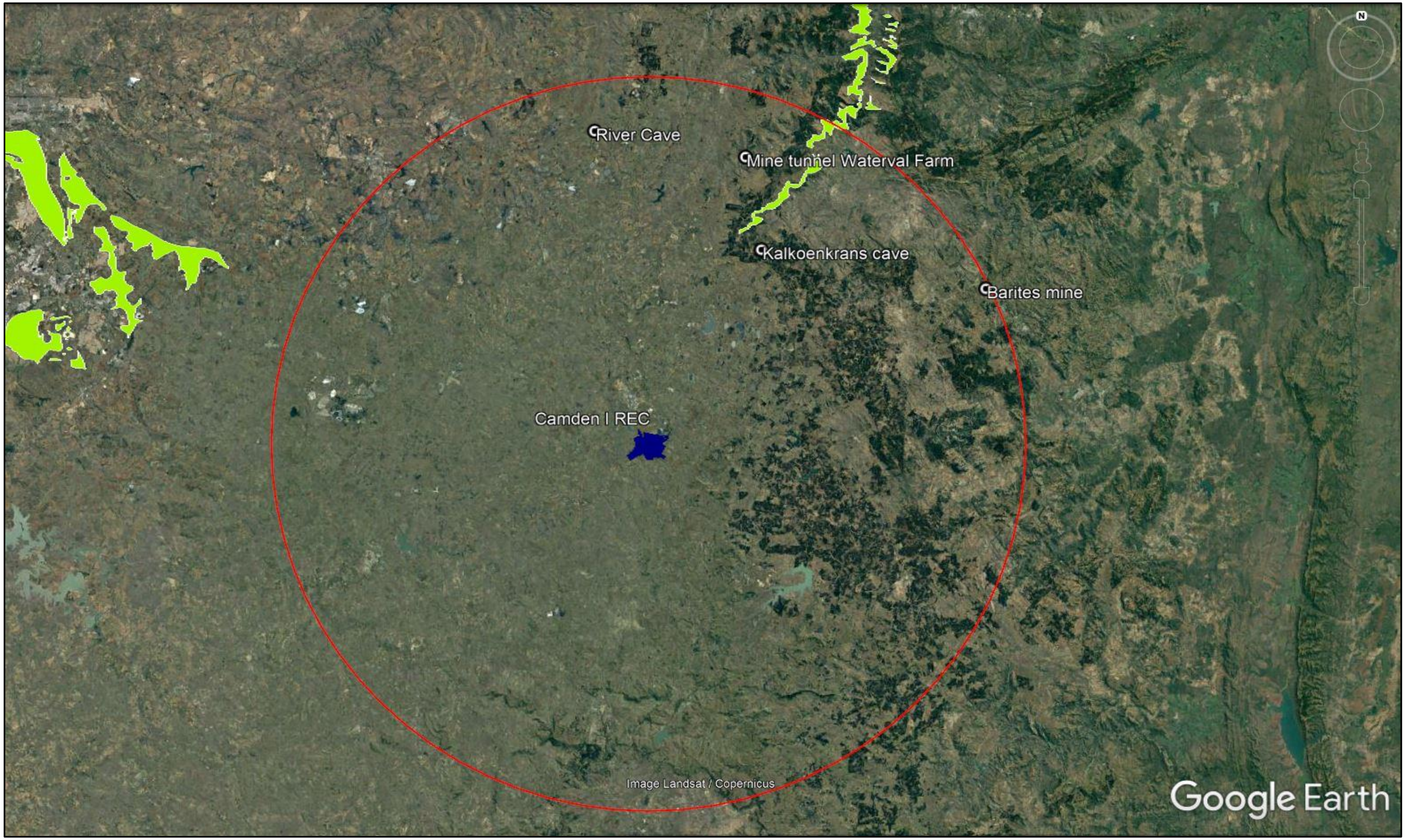

Figure 4.3. Approximate 100km radius (red circle) surrounding Camden I WEF (navy shape). Dolomite geology represented in lime green (SEA data), and four known bat roosts depicted with white circles.

Figure 4.3 shows the dolomitic geology of the greater area, with an approximate 100km site boundary radius shown in red. At its nearest, this extends to approximately 65km north-east of the REC. Dolomite is known to be prone to good cave formation, and many bat colonies may be supported in such caves in the country, particularly in the province of Gauteng. Museum records of bats collected from two caves and two mines within approximately 100km of the site exist. Specimens of *Miniopterus natalensis* and *Rhinolophus clivosus* were collected from River Cave (96km north of site); *R. simulator*, *Myotus tricolor* and *Cloeotis percivali* from a mine tunnel on Waterval Farm (91km north), *R. simulator*, *R. blasii*, *R. clivosus* and *Miniopterus fraterculus* from Kalkoenkrans Cave (64km north-east) and *Miniopterus. natalensis* from Barites mine (108km northeast). The habitat preferences and sensitivity of these species have been discussed in Table 4.1.

The Strategic Environmental Assessment (SEA) assigns 50km buffers to large bat roosts for wind energy, therefore any of the existing or possible cave/roost locations may be assigned a buffer up to 50km if they are found to be supporting large enough bat colonies. All of the above locations are further than 50km from the proposed site.

The Department of Forestry, Fisheries & the Environmental (DFFE) Screening Tool (accessed 03/12/2021) was consulted for the "Bat" theme, to determine the environmental sensitivity ranking assigned to the site area and surrounds. There are no nearby wind or solar developments with an approved Environmental Authorisation or applications under consideration within 30km of the proposed area. For wind energy generation, the tool denotes areas of the site as "High sensitivity" with regards to being within 500m of a river (the Vaal) and within 500m of a wetland; a "Medium sensitivity" is also denoted with regards to the presence of croplands (see Figure 4.4).

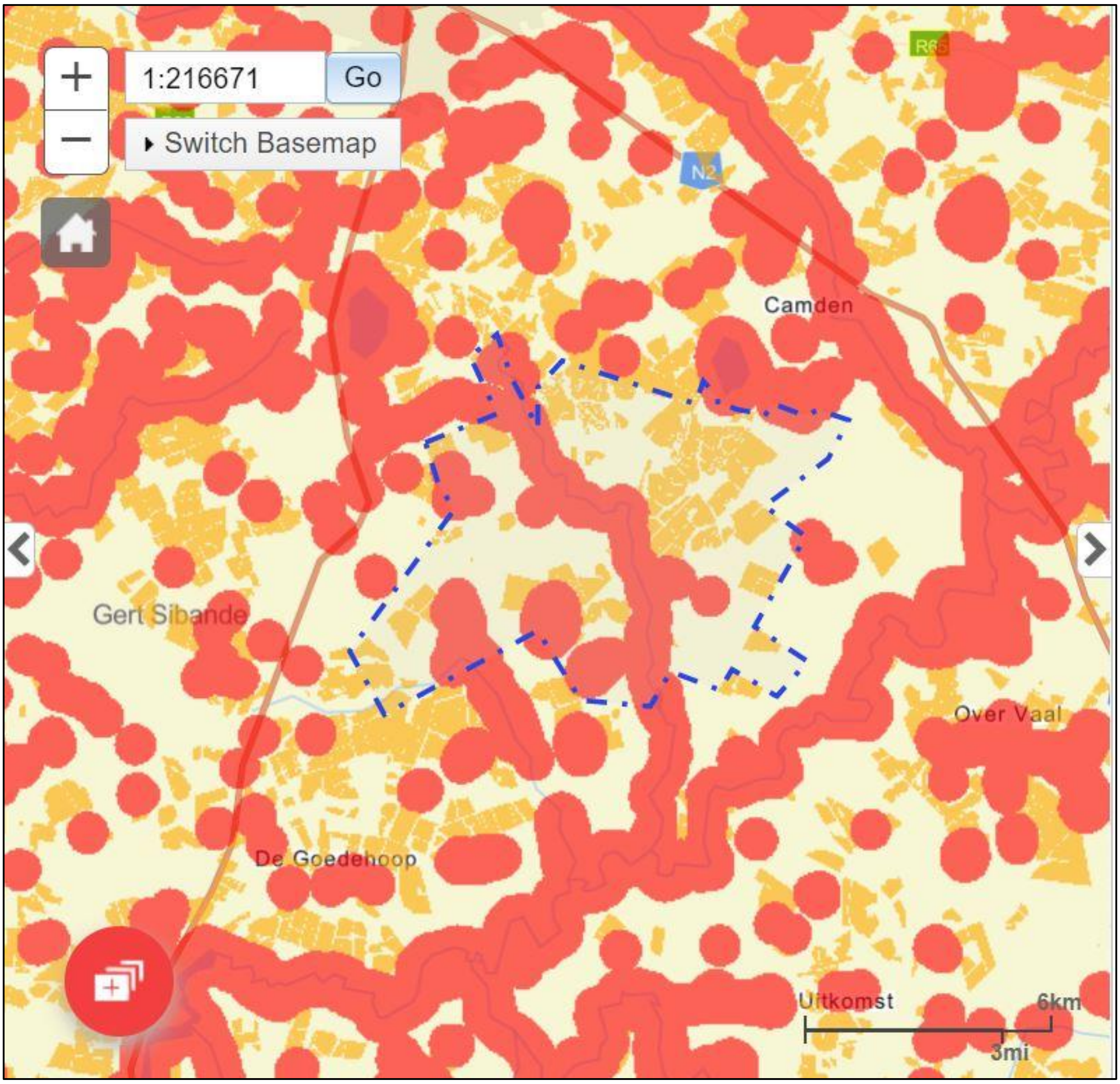

Figure 4.4. DFFE Screening Tool for the “Bat” and “Wind” theme. The Camden I REC boundary is shown in a blue outline, with red and orange areas depicting high and moderate sensitivities in the area, respectively (DFFE Screening Tool 03/12/2021).

4.5 Sensitivity Map

Google Earth satellite imagery and verifications during site visits were used to spatially demarcate areas of the site with high and medium sensitivities relating to bat species ecology and habitat preferences, where high sensitivities and their buffers are no-go zones for turbines and turbine blade overhang (Table 4.2 & Table 4.3). In other words, no turbine blades may intrude into high sensitivity buffers. Medium sensitivities indicate areas of probable increased risk due to seasonal fluctuations in bat activity, but turbines are allowed to be constructed in medium sensitivity areas. Figure 4.5 depicts the sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that are most likely to occur on site.

Table 4.2. Description of parameters used in the development of the sensitivity map.

Last revision	**November 2021**
High sensitivities and 200m buffers	Valley bottom wetlands
	Pans and depressions
	Dams
	Drainage lines capable of supporting riparian vegetation which in turn increases localised insect abundance
	Other water bodies and other sensitivities such as manmade structures, buildings, houses, barns, sheds, stands of tall trees.
Moderate sensitivities and 150m buffers	Seasonal wetlands
	Seasonal drainage lines

Table 4.3. The significance of sensitivity map categories for each infrastructure component for the Camden I WEF.

Sensitivity	Turbines	Roads and cables	Internal overhead transmission lines	Buildings (including substation, battery storage facility and construction camp/yards)
High Sensitivity	These areas are 'no-go' zones and turbines may not be placed in these areas. Turbine blades (blade overhang) may not intrude into these areas.	Preferably keep to a minimum within these areas, where practically feasible.	Allowed inside these areas.	Avoid these areas.
High Sensitivity buffer	These areas are 'no-go' zones and turbines may not be placed in these areas. Turbine blades (blade overhang) may not intrude into these areas.	Allowed inside these areas.	Allowed inside these areas.	Preferably keep to a minimum within these areas where practically feasible.
Moderate Sensitivity	Turbines may be placed within these areas, however, may require priority (not excluding all other turbines) during post-construction studies, and in some instances, there is a higher likelihood that mitigation measures may need to be applied to them.	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.
Moderate Sensitivity buffer	Turbines may be placed within these areas, however, may require priority (not excluding all other turbines) during post-construction studies, and in some instances, there is a higher likelihood that mitigation measures may need to be applied to them.	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.

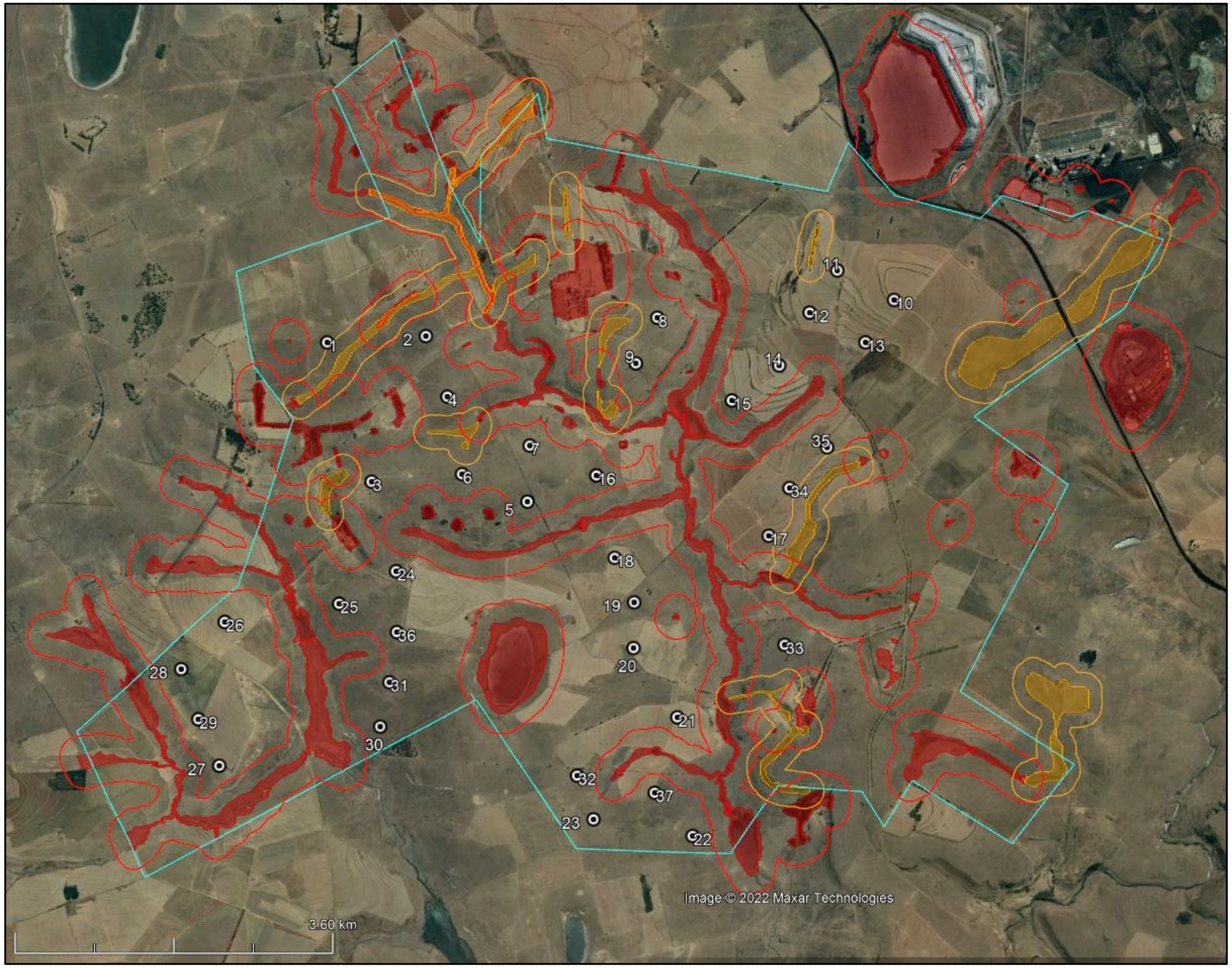

Figure 4.5. Bat sensitivity map of the wind energy facility site. Site area indicated in a dark blue boundary. Sensitivity polygons are provided in .kml format with this report. Shaded red = high sensitivity; Red line = 200m high sensitivity buffer; Shaded orange = medium sensitivity; Orange line = 150m medium sensitivity buffer

4.6 **Cumulative impact consideration within a 30km radius: Proposed Camden II Wind Energy Facility**

Enertrag South Africa (Pty) Ltd has proposed the development of an additional WEF adjacent to the Camden I REC, namely the Camden II Wind Energy Facility, with a capacity of up to 210MW (up to 45 turbines). Additionally, Emoyeni Renewable Energy Farm (Pty) Ltd are proposing the development of the Ummbila Emoyeni Wind Energy Facility with a contacted output of 666MW, approximately 28 km to the west of the Camden I REC. The footprint of these three developments will likely be cumulative, with the ecological impact of all facilities operating in combination likely to exceed the sum of individual parts. The cumulative impacts of Camden II WEF on Camden I WEF are discussed in Section 5.1 (Table 5.25).

4.7 **Passive data results and discussion**

Average hourly bat passes detected per night, total number of bat passes detected over the monitoring period (August 2020 to Oct 2021), and the temporal bat distribution over time by the systems are displayed in Figure 4.6 - Figure 4.19. Six bat species were detected namely *Eptesicus hottentotus*, *Tadarida aegyptiaca, Mops pumilus, Laephotis capensis, Miniopterus natalensis* and *Scotophilus dinganii*. Additionally, bat passes were recorded that are classified up to family level and includes Vespertilionidae, Miniopteridae and Molossidae. All of these families, includes the species identified and were simply used to group bat passes that were harder to identify.

In general, *L. capensis* dominated at 7-10m except at ShM3 where *T. aegyptiaca* had slightly more bat passes. *T. aegyptiaca* dominated at 55m and 110m, this relationship between height and abundance are typical and expected for these two species. Since *T. aegyptiaca* is an open-air forager and a larger bat that can utilise higher airspaces than the smaller *L. capensis* that forages on the edge of vegetation clutter. Considering all species, bat activity decreased as the height of a microphone increased. ShM3 had the highest bat activity in total and ShM2 had the lowest activity.

Miniopterus natalensis is a cave dwelling species, but may also take residence in smaller numbers in culverts and other suitable man -made hollows, this species did not show any abrupt peaks of activity that may indicate migration routes. However, this species had increased seasonal activity during February to March on all systems, and increased activity in October to December at ShM3 only.

Considering average hourly activity per month, the months of October to April displayed the highest activity levels in general. With the months of October, November and March showing exceptional peaks.

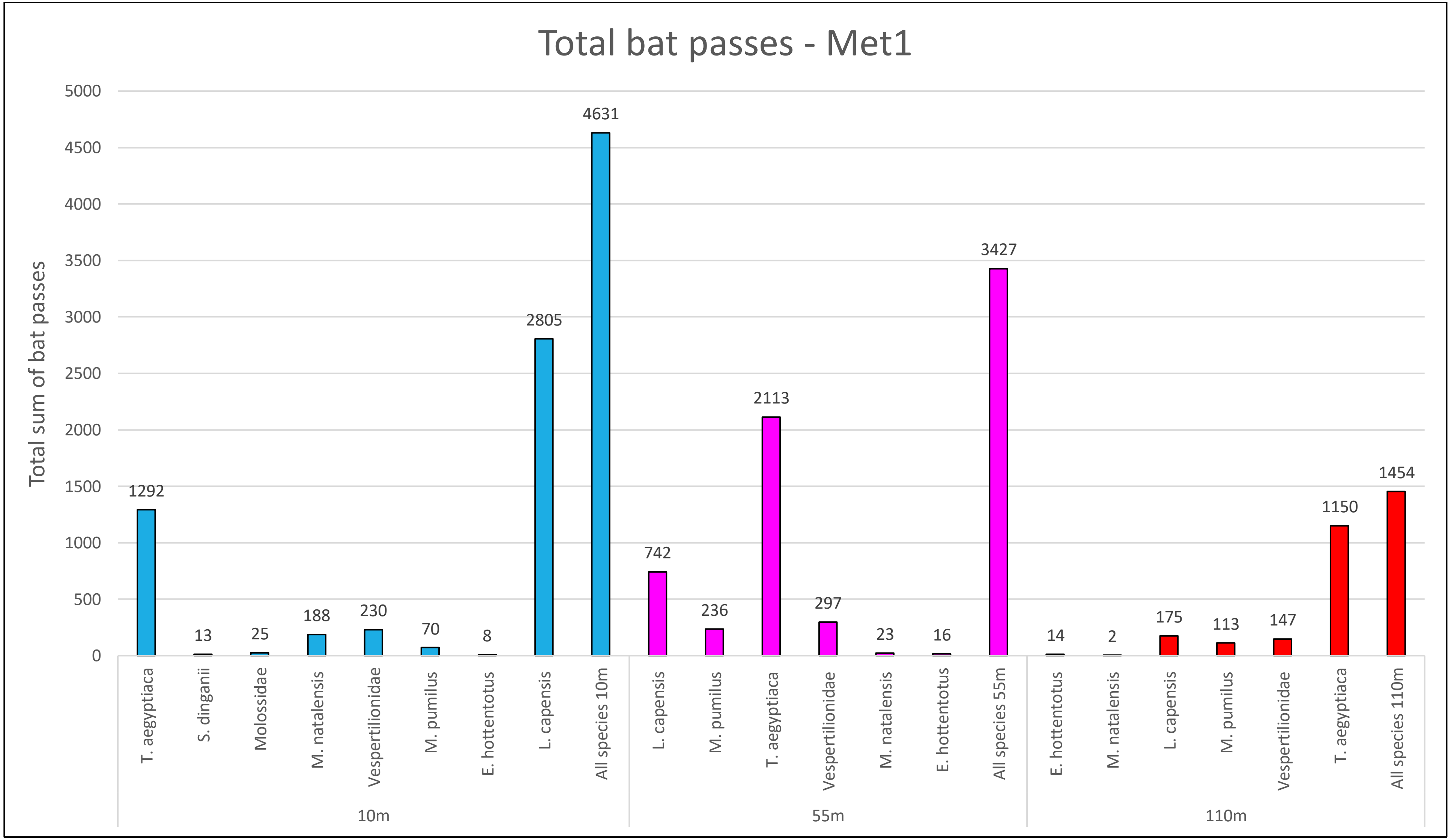

Figure 4.6. Total bat passes recorded over the 12-month monitoring period by Met1.

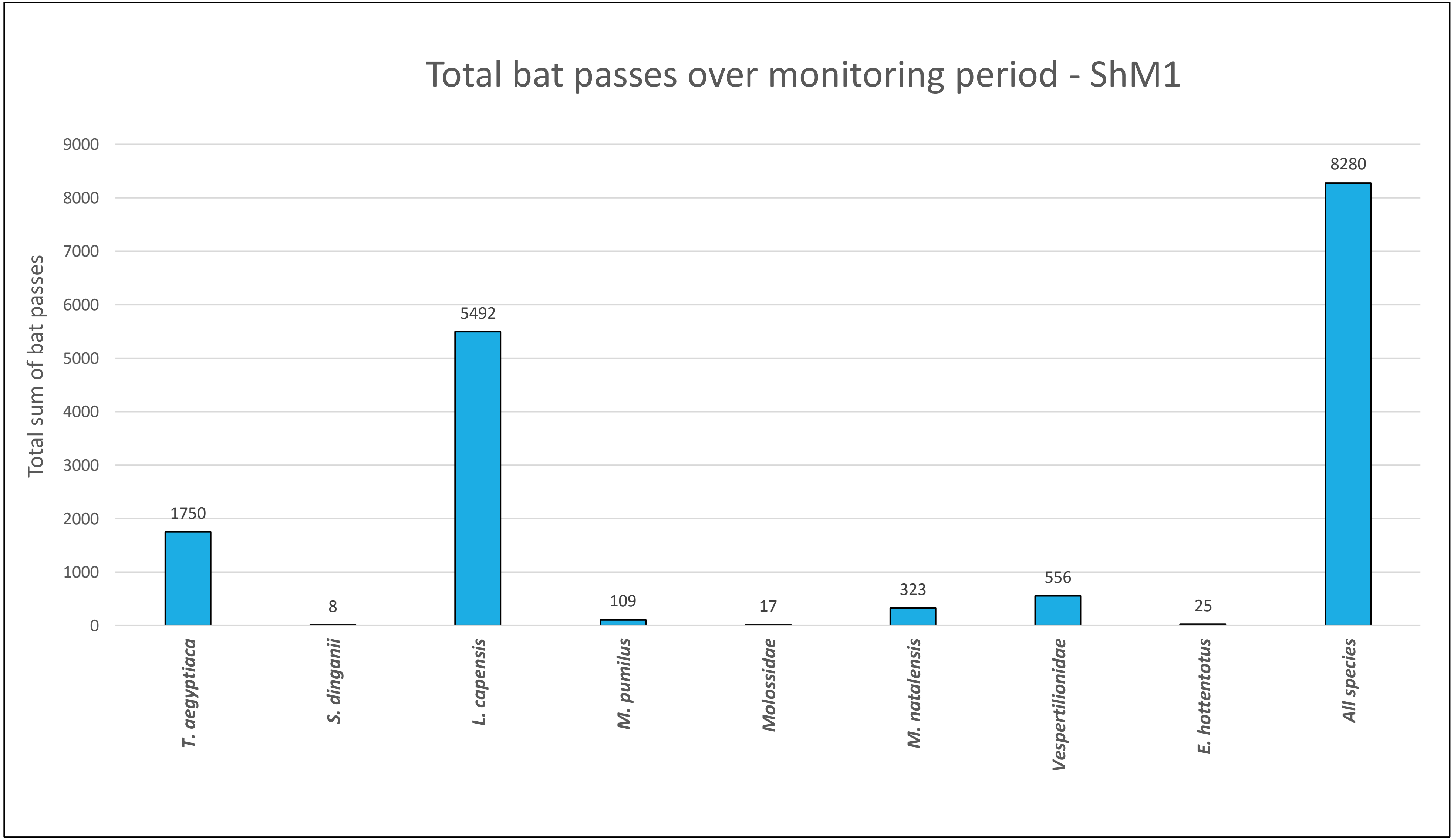

Figure 4.7. Total bat passes recorded over the 12-month monitoring period by C1-ShM1.

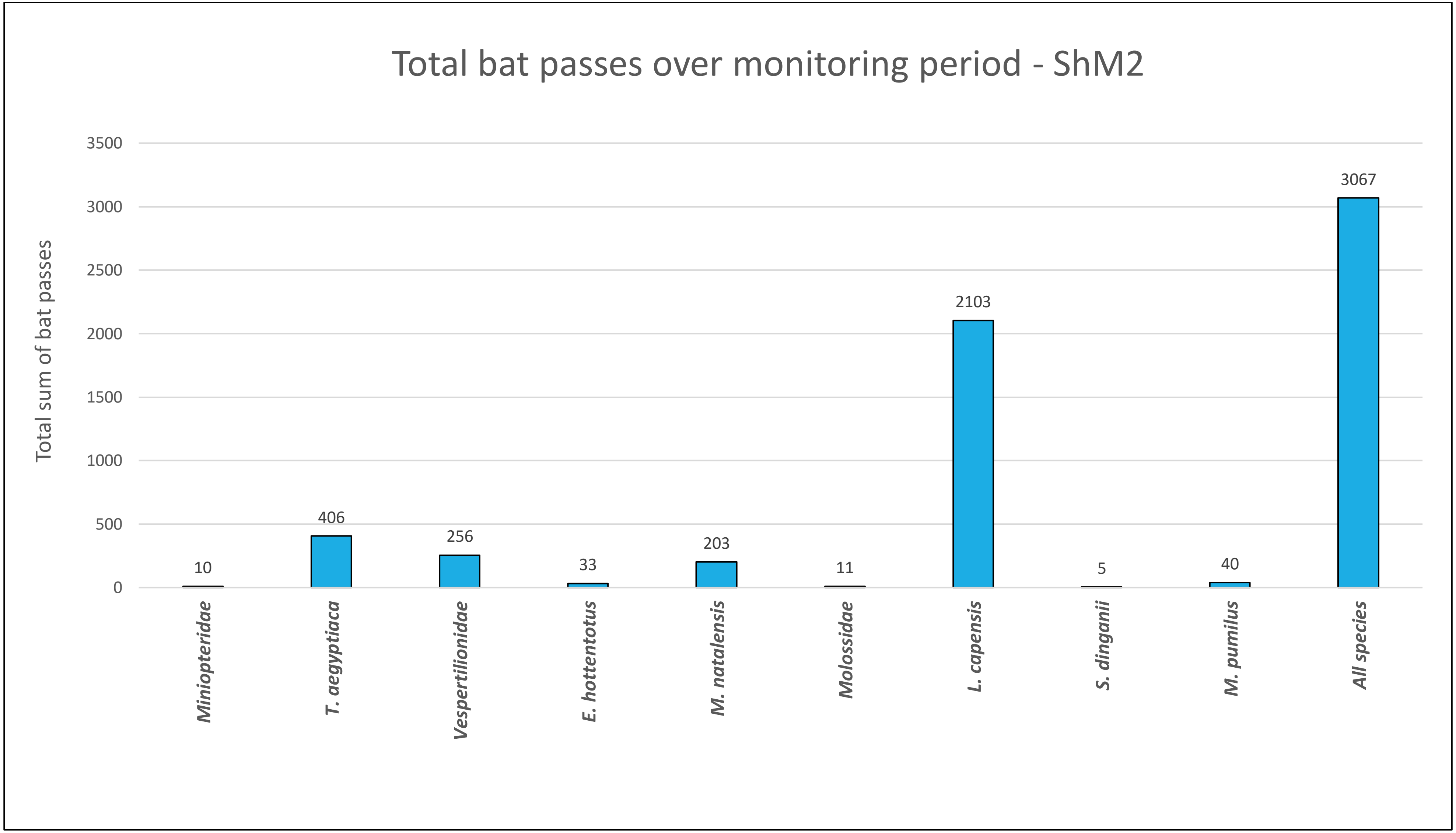

Figure 4.8. Total bat passes recorded over the 12-month monitoring period by C1-ShM2.

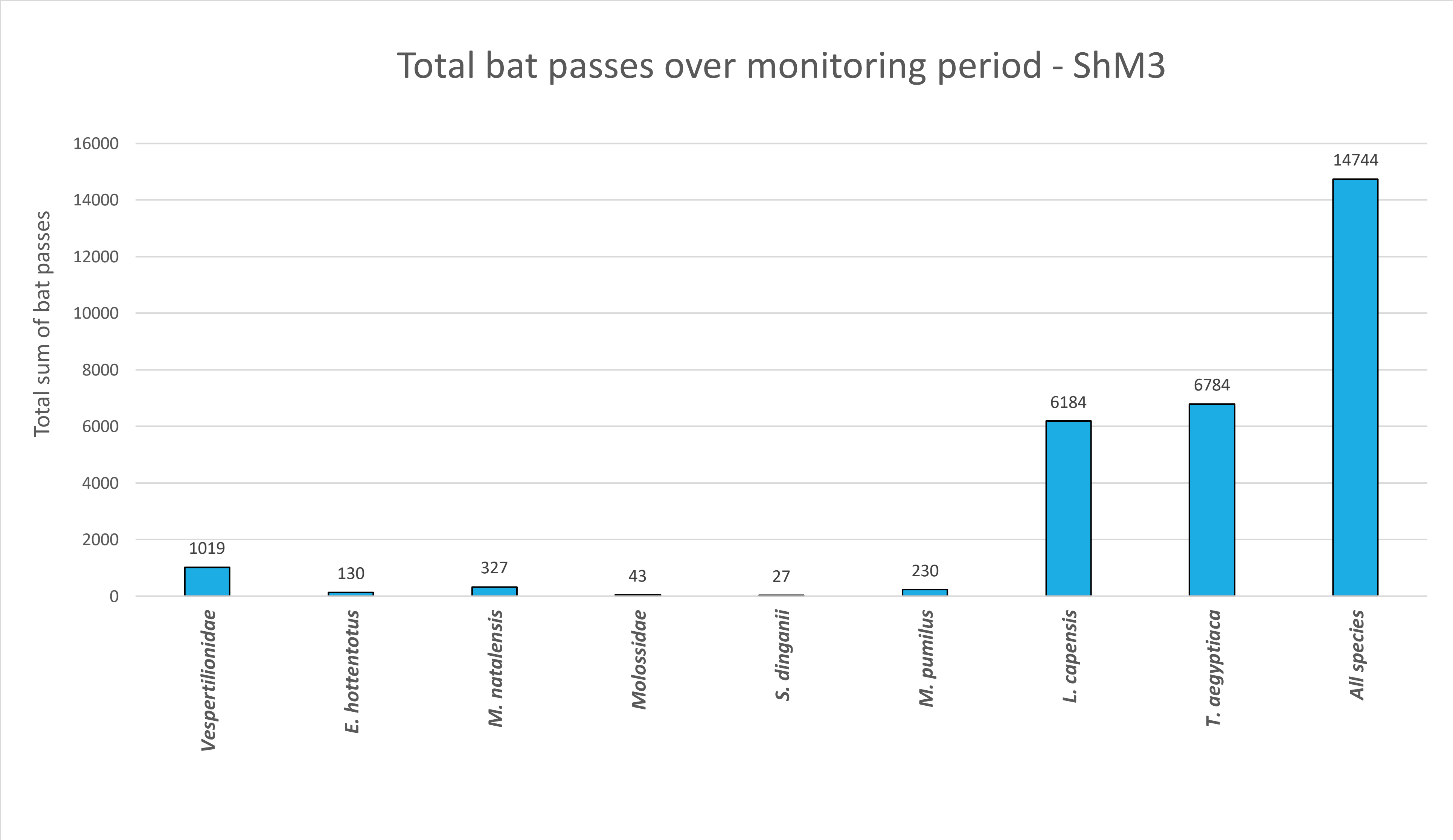

Figure 4.9. Total bat passes recorded over the 12-month monitoring period by C1-ShM3.

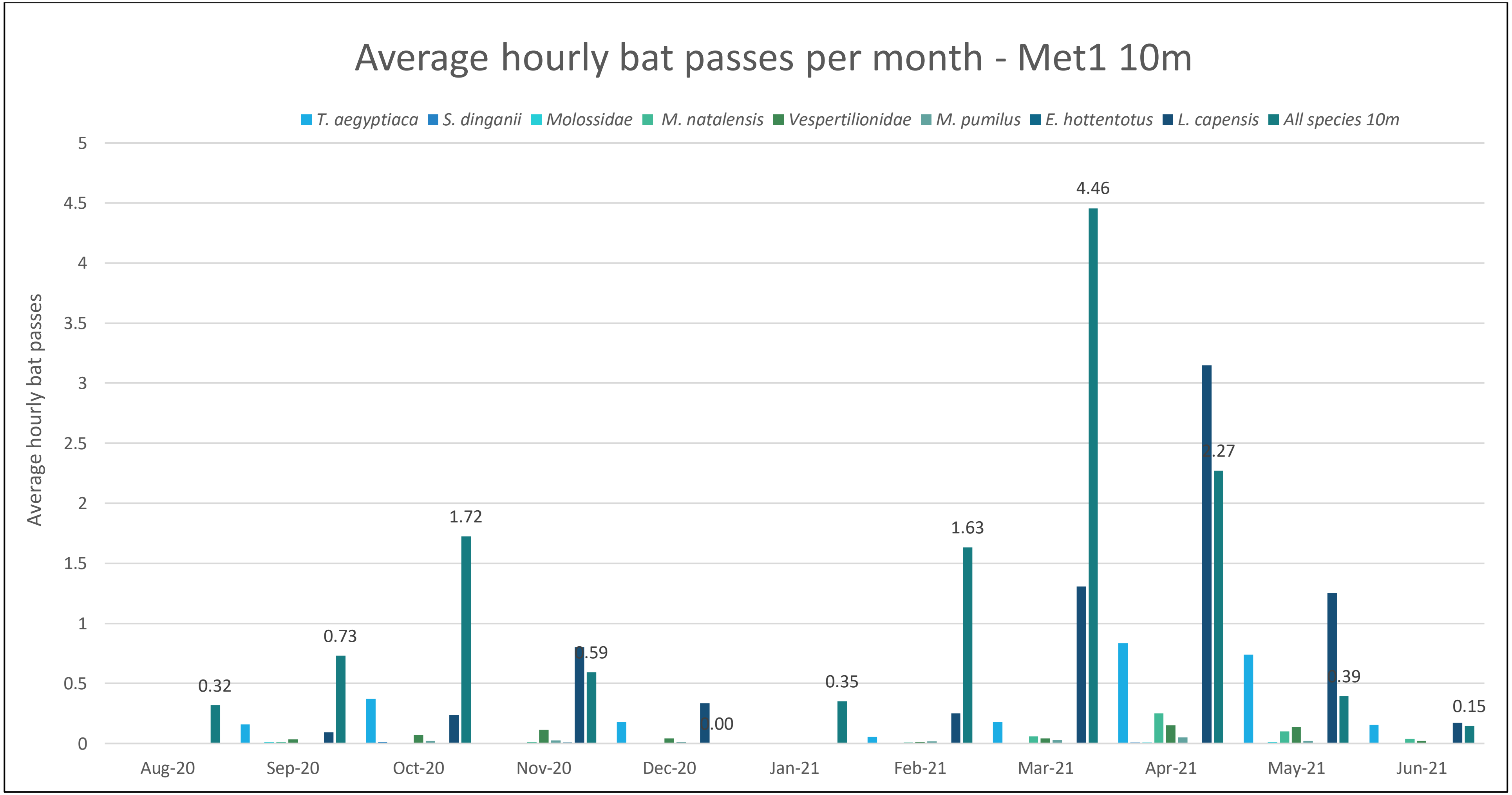

Figure 4.10. Average hourly bat passes recorded per month by Met1 – 10m

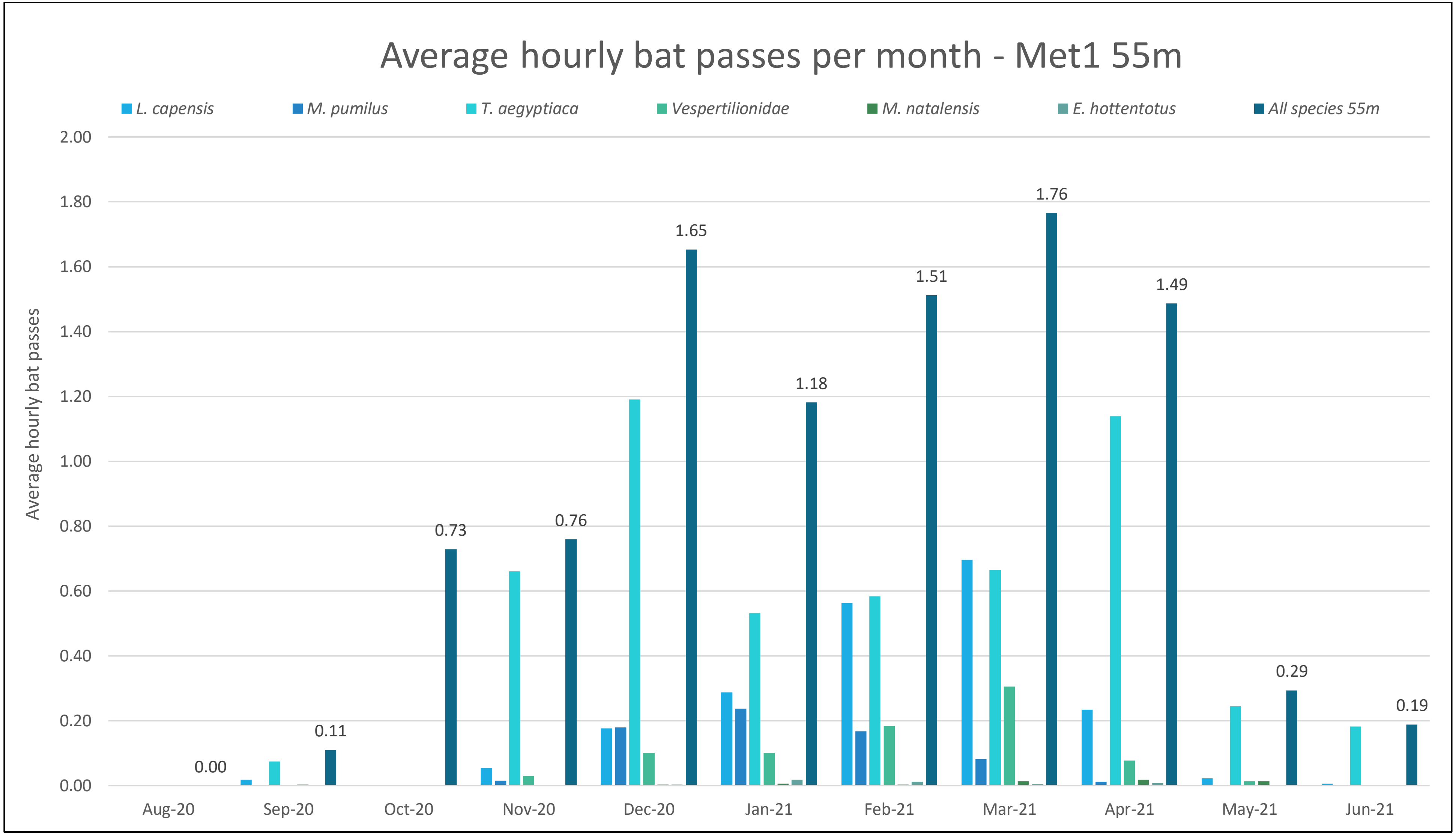

Figure 4.11. Average hourly bat passes recorded per month by Met1 – 55m

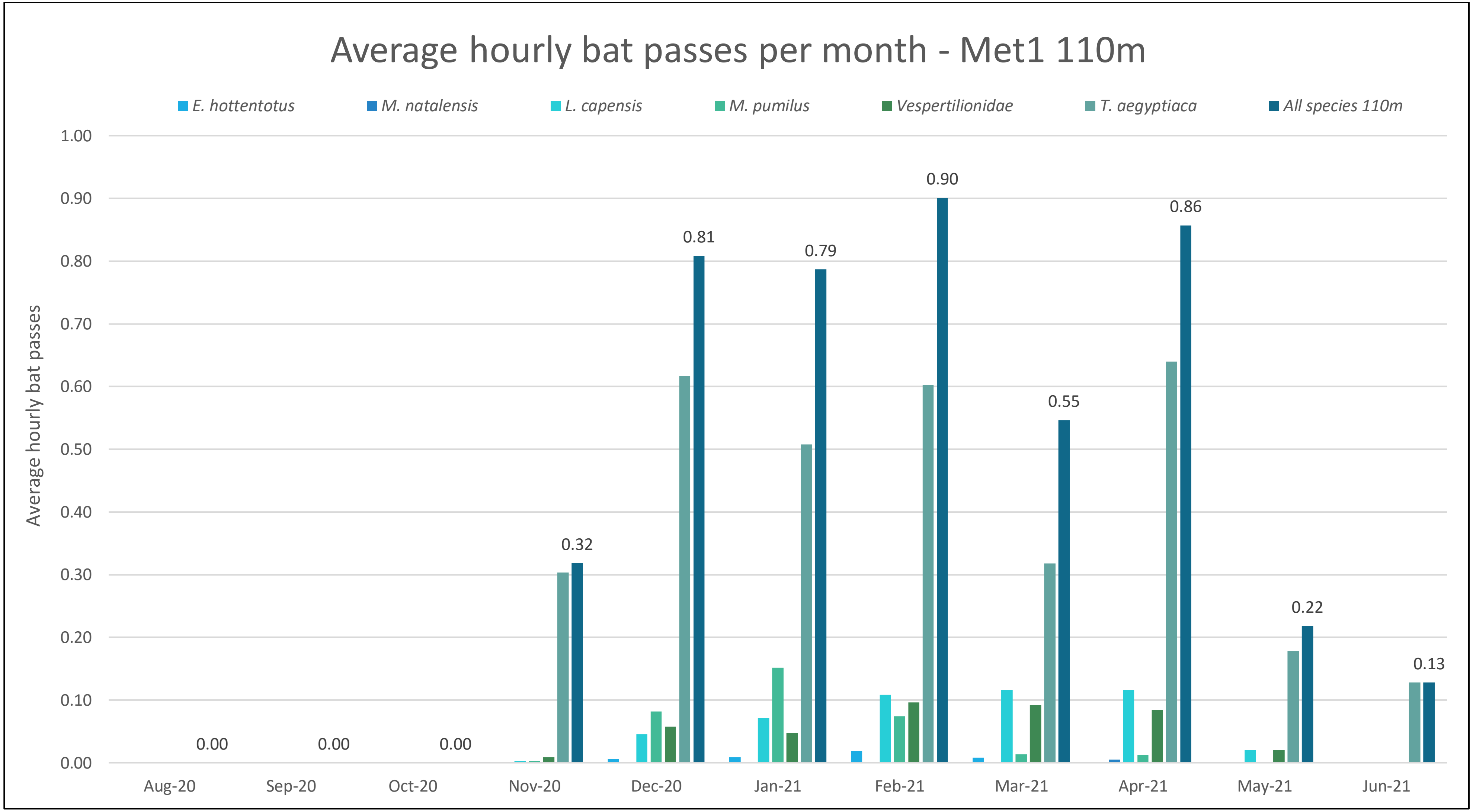

Figure 4.12. Average hourly bat passes recorded per month by Met1 – 110m

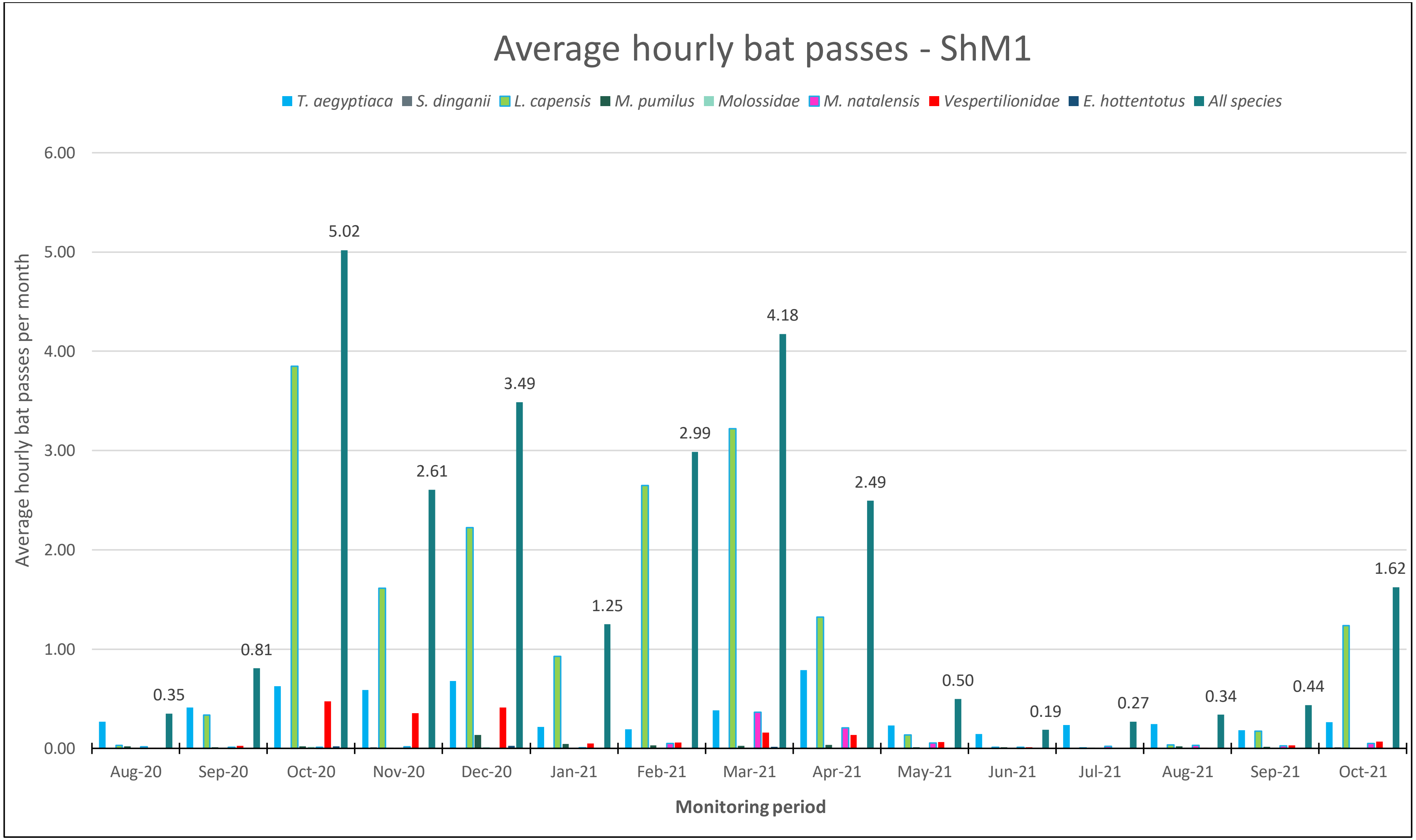

Figure 4.13. Average hourly bat passes recorded per month by C1-ShM1.

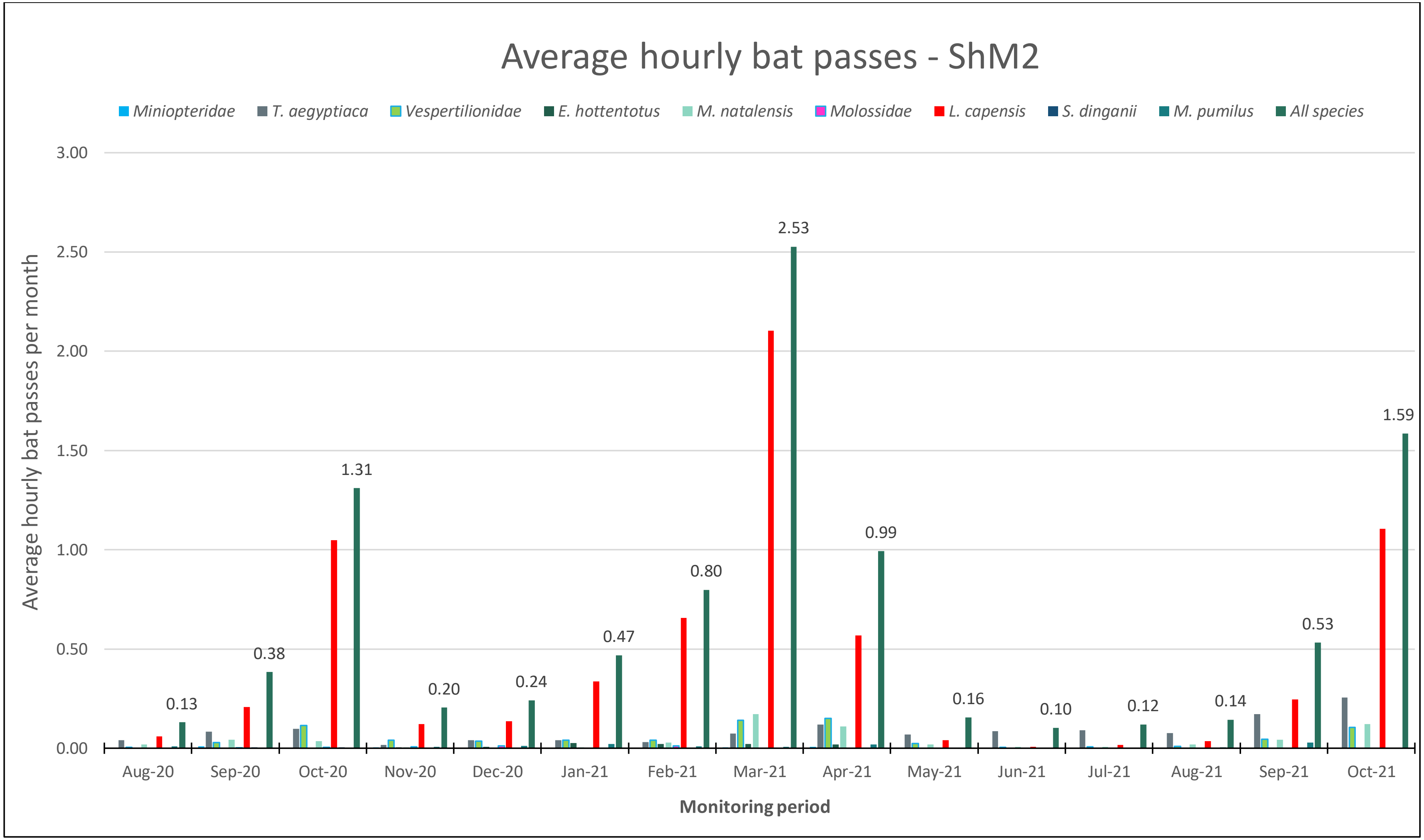

Figure 4.14. Average hourly bat passes recorded per month by C1-ShM2.

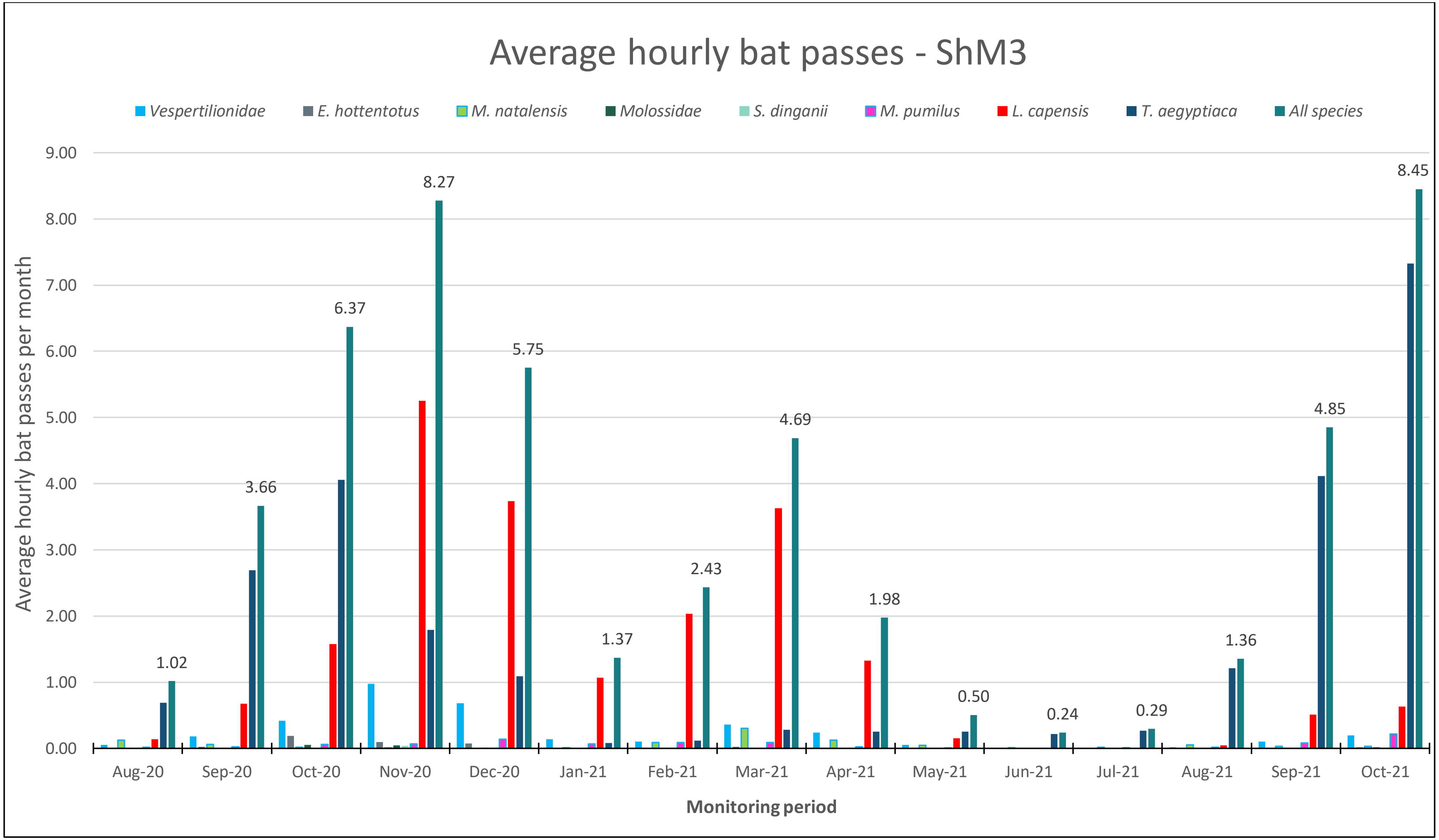

Figure 4.15. Average hourly bat passes recorded per month by C1-ShM3.

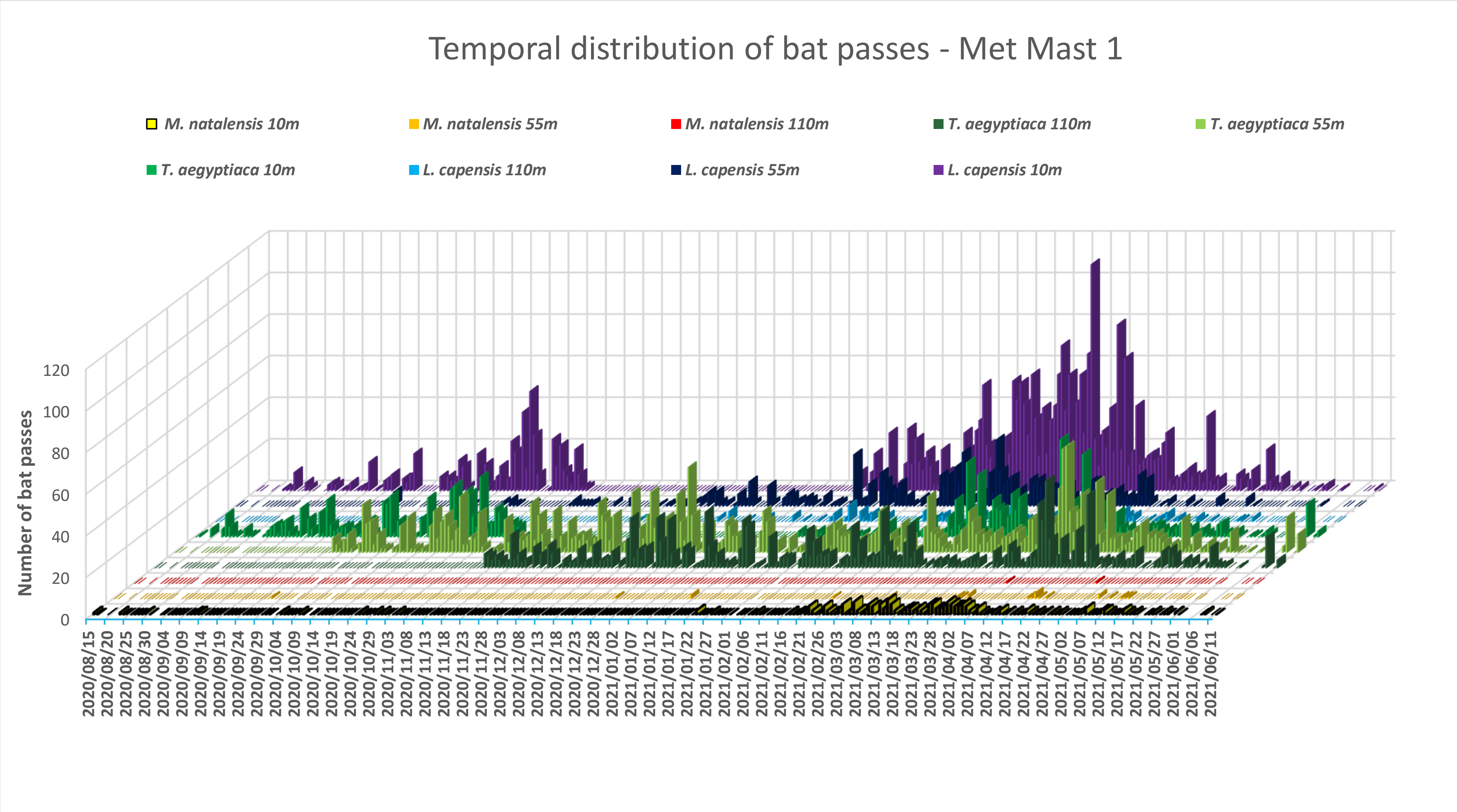

Figure 4.16. Temporal distribution of bat passes detected to date by Met1.

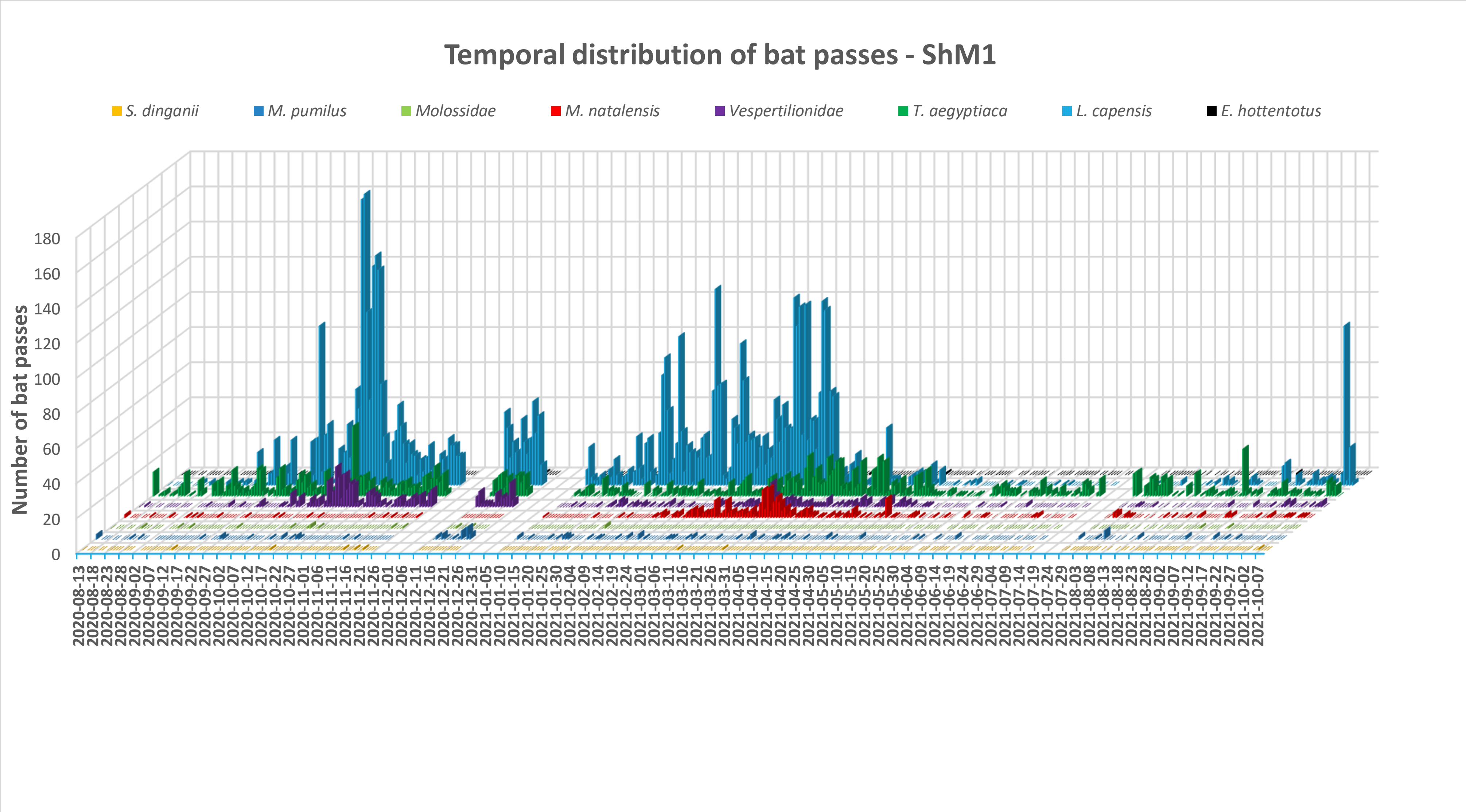

Figure 4.17. Temporal distribution of bat passes detected to date by C1-ShM1.

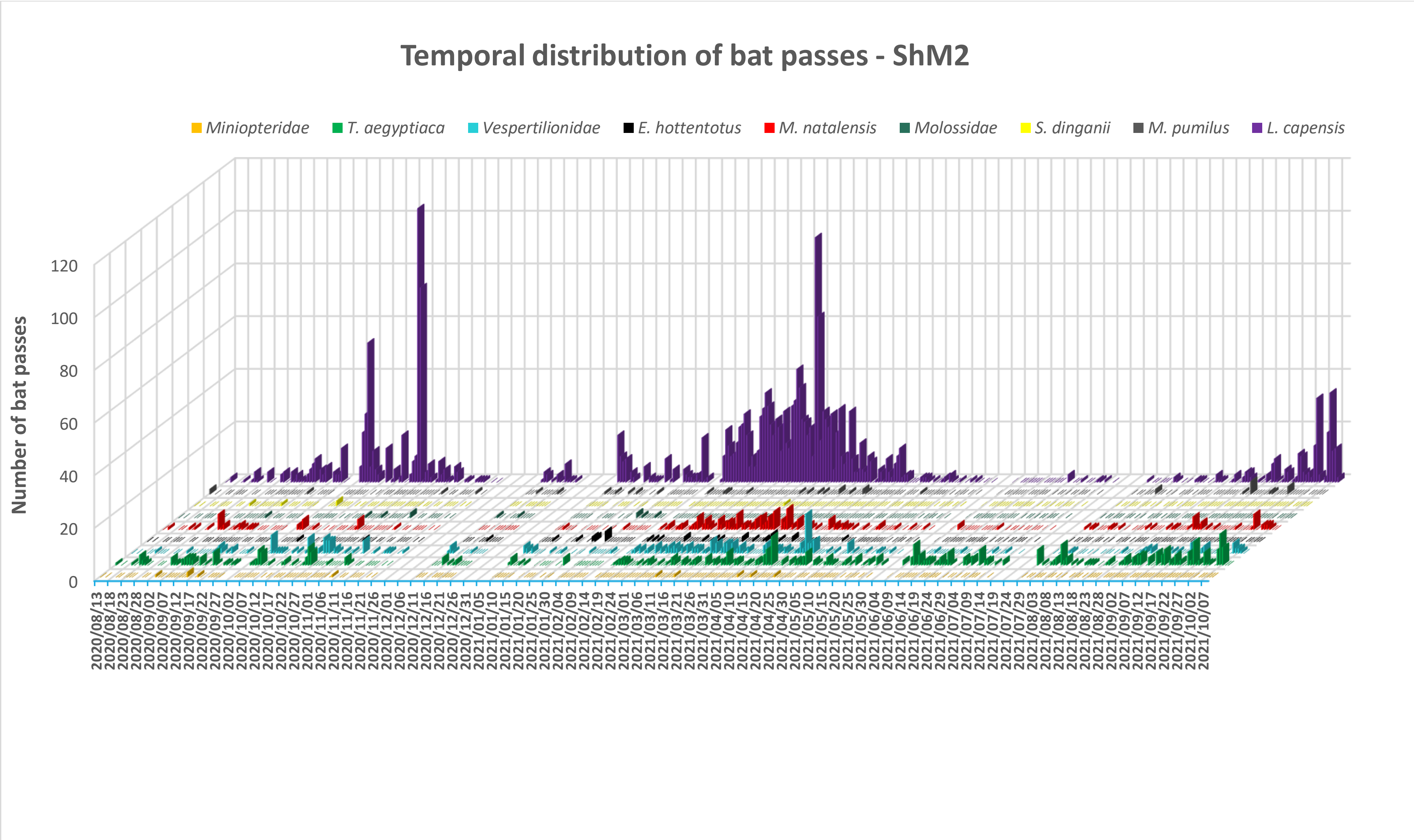

Figure 4.18. Temporal distribution of bat passes detected to date by C1-ShM2.

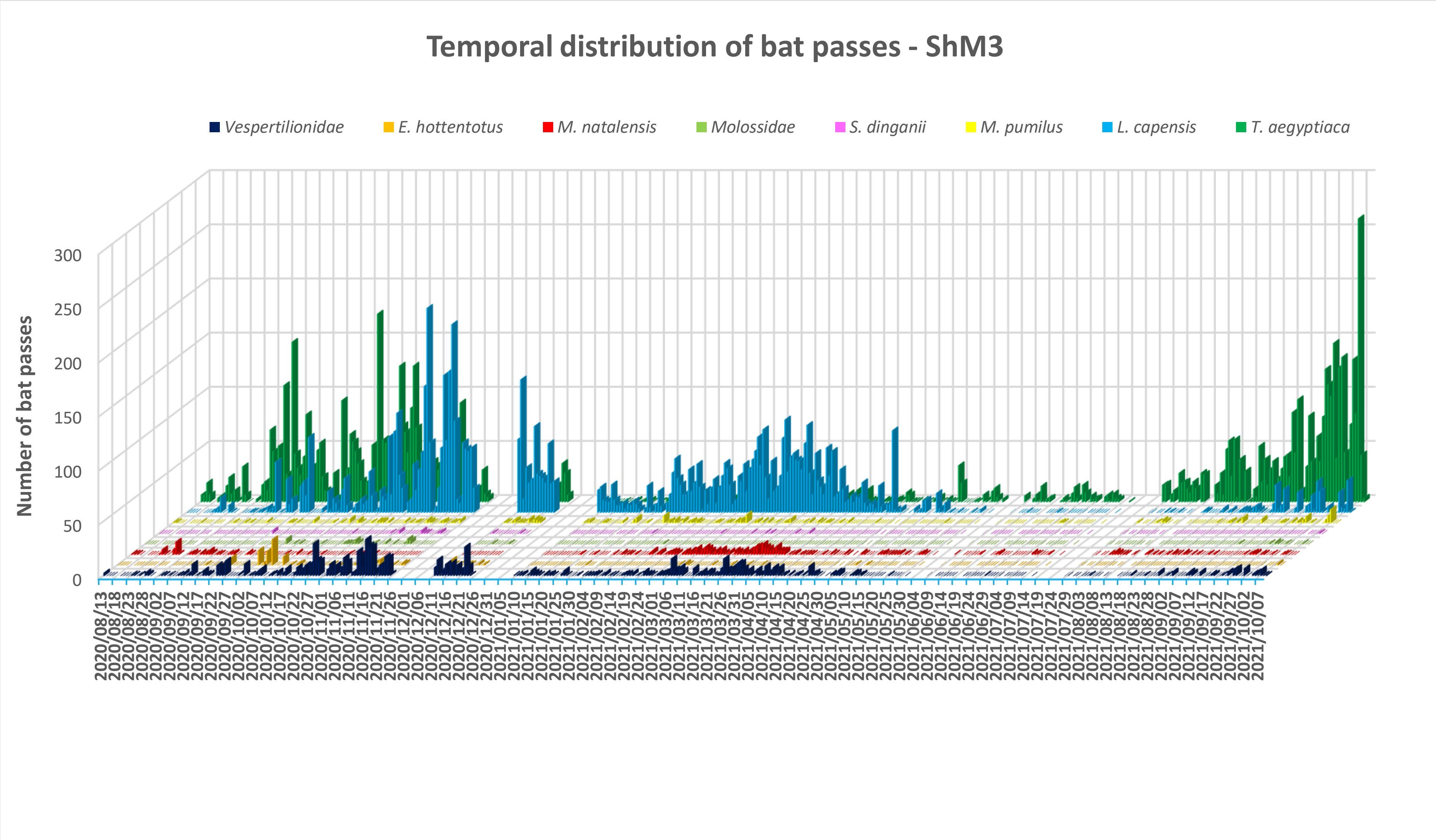

Figure 4.19. Temporal distribution of bat passes detected to date by C1-ShM3.

5 IMPACT ASSESSMENT

Table 5.1 - Table 5.25 below indicate the identified and assessed impacts associated with the proposed Camden I WEF during the construction and operational phases. These are assessed based on the criteria provided by the Environmental Assessment Practitioner (EAP). No significant impacts are identified for the decommissioning phase.

The proposed Grid connection has been considered, and no impacts on bats were identified.

5.1 Wind Energy Facility Impact Assessment

Table 5.1. Summary of identified potential impacts of the proposed Camden I WEF project as well as possible mitigation measures.

Potential impact	Possible mitigation
Construction phase	
Loss of foraging habitat by clearing of vegetation.	Adhere to the sensitivity map criteria. Rehabilitate cleared vegetation where possible at areas such as laydown yards.
Roost destruction during earthworks.	Adhere to the sensitivity map criteria.
Operational phase	
Bat mortalities during foraging.	Turbine layout adjustments to adhere to the sensitivity map, and where needed, reducing blade movement at selected turbines during high-risk bat activity times/weather conditions. Acoustic deterrents are developed well enough to be trialled, if the operational study indicates above threshold mortalities.
Bat mortalities during migration.	Reducing blade movement at selected turbines if a migration route is discovered. Acoustic deterrents are developed well enough to be trialled, if the operational study indicates above threshold mortalities.
Increased bat mortalities due to light attraction and habitat creation.	Only use lights with low sensitivity motion sensors that switch off automatically when no persons are nearby, to prevent the creation of regular insect gathering pools. This will be at

	turbine bases (if applicable, and other infrastructure buildings). For buildings, avoid tin roofs and roof structures that offer entrance holes into the roof cavity.

Table 5.2. Summary of identified potential cumulative impacts of the proposed Camden I & II WEF projects, as well as possible mitigation measures.

Potential impact	Possible mitigation
Construction phase	
Loss of foraging habitat by clearing of vegetation.	Each WEF adhere to its respective sensitivity map criteria. Rehabilitate cleared vegetation where possible at areas such as laydown yards.
Roost destruction during earthworks.	Each WEF adhere to its respective sensitivity map criteria.
Operational phase	
Bat mortalities during foraging.	Each WEF adhere to its respective sensitivity map criteria. Turbine layout adjustments to adhere to the sensitivity maps, and where needed reducing blade movement at selected turbines and high-risk bat activity times/weather conditions. Acoustic deterrents are developed well enough to be trialled, if the operational study indicates above threshold mortalities. Each WEF should measure its bat mortality impact during operation and ensure that the WEF impacts remain within sustainable levels.
Bat mortalities during migration.	Reducing blade movement at selected turbines if a migration route is discovered. Acoustic deterrents are developed well enough to be trialled, if the operational study indicates above threshold mortalities. Each WEF should measure its bat mortality impact during operation and ensure that the WEF impacts remain within sustainable levels.
Increased bat mortalities due to light attraction and habitat creation.	Each WEF to only use lights with low sensitivity motion sensors that switch off automatically when no persons are nearby, to prevent the creation of regular insect gathering pools. This will be at turbine bases (if

	applicable and other infrastructure buildings). For buildings, avoid tin roofs and roof structures that offer entrance holes into the roof cavity.

Table 5.3. Impact assessment for Construction phase

Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Loss of foraging habitat by clearing of vegetation.	Construction activities, temporary and long term, such as construction yards and turbine hard stand and crane pads, will clear vegetation supporting bat insect prey.	Construction	Negative	Easy	2	1	2	4	4	**36**	**N3**	2	1	1	4	3	**24**	**N2**
					Significance	**N3 - Moderate**							**N2 - Low**						
Impact 2:	Roost destruction during earthworks.	Construction activities may possibly disturb or destroy bat roosts underground, and roosts in tall trees. Forcing bats to find alternative roosts.	Construction	Negative	Easy	3	1	3	4	3	**33**	**N3**	3	1	3	4	1	**11**	**N1**
					Significance	**N3 - Moderate**							**N1 - Very Low**						

Table 5.4. Impact assessment for Operational phase

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Bat mortalities during foraging.	Foraging bats can be killed by colliding with turbine blades, or by suffering barotrauma.	Operational	Negative	Hard	4	2	4	4	5	**70**	**N4**	4	2	4	4	3	**42**	**N3**
					Significance	**N4 - High**							**N3 - Moderate**						
Impact 2:	Bat mortalities during migration.	Migrating bats influence several ecosystems since they are cave dwelling species, also over a larger area due to the distances that may be travelled. If turbines are placed within a migration path, a larger area and higher diversity of ecosystems may be impacted.	Operational	Negative	Hard	4	3	4	4	4	**60**	**N3**	4	3	4	4	2	**30**	**N2**
					Significance	**N3 - Moderate**							**N2 - Low**						
Impact 3:	Increased bat mortalities due to light attraction and habitat creation.	Floodlights and other lights at turbine bases or nearby buildings, will attract bats preying on insects and therefore significantly increase the likelihood of these bats being impacted on by moving turbine blades. Habitat creation in the roofs of nearby buildings can cause a similar increased risk factor.	Operational	Negative	Easy	4	1	4	4	5	**65**	**N4**	4	1	4	4	2	**26**	**N2**
					Significance	**N4 - High**							**N2 - Low**						

Table 5.5. Impact assessment of Cumulative effects

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Loss of foraging habitat by clearing of vegetation. Loss of foraging habitat by clearing of vegetation (Construction phase).	Several wind energy facilities will cumulatively amount to more foraging habitat loss; however, these impacts are fragmented and covers a relatively small footprint area.	Cumulative	Negative	Moderate	2	3	2	4	4	**44**	**N3**	2	3	1	4	3	**30**	**N2**
					Significance	**N3 - Moderate**							**N2 - Low**						
Impact 2:	Roost destruction during earthworks (Construction phase).	Several roosts being destroyed can impact bat populations of affected species over a larger area, however the impact is unlikely to occur.	Cumulative	Negative	Moderate	3	3	3	4	3	**39**	**N3**	3	3	3	4	1	**13**	**N1**
					Significance	**N3 - Moderate**							**N1 - Very Low**						
Impact 3:	Bat mortalities during foraging (Operational phase).	Bat mortalities over long periods of time can negatively impact species genetic diversity in a population. If this occurs over a larger area of several wind farms, it decreases the chances of bat populations recovering to a prior state. Bats play an important role in controlling insect numbers, certain species of insects may increase in numbers	Cumulative	Negative	Hard	4	3	4	4	5	**75**	**N4**	4	3	4	4	3	**45**	**N3**

		over a larger area if bats are negatively impacted.																	
					Significance	**N4 - High**							**N3 - Moderate**						
Impact 4:	Bat mortalities during migration (Operational phase).	Migrating bats influence several ecosystems since they are cave dwelling species, also over a larger area due to the distances that may be travelled. If turbines are placed within a migration path, a larger area and higher diversity of ecosystems may be impacted. For migrating bats, the area of influence is dependent on the migration routes, and may therefore involve several WEF's not in the immediate area of the WEF.	Cumulative	Negative	Hard	4	3	4	4	4	**60**	**N3**	4	3	4	4	2	**30**	**N2**
					Significance	**N3 - Moderate**							**N2 - Low**						

Impact 5:	Increased bat mortalities due to light attraction and habitat creation (Operational phase).	Floodlights and other lights at turbine bases or nearby buildings, will attract bats preying on insects and therefore significantly increase the likelihood of these bats being impacted on by moving turbine blades. Habitat creation in the roofs of nearby buildings can cause a similar increased risk factor. Considering several WEF's, the overall mortality rate will be significantly higher if this increased likelihood of impact persists on other surrounding wind farms.	Cumulative	Negative	Moderate	4	3	4	4	5	**75**	**N4**	4	3	4	4	2	**30**	**N2**
					Significance	**N4 - High**							**N2 - Low**						

6 POSSIBLE MITIGATION MEASURES

The correct placement of wind farms and individual turbines, and the application of sufficient sensitivity maps for these technologies can significantly lessen the impacts on bat fauna in an area, and should be considered as the preferred and initial layer of mitigation.

An essential mitigation to implement in the design of the facility is to keep artificial lighting to a minimum at infrastructure buildings and on wind turbines, while still adhering to safety and security requirements. For example, this can be achieved by having floodlights down-hooded, installing passive motion sensors onto lights around buildings, and possibly utilising lights with lighting colours that attract fewer insects. Light pollution will impact bat feeding habits and species compositions negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights.

The required and most effective method of mitigation can be determined from pre-construction acoustic bat activity data, climatic data and the results from the operational bat mortality monitoring. The latter monitoring will determine the need for mitigation and if necessary, the specific turbines to be mitigated. In combination, the data from the pre-construction and operational studies will enable a detailed mitigation schedule to be implemented as needed.

6.1 For wind energy technology

6.1.1 Curtailment that increases cut-in speed

The activity levels of South African bats generally decrease in weather conditions with increased wind speeds. However, in scenarios where significant numbers of bats are being killed, and these bats fly in wind speeds above the turbine manufacturer’s cut-in speed, the turbine’s computer control system (referred to as the Supervisory Control and Data Acquisitions or SCADA system) can be programmed to a cut-in speed higher than the manufacturer's set speed. The new cut-in speed will then be referred to as the mitigation cut-in speed, and can be determined from studying the relation of long term (12-month) bat activity patterns with wind speed. In such a case the turbines are curtailed by means of blade feathering, to render the blades motionless in wind speeds below the mitigation cut-in speed. Curtailment may be implemented during operation if the results of the operational bat mortality monitoring indicate that bats are being killed above sustainable thresholds. These thresholds are advised on during the operational study.

6.1.2 Curtailment to prevent freewheeling

Free-wheeling occurs when the blades are rotating in wind speeds below the generator cut-in speed (also called the manufacturer's cut-in speed), thus no electricity is being produced and only some blade momentum is maintained.

Since bat activity tends to be negatively correlated with wind speed, it means that high numbers of bats are likely to be flying and impacted on in low wind speeds where freewheeling will be occurring. If turbine blades are feathered below the generator cut-in speed, to prevent free-wheeling, it can result in a very significant reduction of bat mortalities with minimal energy production loss. It is recommended that all turbines be curtailed below generator cut-in speed for every night, commencing on the commercial operational date.

6.1.3 Acoustic bat deterrents

This technology is being experimented with on wind farms in South Africa, and thus far yielded positive results that may indicate effectiveness of the devices in the correct scenarios. However, current data on the SA trials is still limited to a small sample set, and the technology will not necessarily be effective in all mitigation scenarios and on all species. Therefore, it should be considered and tested on a case specific basis, and the effect on reducing bat mortalities must be adequately monitored to determine the level of effectiveness. However, development is progressed far enough for deterrents to be trialled, if the operational study indicates above threshold mortalities.

6.1.4 Minimising light pollution on site

All lights on turbines and at substation and/or Operations and Management (O&M) buildings (excluding aviation lights), should be down-hooded and connected to motion sensors (where safe to do so), to minimise light pollution. Light pollution can attract bats that readily forage on insects attracted to light sources, significantly increasing the likelihood of collisions with turbines.

7 CONCLUSION

This Bat Environmental Impact Assessment Report considered information gathered from site visits between August 2020 and October 2021, literature, and satellite imagery. The bat species most likely to be impacted on by the proposed WEF are *Miniopterus natalensis, Laephotis* (formally *Neoromicia*) *capensis* and *Tadarida aegyptiaca*. These species are of special importance based on their likelihood of being impacted by the proposed WEF, due to high abundances and certain behavioural traits. They have also been dominating records of fatalities at wind energy facilities in South Africa. These more abundant species are of a large value to the local ecosystems as they provide a greater contribution to most ecological services than the rarer species, due to their higher numbers. With ever-increasing numbers of wind energy facilities set to become operational in the country over the next few years, the negative impacts on bat populations will accumulate. As such, pressure on all bat species, those rare as well as common, will escalate, increasing the extinction risk for the former and potentially sending the latter into unsustainable population declines over the longer term.

Curtailment may be implemented during operation if the results of the operational bat mortality monitoring indicate that bats are being killed above sustainable thresholds. These thresholds are advised on during the operational study.

It is recommended that all turbines be curtailed below generator cut-in speed for every night, commencing on the commercial operational date. Additional curtailment at wind speeds higher than the generator cut-in speed, may be implemented during operation if the results of the operational bat mortality monitoring indicate that bats are being killed above sustainable thresholds.

Development of acoustic deterrents is progressed far enough for deterrents to be trialled, if the operational study indicates above sustainable threshold mortalities. These thresholds are advised on during the operational study.

The presence of security lights on and around infrastructure creates significant light pollution that can impact bat feeding habits and species composition negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights. Additionally, if the buildings and associated infrastructure are placed close to wind turbines, the light pollution at these buildings can attract photophilic bat species, thereby significantly increasing their chances of being killed by moving blades of turbines within close proximity.

The Strategic Environmental Assessment (SEA) assigns 50km buffers to large bat roosts for wind energy, therefore any existing or possible cave/roost locations may be assigned a buffer up to 50km if they are found to be supporting large enough bat colonies. Figure 4.3 shows the dolomitic geology of the greater area, with an approximate 100km site boundary radius shown in red. At its nearest, the dolomite extends to approximately 65km north-east of the REC. Dolomite is known to be prone to good cave formation, and many bat colonies are supported in such caves in the country, particularly in the province of Gauteng. Museum records of bats collected from two caves and two mines within approximately 100km of the site exist. Specimens of *Miniopterus. natalensis* and *Rhinolophus clivosus* were collected from River Cave (96km north of site); *R. simulator*, *Myotus tricolor* and *Cloeotis percivali* from a mine tunnel on Waterval Farm (91km north), *R. simulator*, *R. blasii*, *R. clivosus* and *Miniopterus fraterculus* from Kalkoenkrans Cave (64km north-east) and *Miniopterus natalensis* from Barites mine (108km northeast). All of the above locations are further than 50km from the proposed site.

A sensitivity map was drawn up indicating potential roosting and foraging areas. The High Bat Sensitivity areas are expected to have elevated levels of bat activity and support greater bat diversity. High Bat Sensitivity areas and their buffers are 'no–go' areas due to expected elevated rates of bat fatalities due to wind turbines. Avoidance is the most affective mitigation measure for reducing the impact on bats, and should be implemented as the first layer of mitigation. No turbine blades may intrude into high sensitivity buffers. Medium sensitivities indicate areas of probable increased risk due to seasonal fluctuations in bat activity, but turbines are allowed to be constructed in medium sensitivity areas. Table 4.3 provides details on the significance of the sensitivity criteria on each infrastructure type. The proposed layout respects the sensitivity map, and no turbines or turbine blades are intruding into high sensitivities and their buffers.

The yearly median of average hourly bat passes at 110m is 0.32 bp/h. the preconstruction guidelines of MacEwan *et al.* (2020), specifies levels of bat mortality risk based on this median activity level and the ecoregion that the site is located in. The site is located in the Highveld Grasslands ecoregion according to Olson *et al.* (2012), and this ecoregion is not covered in the preconstruction guidelines. Therefore, the bat mortality risk cannot be assigned according to the guidelines in MacEwan *et al.* (2020), and the probability of active mitigations being required during operation need to be determined by the results of the operational mortality monitoring.

The pre-construction bat monitoring has now been completed, passive bat activity data has been gathered and provides comparative bat activity and species assemblages across all seasons as well as various habitats, terrain and/or areas of the site.

If the proposed WEF is approved, a minimum of 2 years of operational bat mortality monitoring should be conducted from the start of the operation of the facility.

Thus far, from a bat impact perspective, no reasons have been identified for the Camden I WEF development not to receive Environmental Authorisation, under the mitigative conditions stated in this EIA Report.

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