Bat Impact Assessment Scoping Report

- For the proposed Angora Wind Farm, Northern Cape, South Africa

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PREPARED FOR:

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By

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For:	Bat Impact Assessment Scoping Report

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 Bat Impact Assessment Scoping 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 additional attention to those listed as Threatened or Protected.

Contents

1 OBJECTIVES AND TERMS OF REFERENCE FOR THE STUDY

- 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 identification of possible impacts on bats and a description of the nature and extent of each identified impact
- Identifying gaps in knowledge with regards to each identified impact on bats
- Presentation of no-go areas in the form of bat sensitivity mapping
- 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 Impact Assessment (EIA).

2 INTRODUCTION

This document is the Bat Impact Assessment Scoping Report for the proposed Angora Wind Farm completed by Animalia Consultants (Pty) Ltd.

Great Karoo Renewable Energy (Pty) Ltd is proposing the development of a commercial wind farm and associated infrastructure on a site located approximately 35km south-west of Richmond and 80km south-east of Victoria West, within the Ubuntu Local Municipality and the Pixley Ka Seme District Municipality in the Northern Cape Province. The facility will have a contracted capacity of up to 140MW and will be known as the Angora Wind Farm. The project is planned as part of a larger cluster of renewable energy projects, which include three (3) 100MW PV facilities (known as the Moriri Solar PV, Kwana Solar PV, and Nku Solar PV), an additional 140MW Wind Energy Facility (known as the Merino Wind Farm), as well as grid connection infrastructure connecting the renewable energy facilities to the existing Eskom Gamma Substation.

A preferred project site with an extent of ~29 909ha and a development area of ~4 544ha within the project site has been identified by Great Karoo Renewable Energy (Pty) Ltd as a technically suitable area for the development of the Angora Wind Farm with a contracted capacity of up to 140MW that can accommodate up to 67 turbines (see **Figure 2.1**). The development area consists of four (4) affected properties, which include:

- » Portion 11 of Farm Gegundefontein 53
- » Portion 0 of Farm Vogelstruisfontein 84
- » Portion 1 of Farm Rondavel 85
- » Portion 0 of Farm Rondavel 85

The Angora Wind Farm project site is proposed to accommodate the following infrastructure, which will enable the wind farm to supply a contracted capacity of up to 140MW:

- Up to 67 wind turbines with a maximum hub height of up to 170m and rotor diameter up to 160m. The tip height of the turbines will be up to 250m, and lowest rotor swept height above ground will be 90m (based on 170m hub height and 160m rotor diameter).
- Concrete turbine foundations to support the turbine hardstands.
- Inverters and transformers.
- Temporary laydown areas which will accommodate storage and assembly areas.
- Cabling between the turbines, to be laid underground where practical.
- A temporary concrete batching plant.
- 33/132kV onsite facility substation.
- Underground cabling from the onsite substation to the 132kV collector substation.
- Electrical and auxiliary equipment required at the collector substation that serves that wind energy facility, including switchyard/bay, control building, fences, etc.
- Battery Energy Storage System (BESS).
- Access roads and internal distribution roads.
- Site offices and maintenance buildings, including workshop areas for maintenance and storage.

The wind farm 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 Angora Wind Farm under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme, with the aim of evacuating the generated power into the national grid. 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 Angora Wind Farm set to inject up to 140MW into the national grid.

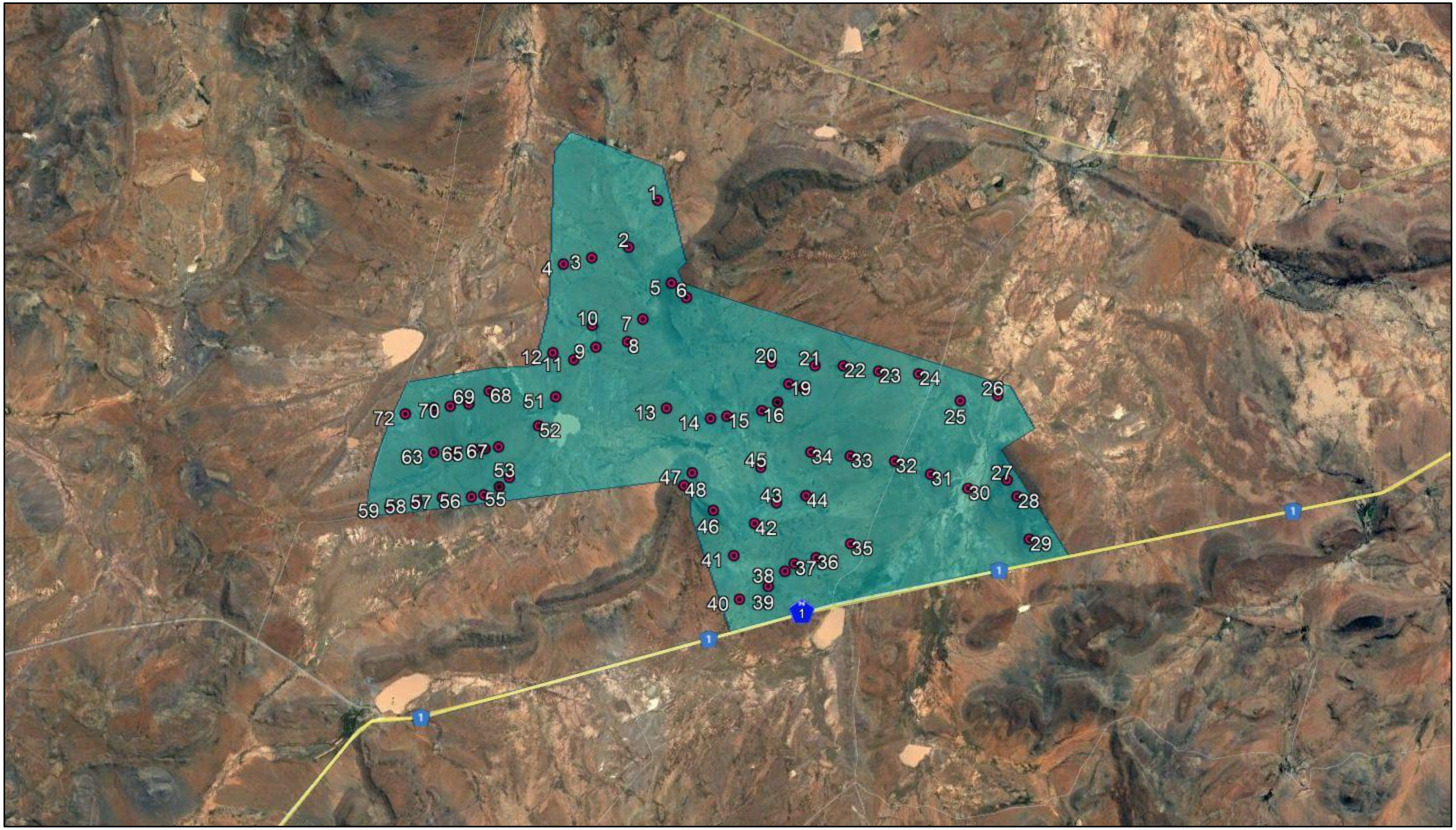


Figure 2.1. Preliminary turbine layout of the proposed Angora Wind Farm

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 varying 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.

2.1 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.

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 *Neoromicia 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, therefore 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.

3 METHODOLOGY

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.

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 chiefly by briefly studying the geographic literature of each site, available satellite imagery and by ground-truthing with site visits. Species probability of occurrence based on the above-mentioned factors are estimated for the site and the surrounding larger area, but also considers species already confirmed on site as well as from the surrounding areas.

3.2 Active & Passive Monitoring

Bat activity is monitored using active and passive bat monitoring techniques. Active monitoring is carried out on site visits by the means of driven transects. A bat detector mounted on a vehicle is used, and transect routes are chosen based on road accessibility. Sampling effort and prevalent weather conditions are considered for each transect.

Passive detection is continuing on the Angora Wid Farm by means of bat monitoring systems on the Meteorological Mast (Met 1) and two Short Masts (ShM1 & ShM2) on site (**Figure 3.1**). It must be noted here that Met 1 is situated close to (but 340m outside of) the Angora Wind Farm boundary, on the adjacent Merino Wind Farm. The data of these three passive systems will be considered in the sensitivity report as they are located in terrain and habitat applicable to this site.

As summarised in **Table 3.1**, the Meteorological Mast has microphones at heights of 7m, 50m and 100m. The Short Mast passive systems each have a microphone at 7m.

During each site visit the bat activity data is downloaded from the monitoring systems; six months of such data is already analysed and is incorporated into this report.

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. **Table 3.1** below summarises the equipment setup.

3.3 Site Visit and Equipment Setup Information

Table 3.1: Equipment setup and site visit information.

Site visit dates	**First visit**	14 – 17 December 2020
	Second visit	12 – 14 April 2021
	Third visit	23 – 25 July 2021
Met mast passive bat detection systems	**Quantity on site**	1 (“Met 1”)
	Microphone heights	7m, 50m, 100m
	Coordinates	Met 1: -31.4799 23.63198
Short mast passive bat detection systems	**Quantity on site**	2
	Microphone height	7m
	Coordinates	Short Mast 1 (-31.46396 23.70978) Short Mast 2 (-31.42928 23.65195)
Replacements/ Repairs/ Comments		N/A
First visit		The passive systems were installed with mounted microphones angled 30° downwards
Second visit		ShM1 SD card memory were full, replaced with larger empty SD cards.
Third visit		Corrupt SD cards caused by firmware instability resulted in data loss on ShM2.
Type of passive bat detector		SM3BAT, Real Time Expansion (RTE) type
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, -12dB
Trigger window (time of recording after trigger ceased)		1 000ms (1 second)
Microphone gain setting		12dB
Compression		WAC0
Single memory card size (each system uses 4 cards)		32GB
Battery size		17Ah; 12V
Solar panel output		20 Watts
Solar charge regulator		6 - 8 Amp with low voltage/deep discharge protection

Other methods	Terrain was investigated during the day for habitat observations.

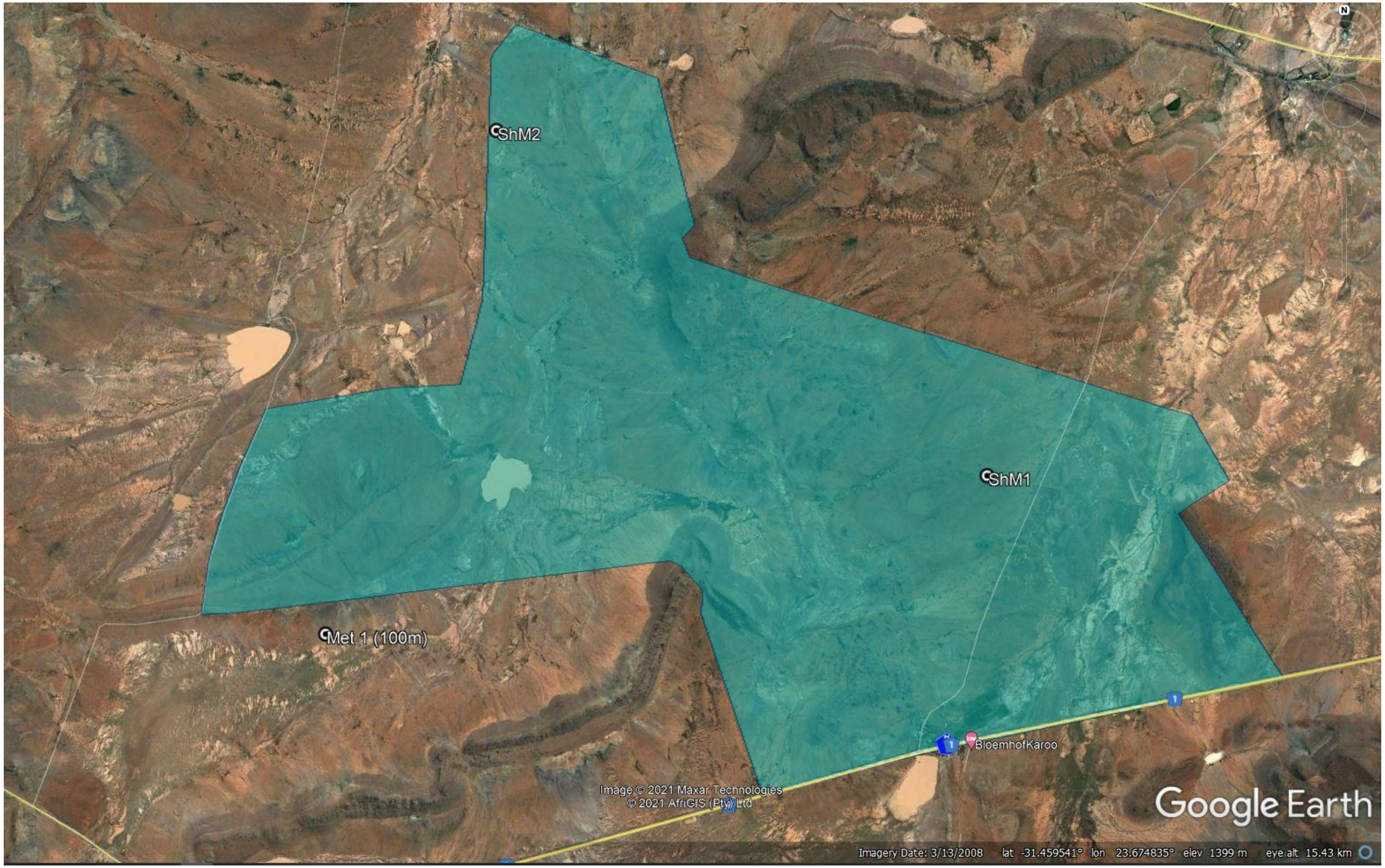


Figure 3.1: Positions of the passive bat detection systems on site. The two Short Mast systems, ShM1 and ShM2 are shown, while note that the Meteorological Mast (Met 1) is positioned just outside the wind farm boundary (on the adjacent Merino Wind Farm).

3.4 Assumptions and Limitations

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 the location of a migratory path.

The sensitivity map is based partially on satellite imagery and from detailed site visits, and 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.

Species identification with the use of bat detection and echolocation is less accurate when compared to morphological identification, nevertheless it is a very certain and accurate indication of bat activity and their presence with no harmful effects on bats being surveyed. Automated species identification by the Kaleidoscope software may produce a smaller portion of incorrect identifications or unknown identifications. However, the automated software is very effective at distinguishing bat calls from ultrasonic noise, therefore the number of bat passes are not significantly overestimated.

It is not possible to determine actual individual bat numbers from acoustic bat activity data, whether gathered with transects or the passive monitoring systems. However, bat passes per night are internationally used and recognized as a comparative unit for indicating levels of bat activity in an area.

Spatial distribution of bats over the study area cannot be accurately determined by means of transects, although the passive systems can provide comparative data for different areas of the site. Transects may still possibly, in rare cases, uncover high activity in areas where it is not necessarily expected and thereby improve understanding of the site.

Exact foraging distances from bat roosts or exact commuting pathways cannot be determined by the current methodology. Radio telemetry tracking of tagged bats is required to provide such information if needed.

4 RESULTS AND DISCUSSION

4.1 Land Use, Vegetation, Climate and Topography

The proposed Angora Wind Farm falls within the Nama Karoo Biome, and the vegetation units found on site include **Upper Karoo Hardeveld** and **Eastern Upper Karoo** (**Figure 4.1**, Mucina & Rutherford 2012).

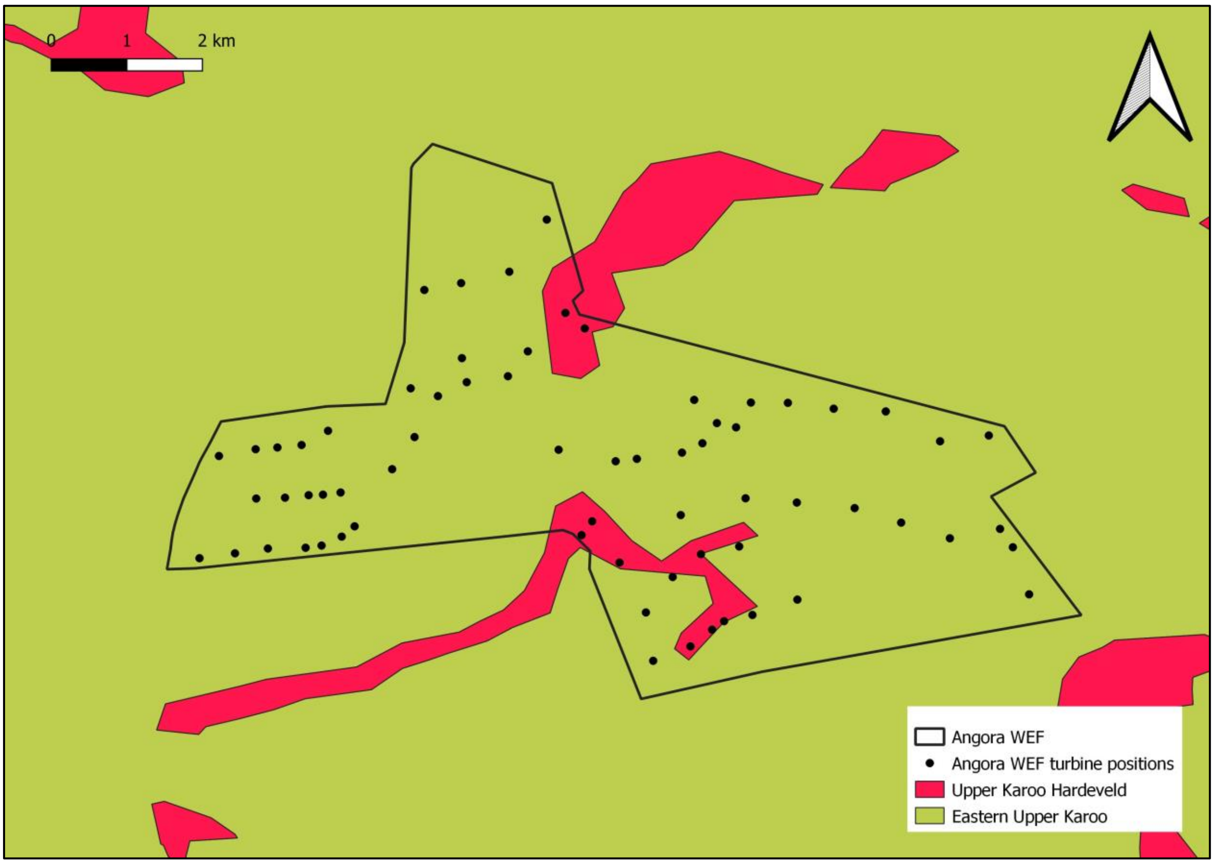


Figure 4.1: Vegetation units present on the proposed Angora Wind Farm, with preliminary turbine positions indicated (Mucina & Rutherford 2012).

4.1.1 Upper Karoo Hardeveld

Upper Karoo Hardeveld is typified by steep-sloped koppies, buttes and mesas as part of the Great Escarpment. Large boulders and stones mark the landscape and it supports sparse vegetation such as dwarf Karoo scrub and drought-tolerant grasses (*Aristida*, *Eragrostis* and *Stipagrostis*).

Geologically, this vegetation unit comprises primitive and skeletal soils in a rocky landscape. These soils cover sedimentary rock such as those mudstones and arenites of the Adelaide Subgroup (Karoo Supergroup). Dolerite boulders cover slopes of the mesas and buttes found here.

The Mean Annual Precipitation of this unit ranges from 150 – 350mm per year from north west to east, and frost days are relatively high, although variable (30 – 80 days, depending on altitude).

4.1.2 Eastern Upper Karoo

Flats and gently sloping plains are found within the Eastern Upper Karoo vegetation unit and intersperse with fingers of Karoo Hardeveld on site.

Dwarf microphyllous shrubs dominate this landscape and ‘white’ grasses (*Aristida* and *Eragrostis* species) are prominant after good summer rains. Karoo scrub species of *Pentzia*, *Eriocephalus*, *Rosenia* and *Lycium* are important taxa (Mucina & Rutherford 2012).

Beaufort Group sandstones and mudstones are common in this vegetation unit, and some Jurassic dolerites are also to be found.

Mean annual precipitation ranges from 180 – 430mm per year (west to east), peaking in March, and as for Karoo Upper Hardeveld, frost incidence is high (30 – 80 days per year). Nearby, Victoria West has recorded mean maximum and minimum monthly temperatures of 37°C and -8°C respectively.

Vegetation units and geology are of great importance as these may serve as suitable sites for the roosting of bats and support of their foraging habits (Monadjem *et al.* 2020). Houses and buildings may also serve as suitable roosting spaces (Taylor 2000; Monadjem *et al.* 2020).

4.2 Currently Confirmed, Previously Recorded as well as Literature Based Species Probability of Occurrence

The column of "Likely risk of impact" describes the likelihood of risk of fatality from direct collision or barotrauma with wind turbine blades for each bat species. The risk was assigned by MacEwan *et al*. (2020) based on species distributions, altitudes at which they fly and distances they traverse; and assumes a 100% probability of occurrence. Additional unconfirmed but potentially occurring species are also listed in **Table 4.1**.

Table 4.1: Table of species that are currently confirmed on site, and/or have been previously recorded in the area and may be occurring based on literature. Roosting or foraging in the study area, the possible site-specific roosts, and their probability of occurrence based on literature as well as recordings and observations in the surrounding area, is also briefly described (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	Likelihood of risk of fatality (MacEwan *et al.* 2020)
Tadarida aegyptiaca	Egyptian free-tailed bat	Confirmed on site	Least Concern (2016 Regional Listing)	Roosts in rock crevices, 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 habitats.	High
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. But is predominantly a medium height clutter edge forager on site.	Medium - High
Miniopterus natalensis	Natal long-fingered bat	Confirmed on site	Least Concern (2016 Regional Listing)	No known caves in the vicinity of the site. Small groups or individuals may roost in culverts or other hollows.	Clutter-edge forager. May forage in more open terrain during suitable weather.	Medium - High
Eptesicus hottentotus	Long-tailed serotine	Confirmed on site	Least Concern (2016 Regional Listing)	It is a crevice dweller roosting in rock crevices, as well as other crevices in buildings. Rock crevices in valleys on site.	It generally seems to prefer woodland habitats, and forages on the clutter edge. But may still forage over open terrain occasionally.	Medium
Sauromys petrophilus	Robert's flat-headed bat	Confirmed on site	Least Concern (2016 Regional Listing)	Roosts mainly in rock crevices.	It forages over a wide range of habitats and may utilise higher air spaces.	High

Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	Literature	Least Concern (2016 Regional Listing)	Roosts in dense foliage of large, leafy trees and may travel several kilometres each night to reach fruiting trees.	Feeds on fruit, nectar, pollen and flowers. If and where available on site.	Medium - High
Nycteris thebaica	Egyptian slit-faced bat	Museum record from greater area	Least Concern (2016 Regional Listing)	Roosts in hollows, aardvark burrows, culverts under roads and the trunks of dead trees.	It appears to occur throughout the savannah and karoo biomes but avoids open grasslands. May possibly occur in the thickets of man-made gardens, and in aardvark burrows.	Low
Cistugo lesueuri	Lesueur's wing-gland bat	Museum record from greater area	Least Concern (2016 Regional Listing)	It is a crevice dweller roosting in rock crevices. Exposed rocky cliffs and rocky koppies.	Areas with available drinking water. Clutter edge forager. May forage in more open terrain during suitable weather.	Medium – High
Rhinolophus darlingi	Darling's horseshoe bat	ACR 2018 record	Least Concern (2016 Regional Listing)	May utilise man made hollows, Aardvark burrows or hollows formed by rocky boulder koppies.	It is associated with a variety of habitats including thickets that may be found in the vegetated drainage areas.	Low
Eidolon helvum	African straw-coloured fruit bat	Literature	Least Concern (2016 Regional Listing) (Globally Near-threatened)	It's a non-breeding migrant with sparse scattered records in the karoo.	Feeds on fruit, nectar, pollen and flowers. If and where available on site.	Medium - High

*Occurrence of species records based on site data collected off passive monitoring systems to date, ACR 2018 and Monadjem *et al*. 2020

4.3 Ecology of bat species that may be impacted the most by the Angora Wind Farm

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 wind farm, due to high abundances and certain behavioural traits. They have also been dominating records of fatalities at wind farms 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 (IUCN 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).

They 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. *Tadarida aegyptiaca* has also adapted to roosting in buildings, in particular roofs of houses (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 likelihood of risk of fatality due to wind turbines (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 displaying moderate to high numbers of mortalities at nearby operating wind farms.

4.3.2 Neoromicia capensis

Neoromicia capensis is commonly called the Cape serotine and has a conservation status of Least Concern (IUCN 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 as *N. capensis* is abundant and widespread and as such has a more significant role to play within the local ecosystem than the rarer bat species. They do not undertake migrations and thus are considered residents of the site.

It 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).

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 mostly, but can occasionally forage in open spaces. They are thought to have a Medium-High likelihood of risk 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. If the site is located within a migratory path the bat detection systems should detect high numbers and activity of the Natal long-fingered bat; this will be examined over the course of the 12-month monitoring survey.

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) advise 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.

4.4 Passive Data

4.4.1 Abundances and Composition of Bat Assemblages

Average hourly bat passes detected per night and total number of bat passes detected over the monitoring period by the systems are displayed in **Figures 4.2 – 4.7**. Five bat species were detected namely *Eptesicus hottentotus*, *Tadarida aegyptiaca, Neoromicia capensis, Miniopterus natalensis* and *Sauromys petrophilus*. Additionally, bat passes were recorded that are classified up to family level and includes Vespertilionidae and Molossidae. Both of these families, includes the species identified and were simply used to group bat passes that were harder to identify.

In general, and overall on all microphones *Tadarida aegyptiaca* was most commonly detected, with its highest occurrences at 100m, then 7m and lowest occurrences at 50m. Overall, *N. capensis* was the second most abundant species with its highest occurrences at 7m on Met Mast 1. The met mast displayed the highest overall bat activity.

Average hourly bat passes per month (**Figures 4.5 – 4.7**) are useful to indicate overall average high activity months and seasons. Gaps in data are considered in average calculations, whereas total bat numbers are influenced by the completeness of a recording schedule. Met Mast 1 displayed the highest average hourly bat activity at 3.69 in January 2021 for *T. aegyptiaca* at 100m, with an average of 4.76 for all species at 7m also in January 2021. Both short masts displayed the highest average hourly bat passes in December 2020, with ShM2 having detected marginally higher activity than ShM1.

The yearly average of average hourly bat passes, at 100m on Met Mast 1, is 1.4 bat passes per hour. According to MacEwan *et al.* (2020), for the Nama Karoo ecoregion it's considered to be bat activity levels indicating a high risk of bat mortalities. Therefore, the probability of active mitigations being required during operation is high.

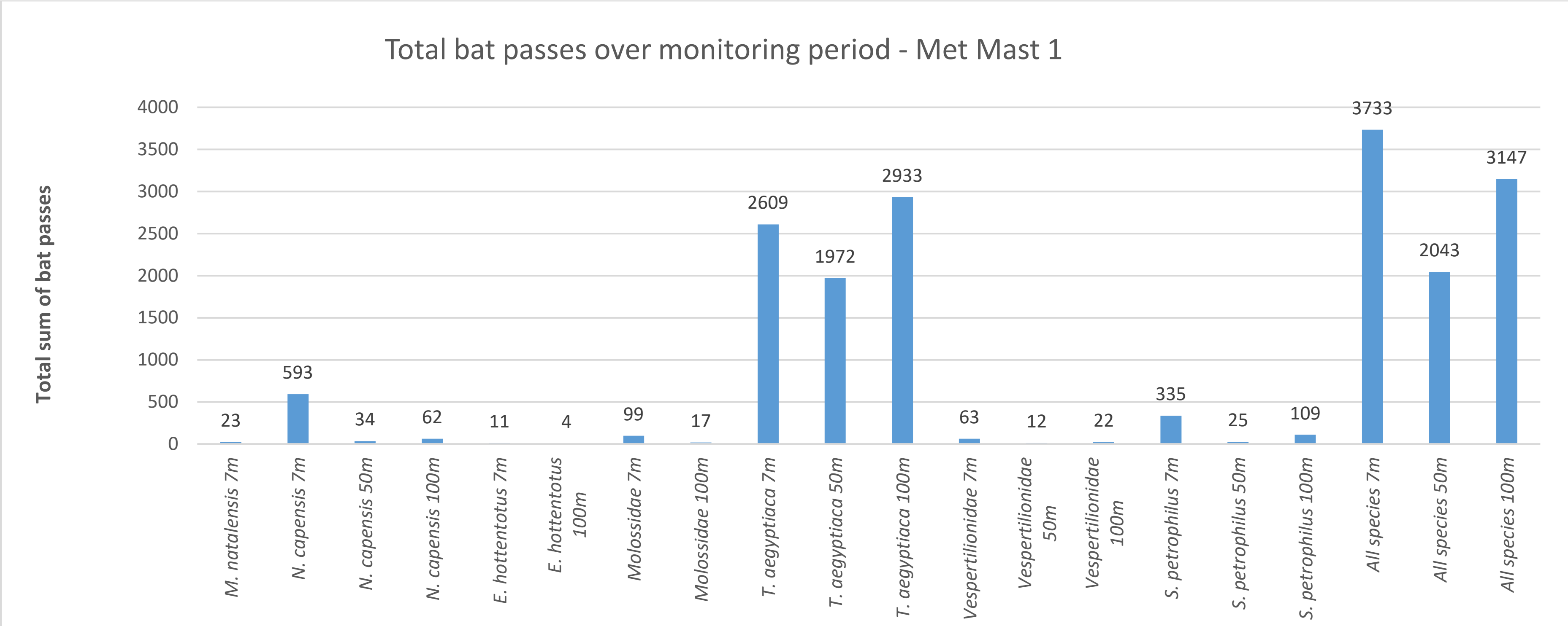


Figure 4.2: Total bat passes recorded over the monitoring period to date by Met Mast 1.

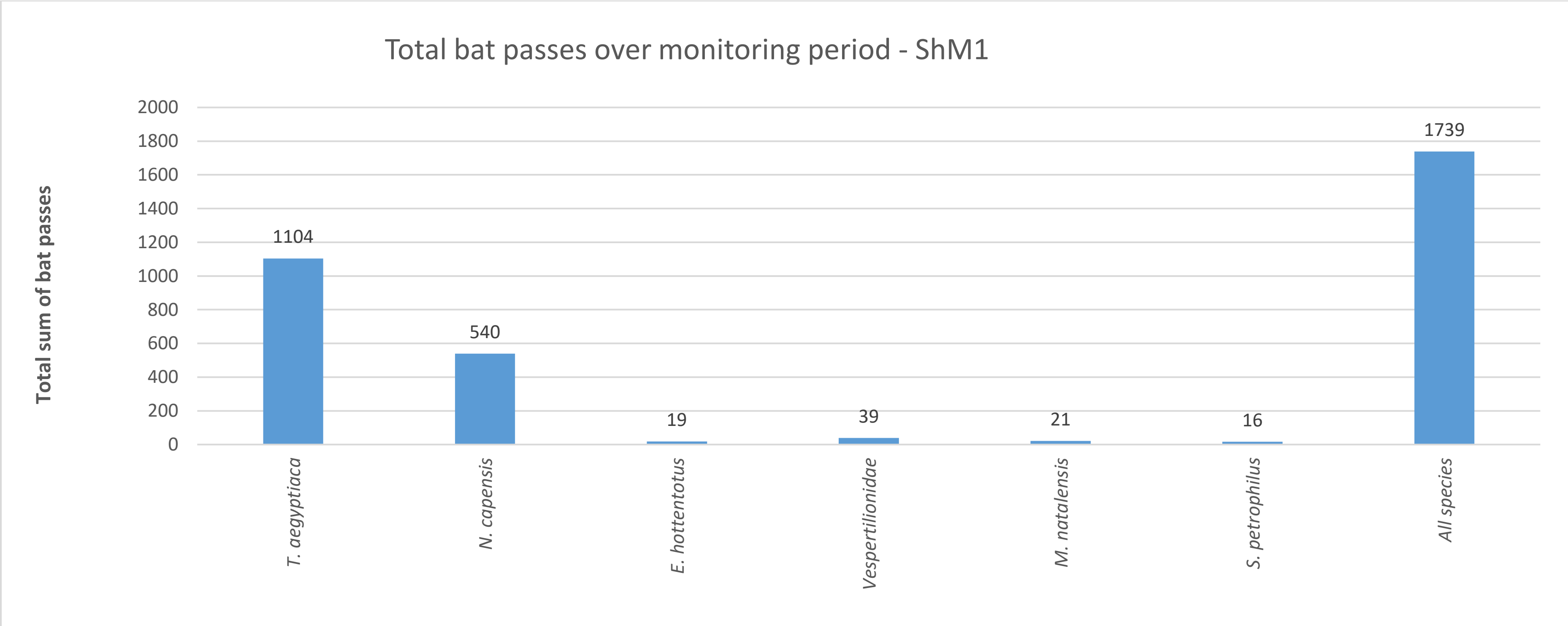


Figure 4.3: Total bat passes recorded over the monitoring period to date by ShM1.

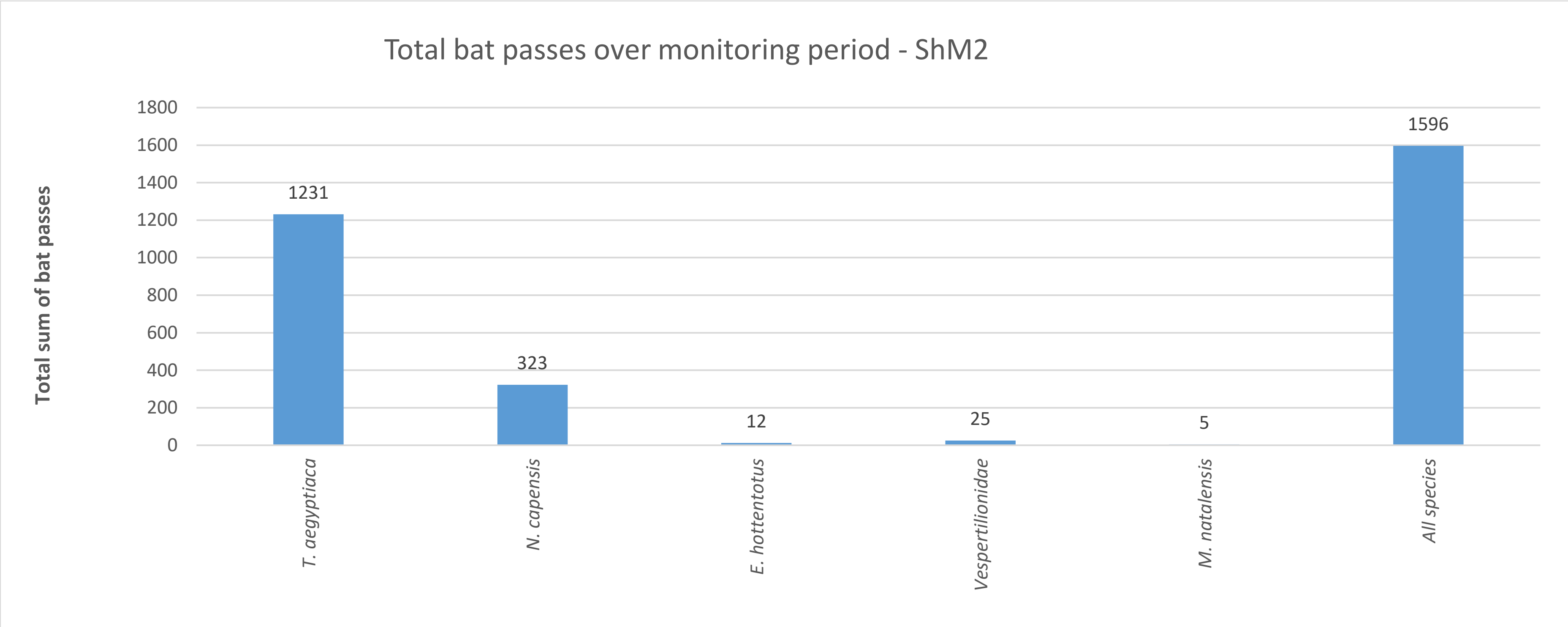


Figure 4.4: Total bat passes recorded over the monitoring period to date by ShM2.

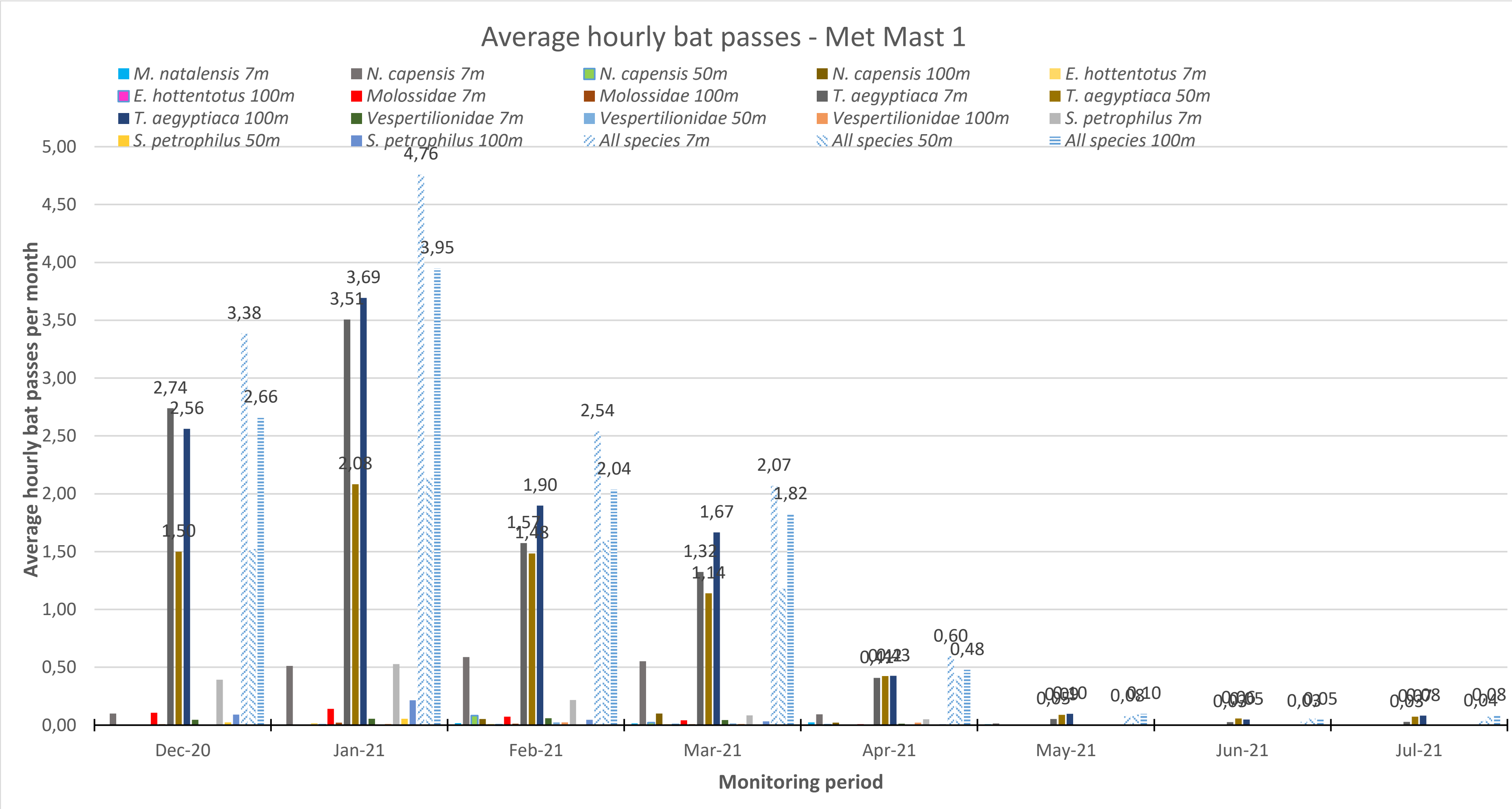


Figure 4.5: Average hourly bat passes recorded per month to date by Met Mast 1.

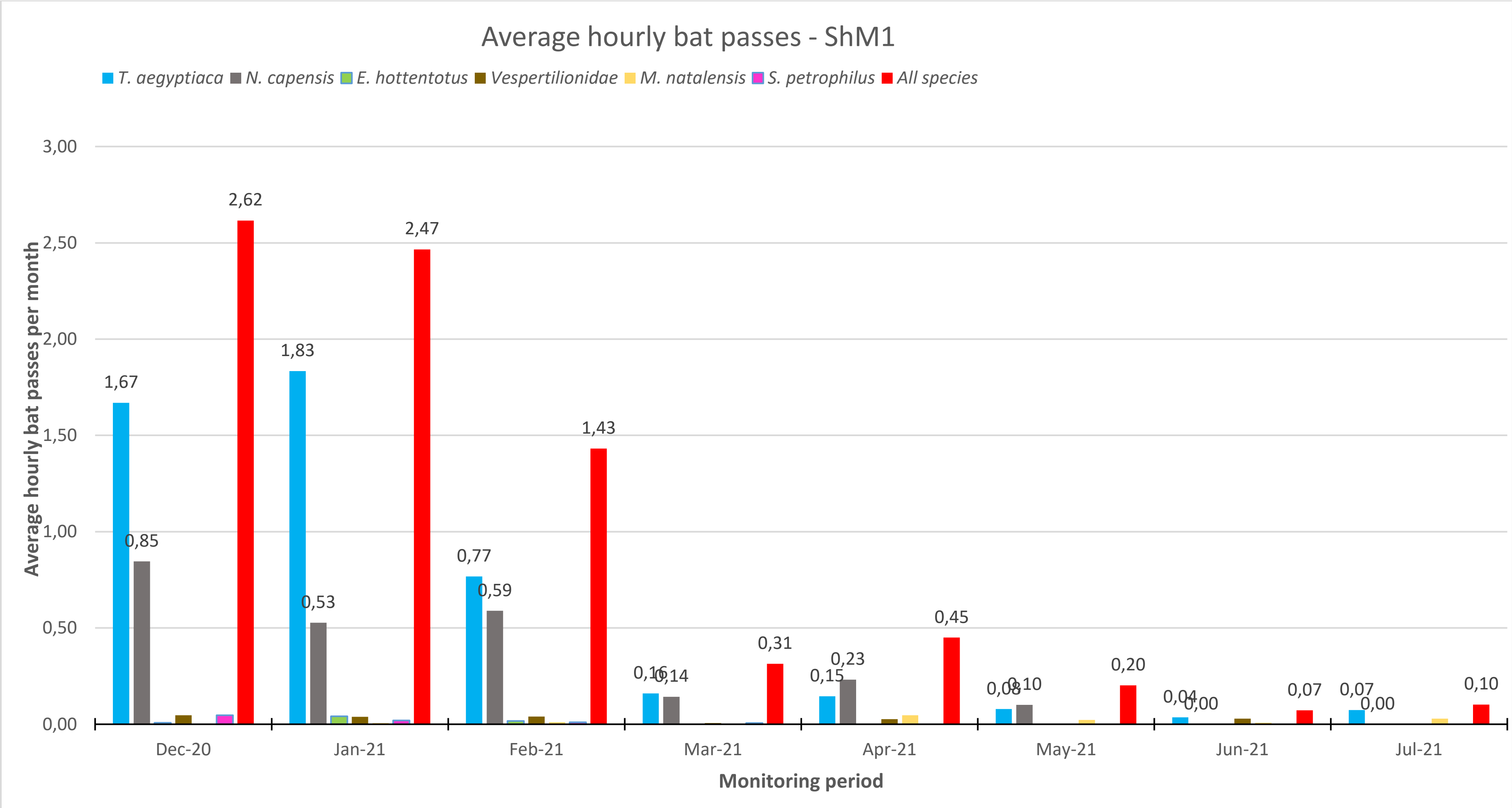


Figure 4.6: Average hourly bat passes recorded per month to date by ShM1.

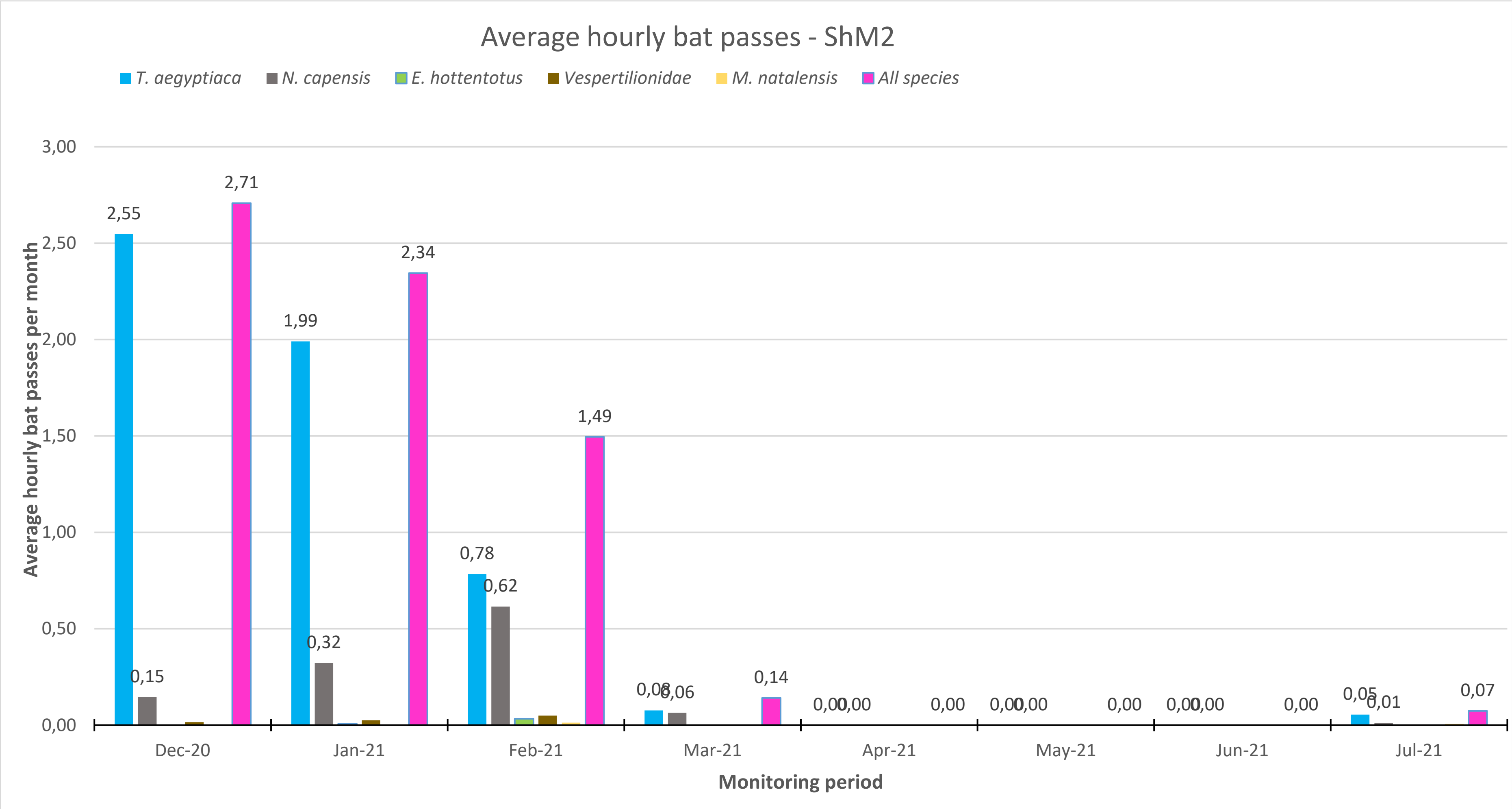


Figure 4.7: Average hourly bat passes recorded per month to date by ShM2.

4.4.2 Temporal Distribution

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 (**Figures 4.8 – 4.10**). This may assist in developing mitigation schedules, if required. On Met Mast 1, prominent peaks of activity were present between 12 and 16 January 2021 for *T. aegyptiaca* at 7m and 100m. With another prominent peak on the night of 24 January for the same species also at 100m. A lower, but yet significant, activity peak was recorded from 11 – 15 March 2021 for *T. aegyptiaca* at 7m, 50m and 100m.

Activity peaks for *T. aegyptiaca* were detected on 21 and 22 December 2020 and 5, 6, 13 and 14 January 2021 at ShM1. Very similarly, at ShM2 peaks were detected on 22 December 2020 and 13 and 14 January 2021.

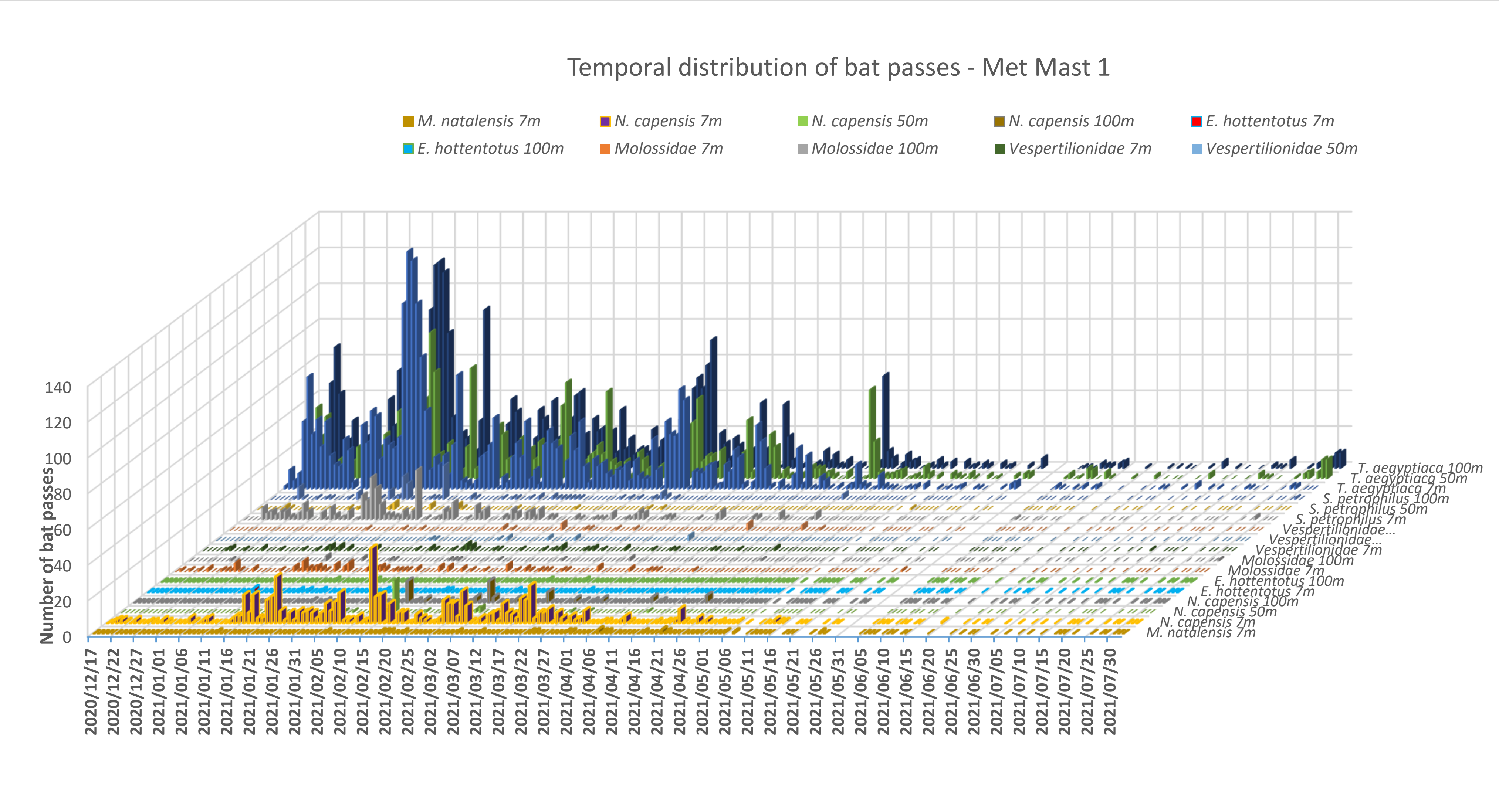


Figure 4.8: Temporal distribution of bat passes detected to date by Met Mast 1.

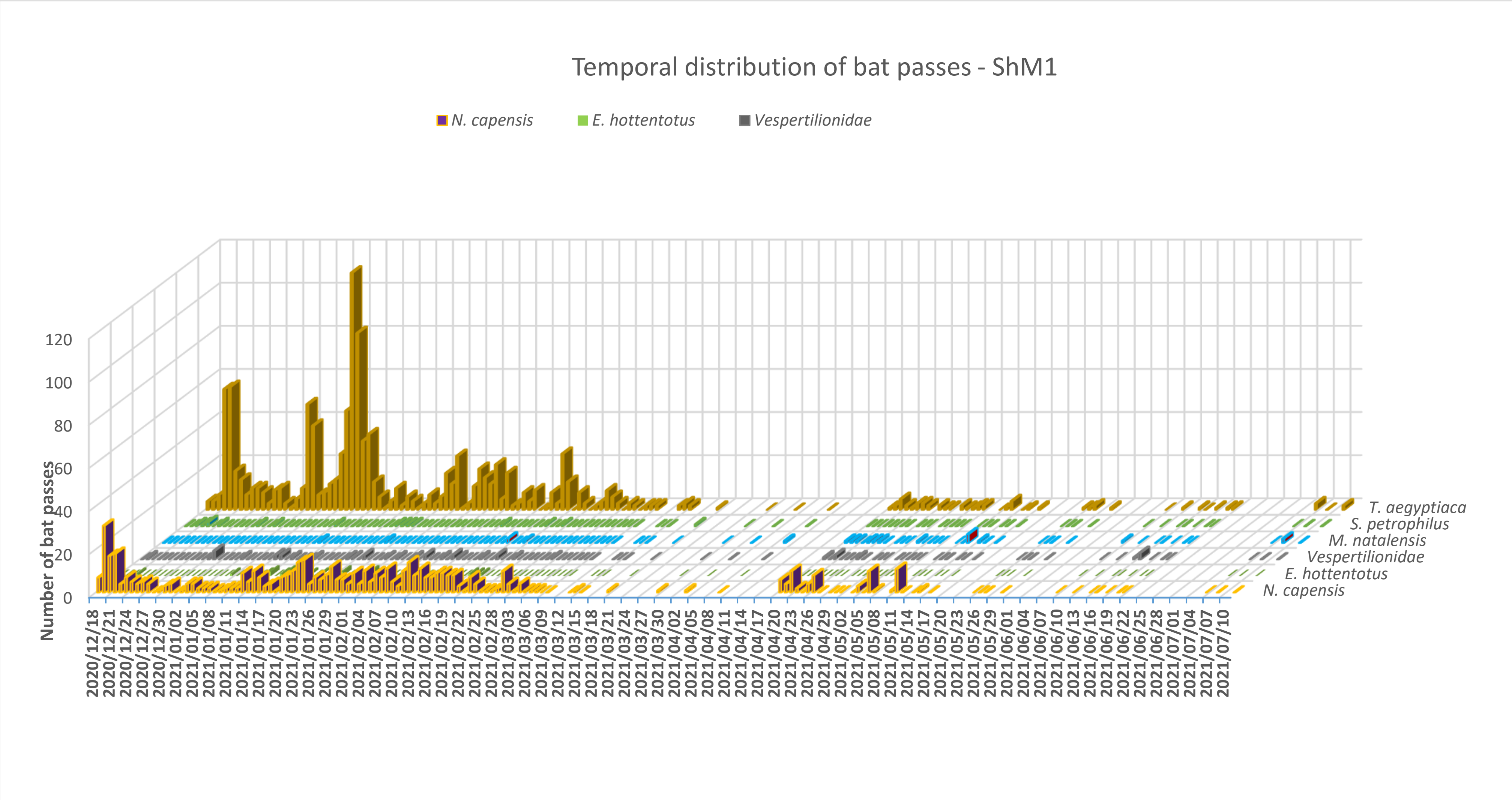


Figure 4.9: Temporal distribution of bat passes detected to date by ShM1.

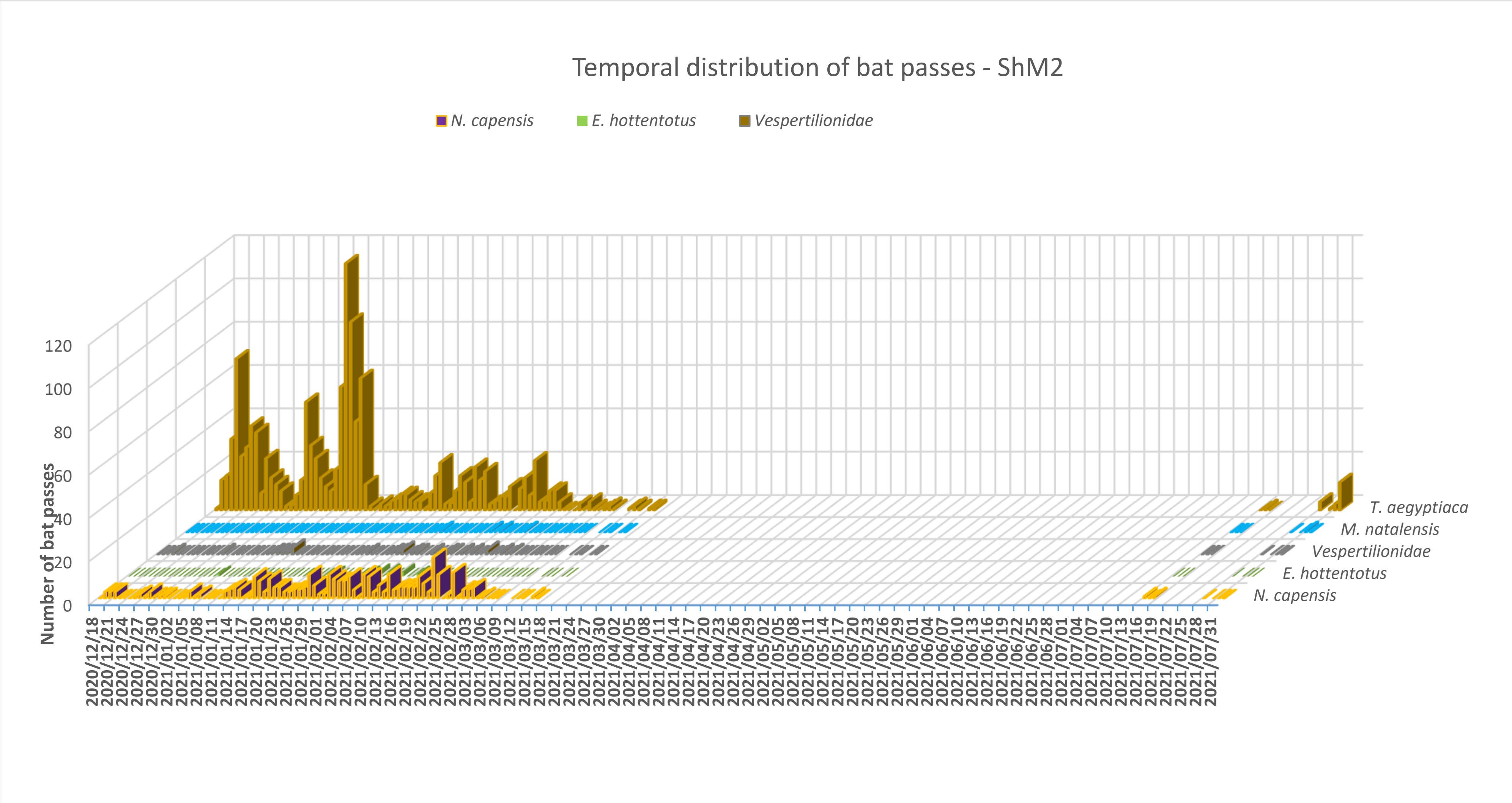


Figure 4.10: Temporal distribution of bat passes detected to date by ShM2.

4.4.3 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 time of emergence and flight time. It is also important to note the environmental factors are never isolated and therefore a combination of the environmental 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 contradict tory effects that the combination of wind speeds and temperatures can have on bat activity.

Wind speed

Some bat species 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.

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 (flies) insects 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.

4.5 Sensitivity Map

Figure 4.11 depicts the sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that are most probable to occur on site. Thus, the sensitivity map is based on species ecology, habitat preferences and bat activity recorded by the passive bat detection systems.

The sensitivities have been classified as high or medium, where high sensitivities and their buffers are no-go zones for turbines and turbine blade overhang (**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, but turbines are allowed to be constructed in medium sensitivity areas.

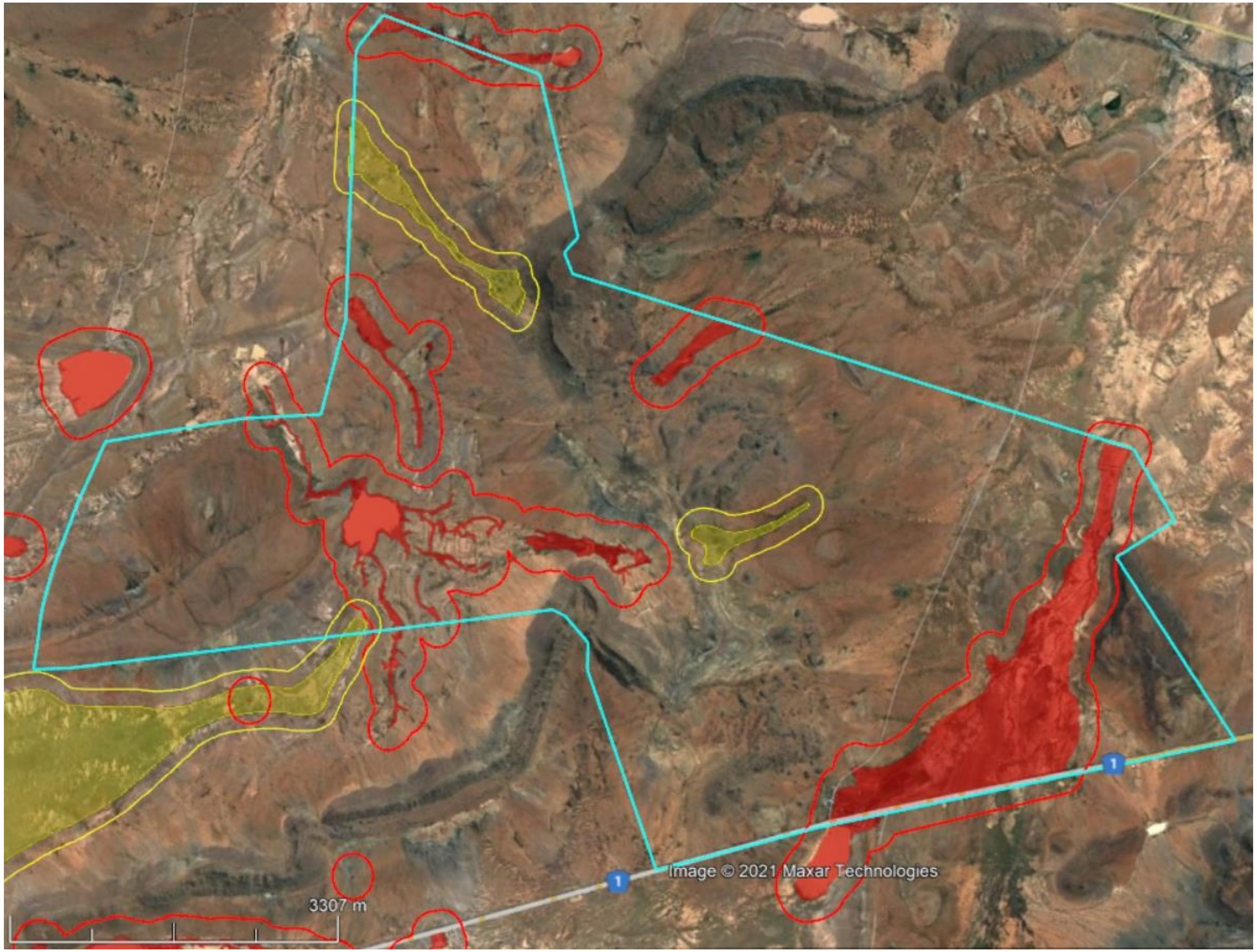
Table 4.2: Description of parameters used in the development of the sensitivity map.

Last revision	October 2021
High sensitivities and 200m buffers	Valley bottom wetlands.
	Pans and depressions.
	Dams.
	Rocky boulder koppies (tors).
	Exposed rocky cliff edges.
	Drainage lines capable of supporting riparian vegetation.
	Other water bodies and other sensitivities such as manmade structures, buildings, houses, barns and sheds.
Moderate sensitivities and 150m buffers	Alluvial plains and washes.
	Seasonal drainage lines.

Table 4.3: Description of sensitivity categories and their significance in the sensitivity map.

Sensitivity	**Description**

High Sensitivity and its buffers	Areas that are deemed critical for resident bat populations, capable of elevated levels of bat activity and support greater bat diversity/activity than the rest of the site. These areas are ‘no-go’ zones and turbines may not be placed in these areas and their buffers. Turbine blades (rotor swept diameter) also may not intrude into high sensitivity buffers.
Medium Sensitivity and its buffers	Areas of foraging habitat or roosting sites considered to have significant roles for bat ecology. Turbines are allowed within these areas and their buffers, but 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 due to seasonal bat activity fluctuations.



High bat sensitivity area
High bat sensitivity 200m buffer

Moderate bat sensitivity area
Moderate bat sensitivity 150m buffer

Figure 4.11: Bat sensitivity map of the site, site area indicated in a blue boundary. Sensitivity polygons are provided in .KML format with this report.

5 IMPACT IDENTIFICATION

Tables 5.1 – 5.4 below indicate the identified impacts associated with the proposed Angora Wind Farm during the construction and operational phases. No significant impacts are identified for the decommissioning phase. No specific gaps in knowledge exists for a specific impact, that can be filled by the EIA phase bat study. The EIA phase will simply improve confidence on the current identified impacts and allow for impact assessment ratings of each impact.

5.1 Construction phase

Table 5.1: Description of impact: foraging habitat destruction.

FORAGING HABITAT DESTRUCTION			
Issue	Nature of Impact	Extent of Impact	No-Go Areas
Potential loss of bat foraging habitat	**<u>Direct impacts:</u>** » Loss of habitat will potentially lead to a reduction in bat insect prey numbers. **<u>Indirect impacts:</u>** » A reduction of insect prey numbers may lead to increased competition for food resources and lowered carrying capacity of the general area.	**Site**	**As per the sensitivity map**
Description of expected significance of impact: Considering the relatively low area footprint of the proposed WEF, the destruction of foraging habitat is not expected to be of a high significance.			
Recommendations with regards to possible mitigations: » Adhere to the bat sensitivity map. » Rehabilitate areas disturbed during construction, such as temporary construction camps and laydown yards.			

Table 5.2: Description of impact: Bat roost disturbance/destruction.

BAT ROOST DISTURBANCE/DESTRUCTION			
Issue	Nature of Impact	Extent of Impact	No-Go Areas
Potential disturbance/destruction of bat roosts	**<u>Direct impacts:</u>** » Loss of bat roosts can lead to direct mortalities of bats utilising the roost.	**Site**	**As per the sensitivity map**

	Indirect impacts: » A reduction of available roosting space may lead to increased competition for roosting areas and lowered carrying capacity of the general area.		
Description of expected significance of impact: Bat roost destruction can result in direct mortalities of bats utilising the roost, thereby potentially causing an impact of high significance. Mitigation is achievable.			
Recommendations with regards to possible mitigations: » Adhere to the bat sensitivity map. » Minimise blasting and earthworks.			

5.2 Operational phase

Table 5.3: Description of impact: Increased bat mortality due to light pollution.

INCREASED BAT MORTALITY DUE TO LIGHT POLLUTION			
Issue	Nature of Impact	Extent of Impact	No-Go Areas
Increased bat mortality due to light pollution	**Direct impacts:** » Increased lights at turbine or buildings near turbines can cause increased bat mortalities. **Indirect impacts:** » Increased mortalities of only certain species that readily forages around lights, can alter species composition dynamics in a population.	**Site**	**As per the sensitivity map**
Description of expected significance of impact: The significance can be high by significantly increasing the probability of bat mortalities, if lights are placed on turbines or near turbines. Artificial lighting can attract insects and thereby bats foraging on the insects, that will increase the probability of these bats to be killed by moving turbine blades.			
Recommendations with regards to possible mitigations: » Adhere to the bat sensitivity map. » Use lights with passive motion sensors that only switch on when a person/vehicle is nearby, if possible for safety and security reasons. » All floodlights must be down-hooded to minimise light pollution.			

Table 5.4: Description of impact: Bat mortality due to moving turbine blades.

BAT MORTALITY DUE TO MOVING TURBINE BLADES			
Issue	Nature of Impact	Extent of Impact	No-Go Areas
Bat mortality due to moving turbine blades.	**Direct impacts:** » Bats can be killed by moving turbine blades. **Indirect impacts:** » Prolonged bat mortalities in a population can lead to lowered breeding rates and loss of genetic diversity.	**Regional**	**As per the sensitivity map**
Description of expected significance of impact: The significance can be very high by causing direct bat mortalities over a prolonged period for the lifetime of the facility.			
Recommendations with regards to possible mitigations: » Adhere to the bat sensitivity map. » If bat mortalities ae found to be unsustainably high during the operational study, a curtailment mitigation schedule may need to be implemented. » Refer to **Section 6**.			

6 POSSIBLE MITIGATION MEASURES

The most effective and required method of mitigation can be determined from preconstruction acoustic bat activity data, climatic data and the results from the operational bat mortality monitoring. The operational bat mortality monitoring will determine the need for mitigation. And if it's required, the specific turbines to be mitigated, in combination with the data from the preconstruction and operational studies, will enable a detailed mitigation schedule to be implemented as needed.

Additional to mitigation by location of turbines (adhering to a bat sensitivity map), other options that may be utilised when necessary include curtailment and acoustic deterrents. These options are discussed in more detail below:

Curtailment that increases cut-in speed:

The activity levels of South African bats generally decrease in weather conditions with increased wind speeds. But, 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 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.

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.

Minimizing 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 Impact Assessment Scoping Report considered information gathered from three site visits, 6 months of passive recordings, literature, and satellite imagery. The passive data indicates that the two bat species most likely to be impacted on by the proposed wind farm are *Neoromicia capensis* and *Tadarida aegyptiaca*. 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.

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.

Turbines within Moderate Bat Sensitivity buffers have a higher likelihood in some instances that mitigation measures may need to be applied to them. However, if the impact during operation from any of the Angora WEF turbines is determined to be above acceptable thresholds, then mitigation measures may need to be applied to these turbines regardless of where they are situated.

Met Mast 1 displayed the highest average hourly bat activity at 3.69 in January 2021 for *T. aegyptiaca* at 100m, with an average of 4.76 for all species at 7m also in January 2021. Both short masts displayed the highest average hourly bat passes in December 2020, with ShM2 having detected marginally higher activity than ShM1.

The yearly average of average hourly bat passes, at 100m on Met Mast 1, is 1.4 bat passes per hour. According to MacEwan *et al.* (2020), for the Nama Karoo ecoregion it's considered to be bat activity levels indicating a high risk of bat mortalities. Therefore, the probability of active mitigations being required during operation is high.

The preconstruction bat monitoring is still ongoing and should continue until 12 months of passive bat activity data has been gathered, which will provide comparative bat activity and species assemblages across all seasons as well as various habitats, terrain and/or areas of the site. The data to be gathered in the remainder of the 12-month assessment forms part of the EIA study, and therefore the EIA plan of study requires the completion of the 12-month preconstruction study. If the proposed wind farm 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, and by considering the bat activity and mortality data from the surrounding wind farms pre- and post-construction studies, no reasons have been for the Angora Wind Farm development not to proceed to the EIA phase.

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