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30 July 2018

Proposed amendment to the environmental authorisation for the Kareebosch Wind Energy Facility in the Northern Cape and Western Cape (DEA ref. 14/12/16/3/3/2/807), and the impacts on bats: TURBINE DIMENSIONS

Animalia Consultants (Pty) Ltd) undertook the pre-construction bat monitoring and impact assessment for the Kareebosch Wind Energy Facility (WEF) in 2014. Importantly, it must be stated that there have not been any material changes on site that would change the diversity and / or population of the bats previously recorded in the area. Therefore, the data collected in the original pre-construction monitoring study remains valid and sufficient to inform the current proposed amendment of the wind turbine specifications. Kareebosch Wind Farm (Pty) Ltd wishes to undertake an amendment to the turbine specifications originally authorized in the environmental authorization (EA) dated 29th January 2016 and amended on 10 July 2016. The proposed amendments are to allow for the possible use of the newer, larger turbines that are now available in the market place and future turbines currently under development. The original wind turbine specifications within the EA include for wind turbines with a rotor diameter of 140m (blade length of 70m), a hub height of 100m and a wind turbine output capacity of 2MW to 3.3 MWs each. The current amendment is proposing an increase to a maximum rotor diameter of 160m (increase the blade length to 80m), increase the hub height to up to 125m and to increase the wind turbine output capacity to between 2MW to 5.5MW. These changes are summarized in Table 1 which also indicates the minimum rotor swept height above ground. Although the probability is much higher for the larger dimensions to be used, the original authorized dimensions are still possible and therefore considered as the minimum in the range of possible dimensions.

Bat activity was significantly higher at 10m than at 50m during the pre-construction assessment, therefore the original wind turbine dimension's rotor swept height above ground is considered as a worst-case scenario.

Table 1: Originally authorized as well as proposed amended turbine dimensions.

Aspect	Original EA	Amendment
Rotor diameter	140m	160m
Hub height	100m	125m
Lowest rotor swept height above ground	30m	45m

The advantage of the proposed amendment is that it will increase the rotor swept height above ground and therefore decrease the likelihood of impacts on bats, but the disadvantage is that it will also result in a larger airspace of moving blades. Although the larger airspace of moving blades is in a lower risk zone and therefore the proposed amendment does not influence risk levels enough to change significance ratings in the impact assessment as assessed during the EIA process. However, the larger turbine dimensions are preferable in keeping the likelihood of impacts on bats to a minimum. The mitigation and management measures specified in the EIA is sufficient and remain unchanged.

No additional impacts as a result of the proposed amendments to the turbine specifications are anticipated on bats. From a bat perspective, the proposed changes will result in no (zero) changes to the significance rating within the original bat impact assessment report that was used to inform the approved EIA. In addition to this, no new mitigation measures are required. The proposed amendments can therefore be supported provided that the recommended mitigation measures as per the original bat pre-construction monitoring report (dated 2014) are adhered to.

If there are any queries, please do not hesitate to contact me.

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Final Report of a 12 Month Long Term Preconstruction Bat Monitoring

- For the proposed Karreebosch Wind Energy Facility, Northern Cape

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July 2015

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Independence:

Animalia Zoological & Ecological Consultation CC has no connection with the developer. Animalia Zoological & Ecological Consultation CC is not a subsidiary, legally or financially of the developer; remuneration for services by the developer in relation to this proposal 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 (NEMBA), 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 additional to those listed as Threatened or Protected.
- NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA), Act 107 of 1998.
  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 additional to those listed as Threatened or Protected.
- South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments - Pre-construction (2014).
  Guidance is provided on preparing, planning and implementing bat preconstruction monitoring with respect to wind energy facility developments, survey techniques and interpreting results.

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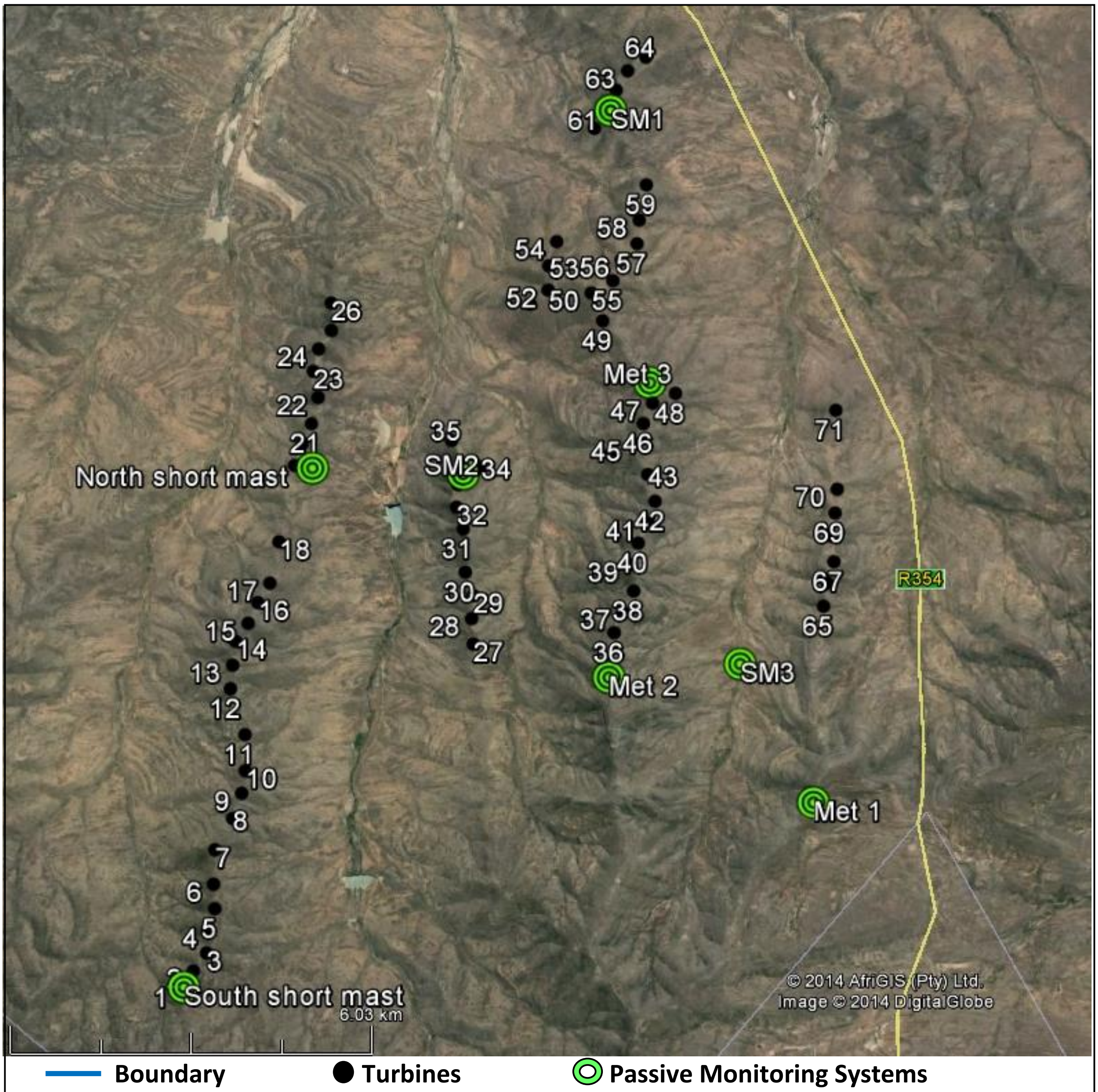


Figure 1: Overview of the Kareebosch Wind Energy Facility turbine layout and passive monitoring system locations.

1 OBJECTIVES AND TERMS OF REFERENCE FOR THE PRE-CONSTRUCTION STUDY

- Study bat species assemblage and abundance on the site
- Study temporal distribution of bat activity across the night as well as the four seasons of the year in order to detect peaks and troughs in activity
- Determine whether weather variables (wind, temperature, humidity and barometric pressure) influence bat activity
- Determine the weather range in which bats are mostly active
- Develop long-term baseline data for use during operational monitoring
- Identify which turbines need to have special attention with regards to bat monitoring during the operational phase and if any turbines, if possible, would ideally be dropped from the final wind farm layout
- Detail the types of mitigation measures that are possible if bat mortalities rates are found to be unacceptable including the potential times/ circumstances which may result in high mortality rates

2 INTRODUCTION

This is the final report for the twelve month pre-construction bat monitoring study at the proposed Karreebosch Wind Energy Facility in the Northern Cape.

Three factors need to be present for most South African bats to be prevalent in an area: (1) availability of roosting space, (2) food (insects/arthropods or fruit), and (3) accessible open water sources. However, the dependence of a bat on each of these factors depends on the species, its behaviour and ecology. Nevertheless, bat activity, abundance and diversity are likely to be higher in areas supporting all three of the above mentioned factors.

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 observations of the site as well as the use of auxiliary sources of information which includes geographic literature and available satellite imagery. Species probability of occurrence based on the above mentioned factors are estimated for the site and the surrounding larger area.

General bat diversity, abundance and activity are determined through the analysis of data obtained from a bat detector mounted within the passive monitoring systems. A bat detector is a device capable of detecting and recording the ultrasonic echolocation calls of bats which may then be analysed with the use of computer software. A real time expansion type bat detector records bat echolocation in its true ultrasonic state which is then effectively slowed down 10 times during data analysis. Thus the bat calls become audible to the human ear, but still retains all of the harmonics and characteristics of the call from which bat species with characteristic echolocation calls can be identified. Although this type of bat detection equipment is advanced technology, it is not necessarily possible to identify all bat species by just their echolocation calls. Recordings may be affected by the weather conditions (i.e. humidity) and openness of the terrain (bats may adjust call frequencies). The range of detecting a bat is also dependent on the volume of the bat call. Nevertheless, it is a very accurate method of recording bat activity.

2.1 The Bats of South Africa

Bats form 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 the wing camber and shape, exploiting functions such as agility and manoeuvrability. This adaptation surpasses the static design of the bird wings in function and enables bats to utilize 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 life styles, 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 bat species 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, within the same population, 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 and according to O'Shea *et al*. (2003), bats may live for up to 30 years, thereby limiting the amount of pups born due to this increased life expectancy. Under natural circumstances, a population's numbers may accumulate over long periods of time. This is due to the longevity and the relatively low predation rate of bats when compared to other small mammals. Therefore, bat populations are not able to adequately recover after mass mortalities and major roost disturbances.

2.2 Relationship between 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). Bat mortalities due to turbines have been attributed to be caused by direct impact with the blades and by barotrauma (Baerwald *et al*. 2008). Barotrauma 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). Rollins *et al.* (2012) carried out a histopathological study to assess whether direct collision or barotrauma was the major cause of mortality. They found an increased incidence of fractures, external lacerations and features of traumatic injury (diaphragmatic hernia, subcutaneous hemorrhage, and bone marrow emboli) in bats killed at wind farms. 73% of bats had lesions consistent with traumatic injury whereas there was a 20% incidence of ruptured tympana, a sensitive marker of barotrauma in humans. Thus the data of this study strongly suggests that traumatic injury from direct collision with turbine blades was the major cause of bat mortality at wind farms and barotrauma is a minor etiology.

Additionally, it has been hypothesized that barotrauma causes mortality only if the bat is within a very short distance of the turbine blade tip such that collision with the blades is a much more likely cause of death.

A study conducted by Arnett (2005) recorded a total of 398 and 262 bat fatalities in two surveys at the Mountaineer Wind Energy Centre in Tucker County, West Virginia and at the Meyersdale Wind Energy Centre in Somerset County, Pennsylvania, respectively. These surveys took place during a 6 week study period from 31 July 2004 to 13 September 2004. In some studies, such as that taken in Kewaunee County (Howe *et al.* 2002), bat fatalities were found exceed bird fatalities by up to three-fold.

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 the turbine, also encouraging the presence of bats. The presence of lights on wind turbines have also been identified as possible causes for increased bat fatalities for non-cave roosting species. This is thought to be due to increased insect densities that are attracted to the lights and subsequently encourage 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 and the swishing sound of the turbine blades has been proposed as possible sources for disorienting bats (Kunz *et al*. 2007). Electromagnetic fields generated by the turbine may also 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.

Whatever the reason for bat fatalities in relation to wind turbines, it is clear that this is a grave ecological problem which requires attention. During a study by Arnett *et al*. (2009), 10 turbines monitored over a period of 3 months showed 124 bat fatalities in South-central Pennsylvania (America), which can cumulatively have a catastrophic long term effect on bat populations if this rate of fatality continues. Most bat species only reproduce once a 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). Mitigation measures are being researched and experimented with globally, but are still only effective on a small scale. An exception is the implementation of curtailment processes, where the turbine cut-in speed is raised to a higher wind speed. 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. It is thought, that by the implementation of such a measure, that bats in the area are not likely to experience as great an impact as when the turbine blades move slowly in low wind speeds. However, this measure is currently not effective enough to translate the impact of wind turbines on bats to a category of low concern.

3 METHODOLOGY

Bat activity was monitored using active and passive bat monitoring techniques. Active monitoring was carried out through site visits with transects made throughout the site with a vehicle-mounted bat detector. Passive detection was conducted through the mounting of passive bat monitoring systems placed on eight monitoring masts on site, specifically the five short 10m masts and three meteorological masts (met masts).

Each monitoring system consisted of an SM2BAT+ time expansion type bat detector that were mounted inside a fiber glass weather-proof box on each of the masts. 12V, 18Ah sealed lead acid batteries powered the systems and 20W solar panels were used to recharge the batteries. Eight amp, low voltage protection regulators and SM2PWR step-down transformers constituted the supporting hardware. Four SD memory cards of a capacity of 32GB each were utilized within each SM2BAT+ detector; this was to ensure substantial memory space with high quality recordings even under conditions of multiple false wind triggers.

One weatherproof ultrasound microphone was mounted at a height of 10 meters on each of the short masts, with two microphones being mounted at 10m and 50m heights on the meteorological masts. These microphones were then connected to the SM2BAT+ bat detectors.

Each detector was set to operate in continuous trigger mode from dusk each evening until dawn (times were correlated with latitude and longitude). Trigger mode is the setting for a bat detector in which any frequency which exceeds 16 kHz and -18 dB will trigger the detector to record for the duration of the sound and 500ms after the sound has ceased, this latter period is known as a trigger window. All signals were recorded in WAC0 lossless compression format. The table below summarizes the above-mentioned equipment set up.

3.1 Site Visits

Site Visit Dates	First visit	3 August - 7 August 2013
	Second Visit	19 - 22 November 2013
	Third Visit	5 – 8 March 2014
	Fourth Visit	26 – 29 May 2014
	Fifth Visit	24 – 27 August 2014
Monitoring Masts		
Met Mast Passive Bat Monitoring Systems	Number on site	3
	Microphone heights	10m; 50m
	Mast South (Met 1)	S 32°52'46.60" E 20°32'27.10”
	Mast Centre (Met 2)	S 32°51'38.27" E 20°30'14.51"
	Mast North (Met 3)	S 32°48'57.38" E 20°30'40.10"
Short Mast Passive Bat MonitoringSystems	Number on site	5
	Microphone height	10m
	SM 1	S 32°46'29.80" E 20°30'13.70"
	SM 2	S 32°49'49.50" E 20°28'36.10"
	SM 3	S 32°51'31.60" E 20°31'38.70"
	North short mast (installed in September 2014)	S 32°48'13.06" E 20°27'11.91"
	South short mast (installed in September 2014)	S 32°54'27.64" E 20°25'37.45"

Monitoring System Specifications	
Type of Passive Bat Detector	SM2BAT+, Real Time Expansion (RTE) Type **(Figure 2)**
Trigger Threshold	>16 kHz, -18 dB
Trigger Window (time of recording after trigger ceased)	2 seconds
Microphone Gain Setting	36 dB
Compression	WAC0
Single Memory Card Size (each systems uses 4 SD cards)	32 GB
Battery Size	12V; 18 Ah
Solar Panel Output	10 Watts
Solar Charge Regulator	8 Amp with low voltage/deep discharge protection
Recording Schedule	Automatically enter trigger mode at sunset each night and end at sunrise each morning (times set according to its latitude and longitude, compensating for seasonal changes). Trigger mode for a half hour,

	for the entire half hour, and then return to ‘sleep’ mode. After ‘sleep’ mode the detector then enters trigger mode for another half hour, the detector then cycles between these half hours of trigger mode for the entire night. This enables a fine resolution of the bat activity for the duration of the night.
Weatherproofing	The microphones were mounted such that they pointed approximately 30 degrees downward to avoid damage from water collecting on the membrane. Microphones were bird proofed, crows have been found to peck at microphones and subsequently destroying them. The bat detectors are mounted inside weather boxes together with all peripherals, to provide protection against the elements.
Recording Schedule	Each detector was set to operate in continuous trigger mode from dusk each evening until dawn (times were automatically adjusted with latitude, longitude and season).
Replacements/ Repairs/ Comments	
First Site Visit	The installation was carried out by the G7 technical team.
Second Site Visit	All batteries (7Ah to 18Ah) and regulators were replaced on all passive monitoring systems.
Third Site Visit	SM 2: The microphone was replaced and microphone cable covering repaired. SM 3: The top segment of the mast was broken, the system was shortened and mic placed lower on the mast. Bat detector was reset
Fourth Site Visit	SM 1: Battery has been disconnected from system, this issue was rectified. SM 2: Microphone foam was replaced. Met mast 2: Left channel (10m) microphone was found disconnected and was reconnected over the site visit. Met mast 3: Solar panel was cleaned.
Fifth Site Visit	All bat monitoring equipment was decommissioned. Equipment faults found during decommission: SM 1 - Battery had lost capacity and was not powering the system. Microphone foam had loosened off. SM 3 - Battery was also loosing capacity and not

	holding its charge. Met mast 1 - Battery connections had been loosened approximately on 21 August 2014 (based on data being collected up to this date) Met mast 2 - 10m microphone was dysfunctional
Auxiliary monitoring methods	
Transects	The EM3 and SM2BAT+ Real time expansion type detector was used to drive transects across the site (where accessible). This provides further insight into the spatial distribution of bat activity.

Please note that on a few occasions during site visits it appeared as though some of the monitoring systems had been tampered with. The following incidents were found over the respective site visits:

- Fourth site visit: Short mast 1 battery was disconnected and thus the system was not being powered. Met mast 1 left channel (10m) microphone was disconnected and thus not recording.
- Fifth site visit: Met mast 1 battery connections had been loosened. Order of the memory cards of the monitoring systems had been swopped around.

Figure 2: SM2BAT+ detector with four 32GB SDHC memory cards

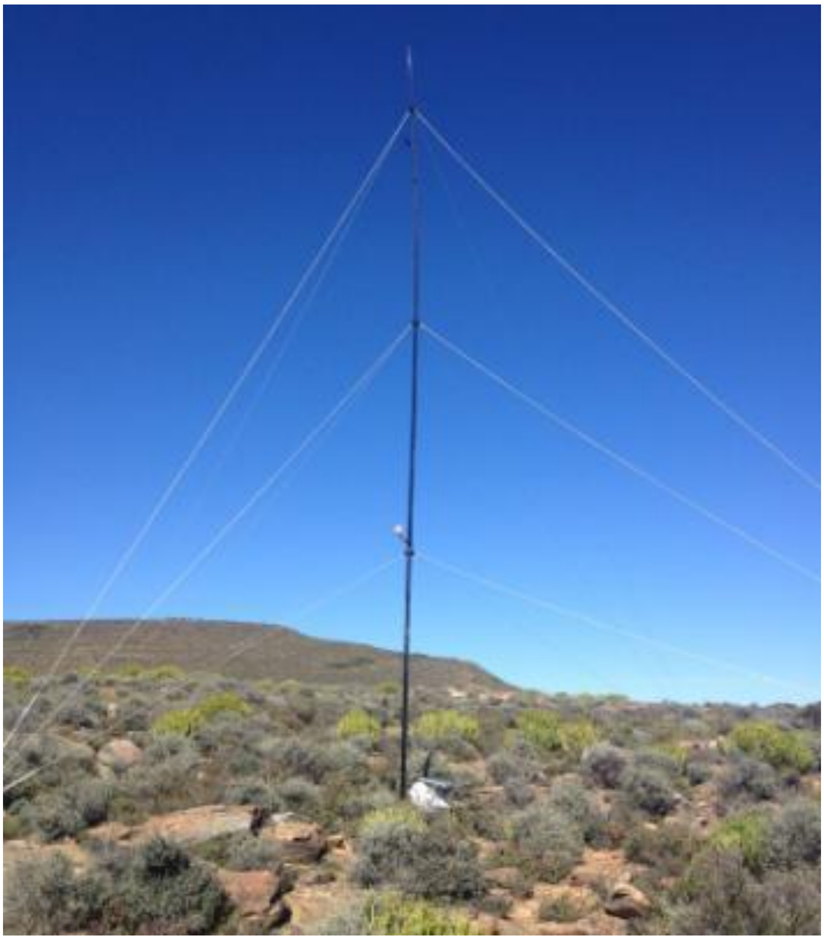


Figure 3: Short mast monitoring system

3.2 Bat Flight Paths

There is a lack of reliable information regarding flight behaviours, flight heights and flight paths of South African bat species. This lack of information pertains to migratory, foraging and commuting behaviours. Thus the information used for preconstruction bat monitoring studies is gleamed from known ecological behaviours of bat species and/or genera. The current extent of knowledge is an indication of the level of risk to South African bats from wind turbines based on broad ecological behaviours. See **Table 1** below taken directly from the South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments - Pre-construction (Third Edition: 2014). This table utilises known flight behaviour to deduce the risk of impact. The authors admittedly record the below table to be the best assumptions of collision risk per bat genera and is not based on evidence work.

Table 1: The likelihood of the risk of fatalities affecting bats

Family / Genus	Relative Status	Likely risk of impact from wind turbine blades (direct collision/barotrauma)
Pteropodidae	Common – restricted distributions Some species known to move large distances	Medium – High
Molossidae	Common – widespread Species fly high enough to come into contact with turbine blades.	High
Emballonuridae	Common – restricted distributions Species fly high enough to come into contact with turbine blades	High
Rhinolophidae	Species with restricted distributions	Low
Hipposideridae	Species with restricted distributions	Low
Nycteridae	Common – widespread and restricted distributions	Low
Miniopteridae	Common – widespread and restricted distributions Some species known to move large distances	Medium – High
Vespertilionidae	Common – widespread and restricted distributions	
Pipistrellus	Species with wide or restricted distributions	Medium
Hypsugo	Wide, but sparse distribution	Low
Nycticeinops	Common throughout restricted distribution	Medium
Neoromicia	Species with wide or restricted distributions	Medium – High
Kerivoula	Species with wide but sparse distributions	Low
Scotoecus	Sparse distributions	Medium – High
Cistugo	Restricted distributions – species endemic to Southern Africa or South Africa	Low
Laephotis	Species with restricted distributions	Low
Glauconycteris	Species with restricted distributions	Medium – High
Myotis	Species with wide or restricted distributions; some species may move large distances	Medium – High
Scotophilus	Some with widespread or restricted distributions	Medium – High
Eptesicus	Wide, but sparse distribution	Medium

The South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments recommend bat monitoring be carried out with the use of passive bat monitoring systems spread across the proposed development area. These acoustic monitoring systems are incapable of tracking flight paths and flight heights of passing bats. This information also cannot be determined by vantage point surveys of visually tracking flight paths. The high risk species demonstrate high flying behaviours, so it is incredibly difficult to plot the flight path of a small mammal flying at night at a minimum height of 50m above the ground. Similarly, this information cannot be obtained via acoustic monitoring transects that are driven across the site because the bat detectors are incapable of recording such sophisticated information.

Radar units would need to be deployed on site to survey the passage rates, flight heights and flight direction of bats. However, this is not currently a requirement of the guidelines. This technology may become necessary if a significant migratory event was detected on site.

The full extent of migratory bat movements across the country is also not well understood. *Miniopterus natalensis* is known to migrate large distances between summer maternity caves and winter hibernation caves. *Myotis tricolor* is also thought to undertake seasonal migrations similar to that of *M. natalensis*. Other migratory species include *Rousettus aegyptiacus, Rhinolophus simulator* and *Eidolon helvum*. The potential barrier effect of wind farms, barotrauma and collisions with turbine blades are great dangers to migratory species. Thus, the pre-construction bat monitoring study specifically aimed at searching for migratory species and migratory events recorded by the passive monitoring systems. One migratory species, *Miniopterus natalensis*, was detected on site, but no migratory events were identified from any of the monitoring systems across the full 12 month study.

Thus, the flight paths and behaviours of bat species on site have not been documented over the duration of the preconstruction monitoring study.

3.3 Assumptions and Limitations

A species list compiled from acoustic detection methods at the locations used, is not comprehensive and exhaustive for the entire site and all habitats on site. Therefore the literature based species probability of occurrence will include more species than detected by the passive systems.

The migratory paths of bats are largely unknown, thus limiting the ability to determine if the wind farm will have a large scale effect on migratory species. This limitation however will be overcome with this long-term sensitivity assessment.

The satellite imagery partly used to develop the sensitivity map may be slightly imprecise due to land changes occurring since the imagery was taken.

Species identification with the use of bat detection and echolocation is less accurate when compared to morphological identification; nevertheless it is still considered an accurate indication of bat activity and their presence with no harmful effects on bats being surveyed.

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.

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.

Costly radar technology would be required to provide more quantitative data on actual bat numbers as well as spatial distribution of multiple bats.

4 RESULTS AND DISCUSSION

4.1 Land Use, Vegetation, Climate and Topography

The site is mainly situated across 2 different vegetation units namely, Koedoesberge-Moordenaars Karoo and Central Mountain Shale Renosterveld. However, the northern and eastern regions of the site also cover relatively small sections of the Tanqua Escarpment Shrubland and Tanqua Wash Riviere vegetation units (**Figure 5**).

The **Koedoesberge-Moordenaars Karoo** vegetation unit consists of a slightly undulating to hilly terrain covered by low succulent scrub and dotted by scattered tall shrubs and patches of 'white' grass on the plains. Geology is mostly mudstone with shale and sandstone of the Adelaide Subgroup, Permian Waterford Formation and other Ecca Group Formations. This type of geology results in the presence of shallow, skeletal soil. Rainfall is bimodal, with one peak occurring in July/August and a further peak over March and April. Mean annual precipitation is 200mm and mean annual temperature being 16^{o}C.

Koedoesberge-Moordenaars Karoo is of the least threatened conservation category with a small portion transformed and no serious alien vegetation invasions recorded (Mucina and Rutherford, 2006).

The **Central Mountain Shale Renosterveld** vegetation unit is found on the southern and south-eastern slopes of the Klein-Roggeveldberge and Komsberg below the Roggeveld section of the Great Escarpment. The landscape consists of slopes and broad ridges of low mountains and escarpments. The vegetation is tall shrubland dominated by renosterbos and large suites of mostly non-succulent karoo shrubs. The vegetation unit falls over mudstone and sandstone of the Adelaide Subgroup with mostly clayey soil. Climate is arid to semi-arid with a mean annual precipitation of 290mm that falls relatively evenly across the year. Mean daily maximum and minimum temperatures are 29.9^{o}C and 0.9^{o}C for January and July (respectively).

The Central Mountain Shale Renosterveld is of least concern conservation status with approximately 1% of the unit transformed. None of the unit is currently under statutory or private protection (Mucina and Rutherford, 2006).

The **Tanqua Escarpment Shrubland** vegetation unit occurs in a narrow belt on northwest-facing slopes of the Klein-Roggeveld berge and on the west and southwest-facing slopes of the Roggeveld Escarpment. The landscape consists of steep flanks below an escarpment overlooking a basin. Vegetation is mostly medium size succulent shrubs. The unit falls over mud rock of the Adelaide Subgroup and Permian Volksrust Formation. The area experiences a winter rainfall regime with peaks occurring in June – August. Mean annual temperature is nearly 16ºC.Conservation status is least threatened with no visible signs of transformation or invasion by alien plant species. Small portion of the vegetation unit is statutorily conserved in the Tankwa Karoo National Park (Mucina and Rutherford, 2006).

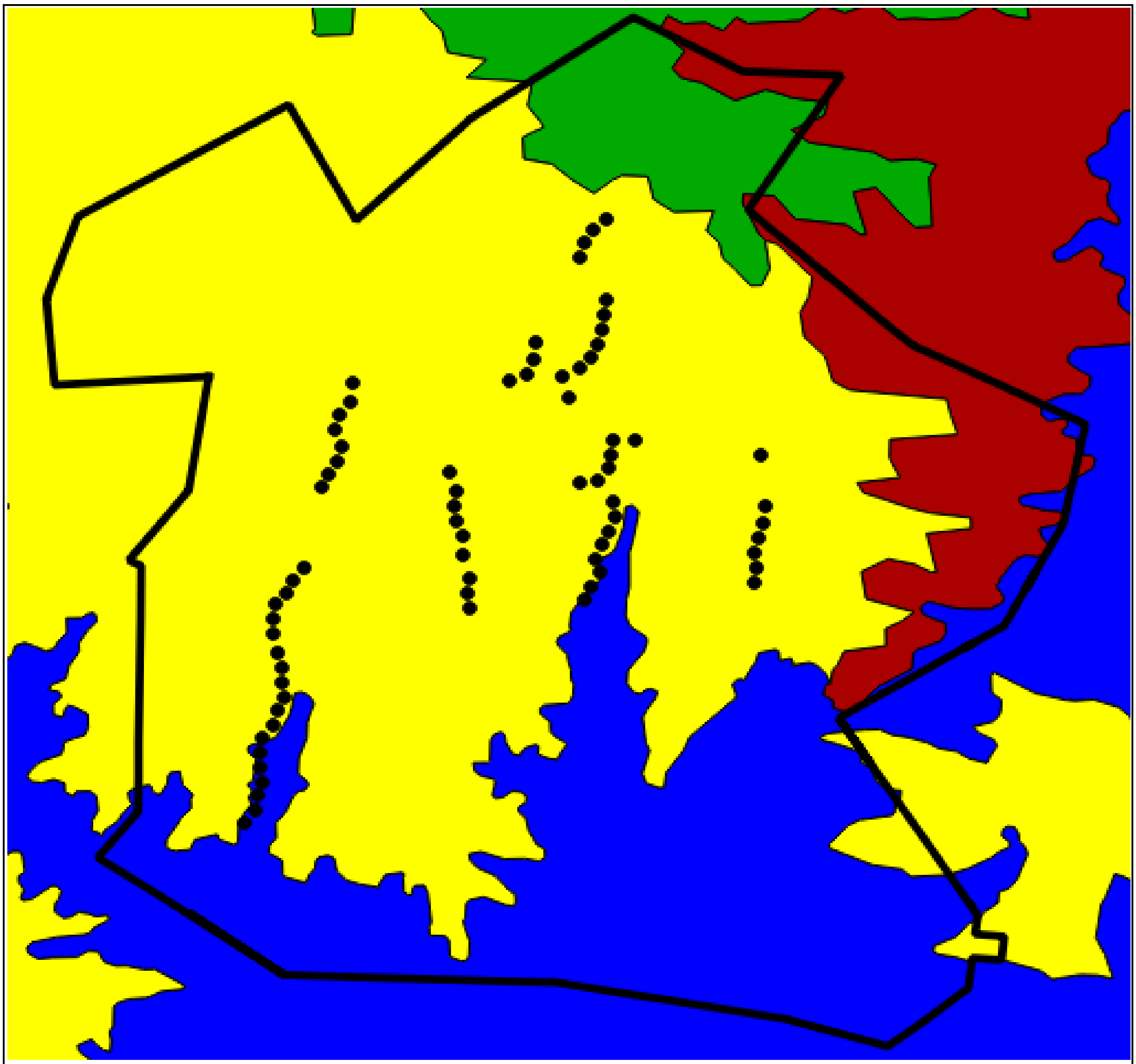
Tanqua Wash Riviere vegetation occurs in the Western and, to a lesser extent, Northern Capes and consists of Alluvia of the Tankwa and Doring rivers. The deeply incised valleys of intermittent rivers support various succulent shrubs alternating with *Acacia* gallery thickets. This vegetation unit occurs upon broad quaternary alluvial floors and drainage lines made up of sediments eroded from the Karoo Supergroup. The area receives a low overall MAP of 162mm which falls mainly in autumn-winter and overall mean annual temperature is >17ºC.The unit's conservation status is least threatened with about 3% already transformed for cultivation and dam-building. About 13% is statutorily conserved in the Tankwa National Park and some private reserves (Mucina and Rutherford, 2006).

The table serves as an indicator of the likelihood of use of each vegetation unit by bats. The potential was graded based on literature, observation, findings on site and considering site modifications from the natural habitat state (farm structures, irrigated pastures).Note that no roosts were found on site; however the roosting potential of the vegetation units is provided as an indicator of the presence of unknown roosts, and of the potential for formation of future roosts.

Table 1: Potential of the vegetation to serve as suitable roosting and foraging spaces for bats

Vegetation Unit	Foraging Potential	Roosting Potential	Comments
Central Mountain Shale Renosterveld	Moderate	Moderate - High	Rocky nature of hill slopes shows high potential for roosting space. Sheltered valleys and associated vegetation may be useful foraging habitat.
Koedoesberge-	Moderate	Moderate	Hilly terrain provides useful

Moordenaars Karoo			roosting crevices. Vegetation present may be used for foraging purposes by both open air foragers and clutter/clutter-edge foragers.
Tanqua Escarpment Shrubland	Moderate	Moderate - High	The steep slopes may have high potential for crevice-roosting. Medium-sized succulent vegetation may be used for foraging by both open air foragers and clutter/clutter-edge foragers.
Tanqua Wash Riviere	Moderate-High	Low-Moderate	The *Acacia* thickets may provide roosting space for crevice-roosters. The deep valleys and associated vegetation is likely useful foraging habitat for clutter/clutter-edge foragers.



Koedoesberge-Moordenaars Karoo	Central Mountain Shale Renosterveld
Tanqua Escarpment Shrubland	Tanqua Wash Riviere
Turbine layout	

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Figure 4: Vegetation units on the site (Mucina and Rutherford, 2006)

4.2 Literature-based species probability of occurrence

"Probability of Occurrence" is assigned based on consideration of the presence of roosting sites and foraging habitats on the site, compared to literature described preferences. The probability of occurrence is described by a percentage indicative of the expected numbers of individuals present on site and the frequency at which the site will be visited by the species (in other words the likelihood of encountering the bat species).

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 Sowler and Stoffberg (2014) based on species distributions, altitudes at which they fly and distances they traverse; and assumes a 100% probability of occurrence. The ecology of most applicable bat species recorded in the vicinity of the site is discussed below.

Table 2: Bat species that may be roosting or foraging on the study area and the possible site specific roosts (Monadjem *et al.* 2010)

Species name	Common Name	Probability of occurrence (%)	Conservation status	Possible Roosting Sites Occupied in Study Area	Foraging Habits (indicative of possible foraging sites in study area)	Likely Risk of Impact (Sowler and Stoffberg, 2014)
Rhinolophus clivosus	Geoffroy's horseshoe bat	20-30	Least Concern	Culverts, rock hollows and any other suitable hollow. Usually roosts in caves and mine adits, no known caves or mine adits close to site,	Clutter forager, may be found near dwellings and in denser vegetative valleys.	Low
Nycteris thebaica	Egyptian slit-faced bat	20-30	Least Concern	Hollows and culverts under roads. No known caves or mine adits close to site,	Clutter forager, may be found near dwellings and in denser vegetative valleys.	Low
Tadarida aegyptiaca	Egyptian free-tailed bat	**90-100 Confirmed**	Least Concern	Caves, rock crevices, under exfoliating rocks, in hollow trees, and behind the bark of dead trees	Open-air forager	**High**
Sauromys petrophilus	Robert's flat-headed bat	**90-100 Confirmed**	Least Concern	Narrow cracks and slabs of exfoliating rock. Rocky habitat in dry woodland, mountain fynbos or arid scrub.	Open-air forager	**High**
Miniopterus natalensis	Natal long-fingered bat	**90-100 Confirmed**	**Near Threatened**	Cave and hollow dependent, but forage abroad. Also take refuge in culverts and vertical hollows, holes.	Clutter-edge forager	Medium - High
Eptesicus hottentotus	Long-tailed serotine	**90-100 Confirmed**	Least Concern	Roosts in rock crevices	Clutter-edge forager	Medium - High
Myotis tricolor	Temmink'smyotis	40-50	Least Concern	Usually roosts gregariously in caves, and sometimes culverts or other hollows. No known caves or mine adits close to site.	Clutter-edge forager	Medium - High
Neoromicia capensis	Cape serotine	**90-100 Confirmed**	Least Concern	Roosts under the bark of trees and under roofs of houses. Very common bat	Clutter-edge forager	Medium - High

4.3 Ecology of Bat Species that may be Largely Impacted by the Karreebosch WEF

There are five bat species recorded in the vicinity of the site that occur commonly in the area. These species are of importance due to their likelihood of being impacted by the proposed WEF, which is a combination of abundance and behaviour. The relevant species are discussed below.

Miniopterus natalensis

Miniopterus natalensis, also 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 Near Threatened (Monadjem *et al*. 2010).

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*. 2010).

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.* 2010; van der 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 (Sowler and Stoffberg 2014). 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) of the habitat preference for foraging activities of *M. schreibersii* in Southern France showed that urban areas were the most used habitat category (54.0%), followed by open areas (19.8 %), woodlands (15.5%), orchards and parks

(9.1 %), and water bodies (1.5 %). On a finer scale, urban areas and deciduous or mixed woodlands were preferred as foraging habitats (types of artificial lighting effects were unmeasured in the urban areas during this study), followed by crops and vineyards, pastures, meadows and scrublands bordered by hedgerows or next to woodland, orchards, parks and water bodies (Vincent *et al*. 2011). Similar preferences for habitat use and foraging activities of *M. natalensis* in South Africa are expected. Therefore areas of wooded and agricultural habitats were prioritised in the sensitivity maps as *M. natalensis* has a higher vulnerability to mortality from turbines in these areas.

Sowler and Stoffberg (2014) 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.

Neoromicia capensis

Neoromicia capensis is commonly called the Cape serotine and has a conservation status of Least Concern 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 of 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*. 2010).

They are tolerant of a wide range of environmental conditions as they survive and prosper within arid semi-desert 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 (Sowler and Stoffberg 2014).

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 occurs. They give birth to twins during late October and November but single pups, triplets and quadruplets have also been recorded (van der Merwe 1994; Lynch 1989).

Tadarida aegyptiaca

The Egyptian Free-tailed bat, *Tadarida aegyptiaca*, is a Least Concern species as it has a wide distribution and high abundance throughout South Africa. 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*. 2010). This species is protected by national legislation in South Africa (ACR 2010).

They roost communally in small (dozens) to medium-sized (hundreds) groups in rock crevices, under exfoliating rocks, caves, hollow trees and behind the bark of dead trees. *T. aegyptiaca* has also adapted to roosting in buildings, in particular roofs of houses (Monadjem *et al*. 2010).

The Egyptian Free-tailed bat 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*. 2010).

The Egyptian Free-tailed bat is considered to have a High likelihood of risk of fatality by wind turbines (Sowler and Stoffberg 2014). Due to the high abundance and widespread distribution of this species, high mortality rates by wind turbines would be a cause of concern as these species have more significant ecological roles than the rarer bat species. The sensitivity maps are strongly informed by the areas that may be used by this species.

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 (Bernard and Tsita 1995). Maternity colonies are apparently established by females in November (Herselman 1980).

Several North American studies indicate the impact of wind turbines to be highest on migratory bats, however there is evidence to the impact on resident species. Fatalities from turbines increase during natural changes in the behaviour of bats leading to increased activity in the vicinity of turbines. Increases in non-migrating bat mortalities around wind turbines in North America corresponded with when bats engage in mating activity (Cryan and Barclay 2009). This long term assessment will also be able to indicate seasonal peaks in species activity and bat presence.

Eptesicus hottentotus

Eptesicus hottentotus, also known as the Long-tailed serotine, has a conservation category of least concern.

This species occurs widely but sparsely in Southern Africa. It has been recorded from the Northern and Western Cape, east to Lesotho and KwaZulu-Natal, and north to Zimbabwe.

Eptesicus hottentotus roosts in small groups of two to four individuals in caves and rock crevices, suggesting that it may require suitable roosting sites in rocky outcrops. It is a clutter-edge forager. Its diet comprises mainly Coleoptera. No reproductive information is available for southern Africa (Monadjem *et al*. 2010).

The Long-tailed serotine is considered to have a Medium likelihood of risk of fatality by wind turbines (Sowler and Stoffberg 2014). Due to the widespread but sparse distribution of this species.

Sauromys petrophilus

Sauromys petrophilus, Roberts's flat-headed bat, has a conservation category of least concern. This species is widespread and abundant in the arid western parts of Namibia and South Africa, extending south to the Western Cape. There is a separate population in northern South Africa, Zimbabwe and northern Mozambique.

It roosts communally in small groups of up to 10 individuals in narrow cracks and under slabs of exfoliating rock. This species is closely associated with rocky habitats, usually in dry woodland, mountain fynbos or arid scrub.

Sauromys petrophilus has long, narrow wings with high wing loading and intermediate aspect ratio making it adapted to open-air forager strategies. Its diet consists mainly of Diptera, Hemiptera and Coleoptera.

Reproductive information of this bat is currently lacking. The only available information is that pregnant and lactating females have been found in mid-November near Mutoko in northeast Zimbabwe (Monadjem *et al*. 2010).

This species is considered to have a High likelihood of risk of fatality by wind turbines (Sowler and Stoffberg 2014). Due to the widespread distribution of this species and it flies high enough to come into contact with turbine blades.

4.4 Transects

Transect routes were chosen at random using an EM3 RTE detector and an SM2BAT+ detector, the transect routes were repeated over the different site visits. The bat calls recorded by the detector were analysed and the confidence in species identification is high. All weather information was taken from www.worldweatheronline.com for the town of Matjiesfontein, which is approximately 50 kilometres south from the site, in the Western Cape.

4.4.1 First Site Visit

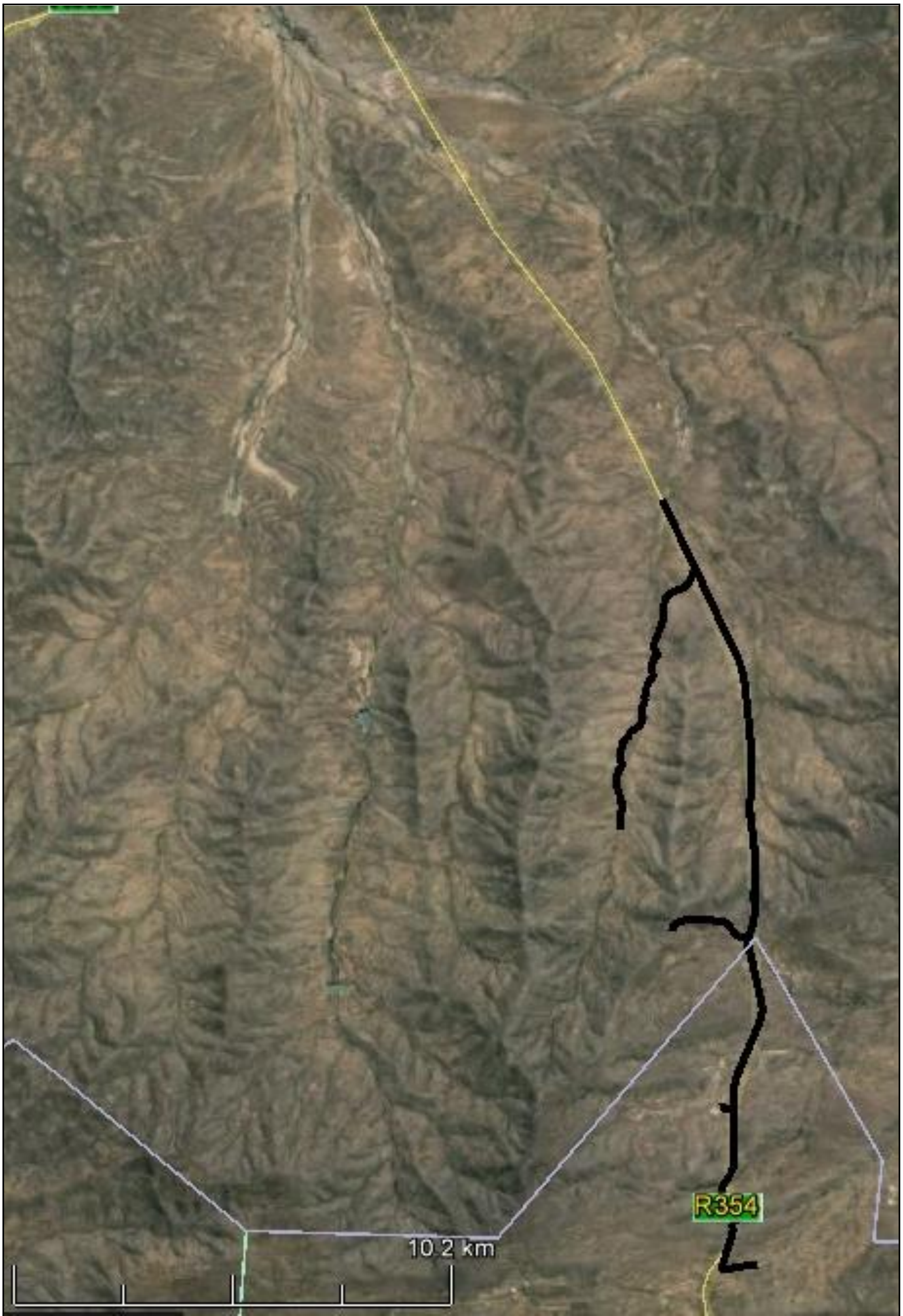
Table 3: Transect survey effort for the first site visit.

TRANSECT NIGHTS	DISTANCE TRAVELLED (km)	DURATION
4 August 2013	64	6 hrs 43 min

Table 4: Climatic conditions during the first site visit.

TRANSECT NIGHT	TEMPERATURE (°C)	PRECIPITATION (mm)	WIND SPEED (km/h)
4 August 2013	9	0	11

No bat echolocation calls were detected during this site visits' transects. This may be due to the low temperatures experienced. A comprehensive transect route on the neighbouring Roggeveld Phase 1 site during the same time period also did not yield any bat calls. Thus indicating that low activity was widespread across the general area of the site and neighbouring sites.



Tracks traversed

Figure 5: Transect route of the first site visit

4.4.2 Second Site Visit

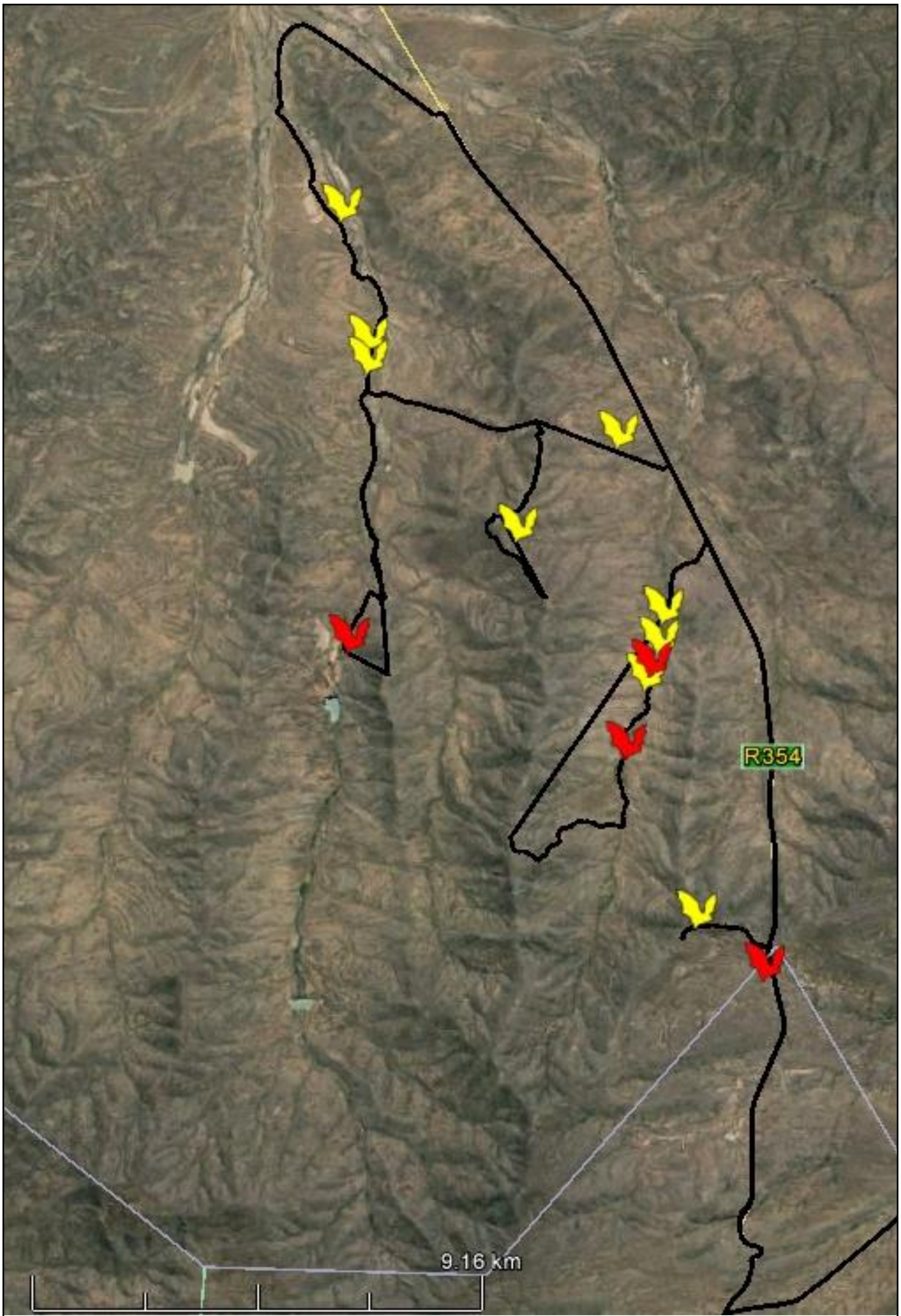
Table 5: Transect survey effort for the second site visit.

TRANSECT NIGHT	DISTANCE	DURATION
19 November 2013	69 km	4 hrs 49min
20 November 2013	93 km	6hrs
21 November 2013	70 km	5hrs14min

Table 6: Climatic conditions during the second site visit.

TRANSECT NIGHT	TEMPERATURE (°C)	PRECIPITATION (mm)	WIND SPEED (km/h)
19 November 2013	16	0.9	20.9
20 November 2013	14	0.1	16
21 November 2013	18	0	9.7

The driven transect was done by C. Kruger and the route was chosen randomly based on location when the sun set. The most activity recorded during the transect was around the lower slopes close to a water source. Only two species were recorded, namely *Tadarida aegyptiaca* and *Neoromicia capensis*.



Tadarida aegyptiaca — Neoromicia capensis — Track traversed

Figure 6: Transect route of the second site visit.

4.4.3 Third Site Visit

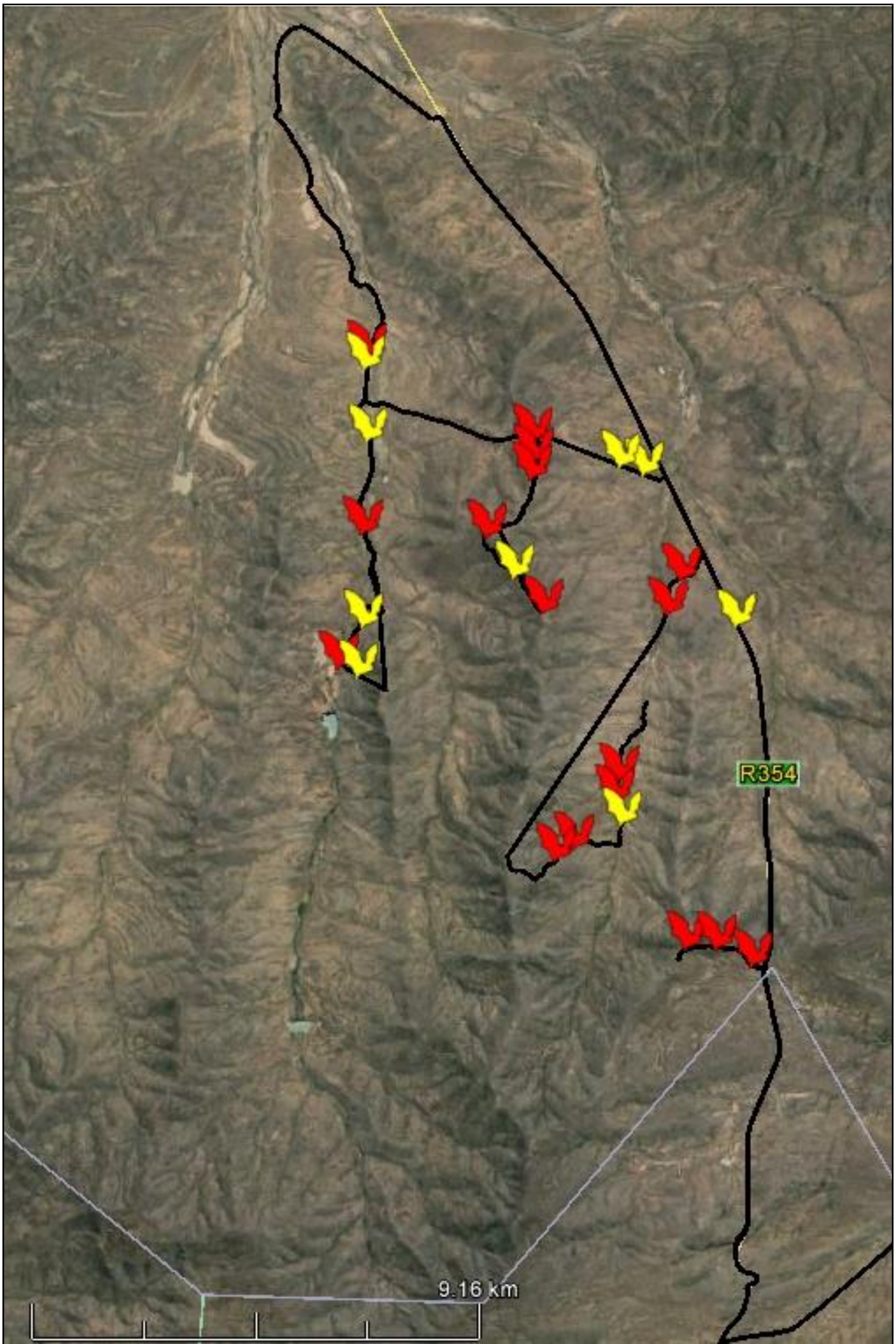
Table 7: Transect survey effort for the third site visit.

TRANSECT NIGHT	DISTANCE	TIME SPENT (hrs)
5 March 2014	62.3km	5hrs15min
6 March 2014	96.3km	6hrs22min
7 March 2014	52.1km	4hrs12min

Table 8: Climatic conditions during the third site visit.

TRANSECT NIGHT	TEMPERATURE (°C)	PRECIPITATION (mm)	WIND SPEED (km/h)
5 March 2014	26	0	6.4
6 March 2014	26	0	9.7
7 March 2014	25	0	11.2

The driven transect was done by C. Kruger and the route was chosen randomly based on location when the sun set. Two species were recorded by the bat detector, namely *Tadarida aegyptiaca* and *Neoromicia capensis* with most activity recorded on the lower slopes compared to the higher lying areas.



Tadarida aegyptiaca — Neoromicia capensis

Track traversed

Figure 7: Transect route of the third site visit.

4.4.4 Fourth Site Visit

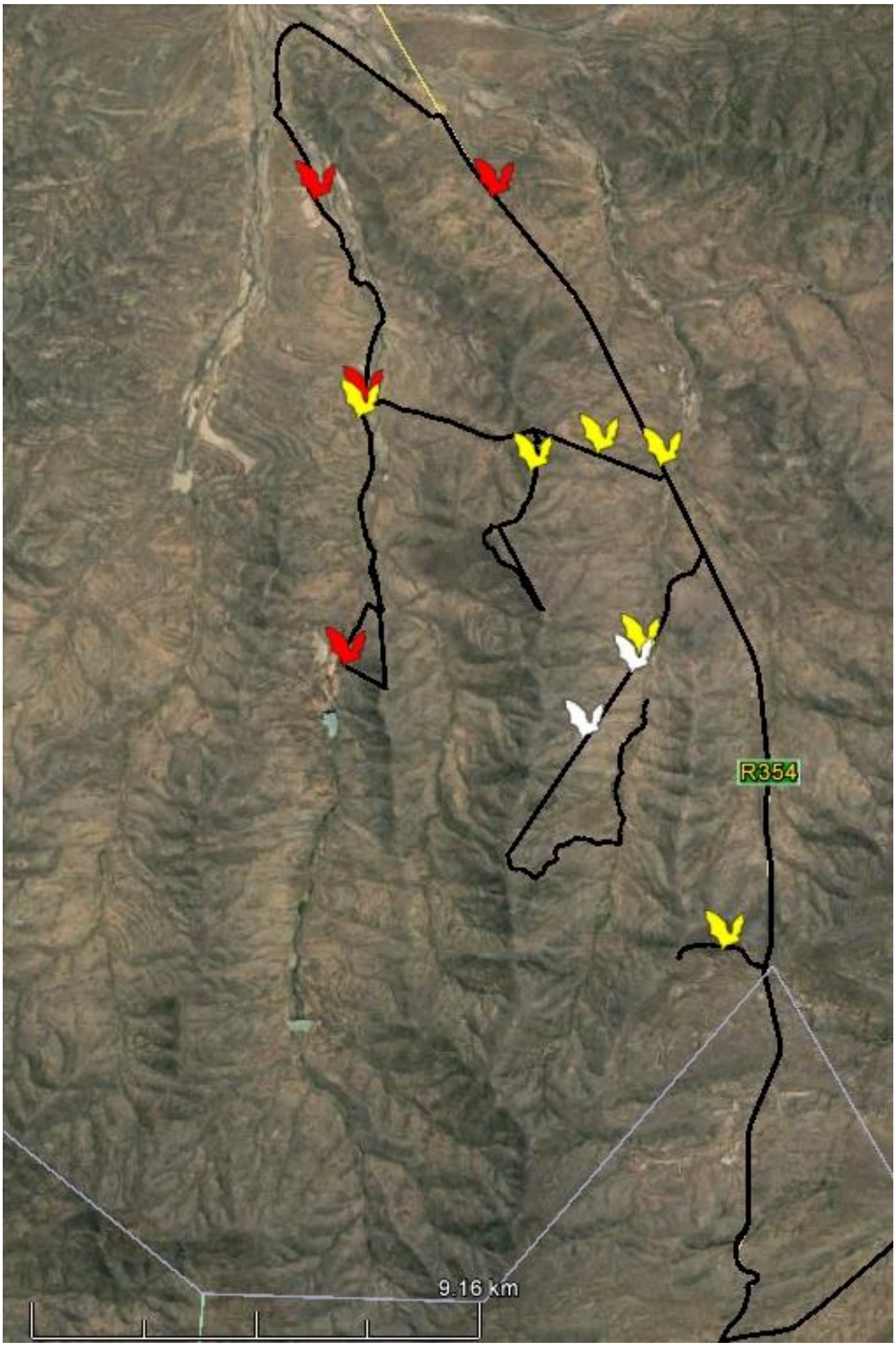
Table 9: Transect survey effort for the fourth site visit.

TRANSECT NIGHT	DISTANCE	TIME SPENT (hrs)
26 May 2014	68km	5hrs20min
27 May 2014	88km	6hrs49min
28 May 2014	28.4km	1hr54min

Table 10: Climatic conditions during the fourth site visit.

TRANSECT NIGHT	TEMPERATURE (°C)	PRECIPITATION (mm)	WIND SPEED (km/h)
26 May 2014	15	0	9.7
27 May 2014	14	0	19.3
28 May 2014	12	0.1	14.5

The driven transect was done by C. Kruger and the route was chosen randomly based on location when the sun set. Three species were recorded by the bat detector, namely *Tadarida aegyptiaca, Neoromicia capensis* and *Miniopterus natalensis,* with most activity recorded on the lower slopes compared to the higher lying areas. A cold front and wet, winter weather conditions were experienced which could account for the lower activity compared to other seasons transects.



Tadarida aegyptiaca *Neoromicia capensis* *Miniopterus natalensis*

Track traversed

Figure 8: Transect route of the fourth site visit.

4.4.5 Fifth Site Visit

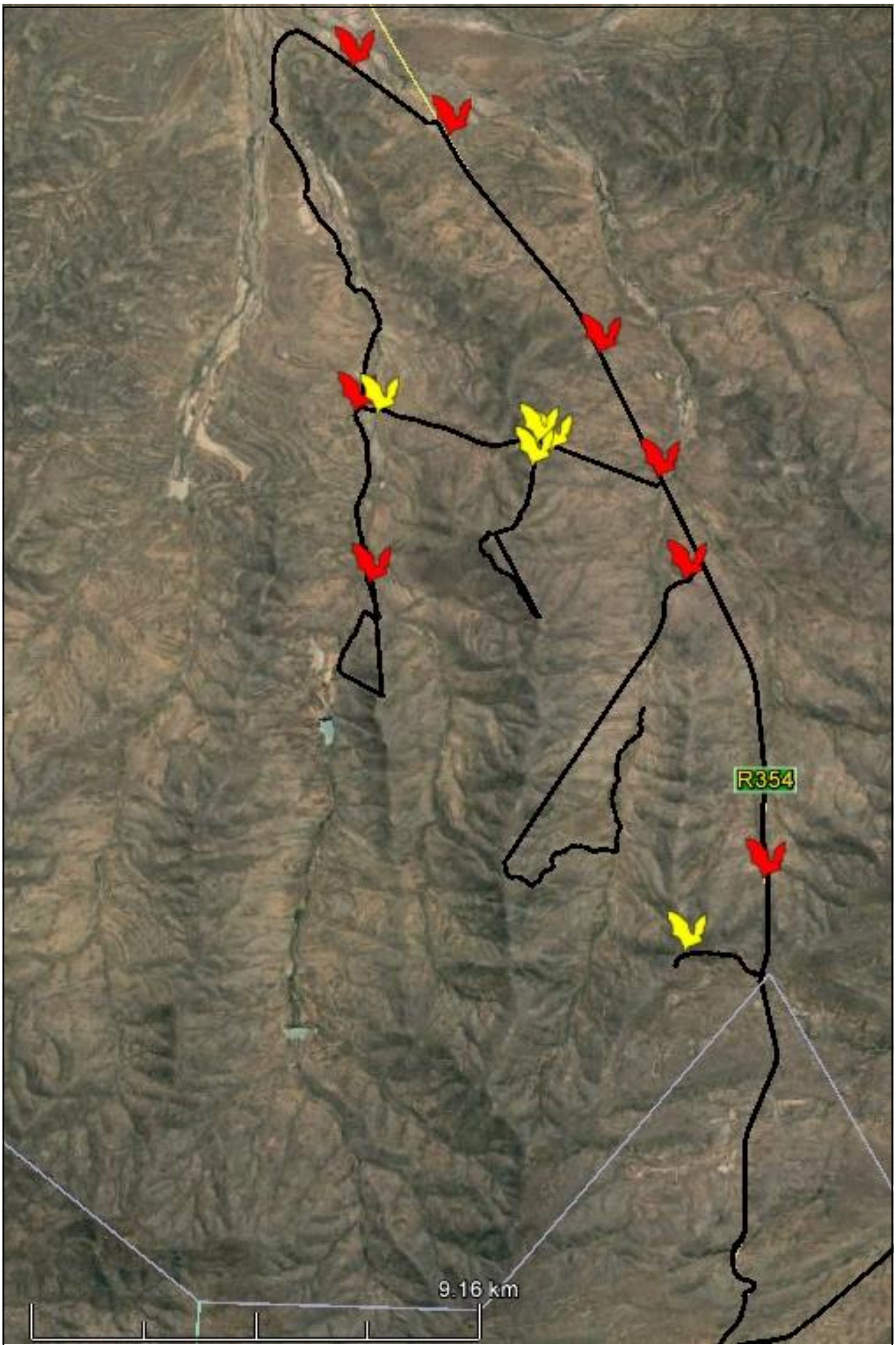
Table 11: Transect survey effort for the fifth site visit.

TRANSECT NIGHT	DISTANCE	TIME SPENT (hrs)
24 August 2014	58.3km	4hrs42min
25 August 2014	45.1km	4hrs20min
26 August 2014	35.9km	2hr32min

Table 12: Climatic conditions during the fifth site visit.

TRANSECT NIGHT	TEMPERATURE (°C)	PRECIPITATION (mm)	WIND SPEED (km/h)
24 August 2014	11	0	8
25 August 2014	12	0	16.1
26 August 2014	12	0	12.9

The driven transect was done by C. Kruger and the route was chosen randomly based on location when the sun set. Two species were recorded by the bat detector, namely *Tadarida aegyptiaca* and *Neoromicia capensis. Tadarida aegyptiaca* was the most abundant species detected over these transects. Prevailing weather conditions could account for the relatively low bat activity.



Tadarida aegyptiaca | Neoromicia capensis | Track traversed

Figure 7: Transect route of the fifth site visit.

4.5 Sensitivity map

Figures 8 - 10 depict the bat sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that are confirmed and most probable to occur on site. Thus the sensitivity map is based on species ecology and habitat preferences. Landscape features important to bats were categorised as high or moderate sensitivity as described in **Table 13** below. Buffers were also applied to these categorised areas as described below. This map can be used as a pre-construction mitigation in terms of improving turbine placement with regards to bat preferred habitats on site.

The results of transect surveys is usually used to inform the sensitivity map. Transects are done to provide insight on the different habitats across the site and to locate specific features/habitats that yield consistently higher bat activity. In such cases, the transect results serve as motivation to demarcate that habitat/feature as bat sensitive. In this case of Karreebosch WEF, the transects unveiled higher activity in valley type terrains.

Last iteration	October 2013
High sensitivity buffer	200m from blade tip to nearest feature of High sensitivity (based on 140m rotor diameter and 100m hub height). On a flat surface the distance from the base of a turbine must be 250m from a sensitivity to maintain 200m from the blade tip (if the sensitivity feature is on ground level), thus a 250m buffer in relation to turbine bases have been applied to all High sensitive features. However, in cases where 250m overlapped with a proposed turbine position, the difference in elevation between the turbine position and sensitivity (at a lower elevation in this case) has been incorporated in the formula which effectively increases that specific turbines hub height (in relation to the sensitivity). Formula used: b=$\sqrt{(200+bl)^2-(hh+ed)^2}$, derived from Mitchell-Jones & Carlin (2009). Where: *b*= horizontal buffer distance to turbine base *bl* = blade length *hh*= hub height *ed*= elevation difference between turbine base and sensitivity
Moderate	100m radial buffer

sensitivity buffer	
Features used to develop the sensitivity map	Drainage lines closest to proposed turbine positions, especially when exposed rock that can be used as roosting space is visible in the drainage line
	Clumps of larger woody plants. These features provide natural roosting spaces and tend to attract insect prey. Mostly in drainage lines
	Most prominent horizontal ridges of exposed rock on hill slopes can offer roosting space.
	Valleys and lower altitudes are expected to offer more sheltered terrain for bat prey (insects) as well as foraging bats.

There are no South African guidelines for the consideration of specific buffer zone distances for bats in relation to wind farms. The following other guidelines have been used to advise buffers.

- Gauteng Department of Agriculture and Rural Development recommend a 500m buffer for natural bat caves and a 200m buffer on conservation important vegetation and habitat features.
- The Eurobats Guidance (Rodrigues *et al.* 2008) proposes a minimum buffer distance of 200m from forest edges.

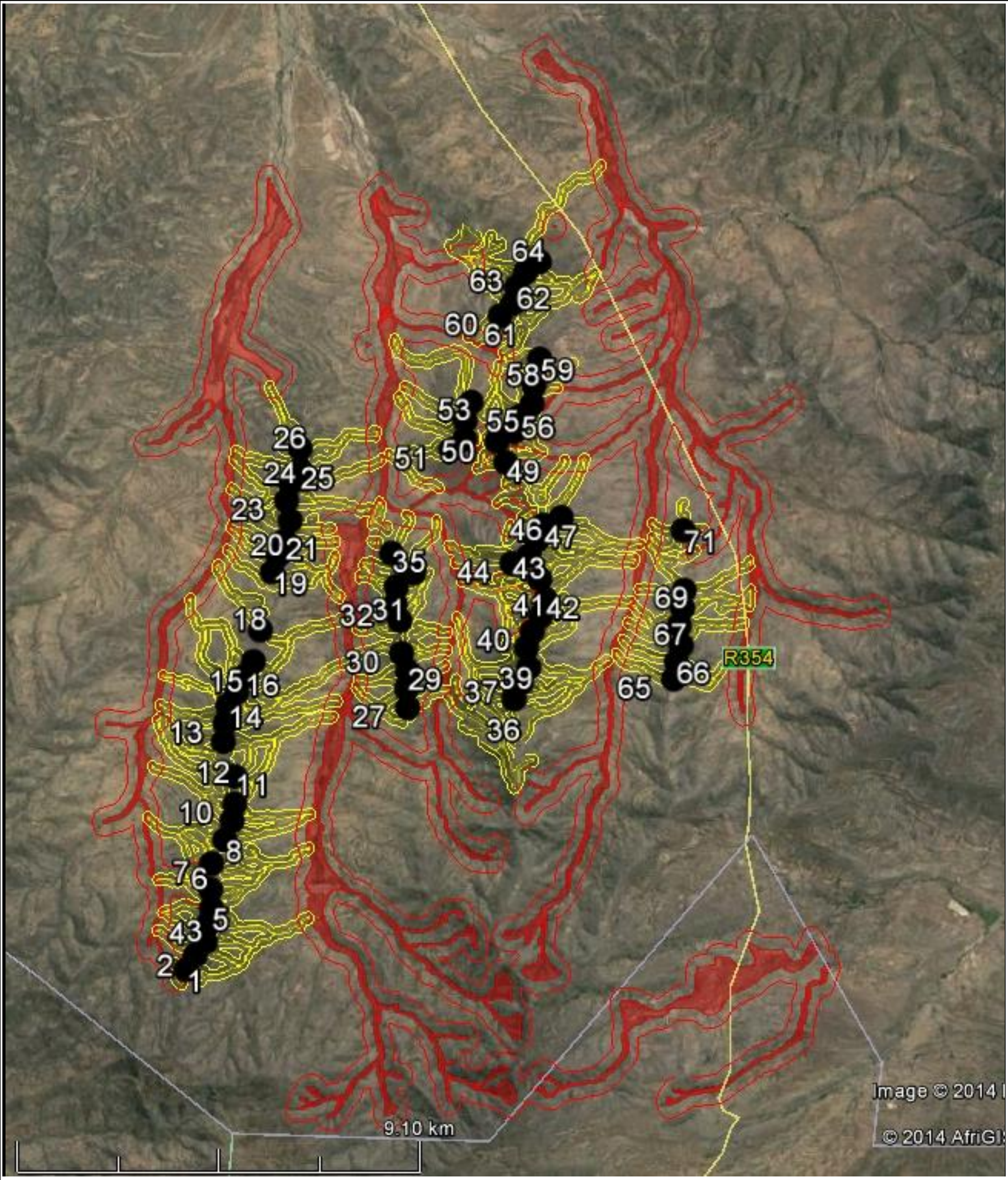
Table 13: Description of sensitivity categories utilized in the sensitivity map

Sensitivity	**Description**
Moderate Sensitivity	Areas of foraging habitat or roosting sites considered to have significant roles for bat ecology, with an expected relative higher risk of impacting on local bats. Turbines within or close to these areas must acquire priority (not excluding all other turbines) during pre/post-construction studies and mitigation measures, if any is needed.
High Sensitivity and their buffers	Areas that are deemed critical for resident bat populations, capable of elevated levels of bat activity and support greater bat diversity than the rest of the site. These areas are 'no-go' areas and turbines must not be placed in these areas.

According to the updated proposed turbine layout, incorporated into the sensitivity map (**Figure 10**), the following turbines are located in potentially sensitive areas:

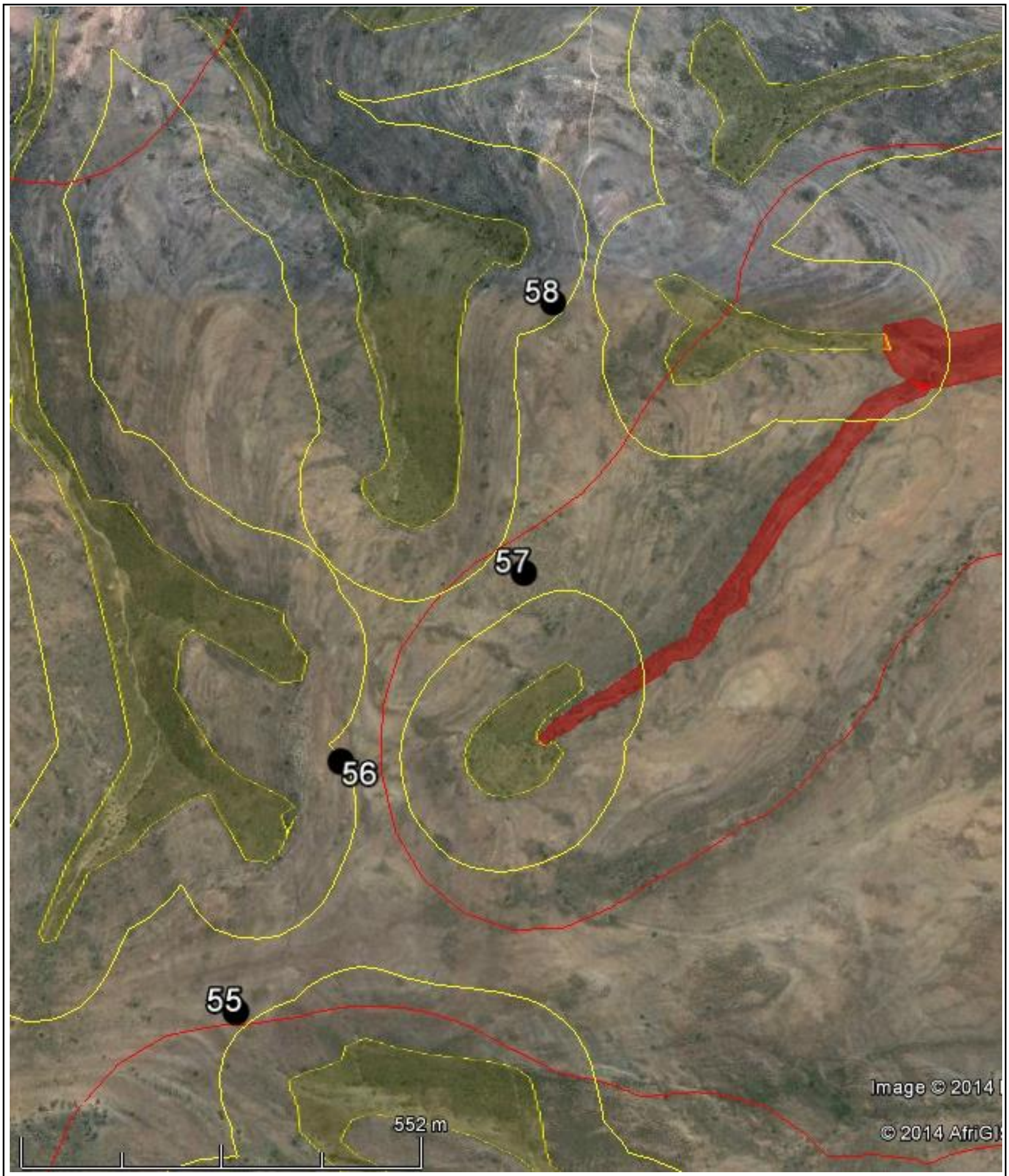
Turbines in High bat sensitivity	None
Turbines in High bat sensitivity buffer	57, 52 (marginally)
Turbines in Moderate bat sensitivity area	27
Turbines in Moderate bat sensitivity buffer	4, 28

The specific locations of the turbines listed above as falling within high bat sensitivity buffers, and their respective positions, can be seen in **Figure 11** below. So too can the specific position of turbine 27, listed as occurring in a moderate bat sensitivity area, be found in **Figure 12**.



High sensitivity | High sensitivity buffer | Moderate sensitivity
Moderate sensitivity buffer | Proposed turbines

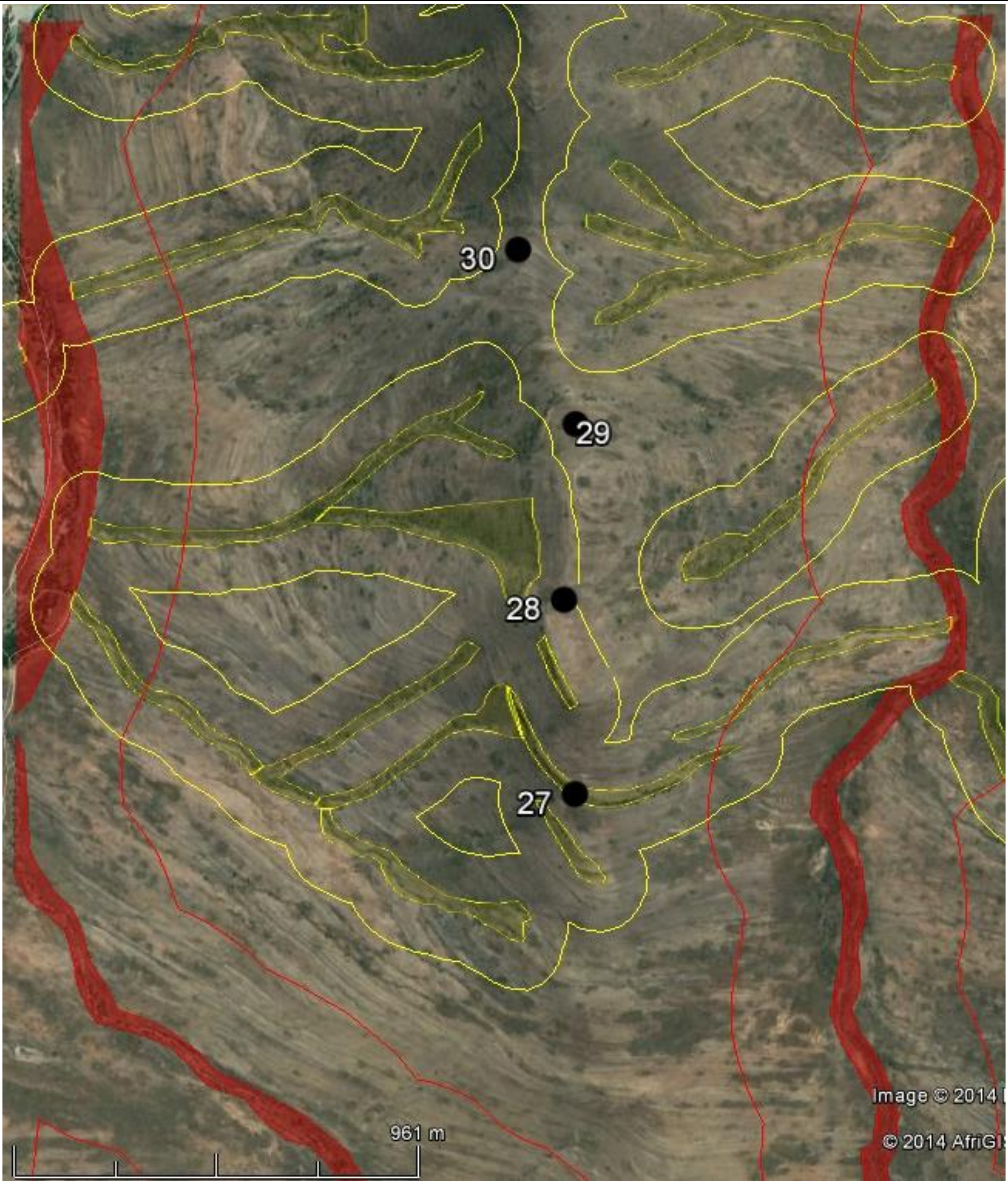
Figure 10: Bat sensitivity of the Karreebosch site



High sensitivity | High sensitivity buffer | Moderate sensitivity

Moderate sensitivity buffer | Proposed turbines

Figure 11: Bat sensitivity of the northern central part of site indicating turbine 57 located within High bat sensitivity buffer.



High sensitivity
High sensitivity buffer
Moderate sensitivity
Moderate sensitivity buffer
Proposed turbines

Figure 12: Bat sensitivity of the southern central part of site indicating the turbines located within a moderate bat sensitivity area and buffer

4.6 Passive data

The long term monitoring data is presented below in terms of composition and abundance, temporal distribution and relation with wind and temperature conditions. The results of the eight systems have been differentiated from one another as they are positioned in different localities and thus are exposed to different environmental conditions. The eight systems are also within different habitats, which may affect the presence of certain bat species and their activity patterns.

Table 14 below displays the time periods for each site visits monitoring period during which the systems were properly functional and operating.

Table 14: Periods over which the monitoring systems were operational

1st – 2nd site visit	MET 3	2013/08/05 – 2013/11/22
	MET 2	2013/08/05 – 2013/11/21
	MET 1	2013/10/21 – 2013/11/21
	SM 3	2013/10/22 - 2013/11/21
	SM 2	2013/08/05 – 2013/11/02
	SM 1	2013/08/05 – 2013/11/26
2nd – 3rd site visit	MET 3	2013/11/23 – 2014/03/05
	MET 2	2013/11/21 – 2014/03/06
	MET 1	2013/11/27 – 2014/03/06
	SM 3	2013/11/30 – 2014/03/06
	SM 2	2013/11/28 – 2014/03/03
	SM 1	2013/11/26 – 2014/03/03
3rd – 4th site visit	MET 3	2014/03/05 – 2014/05/28
	MET 2	2014/03/06 – 2014/04/18
	MET 1	2014/03/06 – 2014/05/28
	SM 3	No data
	SM 2	2014/03/16 – 2014/03/20
	SM 1	No data
4th – 5th site visit	MET 3	2014/05/28 – 2014/08/25
	MET 2	2014/05/28 – 2014/07/31
	MET 1	2014/05/28 – 2014/08/21
	SM 3	2014/05/28 - 2014/08/26
	SM 2	2014/05/29 – 2014/08/25
	SM 1	2014/05/29 – 2014/07/21

Met mast 2 monitoring system detected zero bat passes for both microphones over the entire monitoring period. This is the result of a combination of low activity, monitoring system and microphone failures. Graphs are thus not displayed for this system according to the precautionary principle.

The 50m microphone of met mast 3 did not detect any bat passes over the monitoring period, which is highly suspicious and thus was excluded from the below graphs according to the precautionary principle.

The 50m microphone of met mast 1 was functioning correctly throughout the study period.

4.6.1 Abundances and composition of bat assemblage

Figures 13 - 18 display the bat species assemblages, and number of bat passes detected per species, at each monitoring station, over the monitoring period. The monitoring periods for the detectors on the North and South short masts shown in **Figure 18** were, respectively, 2nd – 6th September 2014 and 2nd September – 3rd October 2014.

An assemblage of five different bat species was detected on site by the passive monitoring systems. These species were identified by parameters of peak frequency, slope, duration and bandwidth of their echolocation calls recorded by the passive monitoring systems. This diversity is relatively normal for this area of the Northern Cape.

All three short mast systems detected relatively similar numbers of passes of each species were detected at the short masts (**Figures 13 – 15**). *Neoromicia capensis* and *Tadarida aegyptiaca* were recorded significantly more frequently than the other species. Only short masts 1 and 3 recorded noteworthy numbers of the conservation important species *M. natalensis*. Met mast 3 shows similar patterns in the assemblage recorded at this station, (**Figure 17**). The activity at this station was also similar to the short masts with the exception that *T. aegyptiaca* was recorded in substantially higher numbers than *N. capensis*. Once again the 10m microphone of Met mast 1 recorded a similar assemblage of bats in similar proportions to those of the short masts (**Figure 16**). However, the 50m microphone of this station only recorded the two open-air foraging species on site, namely *T. aegyptiaca* and *S. petrophilus*. The 50m microphone on Met mast 1 recorded 50% less *T. aegyptiaca* than the 10m microphone on the same Met mast and no *N. capensis* at 50m, indicating a negative correlation between bat activity and height above ground. In general the airspace around 50m were dominated by *T. aegyptiaca.*

The assemblage/s and number of passes recorded at the 10m microphones of the North and South short masts were dominated by the open-air foraging species, with only *N. capensis* also being recorded though in low numbers (**Figure 18**). However, the monitoring periods of these systems were brief.

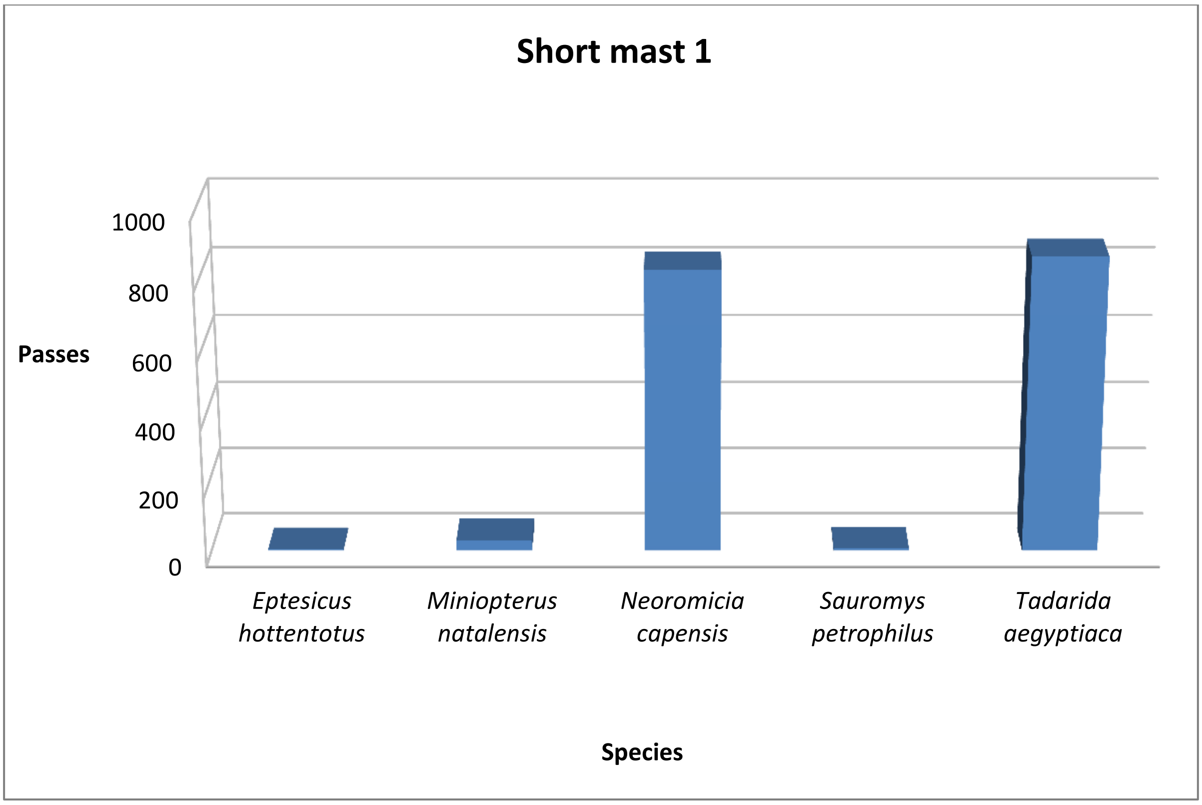


Figure 13: Species assemblage detected by Short mast 1 over the monitoring period

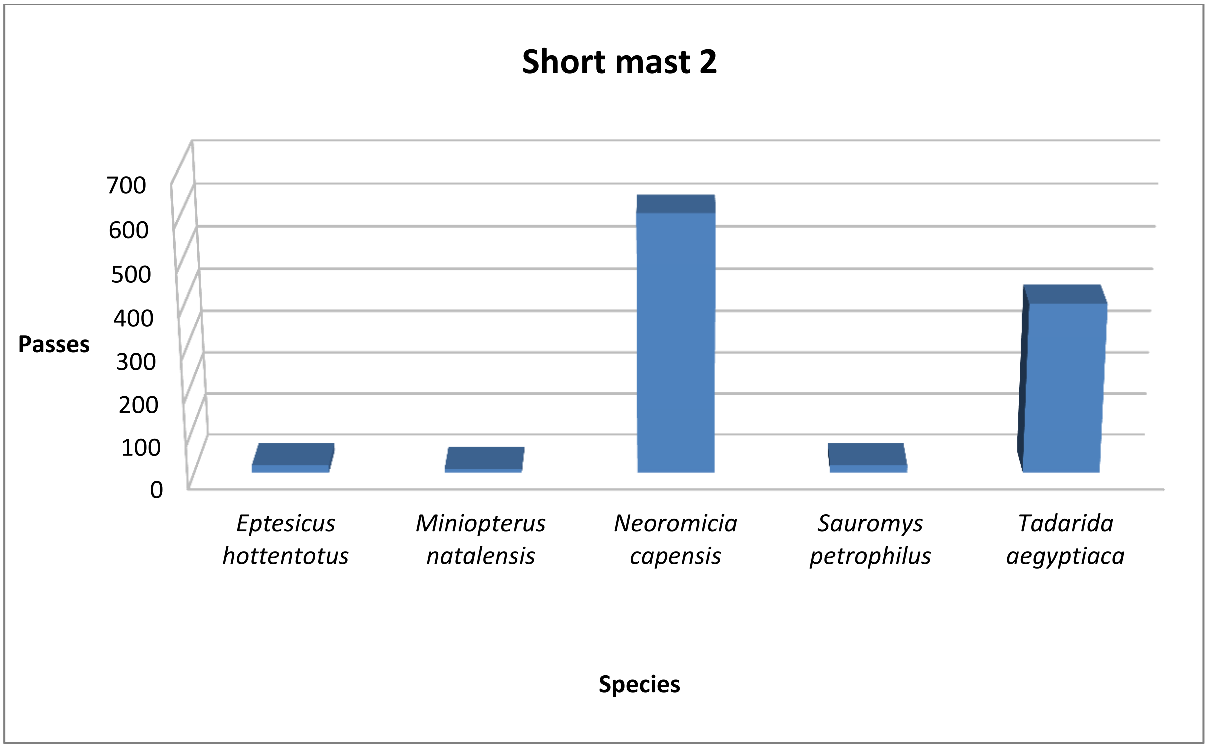


Figure 14: Species assemblage detected by Short mast 2 over the monitoring period

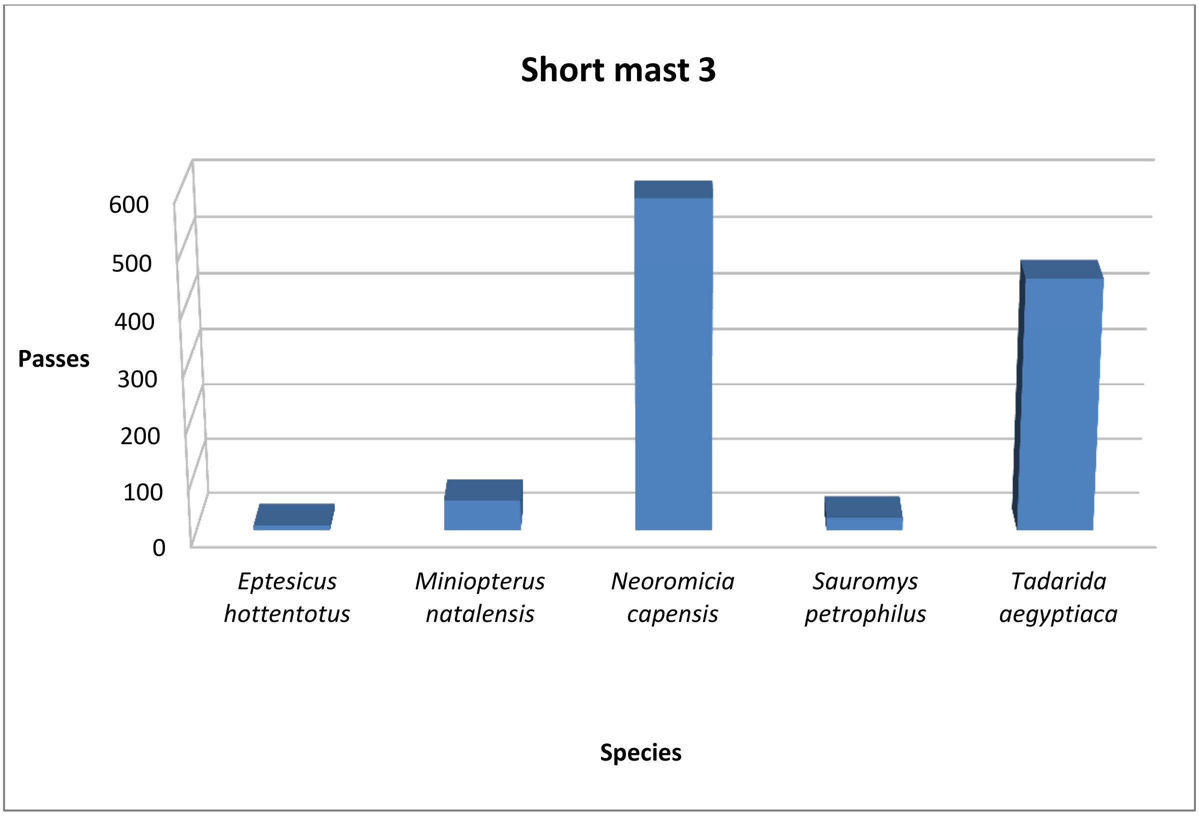


Figure 15: Species assemblage detected by Short mast 3 over the monitoring period

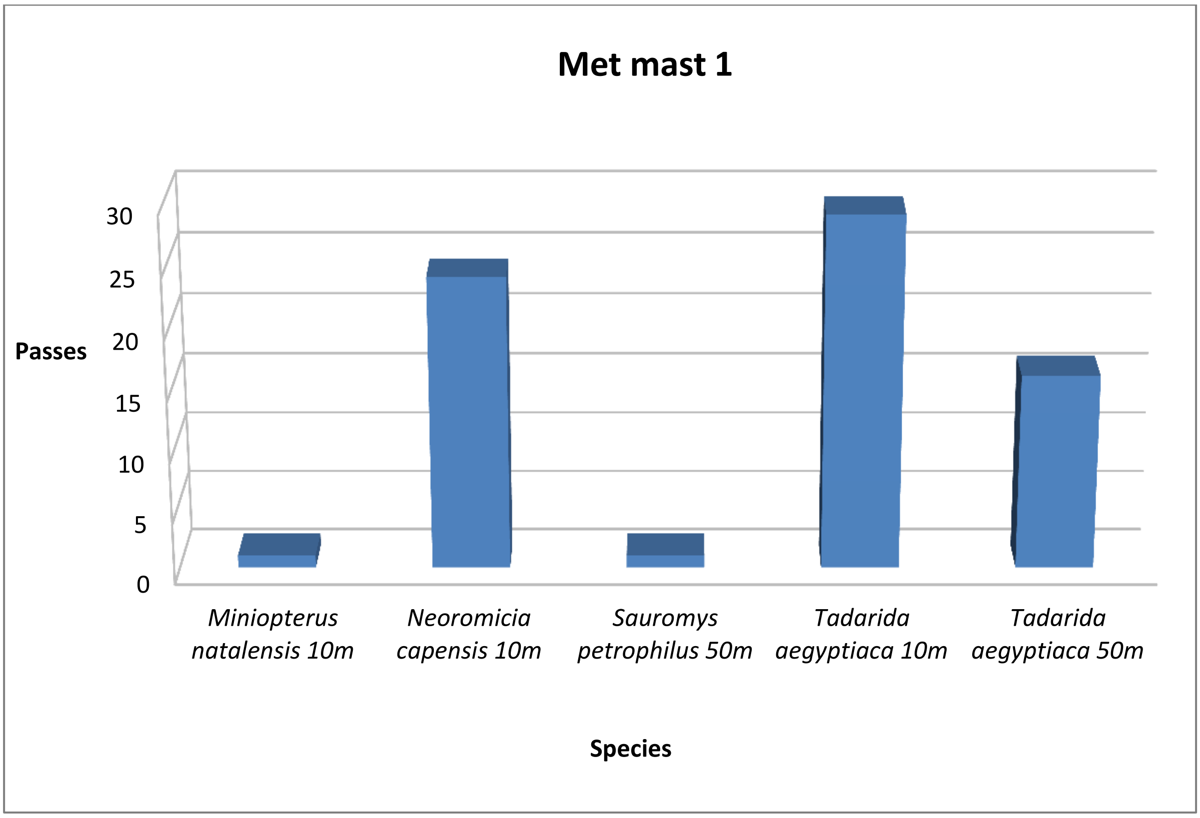


Figure 16: Species assemblage detected by Met mast 1 over the monitoring period.

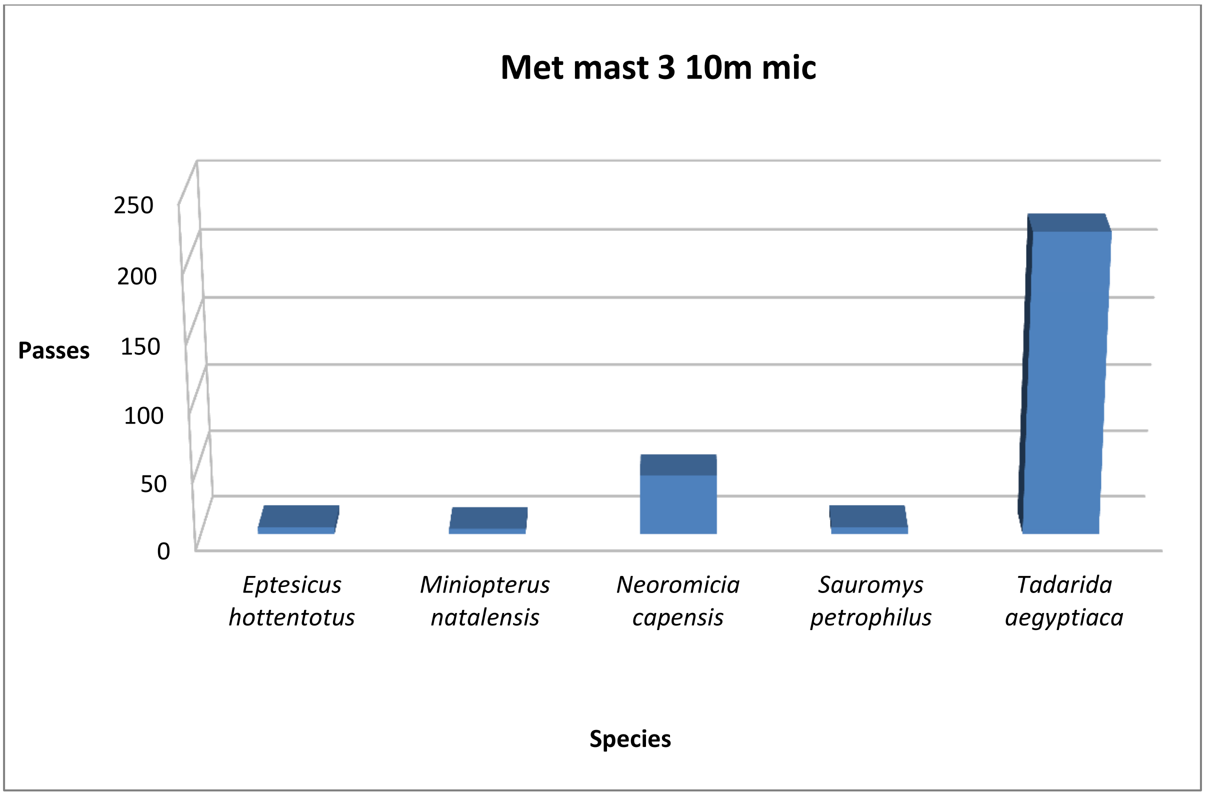


Figure 17: Species assemblage detected by the 10m mic of Met mast 3 over the monitoring period

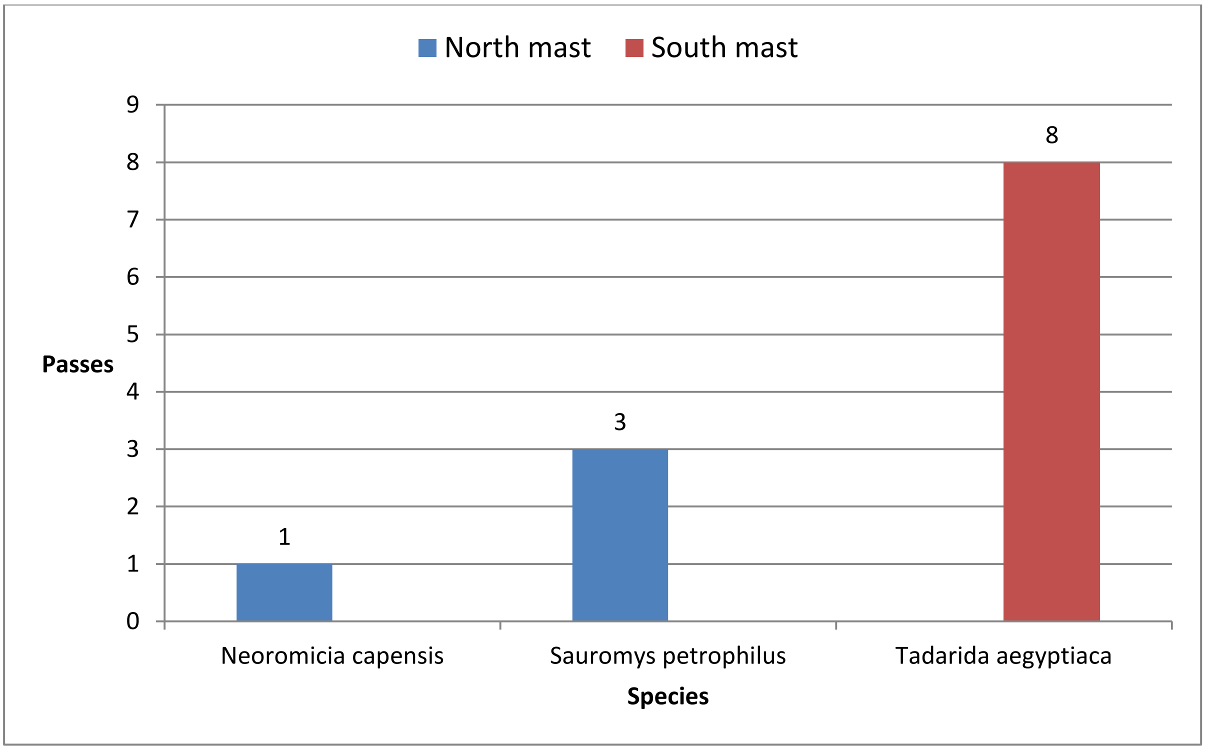


Figure 18: Species assemblages detected by the 10m mics of the North and South short masts over their respective monitoring periods

4.6.2 Average bat passes per night

The number of bat passes per month was averaged on a nightly basis, based on the number of nights that the systems were properly operational (**Figure 18**).

The figure displays a clear trend amongst most monitoring systems for a general increases from September 2013 over the whole of spring and summer to a peak in March 2014. Thereafter activity largely declines into winter, with only Short mast 3 showing a significant peak over August 2014.

Short mast 1 and Short mast 2 display high activity over spring and summer with a final peak in March. Short mast 3 which is located in a more sheltered habitat in a valley is unique in the sense that its greatest peak in activity occurs at the end of winter. The 10m microphone at Met mast 1 did not detected significantly high activity levels. The 10m microphone on Met mast 3 detected elevated activity levels over summer with a peak in March and then gradual decline into winter.

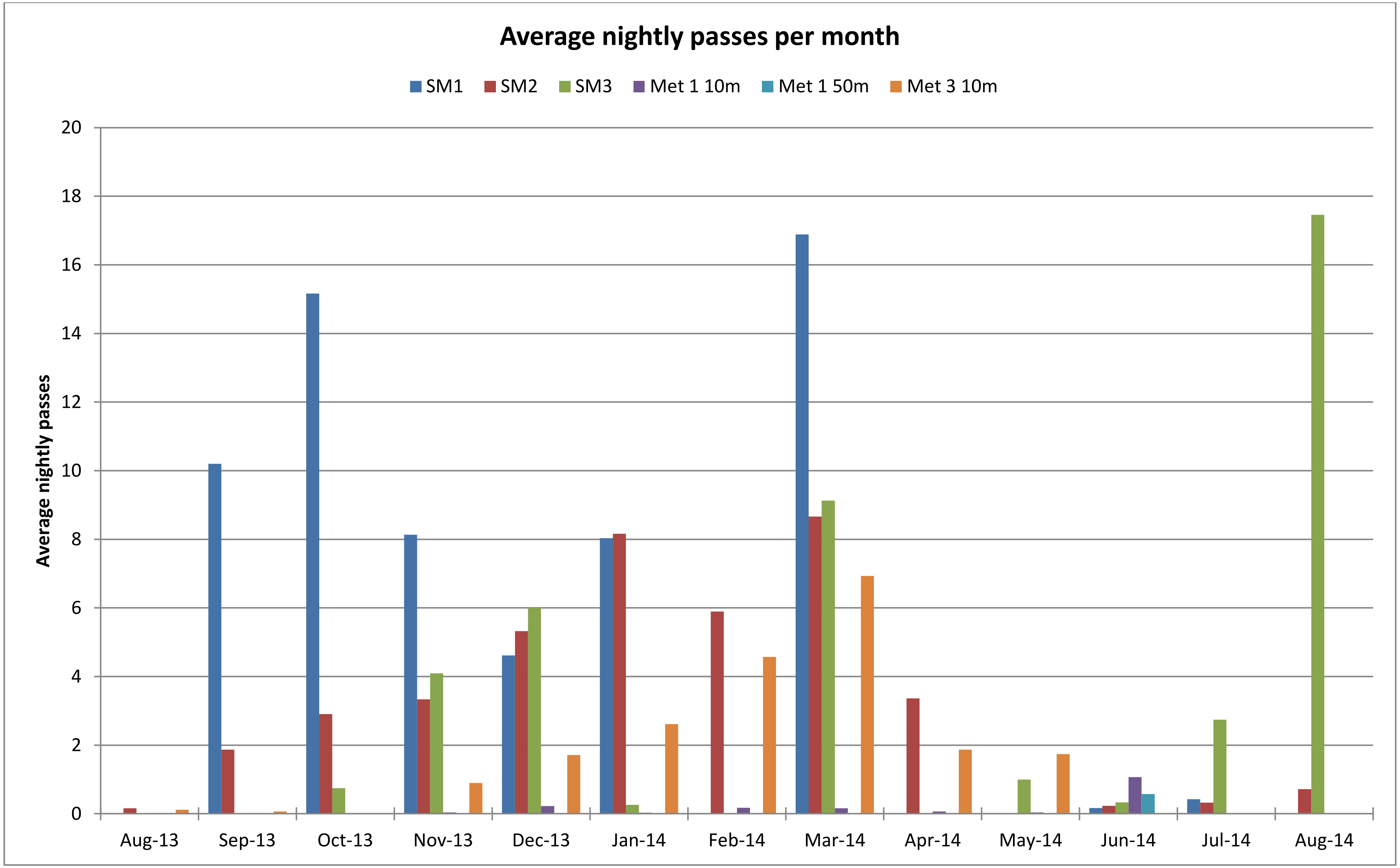


Figure 18: Average nightly passes per month for each monitoring system

4.6.3 Temporal Distribution

4.6.3.1 Seasonal Distribution over the Monitoring Period

Figures 19 - 26 display the sum of bat passes at each station for each species, per night, across the respective monitoring periods of the systems. The peak activity times identified are mostly an amalgamation of the temporal distribution of *N. capensis* and *T. aegyptiaca* as they were the species detected more often by a substantial margin. These data will be used to inform the times of year of peak bat activity and thus used for mitigation implementation. Since *N. capensis* and *T. aegyptiaca* are the most common and abundant species it is fitting that mitigation be directed by their times of activity. These two species will be impacted the most by the wind farm development and will, as a result, constitute the majority of casualties. Their considerable relative abundance on site, compared with other species, means they must be mitigated for to ensure the critical ecosystem services they provide are not lost. Moreover, the other species recorded on site, which are at risk of impact, have similar overall ecologies to either *N. capensis* or *T. aegyptiaca*. Hence mitigating impacts on these two primary species should also mitigate impacts on the other species present. The only exception would be migration events of *M. natalensis* however, there is little evidence of any significant migration events occurring on this site.

High activity periods identified from the below figures are as follows:

Short Mast 1:

- 2013
    - Mid-September – mid-October
    - Early November – late January 2014
- 2014
    - Month of March

Short Mast 2:

- 2013
    - Mid-September – mid-October
    - Late November – end February 2014
- 2014
    - Mid-March – early April

Short Mast 3:

- 2013
    - Late November – late December
- 2014
    - Late February – mid-March

    - Late July – late August

Met mast 1:

- No periods of high activity were identified

Met mast 3:

- 2013
    - Late November – late March 2014
- 2014
    - Mid-April – early May

North and South short masts:

- These systems were only operational for a brief period during spring of 2014 (i.e. early September – early October) so it is inappropriate to derive conclusions regarding seasonal bat activity patterns based on their data. However, three species of bat were still recorded at these stations which supports the suggestion that spring is an important season for bat activity.
- Bat activity at these two stations were lower than activity detected by the other 10m microphones, but the sample size were significantly smaller. However, due to the similarity in terrain and habitat to the remainder of the site, there is a high probability that bat activity levels and patterns will be similar to other 10m microphones on the remainder of the site during a 12 month cycle.

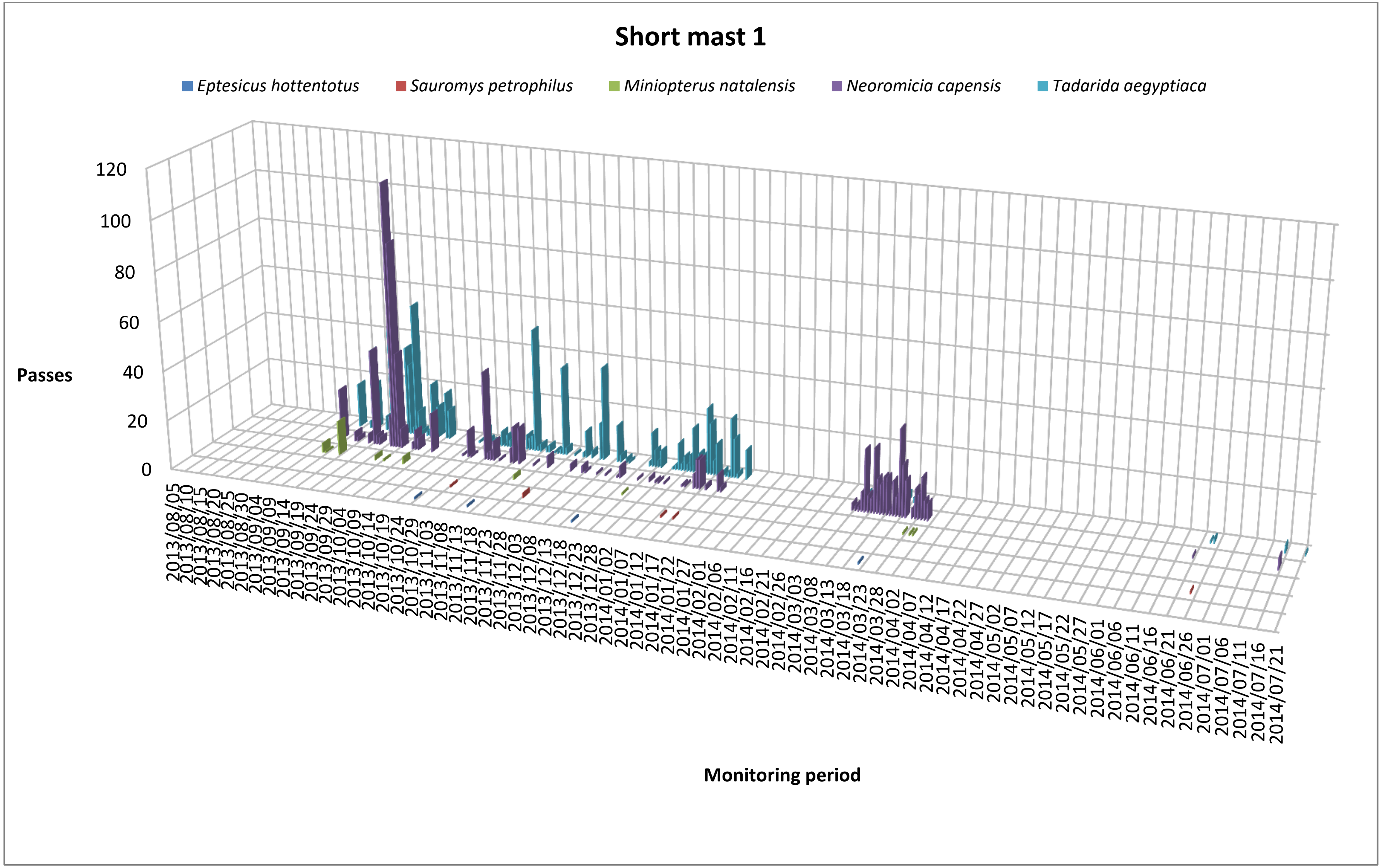


Figure 19: Temporal distribution of activity detected by Short mast 1

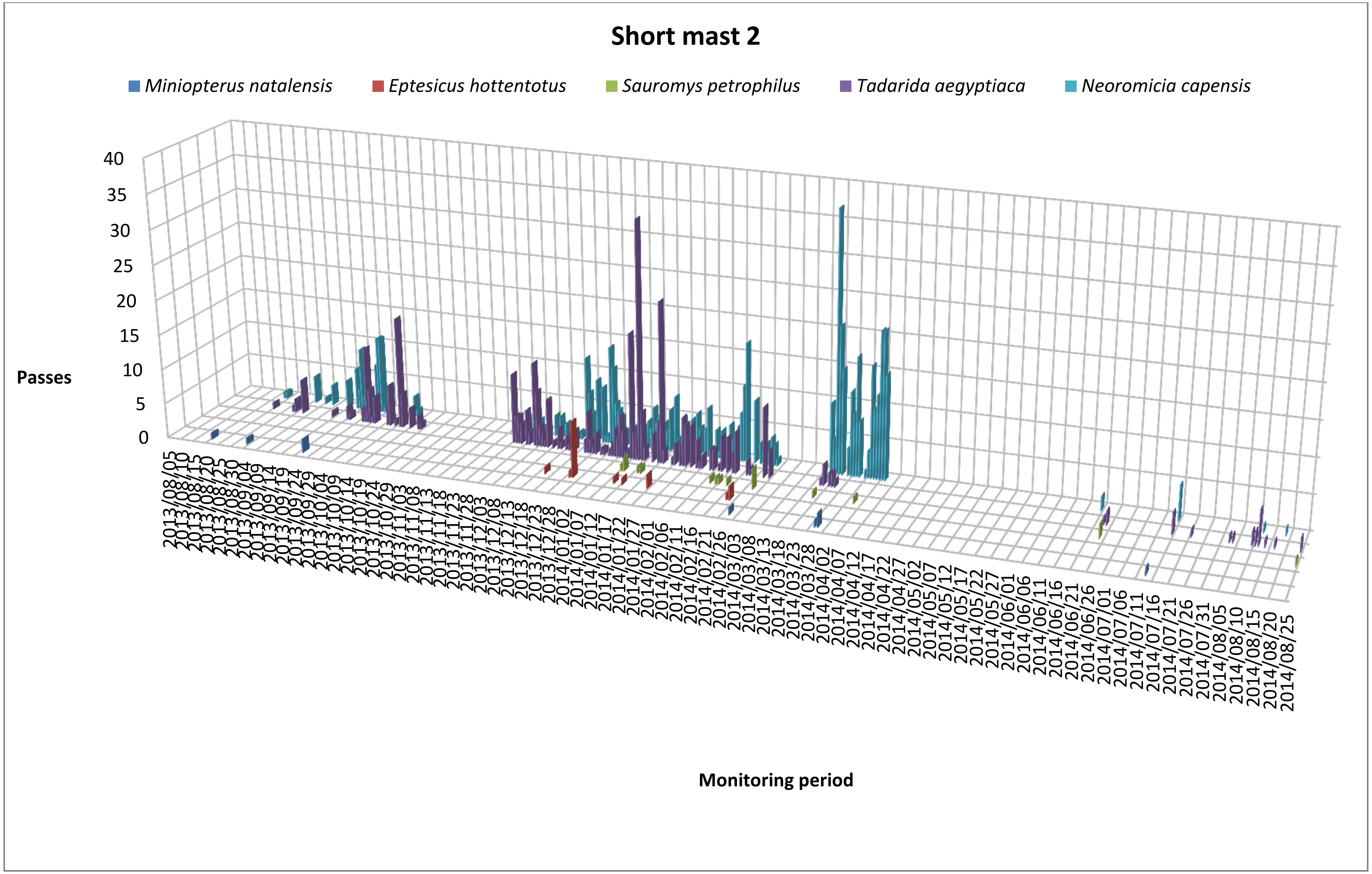


Figure 20: Temporal distribution of activity detected by Short mast 2

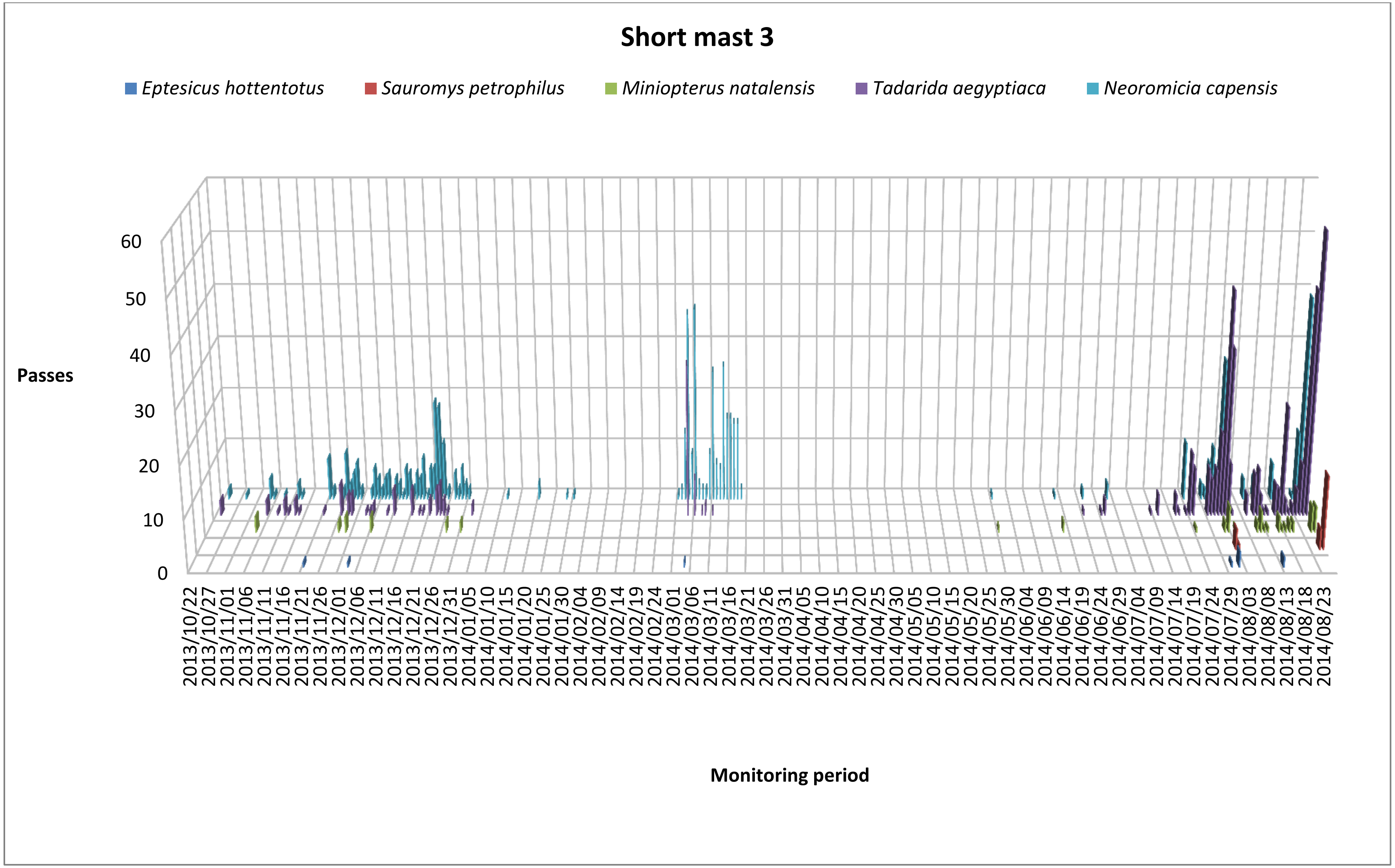


Figure 21: Temporal distribution of activity detected by Short mast 3

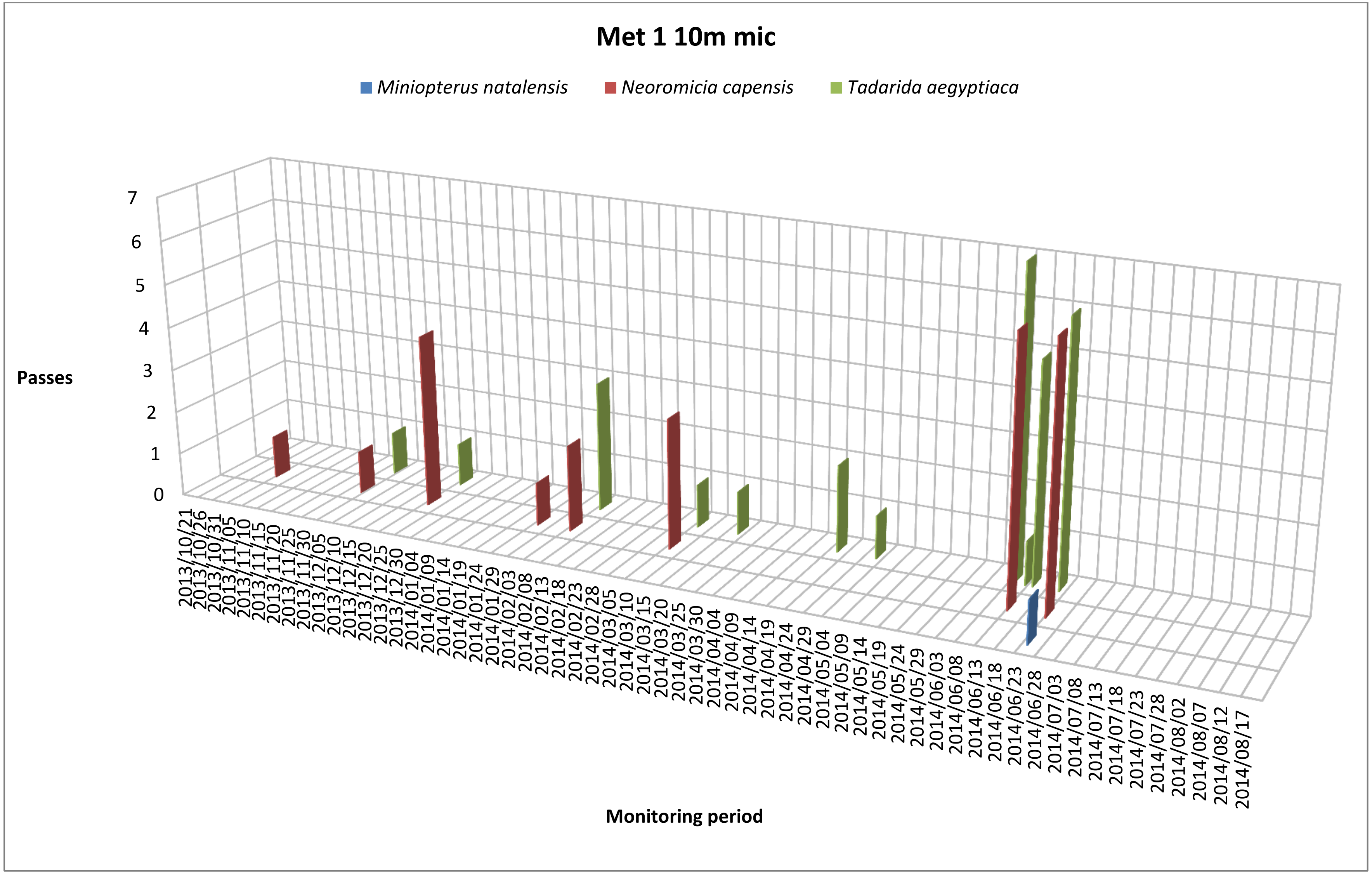


Figure 22: Temporal distribution of activity detected by the 10m mic of Met mast 1

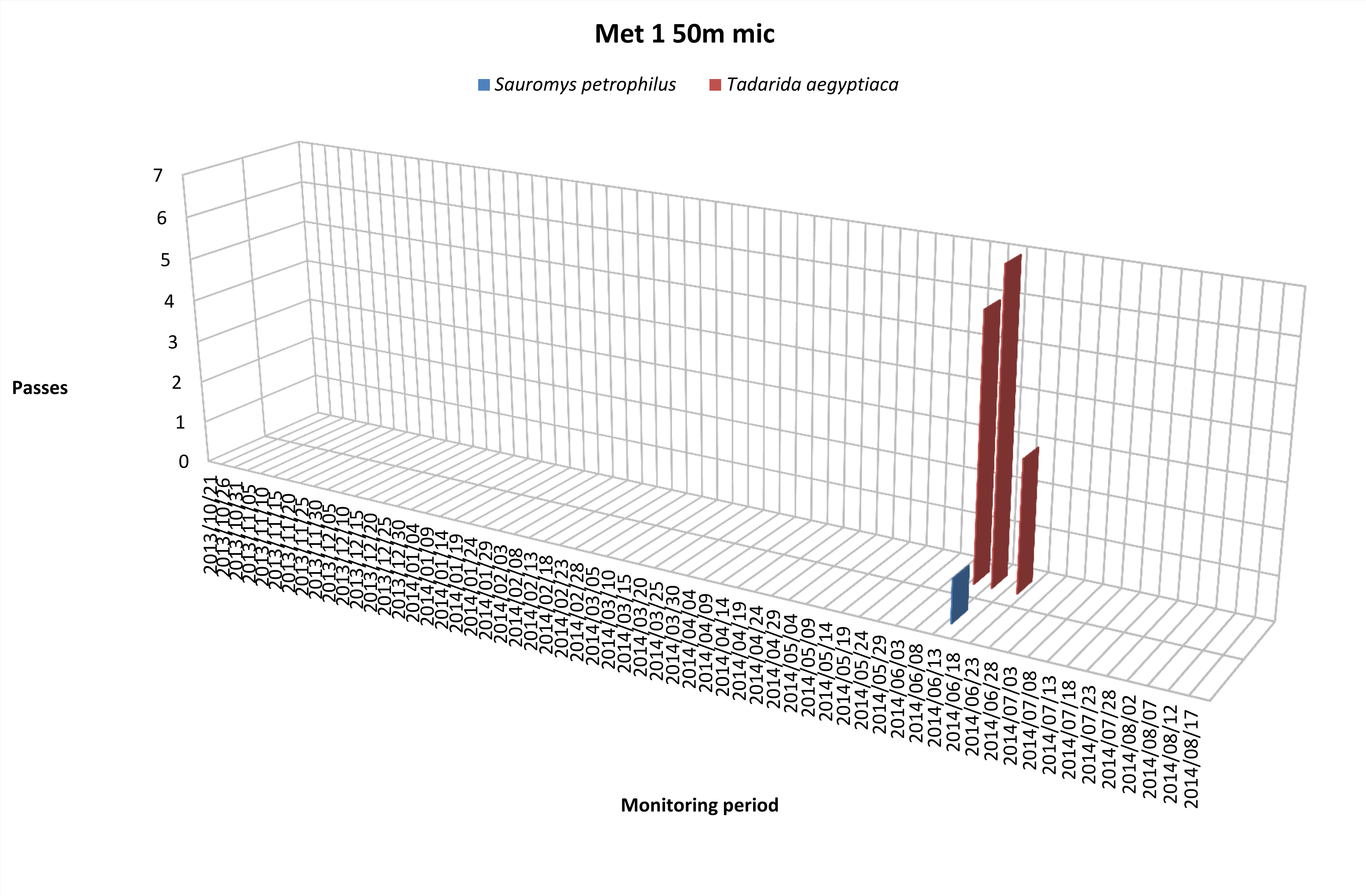


Figure 23: Temporal distribution of activity detected by the 50m mic of Met mast 1.

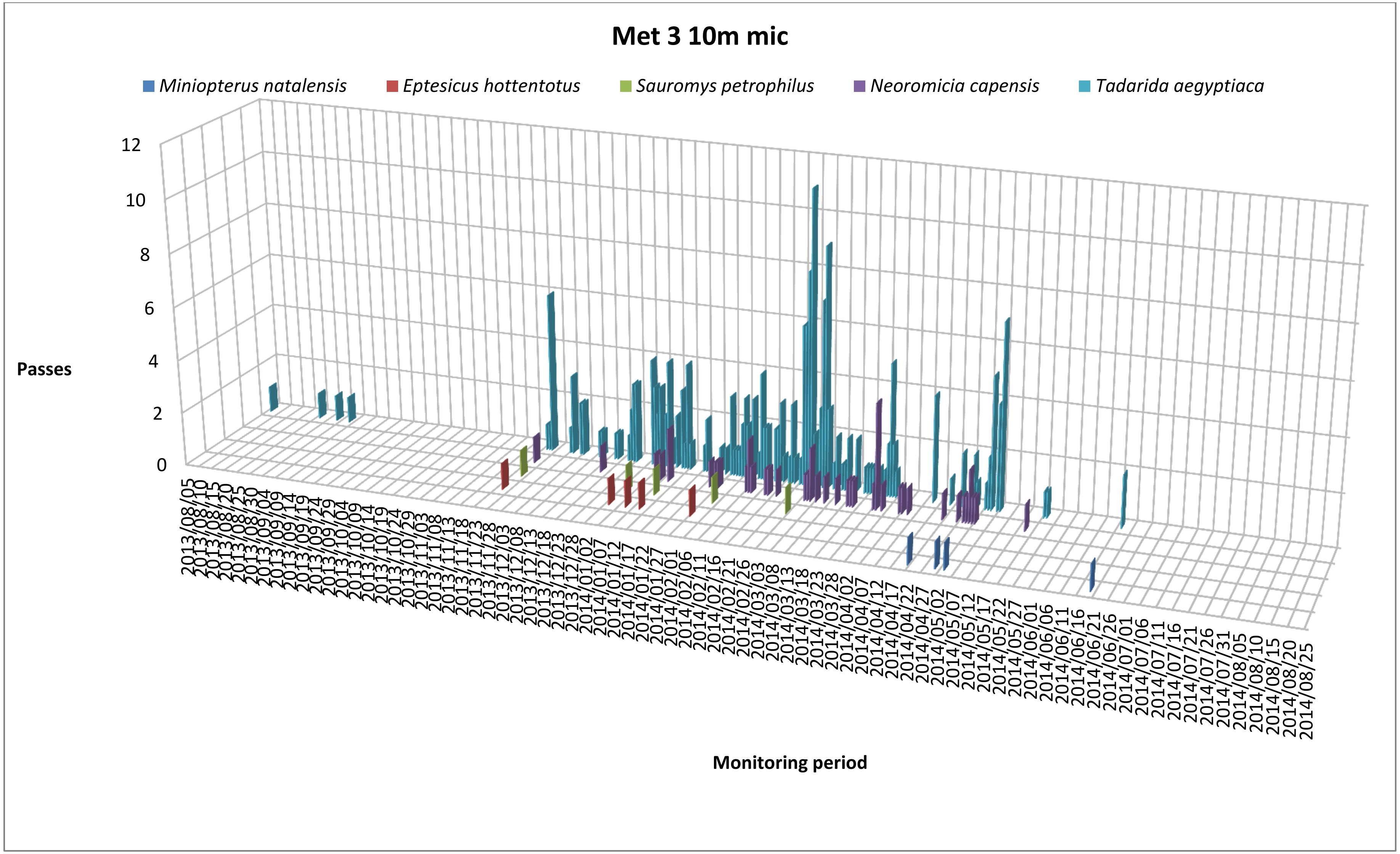


Figure 24: Temporal distribution of activity detected by the 10m mic of Met mast 3

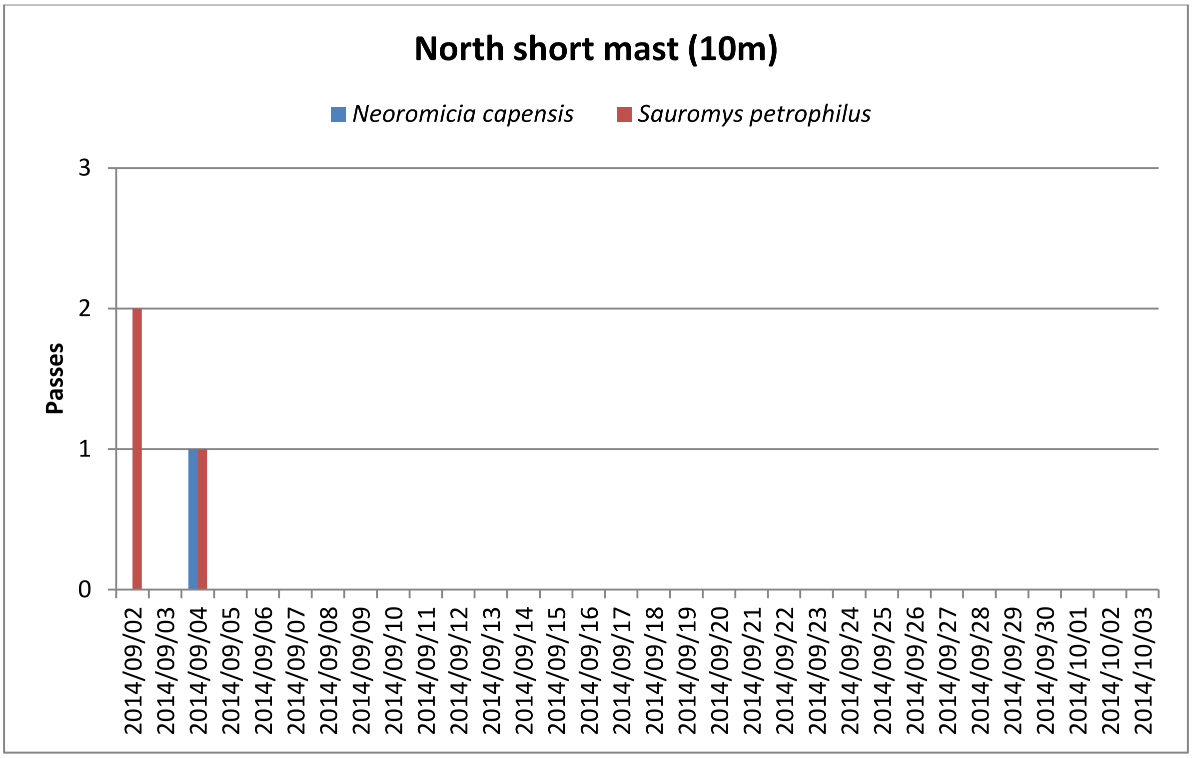


Figure 25: Temporal distribution of activity detected by the right hand 10m mic of the North short mast

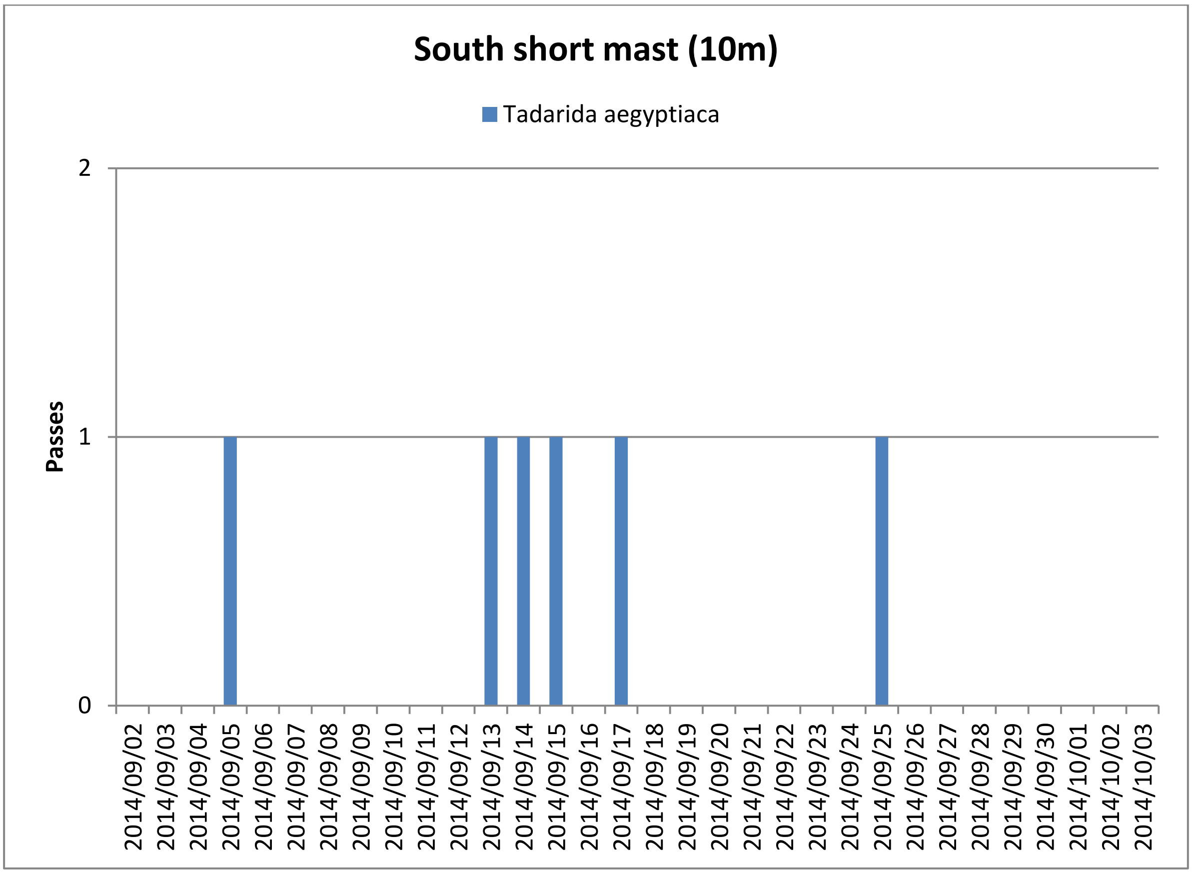


Figure 26: Temporal distribution of activity detected by the right hand 10m mic of the South short mast

4.6.4 Distribution of bat activity across the night per season

The distribution of bat activity across the night, per season, has been analysed in this section. The 12 month monitoring period was divided based on generic calendar seasons outlined in **Table 15**.

Table 15: Time frame of each season

Season	Monitoring period
Winter	1 June – 31 August
Spring	1 September – 30 November
Summer	1 December – 28 February
Autumn	1 March – 31 May

The number of bat passes per 10 minute interval over the seasonal monitoring periods were summed to generate the figures of bat activity over the time of night. Higher levels of activity indicate preference for activity over a particular period of the night. These periods (**Table 16**) were then used to inform mitigation implementation. Once again, peak activity times are mostly an amalgamation of the activity of *T. aegyptiaca* and *N. capensis*. The figures show that there are seldom cases of other species being highly active in the absence of high activity levels of these two abundant species.

Table 16: Seasonal peak activity time frames for the Short mast systems

	Spring	Summer	Autumn	Winter
Short mast 1	Sunset – 22:00	20:00 – 01:00	23:00 - sunrise	Low activity
Short mast 2	Sunset – 00:00	Sunset – 00:00	00:00 - sunrise	Low activity
Short mast 3	Sunset – 21:00	Sunset – 23:30 and 03:00 – 05:00	19:30 – 03:50	Sunset – 21:00
Met mast 1 10m	Low activity	00:00 - 03:00	Low activity	Low activity
Met mast 1 50m	Low activity	Low activity	Low activity	Low activity
Met mast 3 10m	23:30 - 03:00	20:30 - 02:00	20:30 - 00:00	Low activity
North short mast	Limited data	No data	No data	No data
South short mast	Low activity	No data	No data	No data

Due to the low bat activity occurring at the Met mast systems no broad activity time frames were included for these stations in **Table 16** above. However, comments shall be made as to activity time frames suggested by the figures below.

4.6.4.1 Spring

Overall, the majority of spring activity occurred during the first ≈5-6 hours of the night, though some minor peaks also occurred during the early morning hours. Although very little data were recorded at the Met masts, the activity patterns appear to be congruent with these results.

4.6.4.2 Summer

Due to later sunset times, summer bat activity starts later in the evenings. However, the overall activity patterns are similar to those in spring. The activity occurs mostly throughout the night but has at least one and sometimes two distinct peaks. These peaks generally occur during the first few hours after sunset and before sunrise.

4.6.4.3 Autumn

The results of the Short mast data during autumn are quite surprising. While specific peaks are still evident, these data suggest that bat activity occurs almost throughout the night during autumn. Moreover, the peaks in activity often seem to occur during the early hours of the morning before sunrise rather than after sunset. Only the Met masts show slightly higher activity levels earlier in the night than later. However, these systems recorded comparably small amounts of data.

4.6.4.4 Winter

Overall the winter activity patterns are far more usual. Compared with the other seasons, bat activity appears relatively low and for the most part is limited to the first ≈2-4 hours of the night after sunset. Only Short mast 3 showed bat activity continuing into the early morning hours after midnight and most noteworthy in this is that some of this activity is that of *M. natalensis*. However it’s important to note that SM3 were located in a valley.

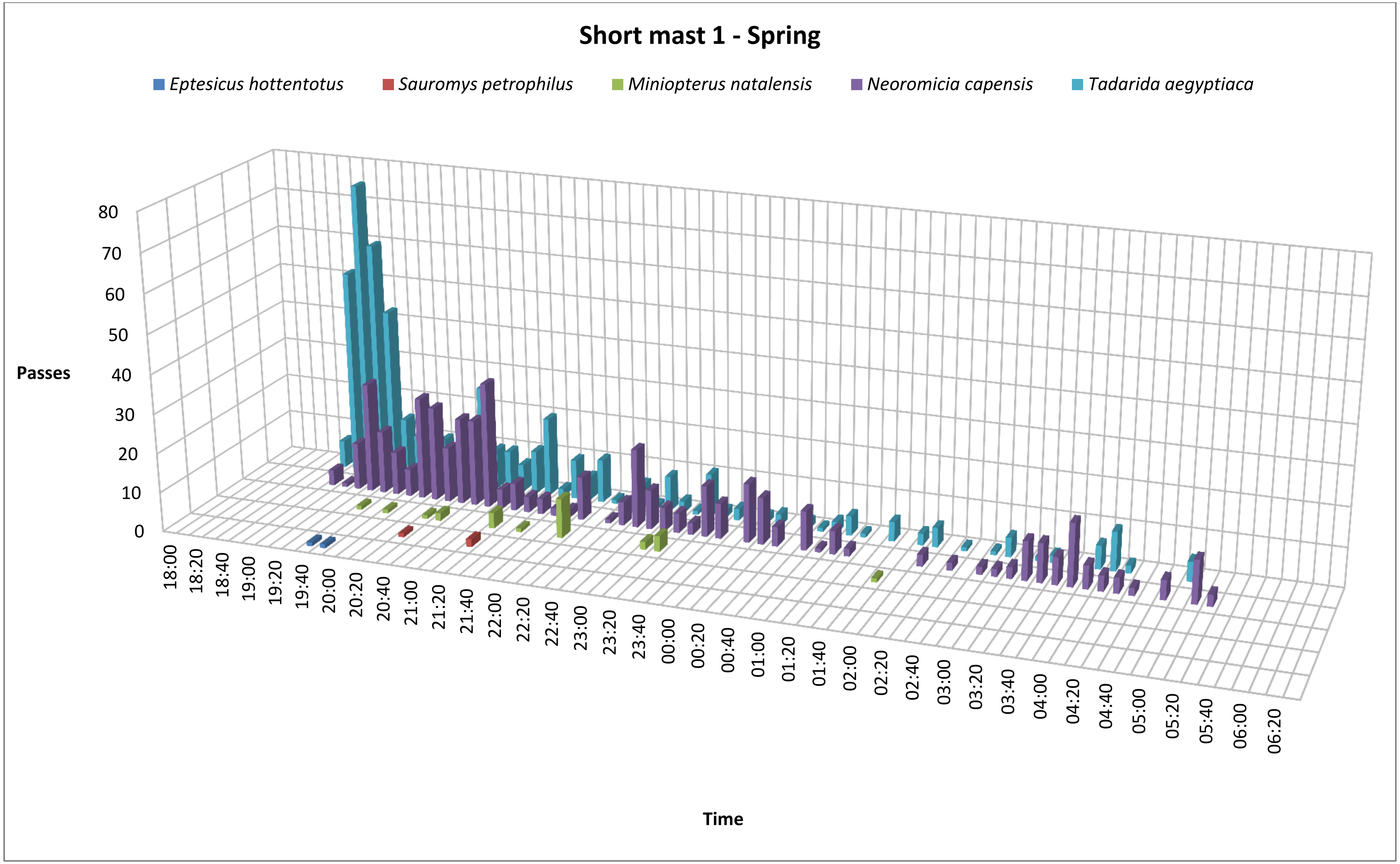


Figure 27: Temporal distribution of activity across the night as detected by Short mast 1 in spring

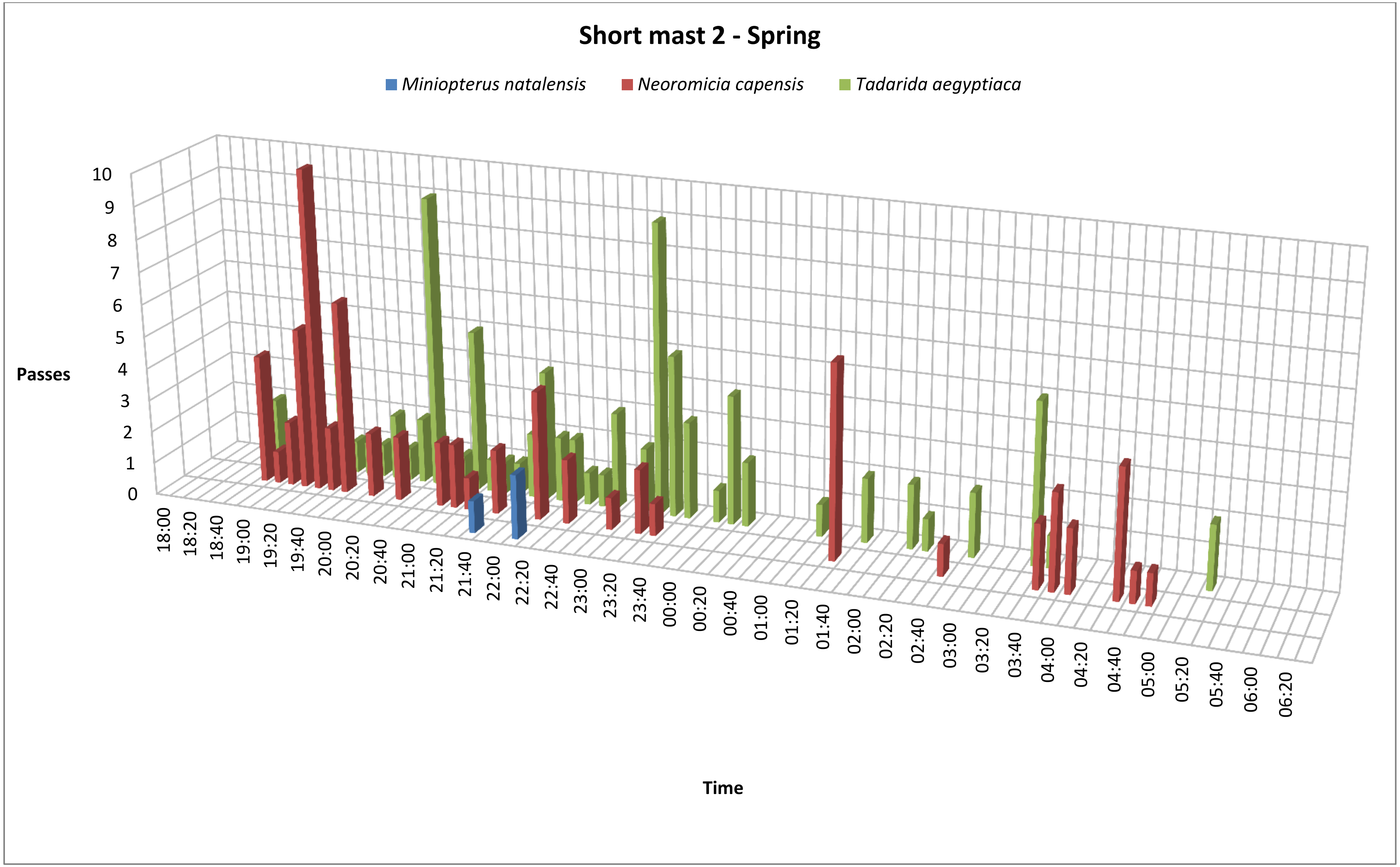


Figure 28: Temporal distribution of activity across the night as detected by Short mast 2 in spring

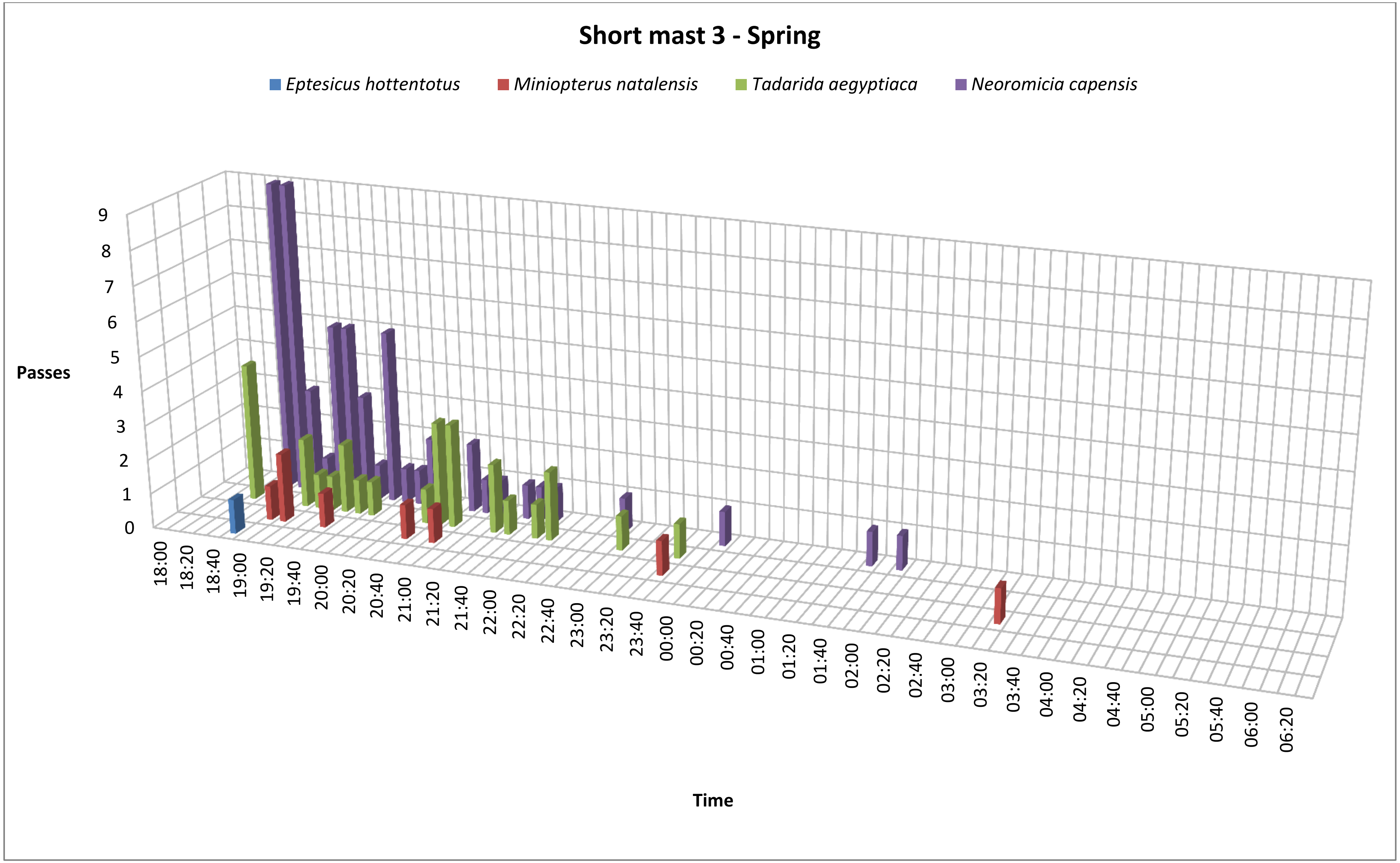


Figure 29: Temporal distribution of activity across the night as detected by Short mast 3 in spring

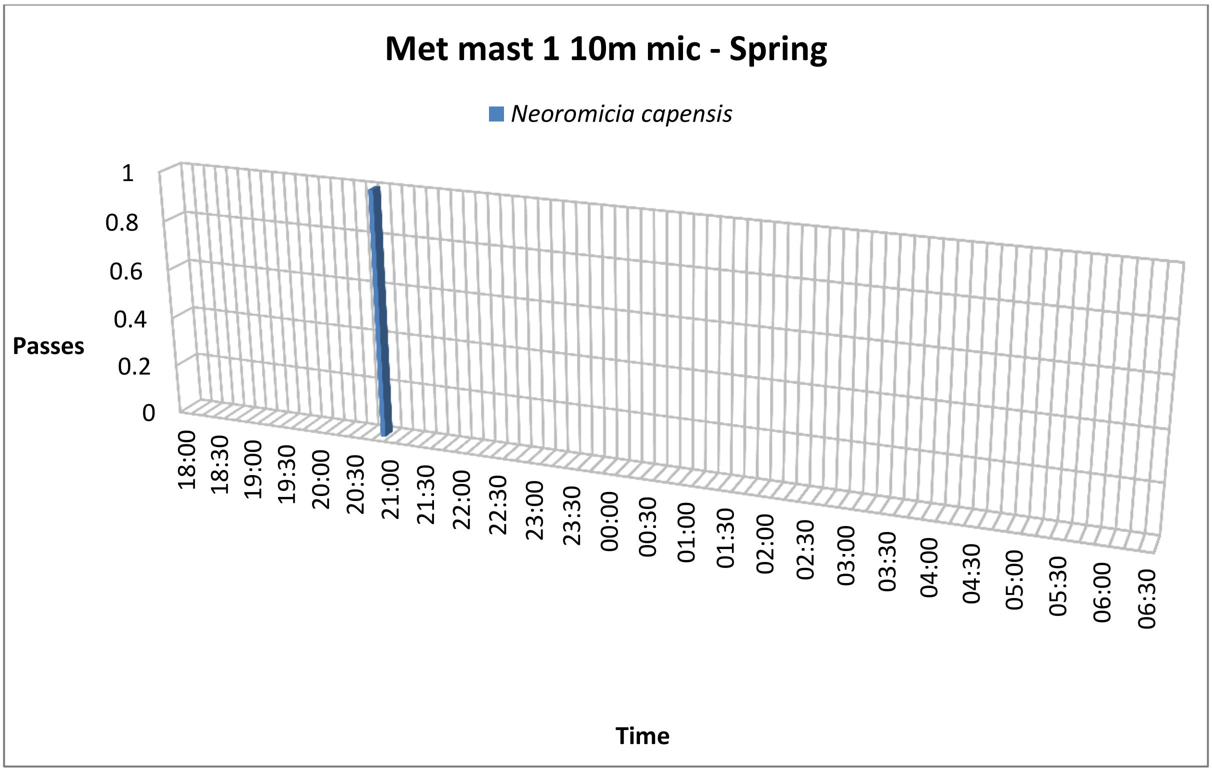


Figure 30: Temporal distribution of activity across the night as detected by the 10m mic of Met mast 1 in spring

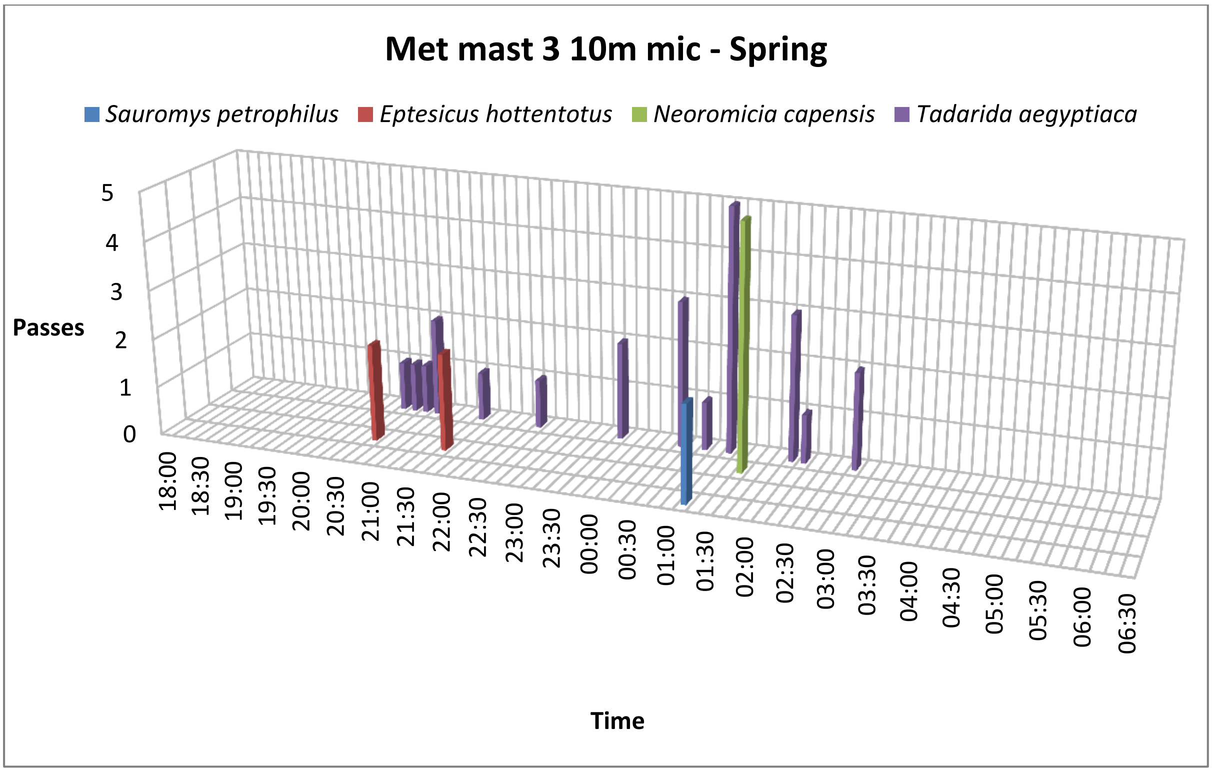


Figure 31: Temporal distribution of activity across the night as detected by the 10m mic of Met mast 3 in spring

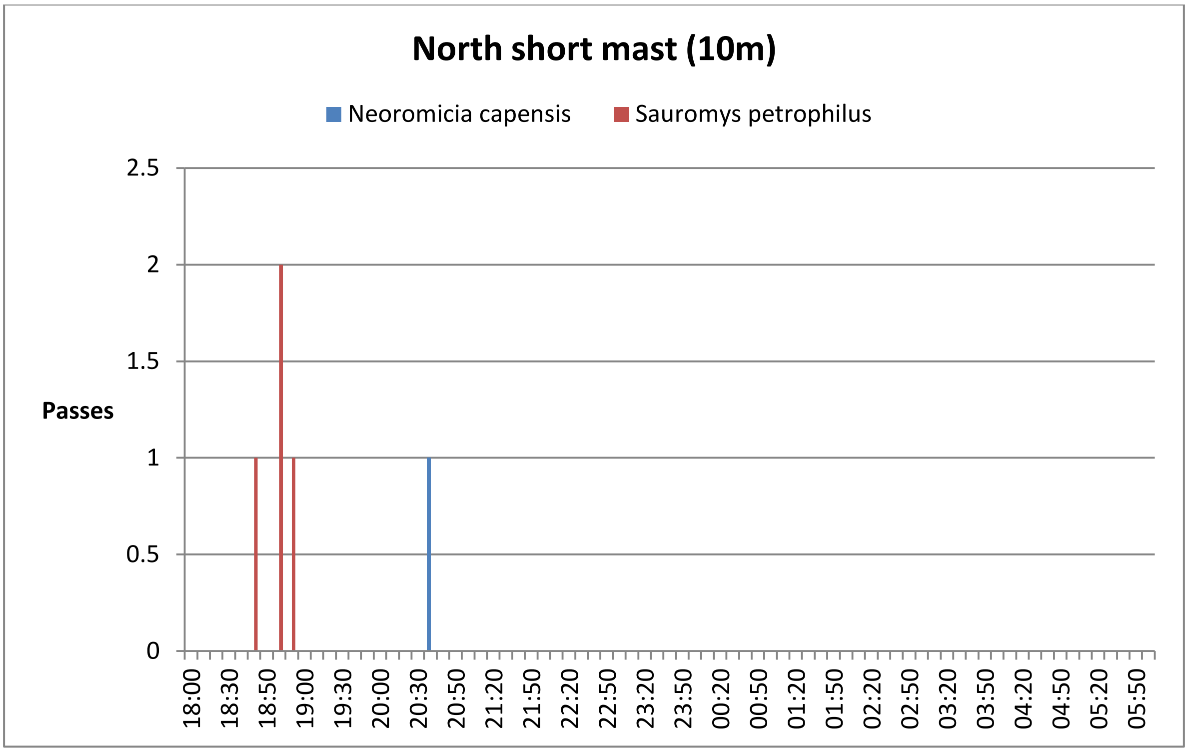


Figure 32: Temporal distribution of activity across the night as detected by the right hand mic of the North short mast in spring

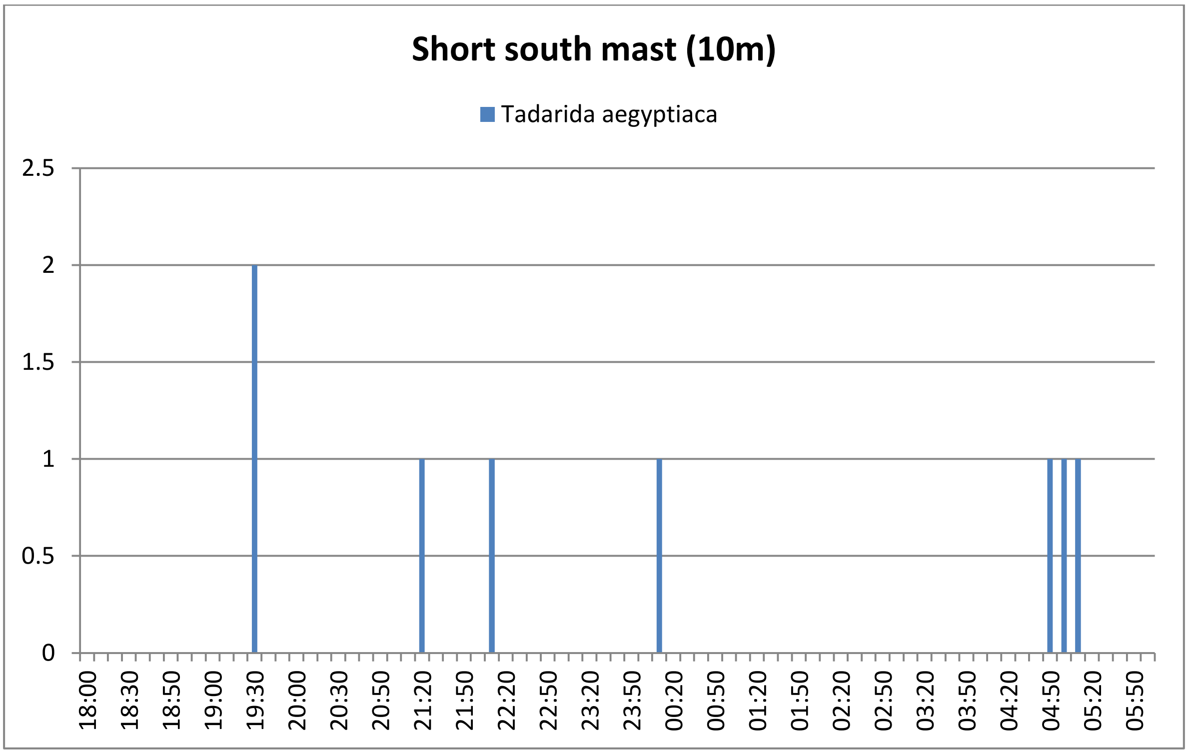


Figure 33: Temporal distribution of activity across the night as detected by the right hand mic of the South short mast in spring

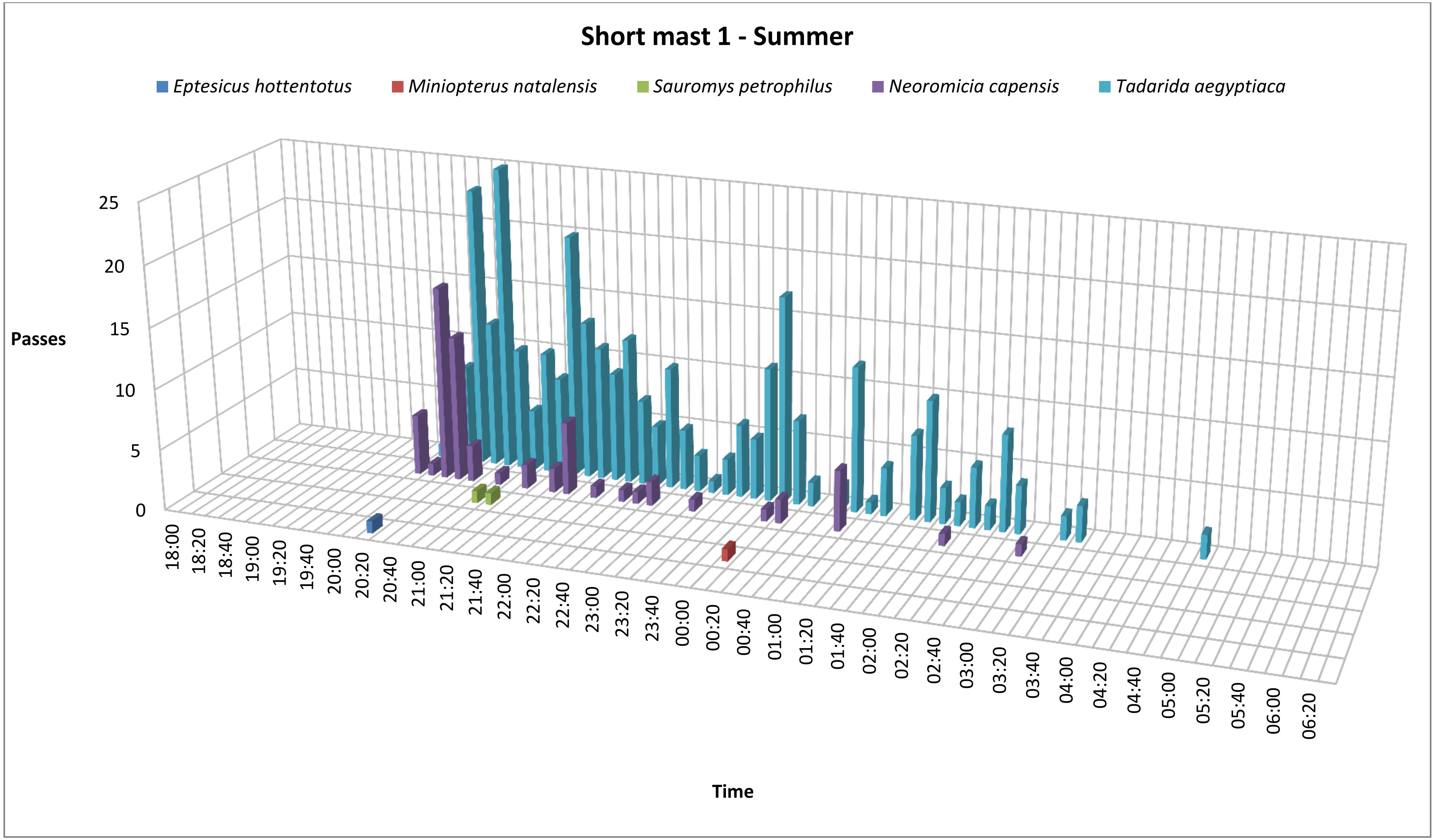


Figure 34: Temporal distribution of activity across the night as detected by Short mast1 in summer

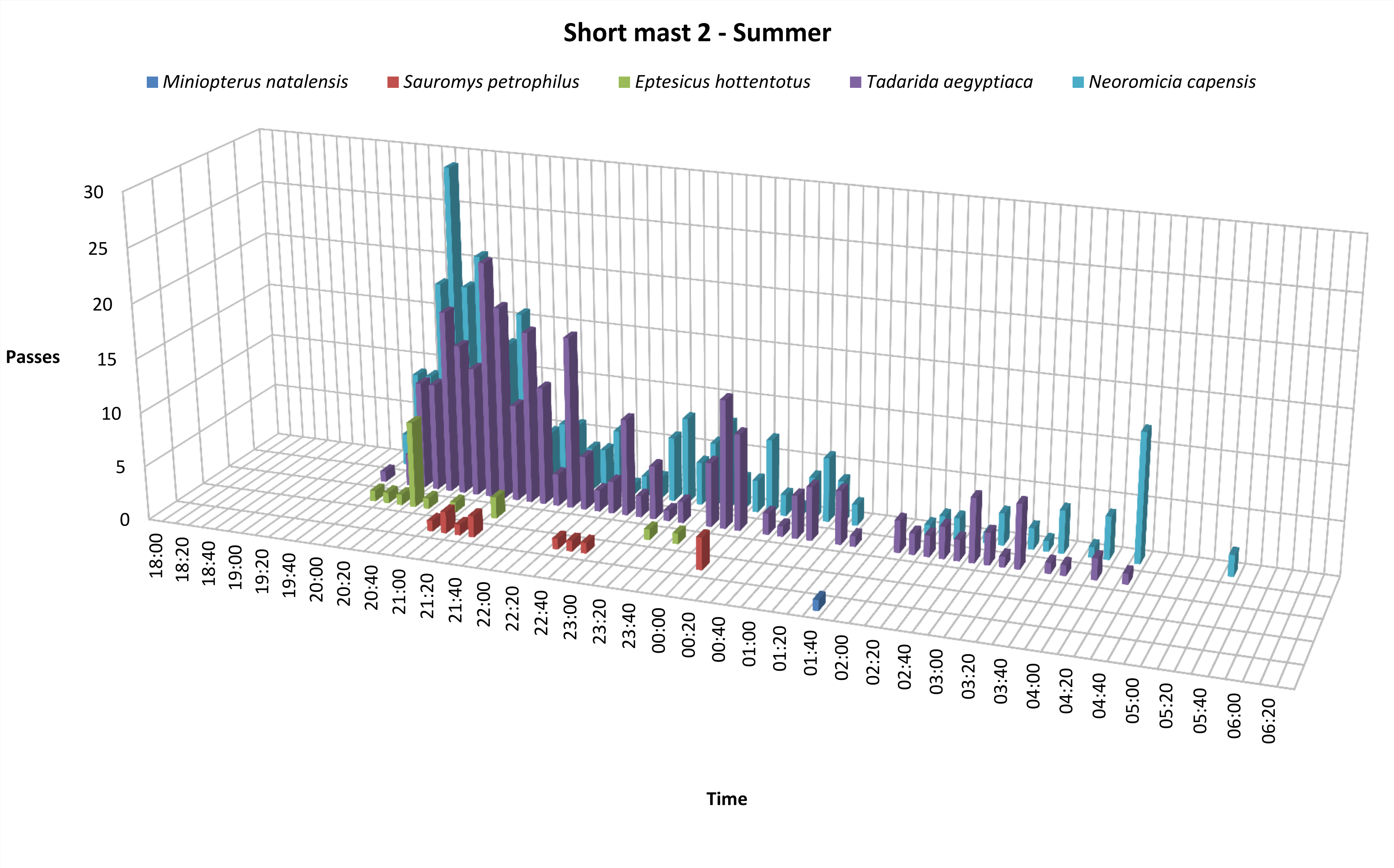


Figure 35: Temporal distribution of activity across the night as detected by Short mast 2 in summer

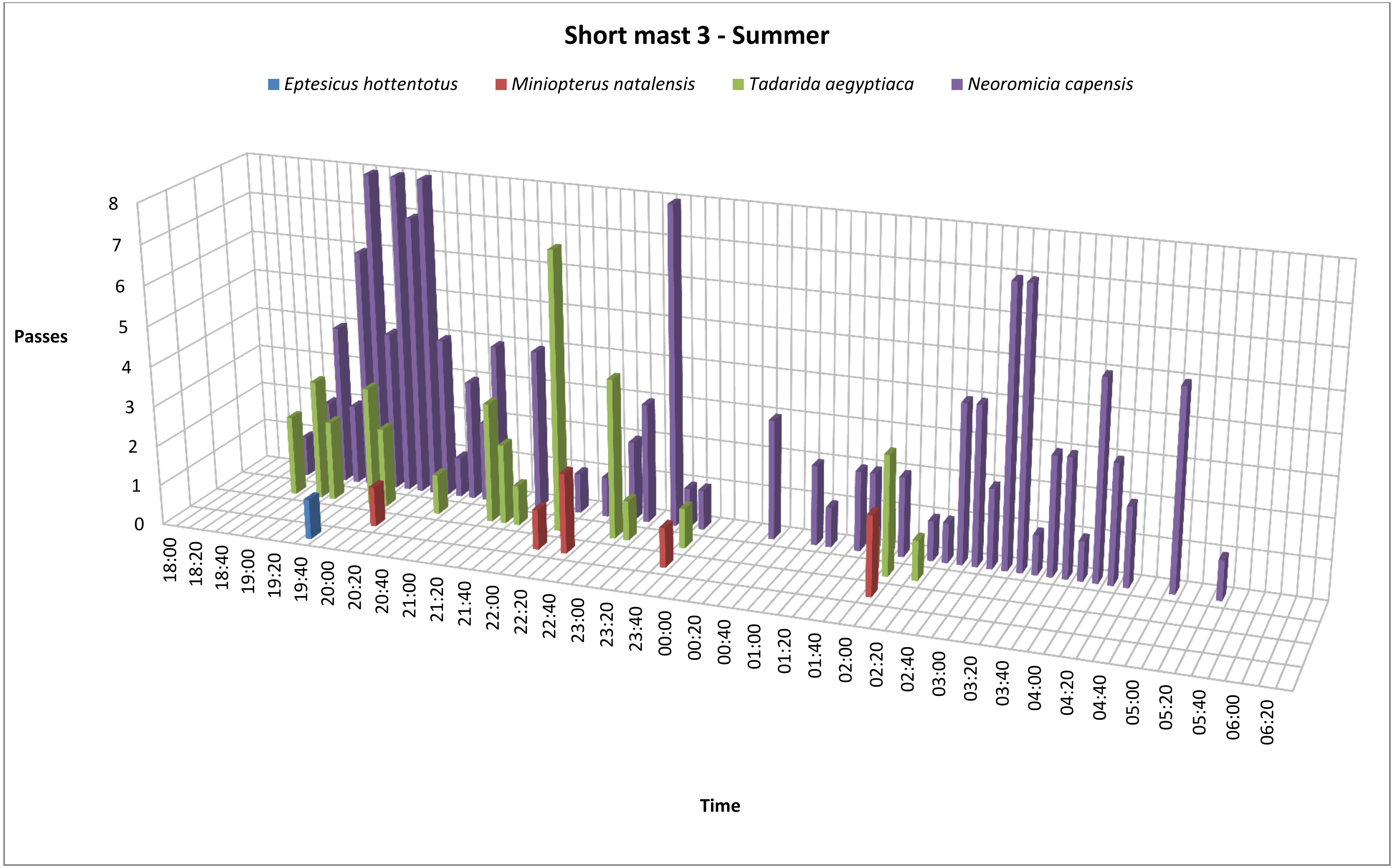


Figure 36: Temporal distribution of activity across the night as detected by Short mast 3 in summer

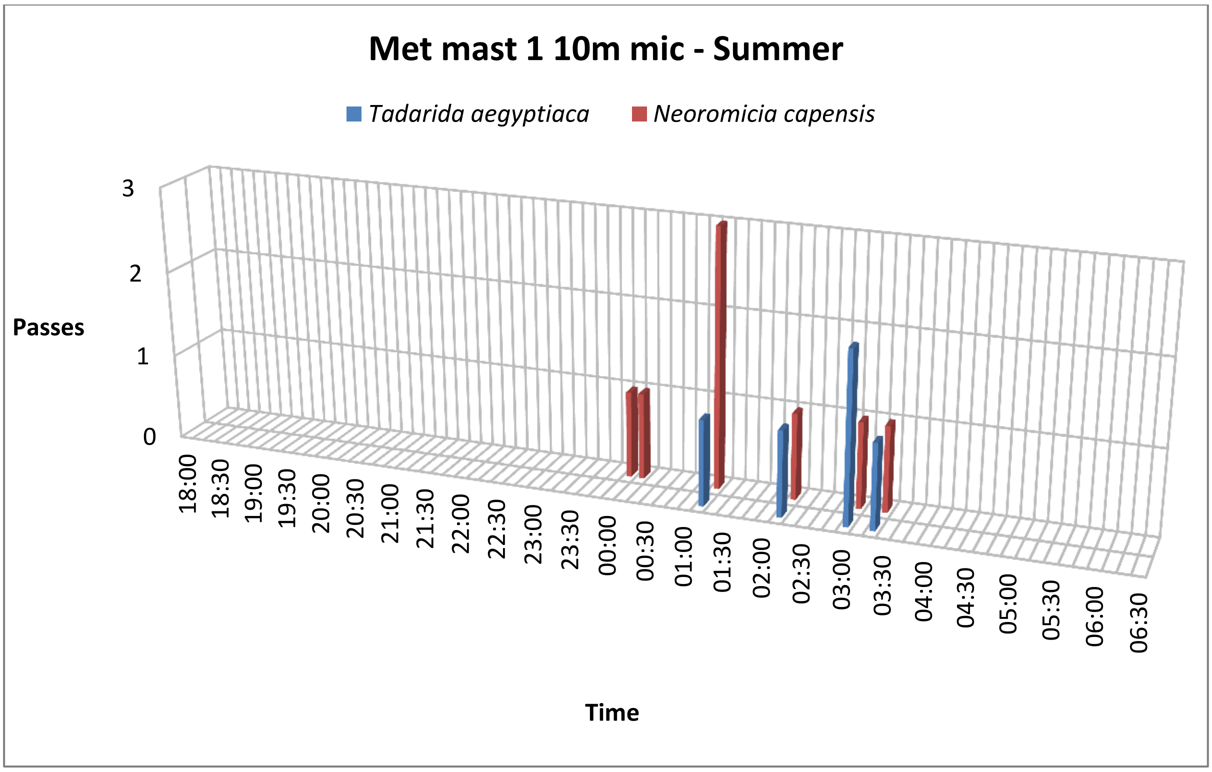


Figure 37: Temporal distribution of activity across the night as detected by the 10m mic of Met mast 1 in summer

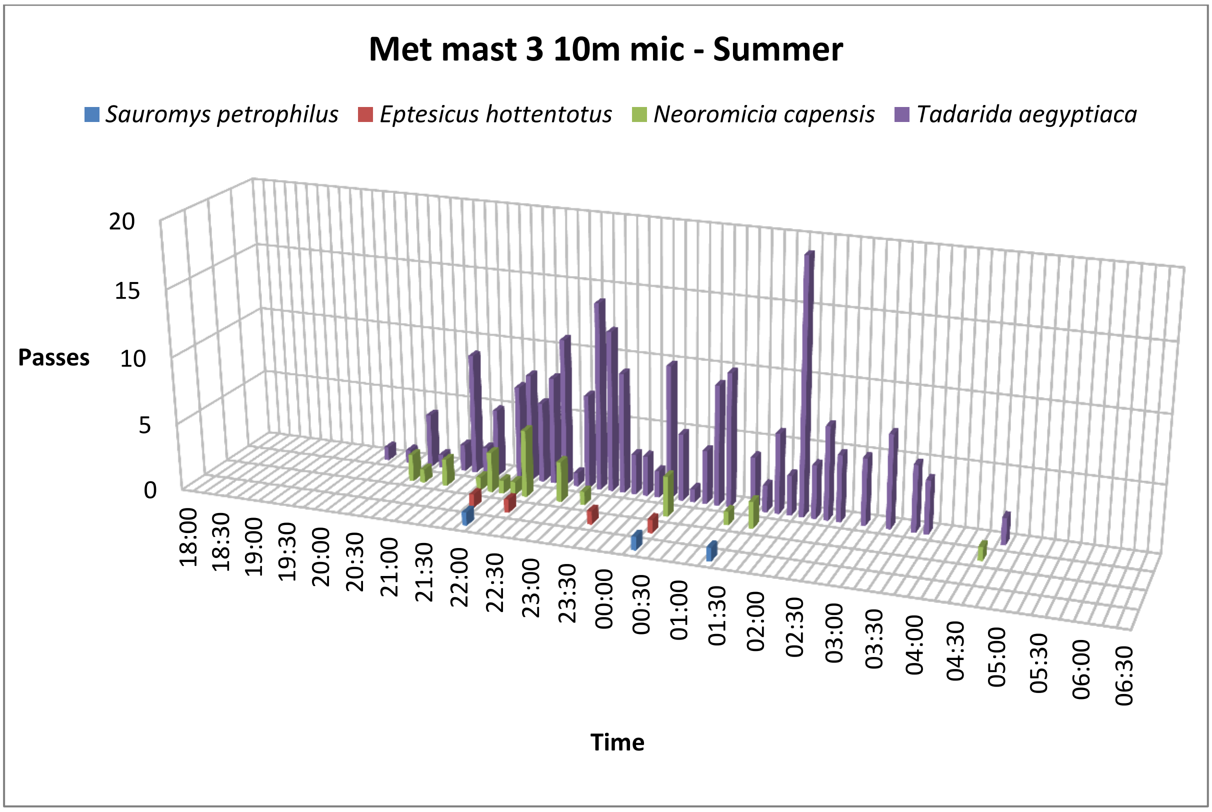


Figure 38: Temporal distribution of activity across the night as detected by the 10m mic of Met mast 3 in summer

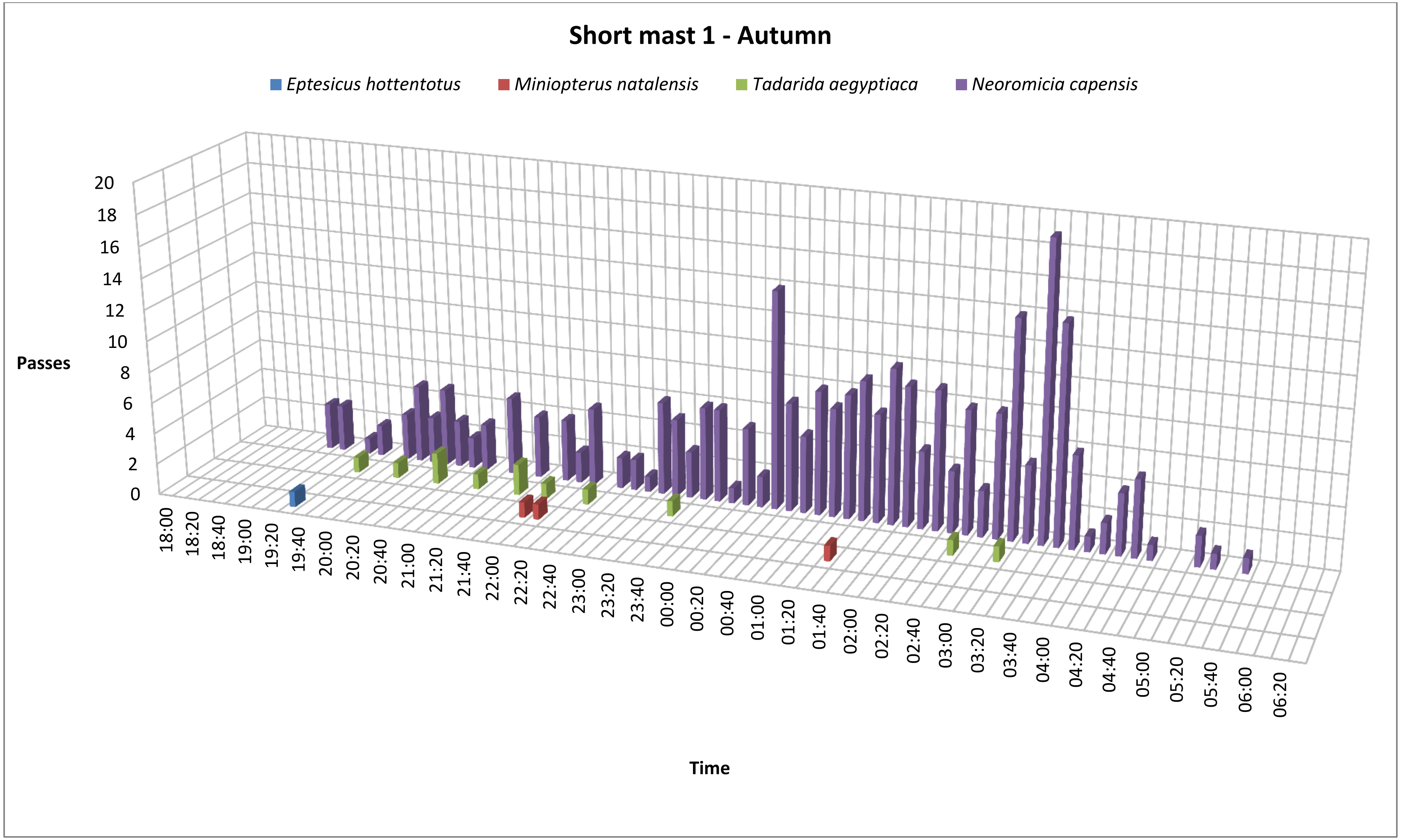


Figure 39: Temporal distribution of activity across the night as detected by Short mast 1 in autumn

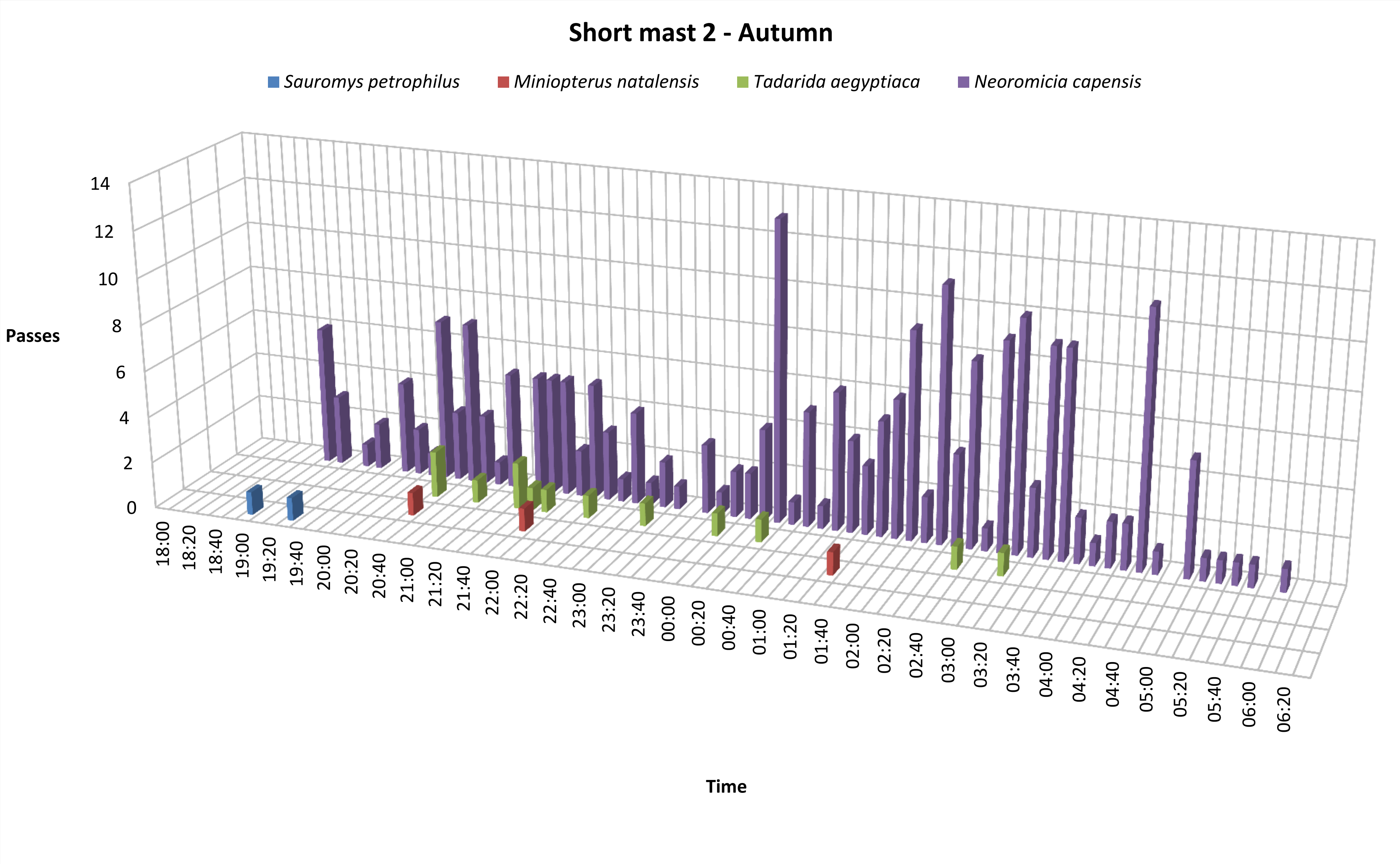


Figure40 : Temporal distribution of activity across the night as detected by Short mast 2 in autumn

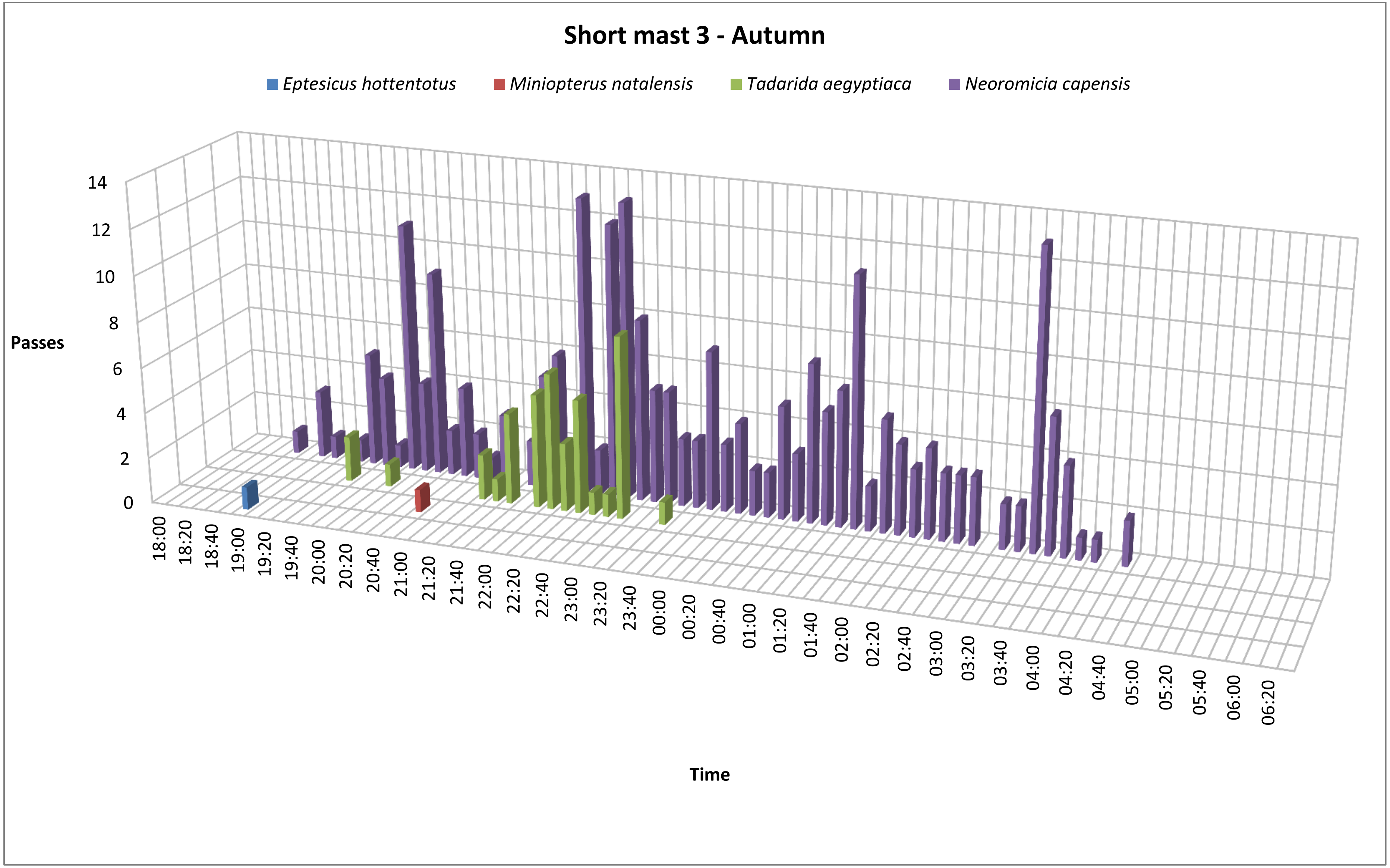


Figure 41: Temporal distribution of activity across the night as detected by Short mast 3 in autumn

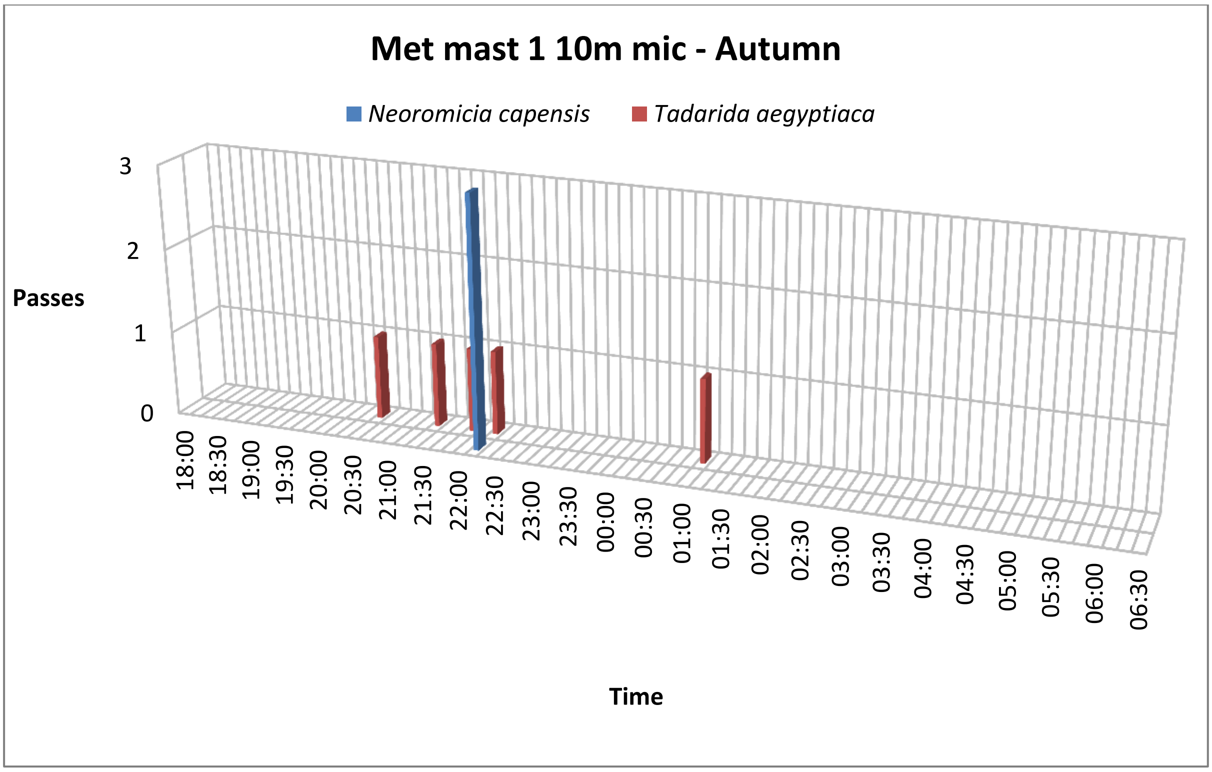


Figure 42: Temporal distribution of activity across the night as detected by the 10m mic of Met mast 1 in autumn

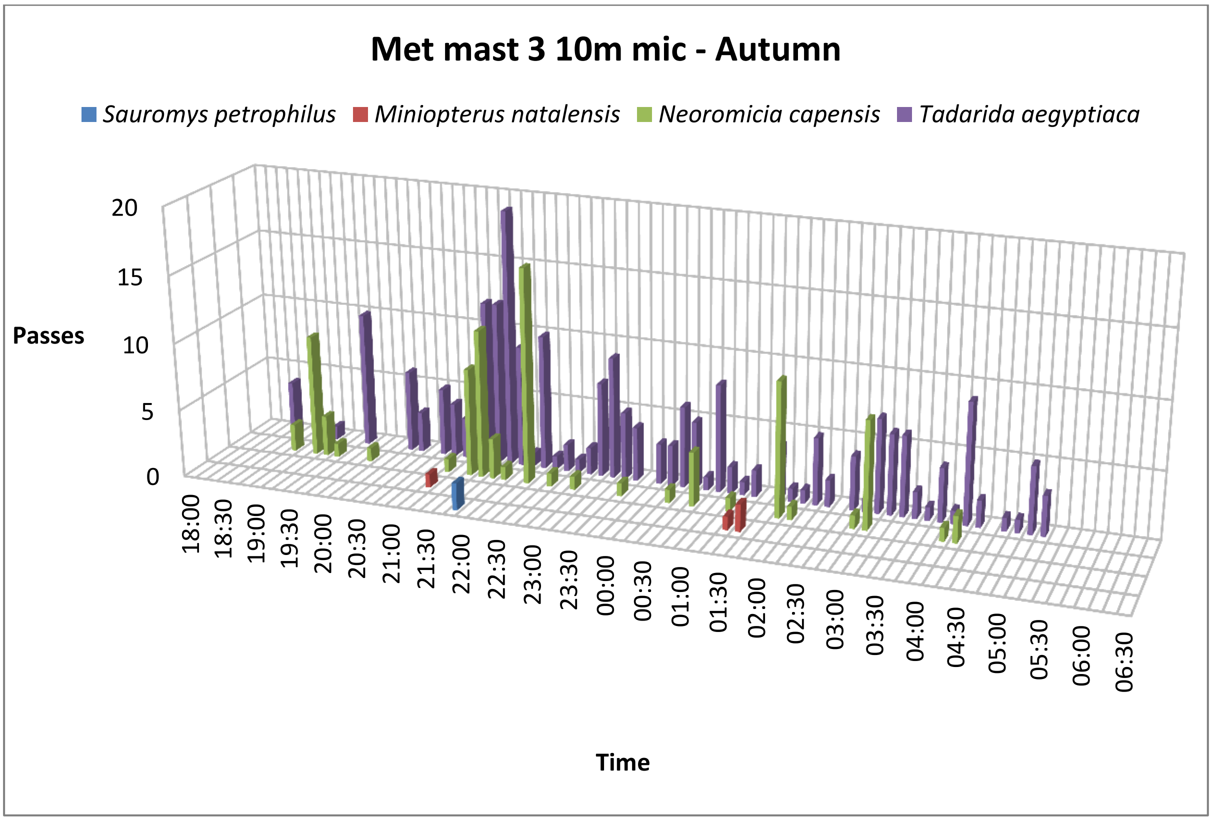


Figure 43: Temporal distribution of activity across the night as detected by the 10m mic of Met mast 3 in autumn

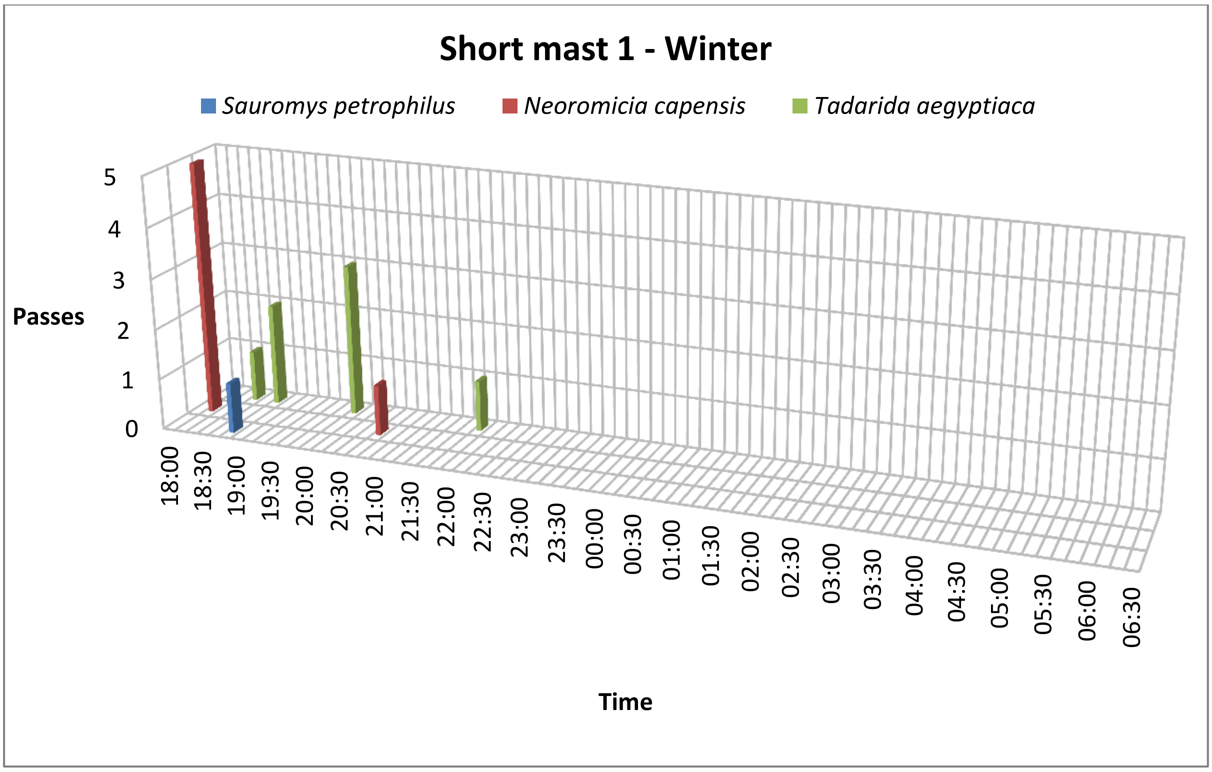


Figure 44: Temporal distribution of activity across the night as detected by Short mast 1 in winter

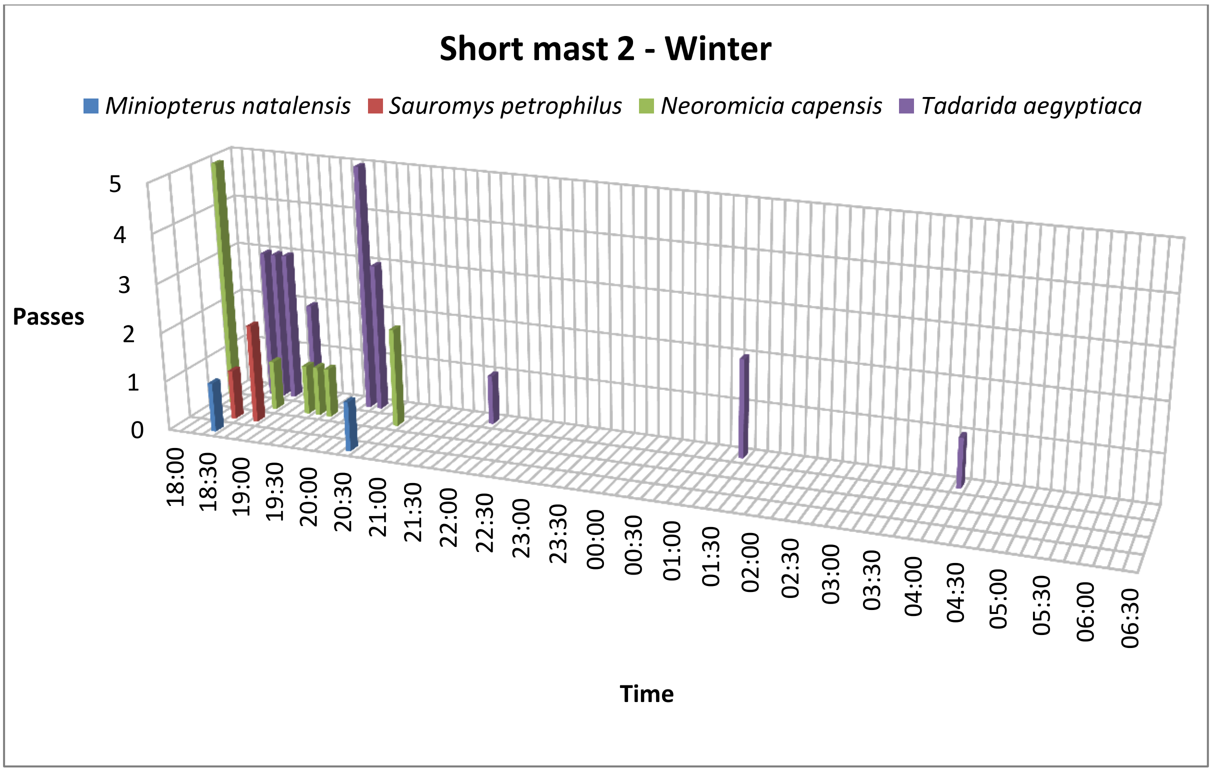


Figure 45: Temporal distribution of activity across the night as detected by Short mast 2 in winter

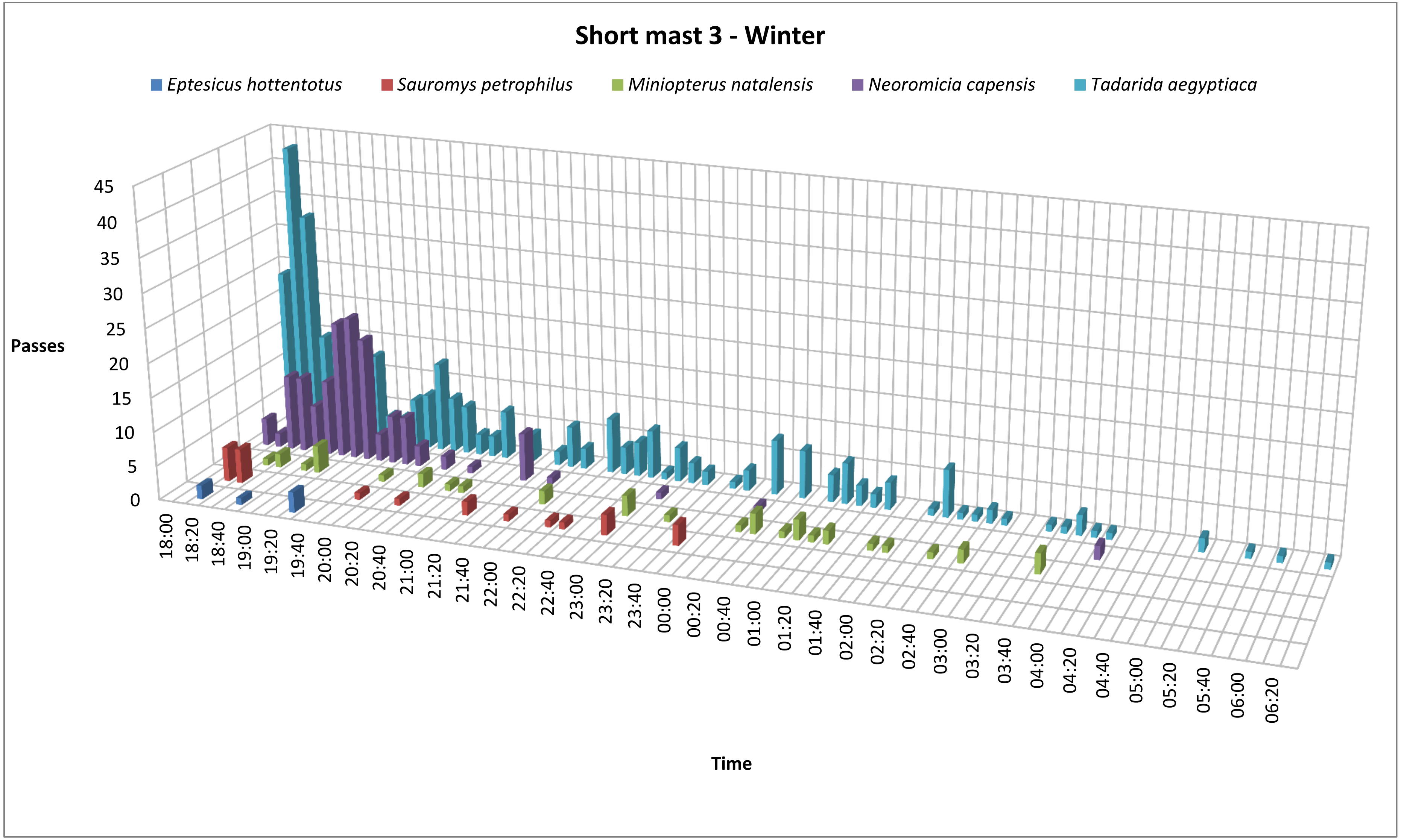


Figure 46: Temporal distribution of activity across the night as detected by Short mast 3 in winter

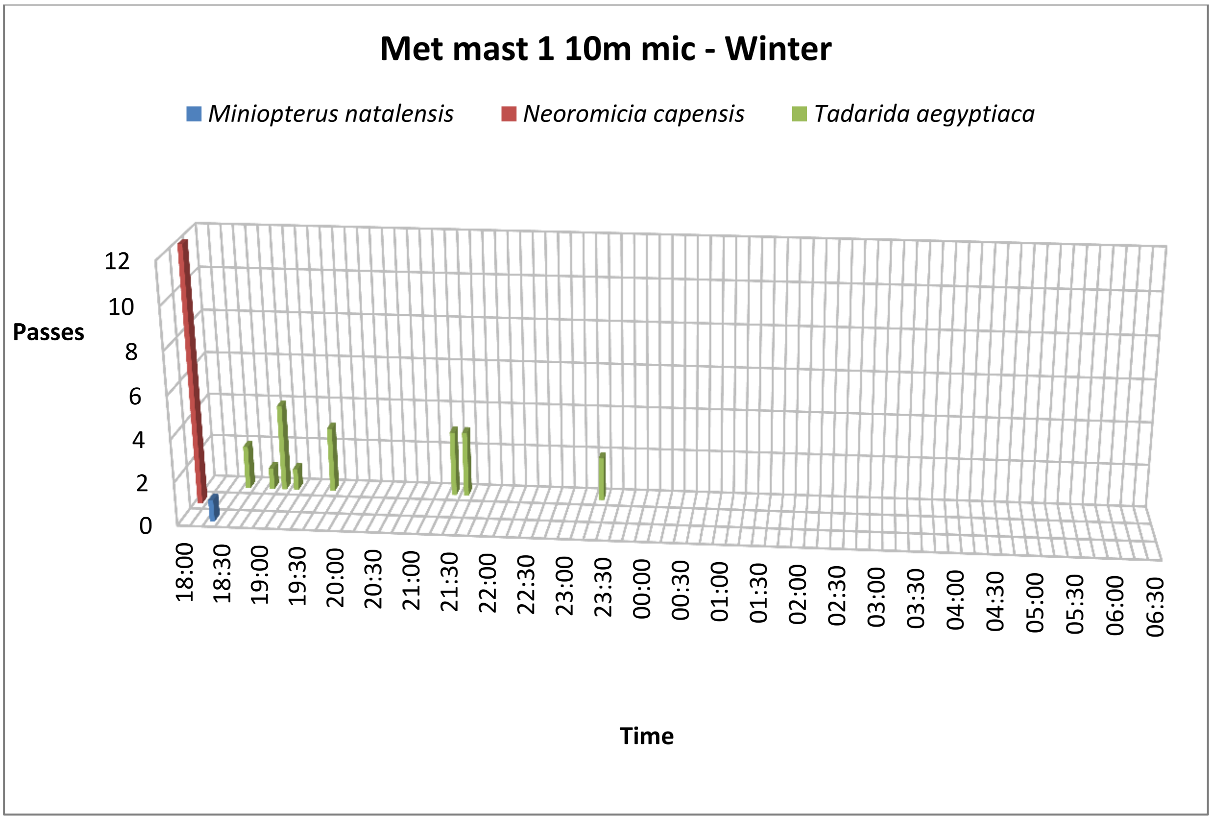


Figure 47: Temporal distribution of activity across the night as detected by the 10m mic of Met mast 1 in winter

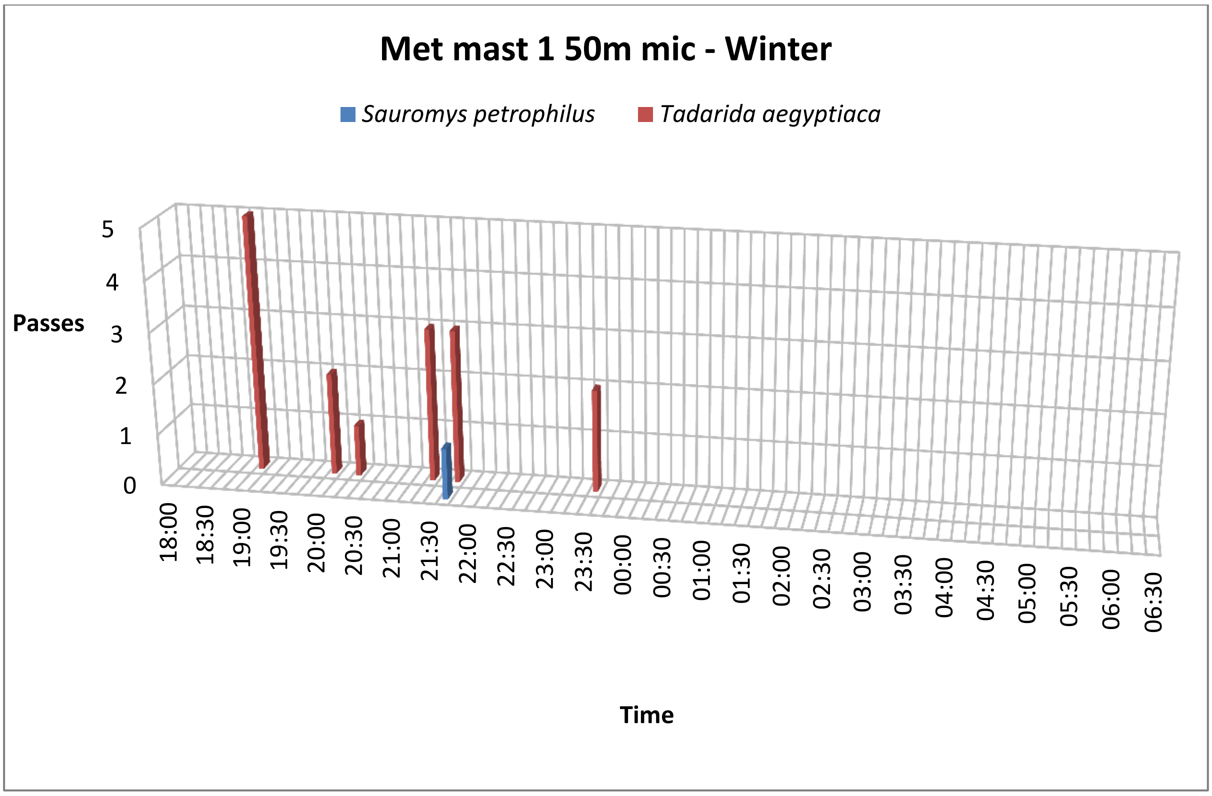


Figure 48: Temporal distribution of activity across the night as detected by the 50m mic of Met mast 1 in winter

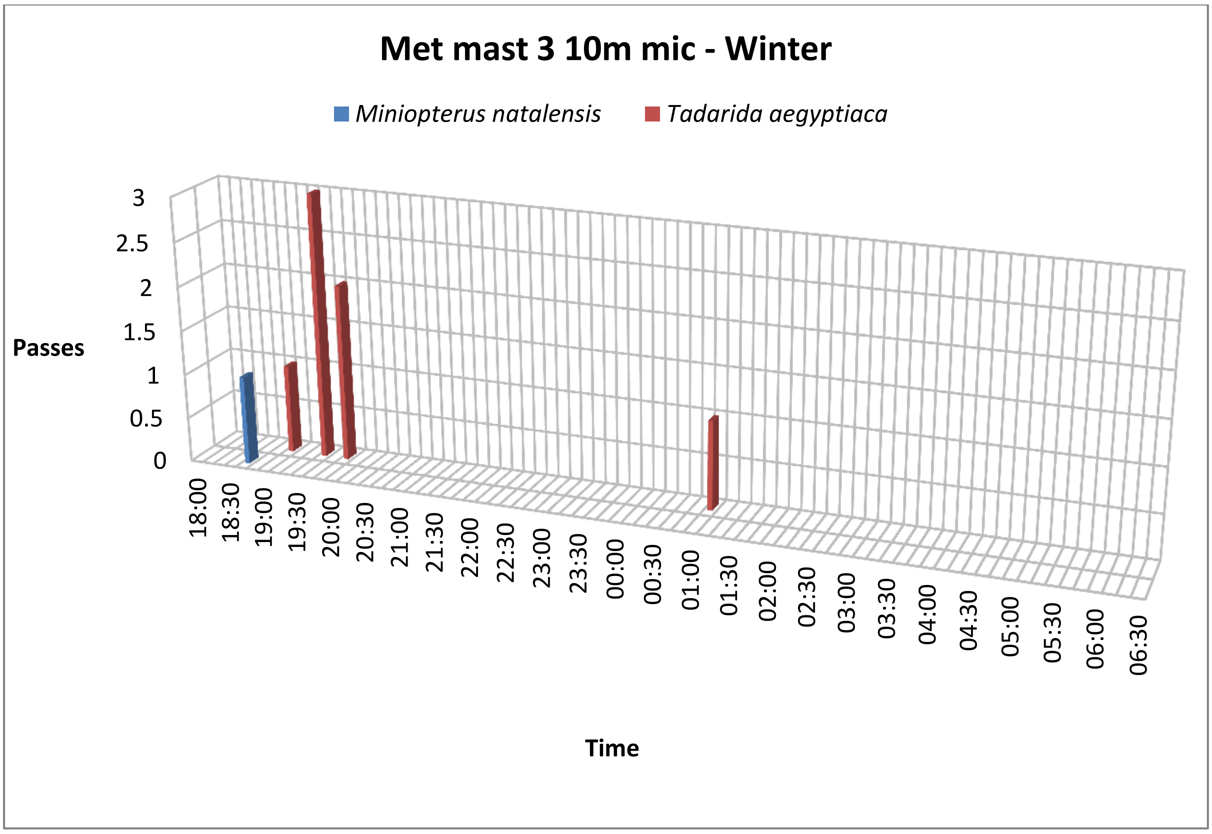


Figure 49: Temporal distribution of activity across the night as detected by the 50m mic of Met mast 3 in winter

4.6.5 Relationship between Bat Activity and Weather Conditions

Several sources of literature, referred to below, describe how numerous bat species are influenced by weather conditions. Weather may influence bats in terms of lowering activity, changing time of emergence and flight time. It is also important to realise that environmental factors are never isolated and therefore a combination of the environmental factors can have synergistic or otherwise contradictory influences on bat activity. For instance 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 and temperature influence 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’ (usually > 6.0 m/s) wind speeds (Arnett *et al*., 2010).

Wind speed and direction also affects 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).So at edges exposed to wind, flight activity of insects, and thus bats may be suppressed and at edges to the lee side of wind, bat activity may be greater. This relationship is used in the sensitivity map whereby the larger vegetation and man-made structures provide shelter from the wind. However the turbine localities are situated on the ridges of the site such that they will be in areas exposed to the wind and not protected by vegetation or structure.

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 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.

The results below present figures of the sum of bat passes that were detected within specific wind speed and temperature categories. However, the distribution of bat activity within each wind speed and temperature range may be biased due to the frequency of occurrence of each wind speed and temperature range. Thus the number of bat passes were ‘normalised’ wherein the frequency with which each wind speed and temperature range were recorded was taken into account. The ‘normalised’ sum of bat passes per wind speed and temperature range are presented below. Cumulative percentages of the normalised sum of bat passes per wind speed and temperature ranges are also presented. The lowest wind speed at which 80% of bats were detected (of the normalised sum of bat passes) will then be used to inform mitigation.

The aim of this analysis is to determine the wind speed and temperature range within which 80% of bat passes are detected. Ultimately these values of wind speed and temperature will be used to mitigate turbine operation based on conserving 80% of detected bat passes, keeping in mind the synergistic or otherwise contradictory effects that the combination of wind speeds and temperatures can have on bat activity.

In the analysis below, bat passes for the three short masts were recorded at a height of 10m and thus wind speed measured at 10m height and temperature data measured at a height of 1m was used. The wind speed data was modelled at the microphone position (10m height) of each mast using the CFD flow model Windsim (www.windsim.com) for the period covering the bat monitoring campaign. Short Mast 3 wind speed data was calculated by transferring the Met mast 2 15m wind speeds, while Short Mast 1 and Short Mast 2 were modelled on the basis of the Met mast 3 wind speeds. The temperature data was based on the internal temperature recorded by the SM2bat loggers, with all "logger warm up hooks" replaced by straight line approximations and an offset of -4°C was applied. This climate data was prepared as such by G7.

The wind speed analysis for Met mast 3 below utilised bat data from 10m height and wind speed measured at 15m height.

Time periods used in the analysis below for each monitoring system were identified in Sections 4.6.2 and 4.6.3 as periods of elevated activity. The analysis was not performed for time frames of lower activity levels. The time periods used in the analysis below corresponds with the time periods and systems used to inform mitigation in Section 6:

Short mast 1

- 15 September - 15 October 2013
- month of March 2014

Short mast 2

- 1 December 2013 – 28 February 2014
- 15 March - 15 April 2014

Met mast 3

- 1 - 15 March 2014

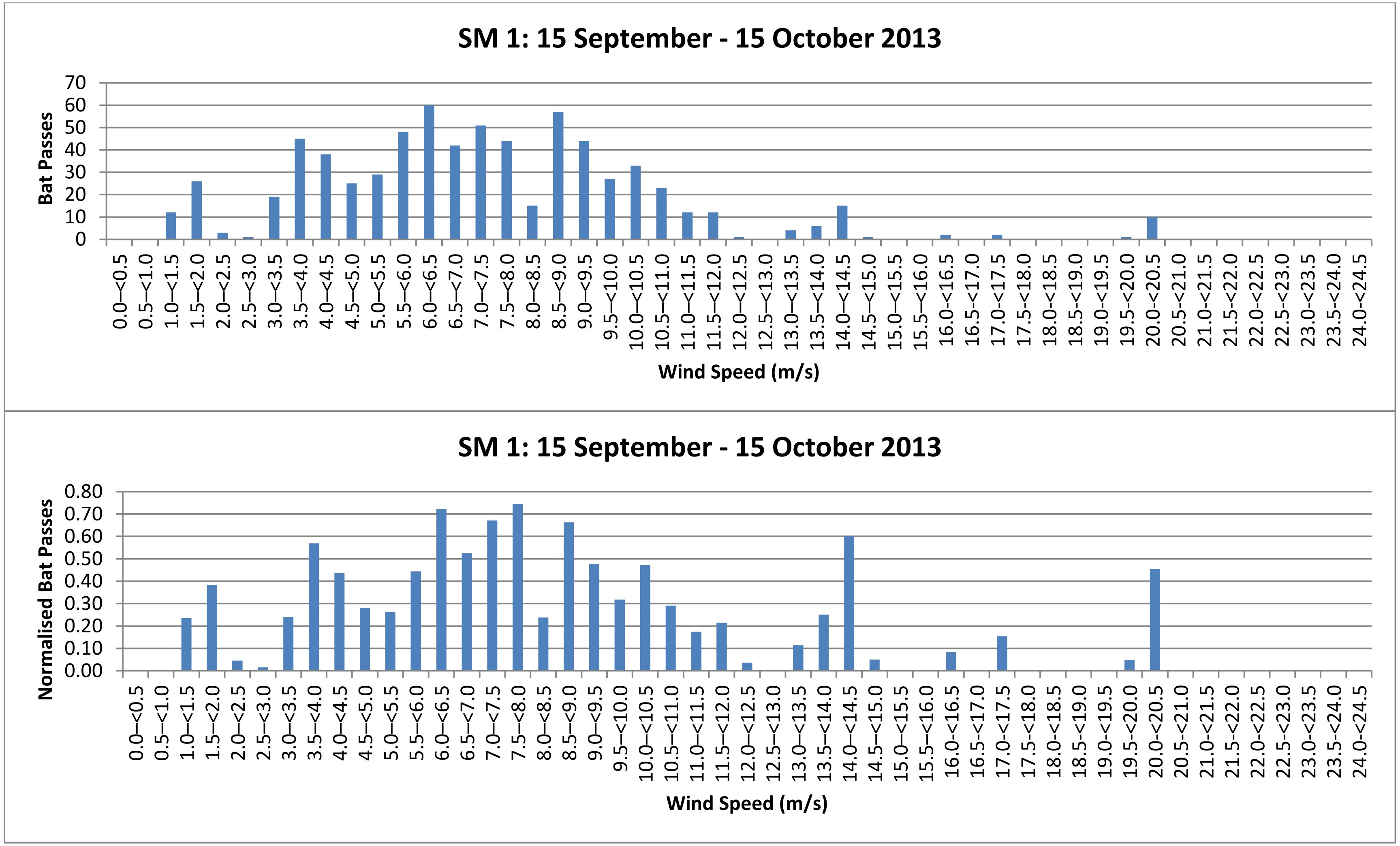


Figure 50: Sum of bat passes (top) and normalised passes (bottom) per wind speed category

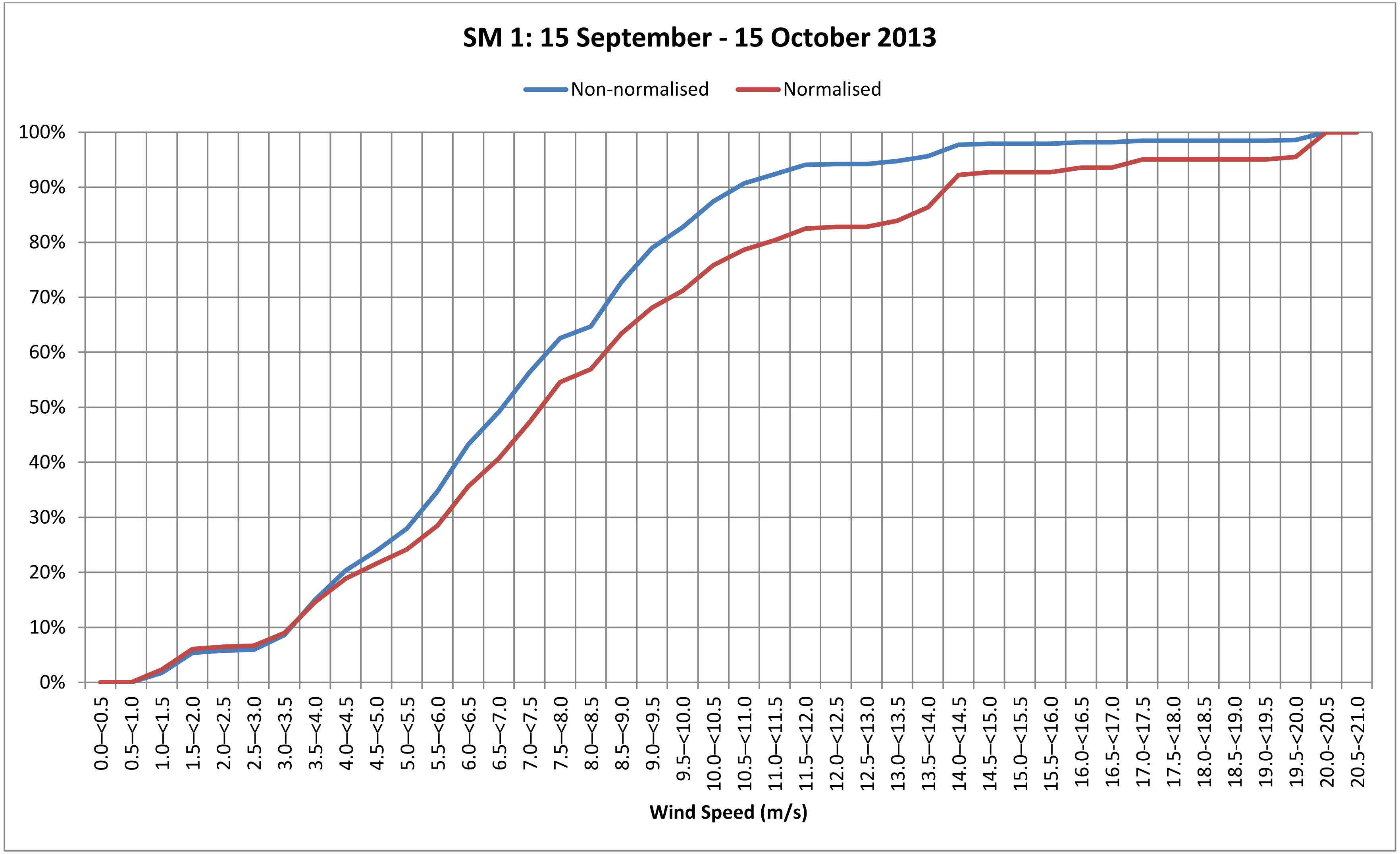
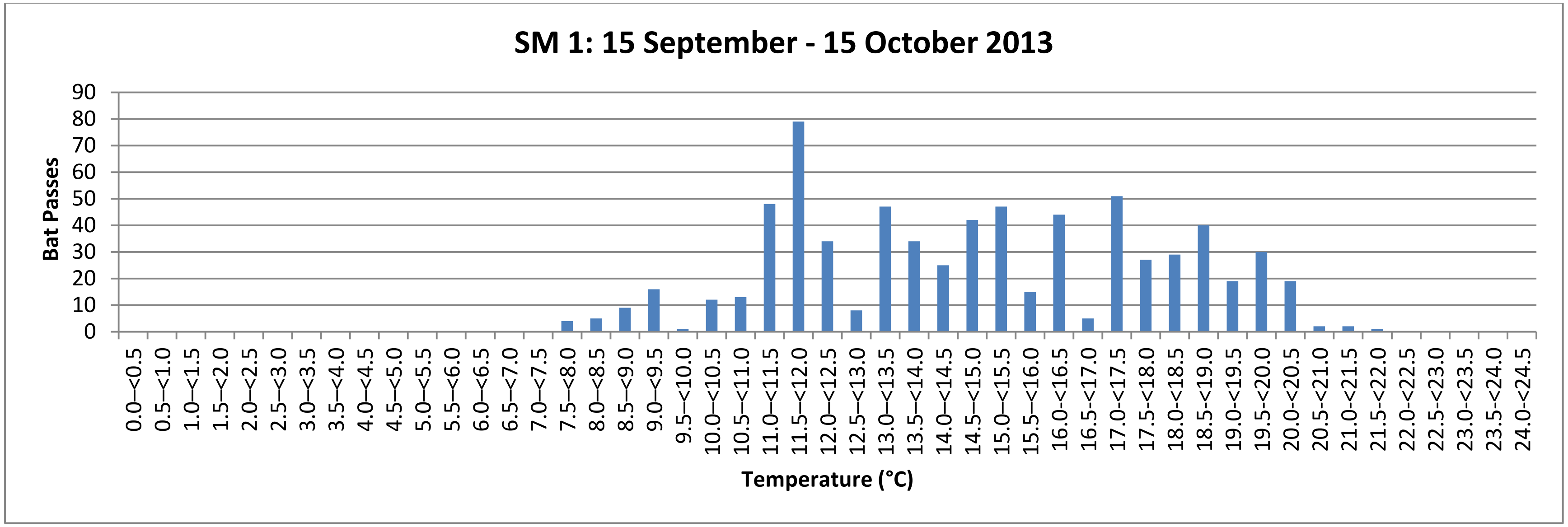


Figure 51: Cumulative percentage of normalised and non-normalised bat passes per wind speed category



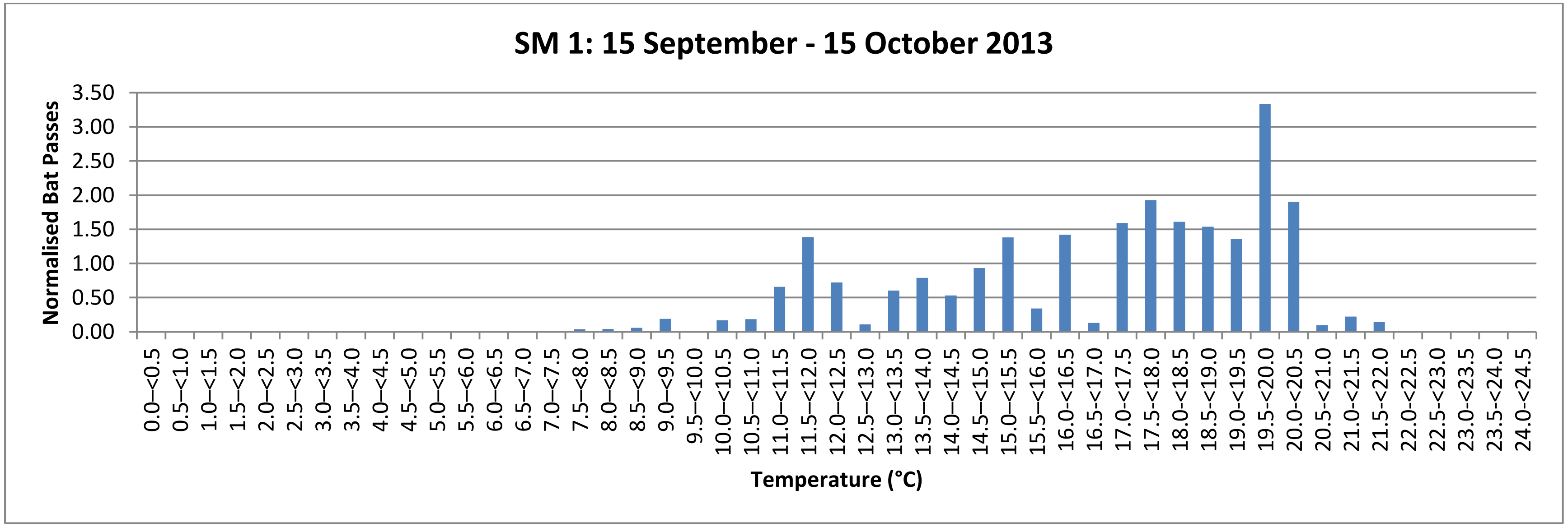


Figure 52: Sum of bat passes (top) and normalised passes (bottom) per temperature category

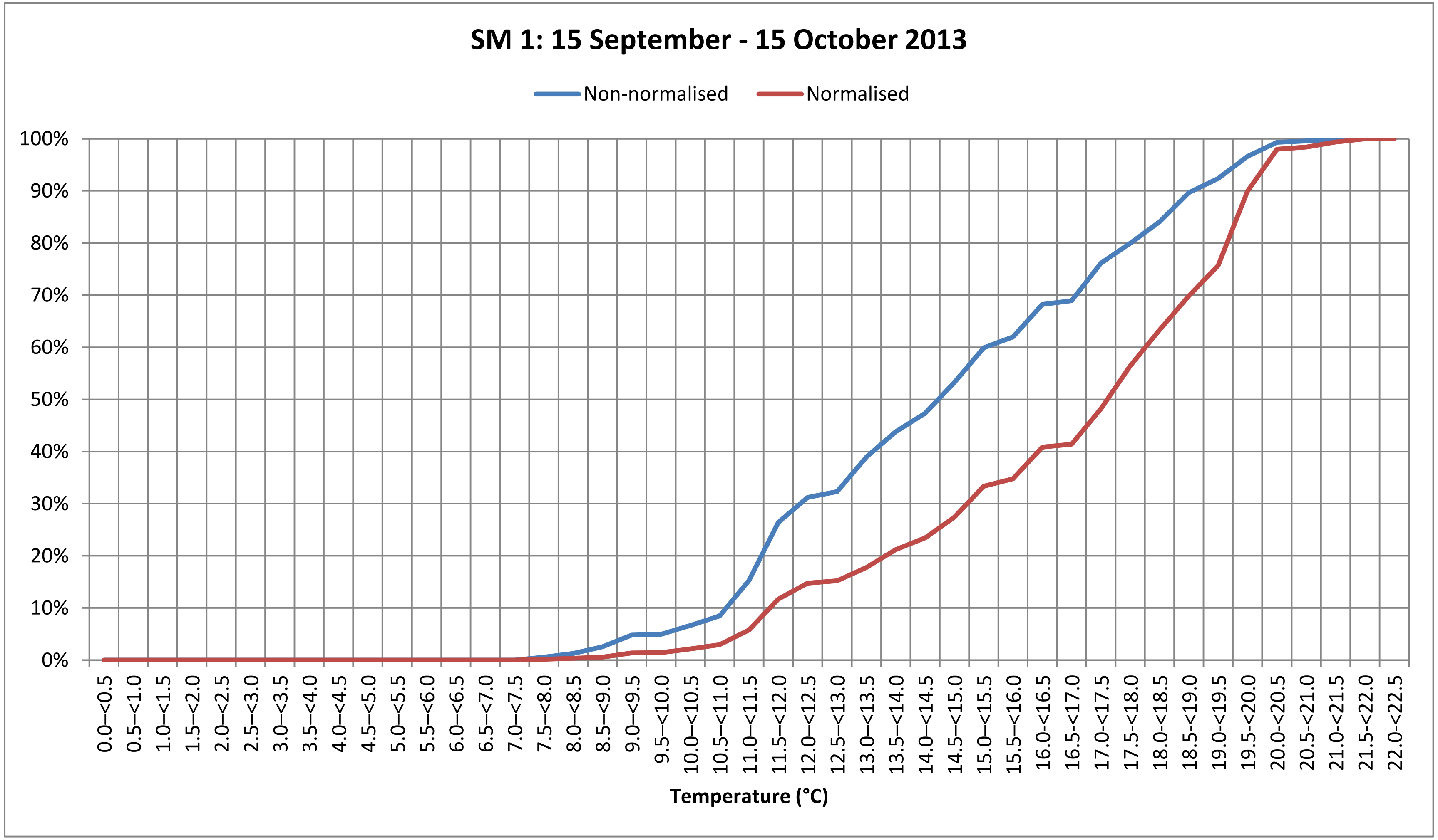


Figure 53: Cumulative percentage of normalised and non-normalised bat passes per temperature category

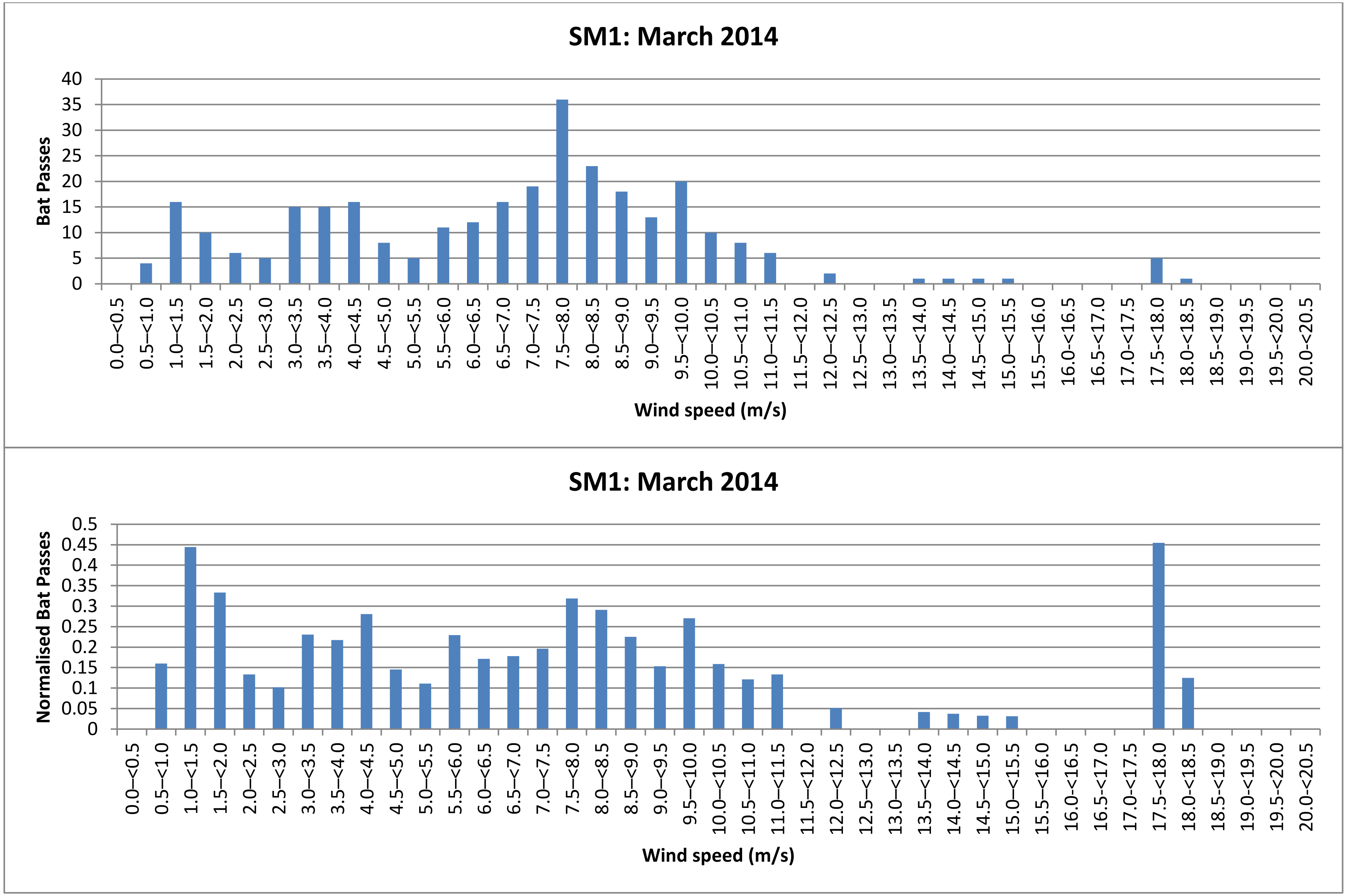


Figure 54: Sum of bat passes (top) and normalised passes (bottom) per wind speed category

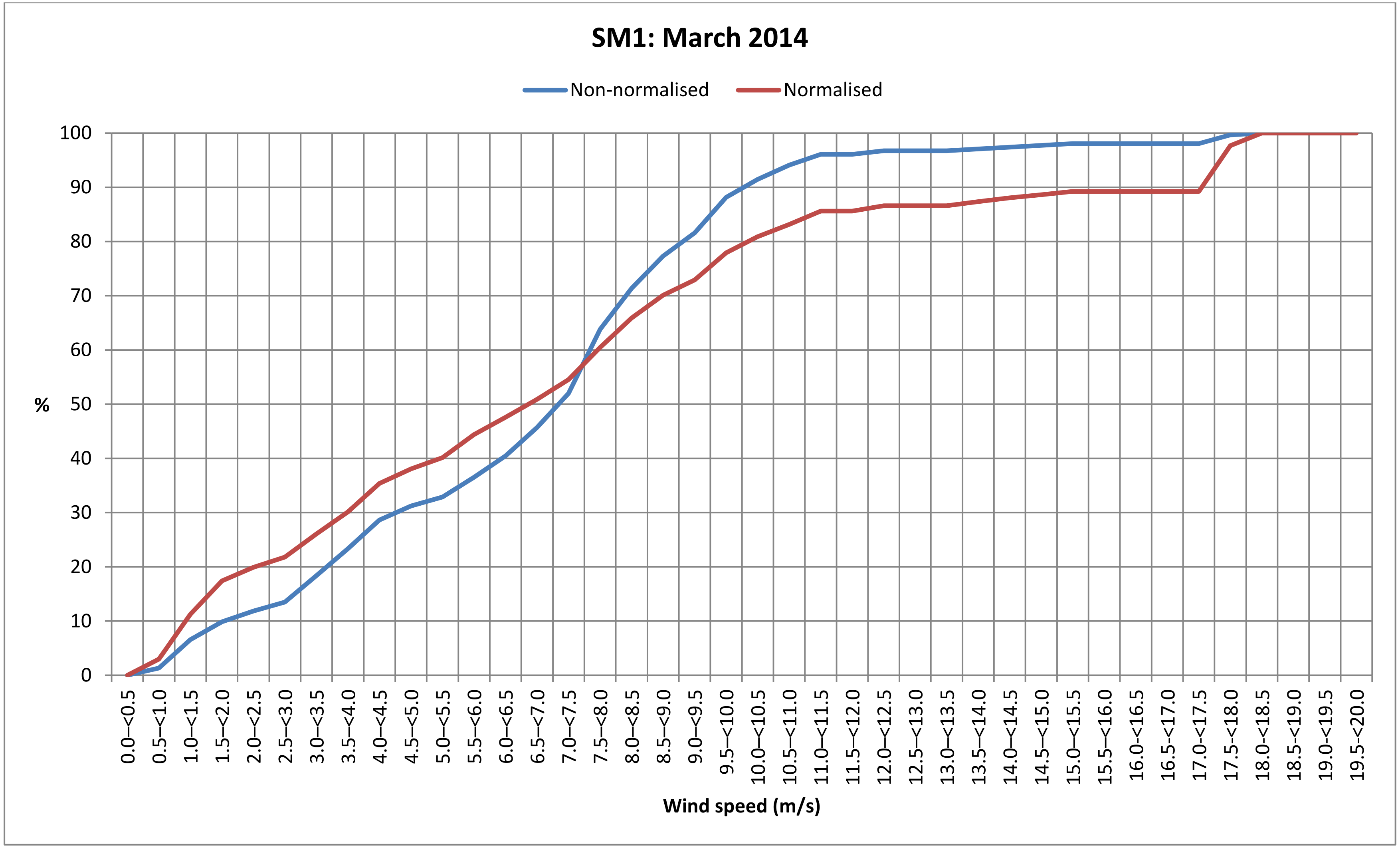


Figure 55: Cumulative percentage of normalised and non-normalised bat passes per wind speed category

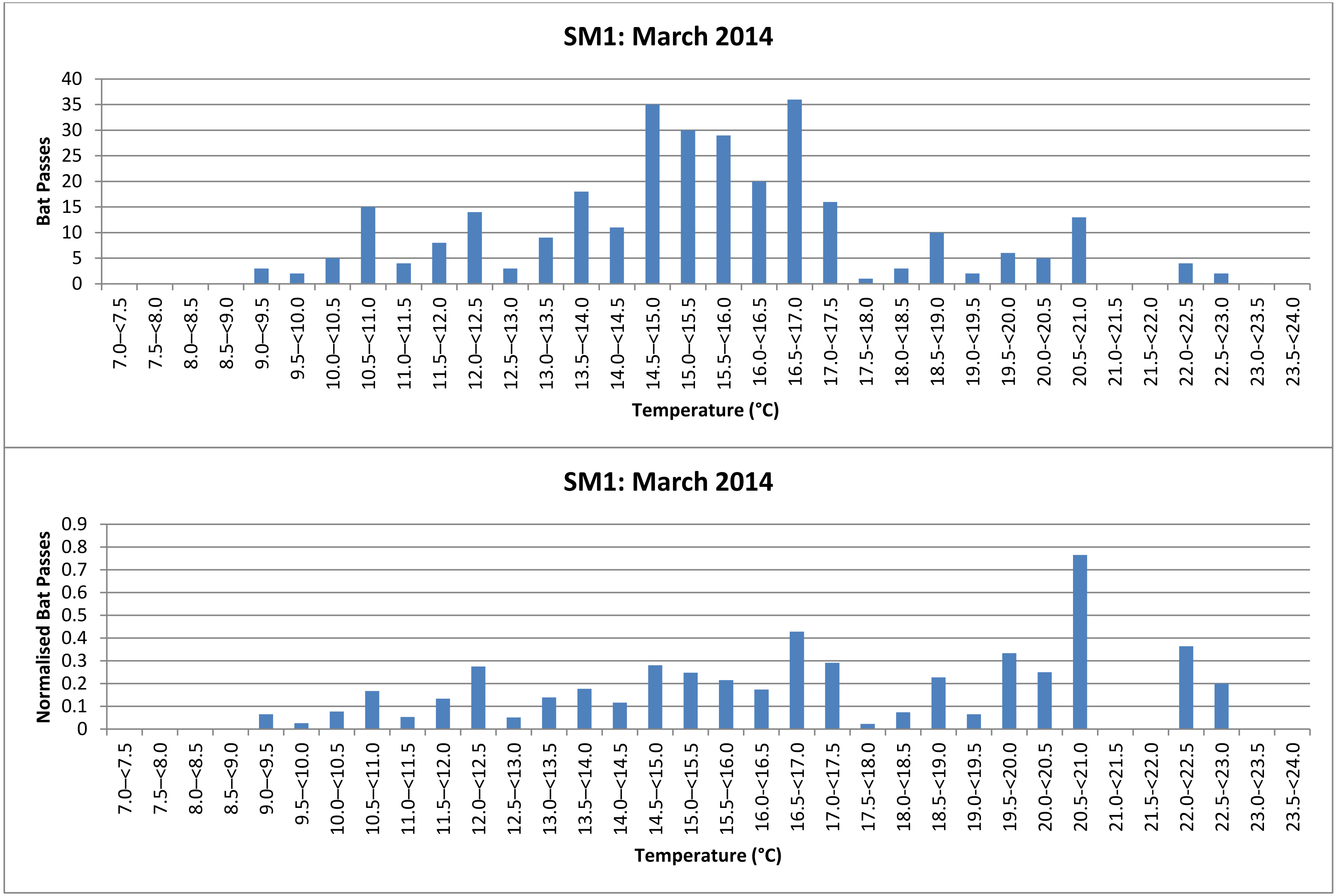


Figure 56: Sum of bat passes (top) and normalised passes (bottom) per temperature category

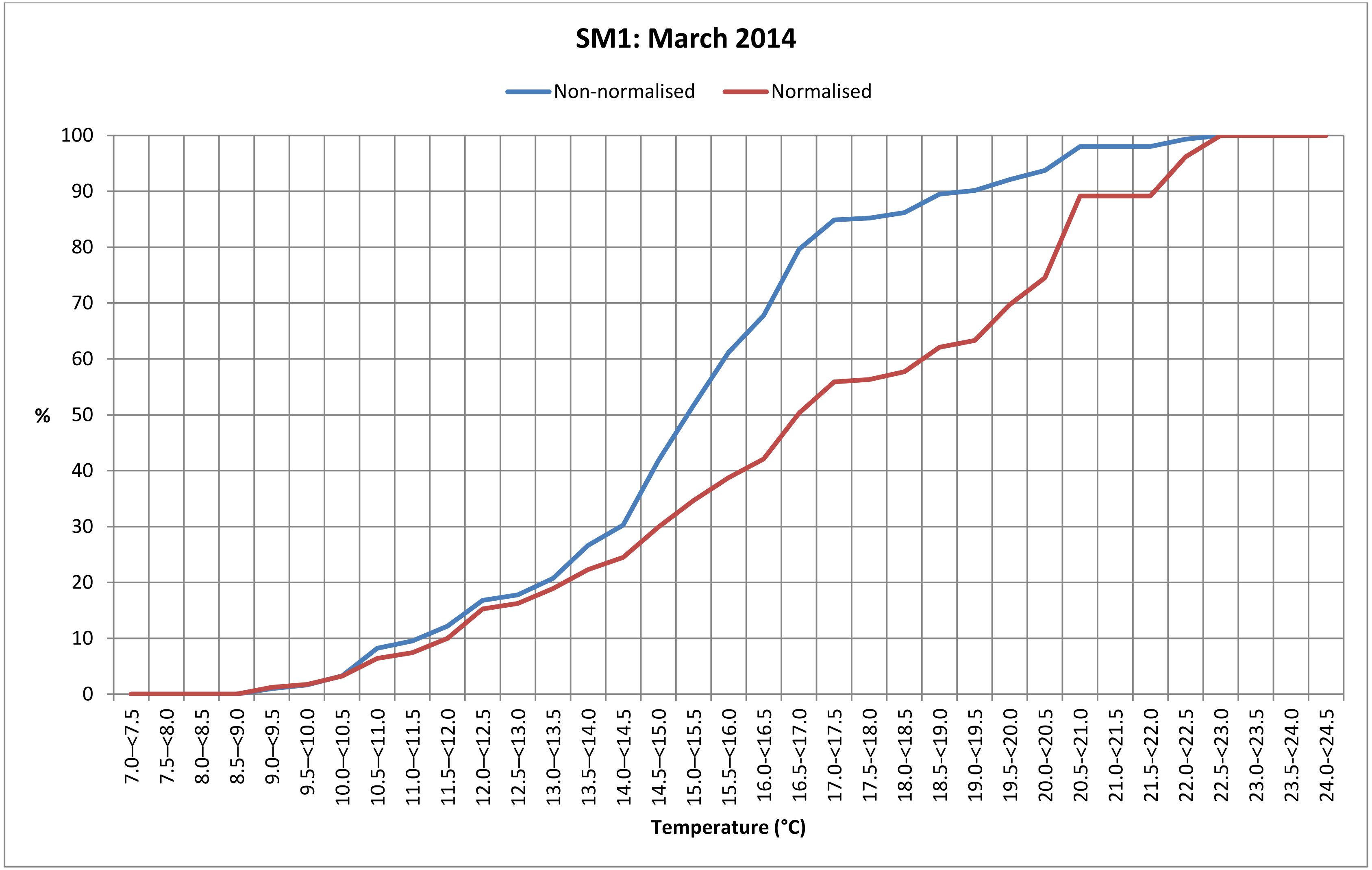


Figure 57: Cumulative percentage of normalised and non-normalised bat passes per temperature category

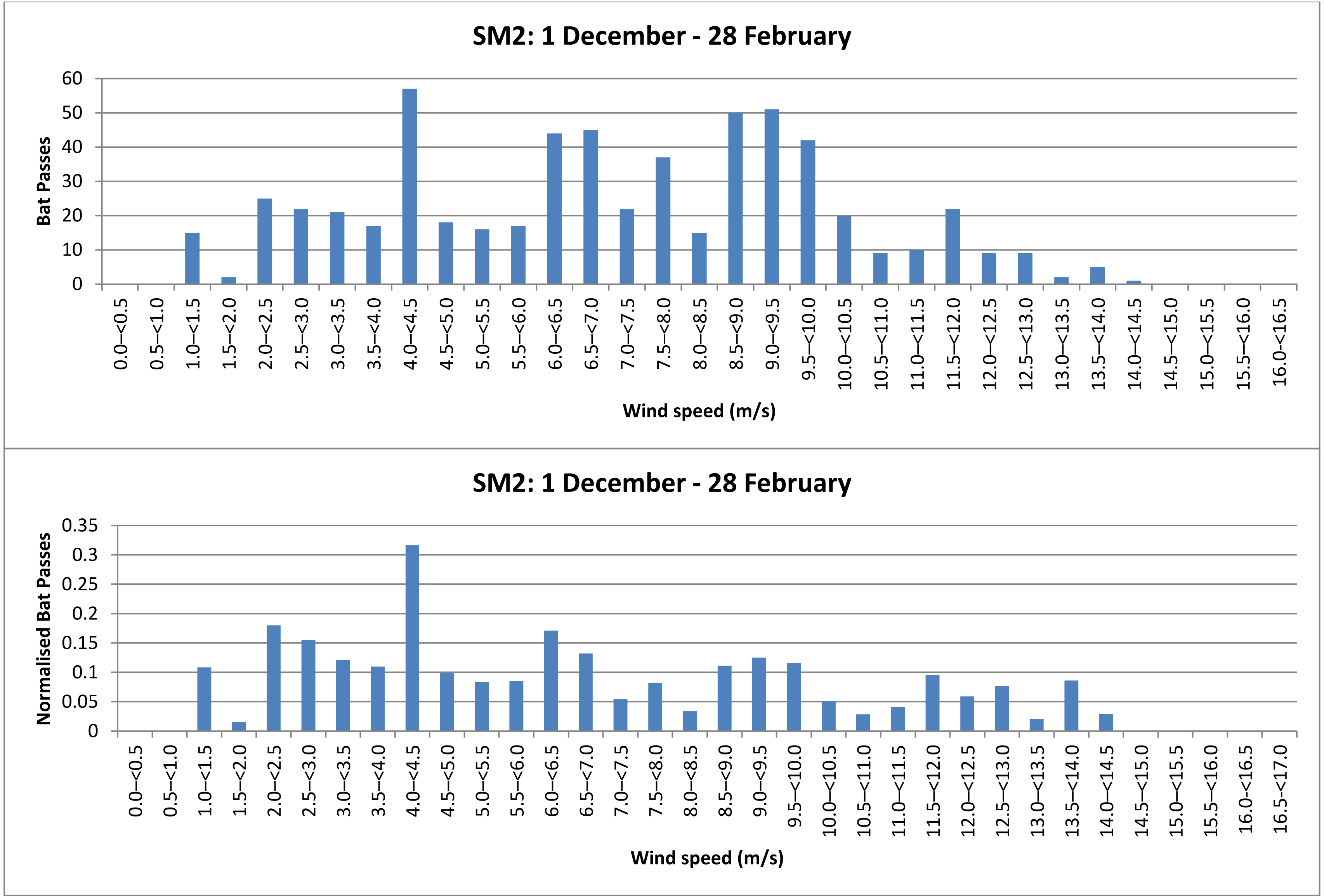


Figure 58: Sum of bat passes (top) and normalised passes (bottom) per wind speed category

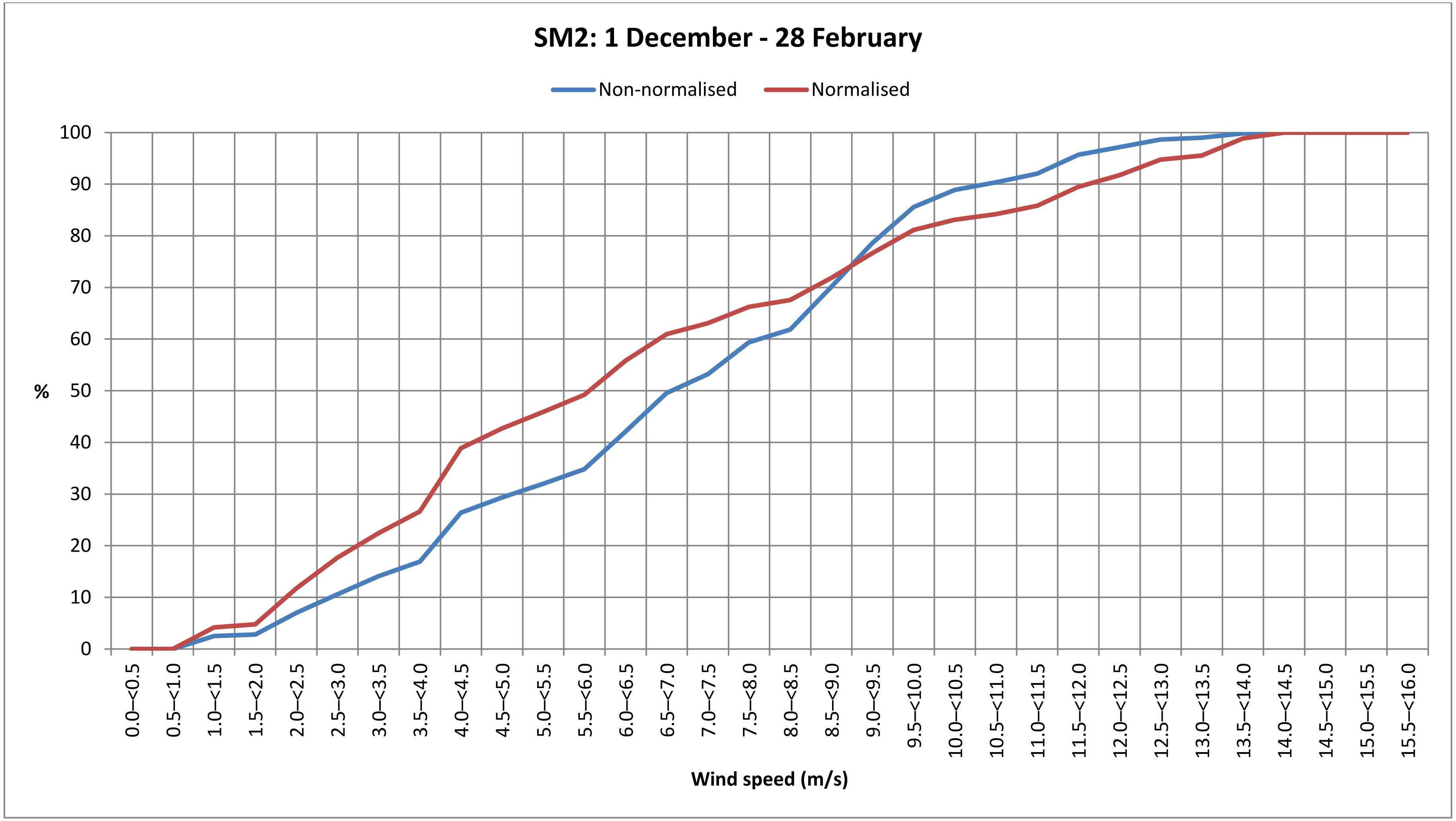
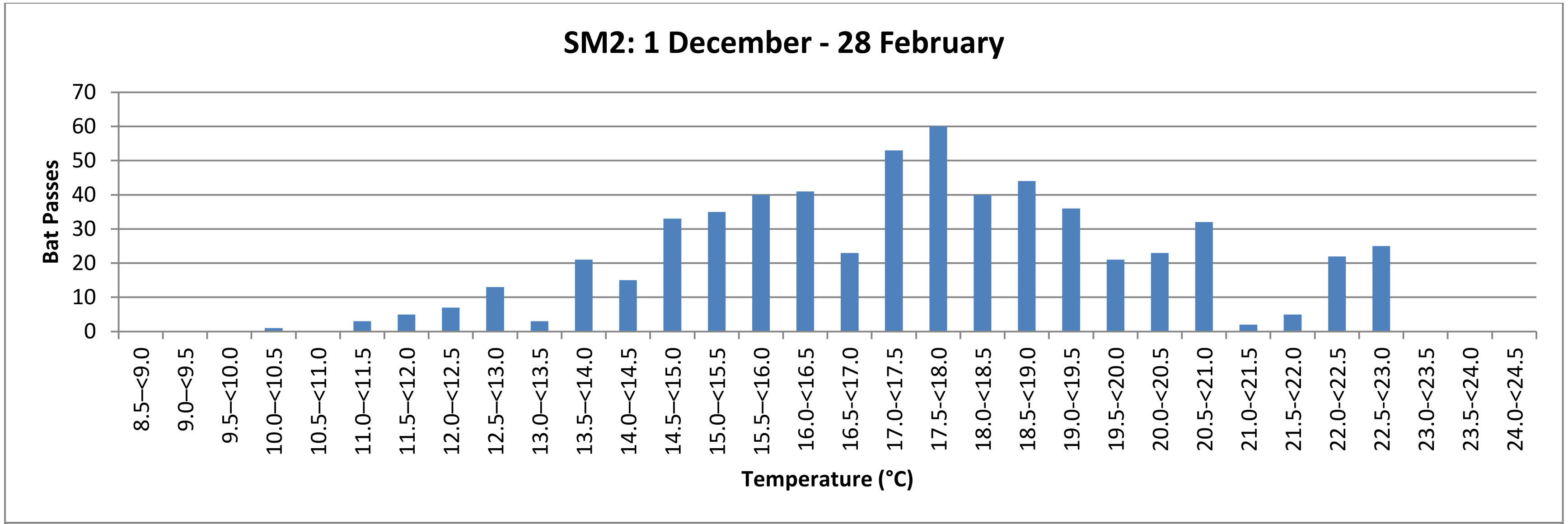


Figure 59: Cumulative percentage of normalised and non-normalised bat passes per wind speed category



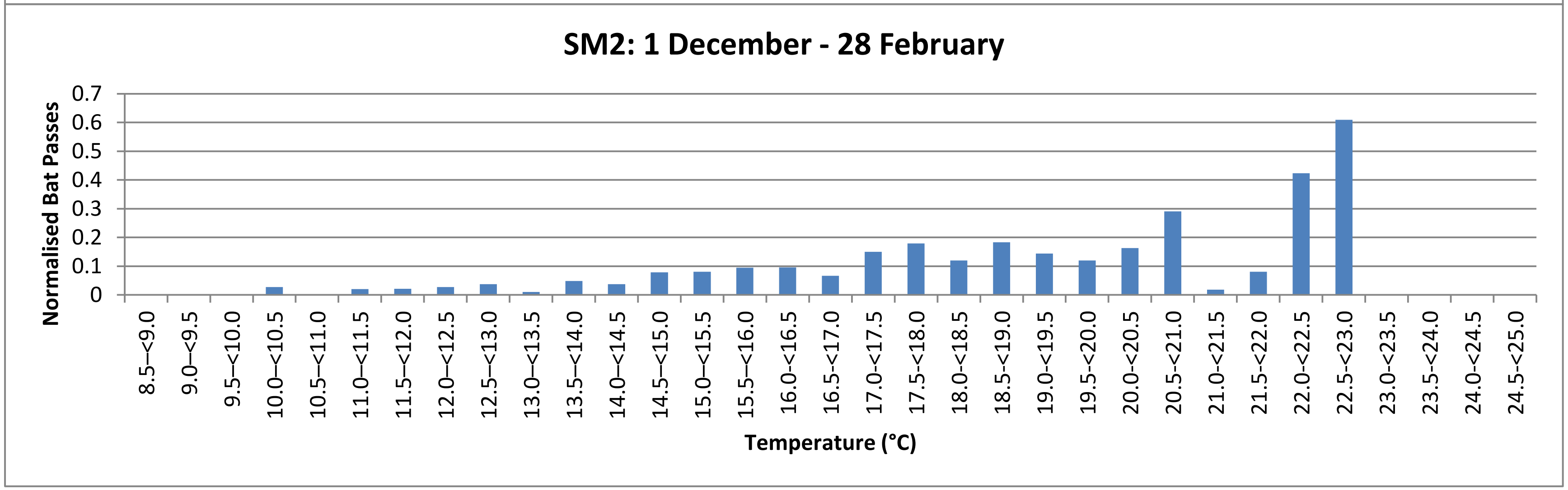


Figure 60: Sum of bat passes (top) and normalised passes (bottom) per temperature category

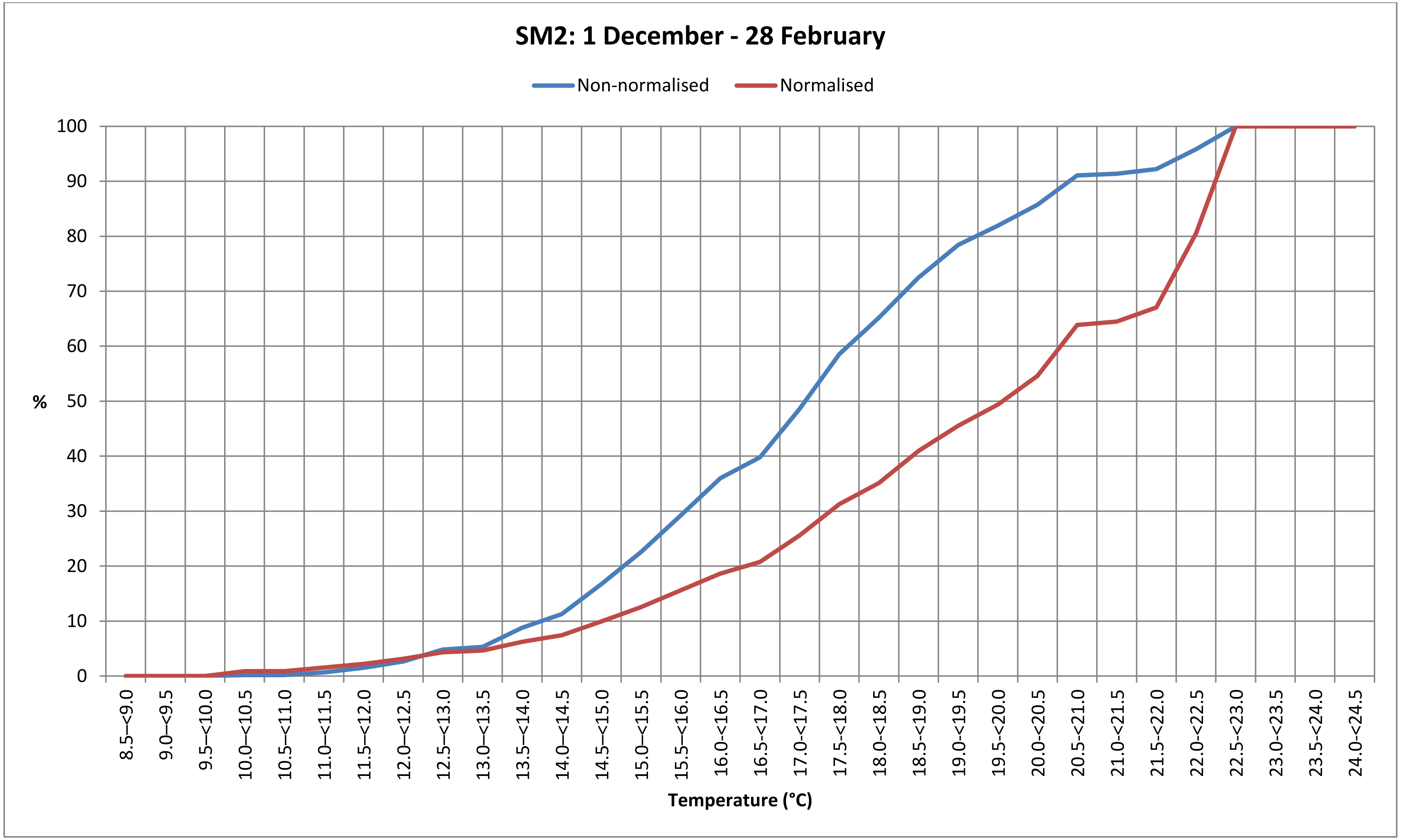


Figure 61: Cumulative percentage of normalised and non-normalised bat passes per temperature category

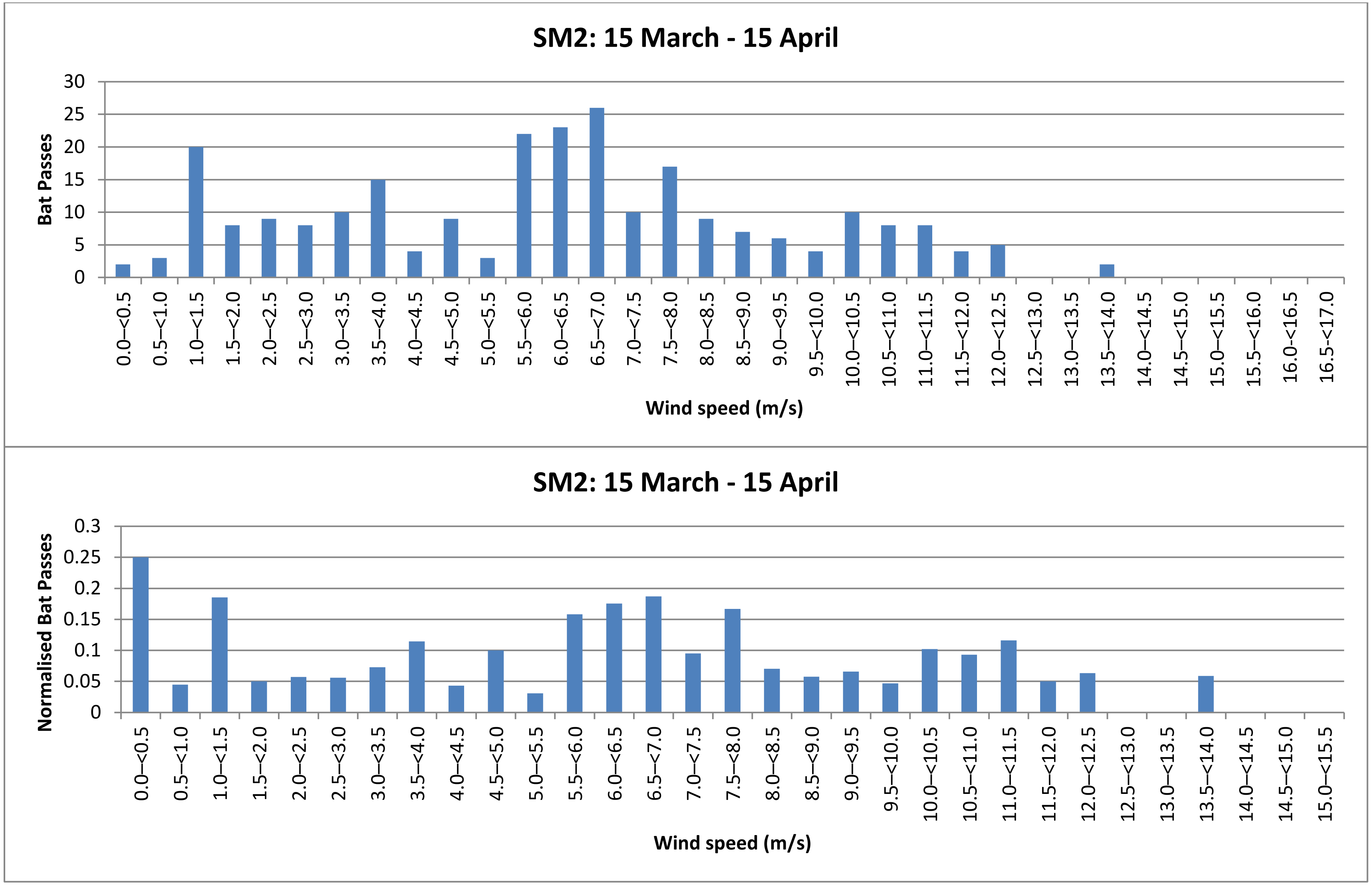


Figure 62: Sum of bat passes (top) and normalised passes (bottom) per wind speed category

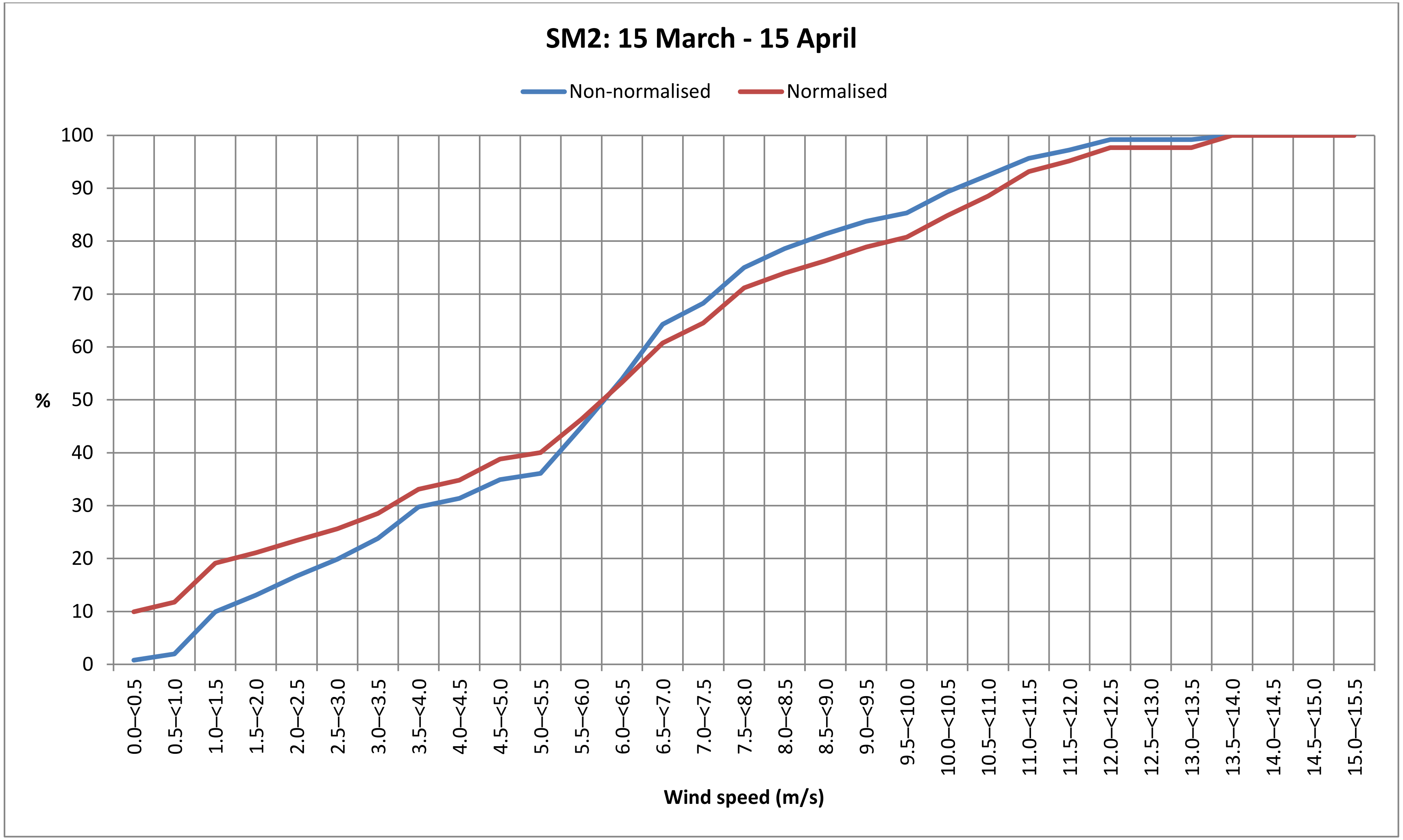


Figure 63: Cumulative percentage of normalised and non-normalised bat passes per wind speed category

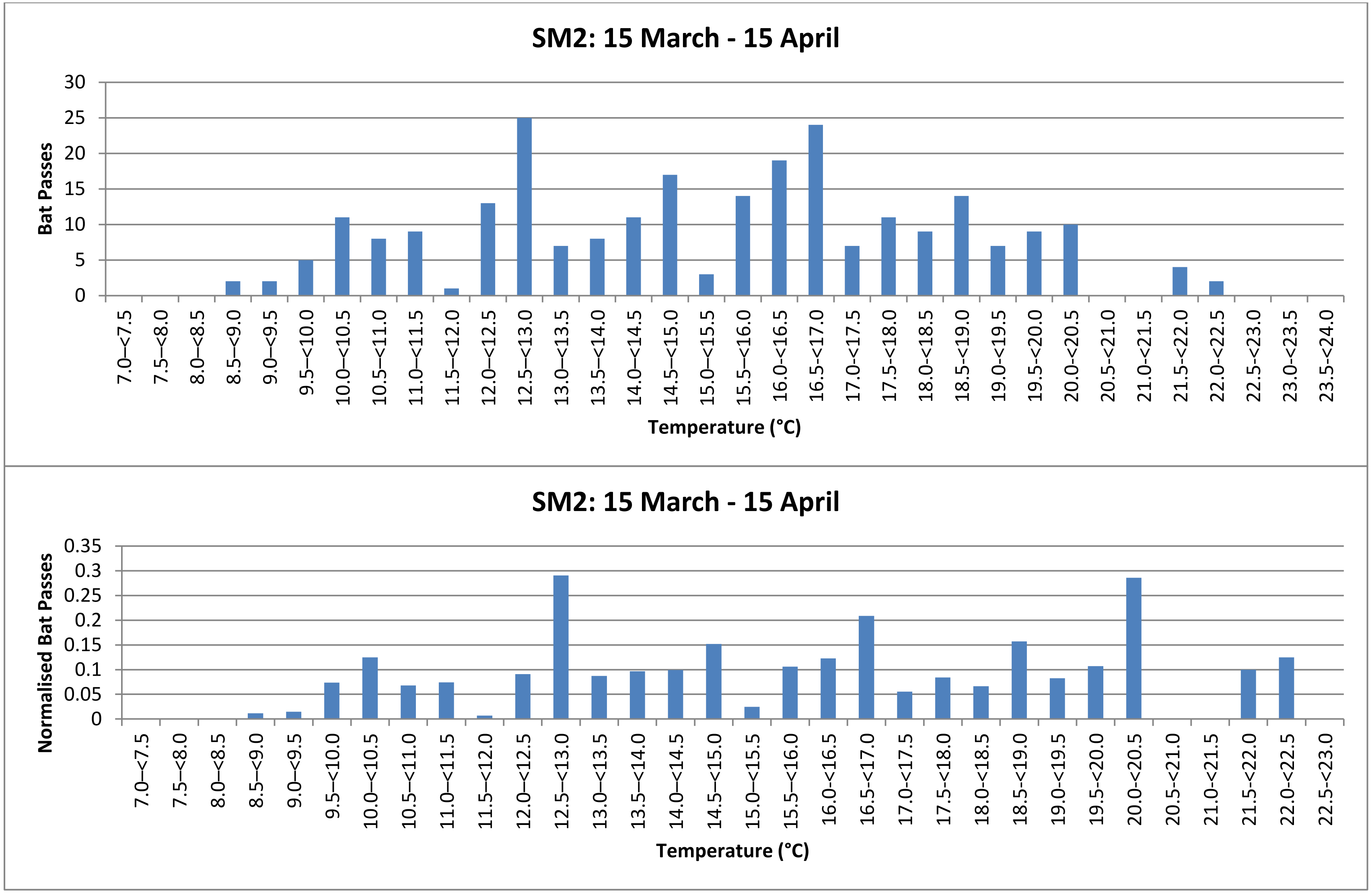


Figure 64: Sum of bat passes (top) and normalised passes (bottom) per temperature category

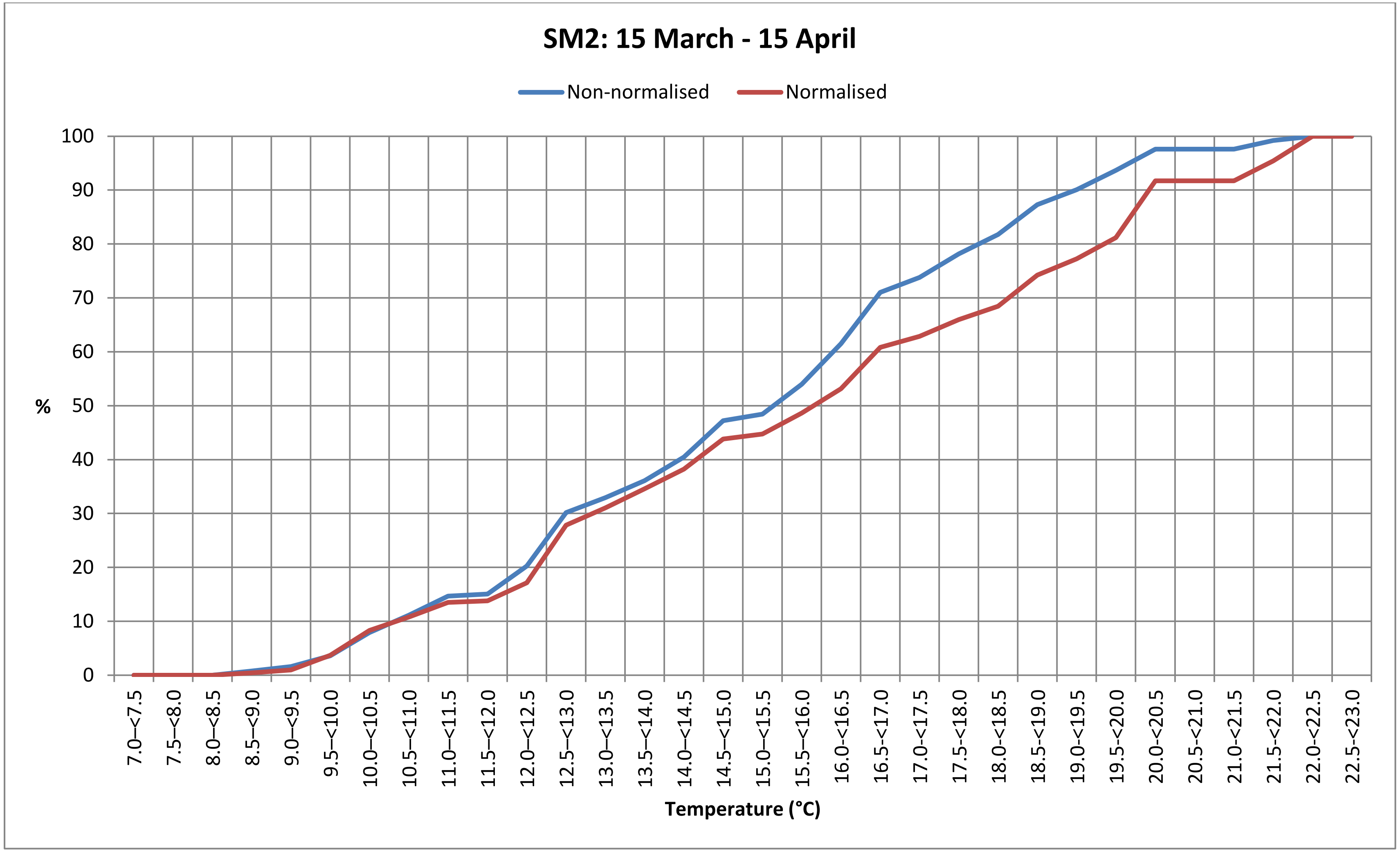
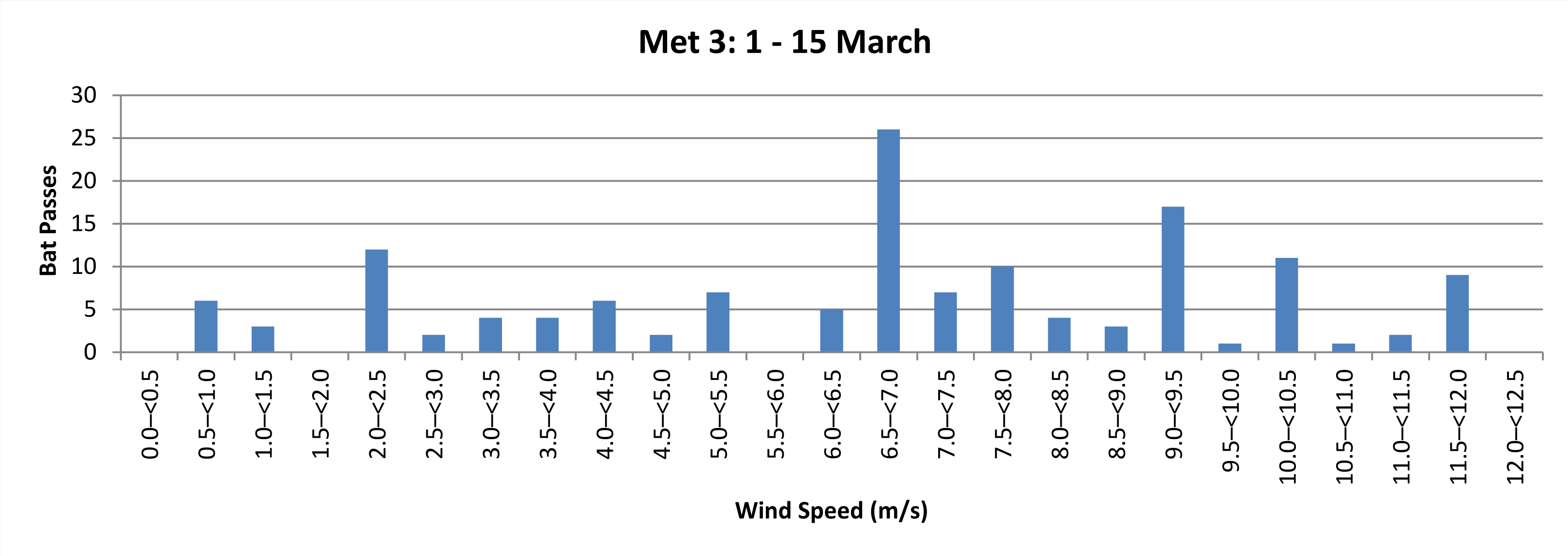


Figure 65: Cumulative percentage of normalised and non-normalised bat passes per temperature category



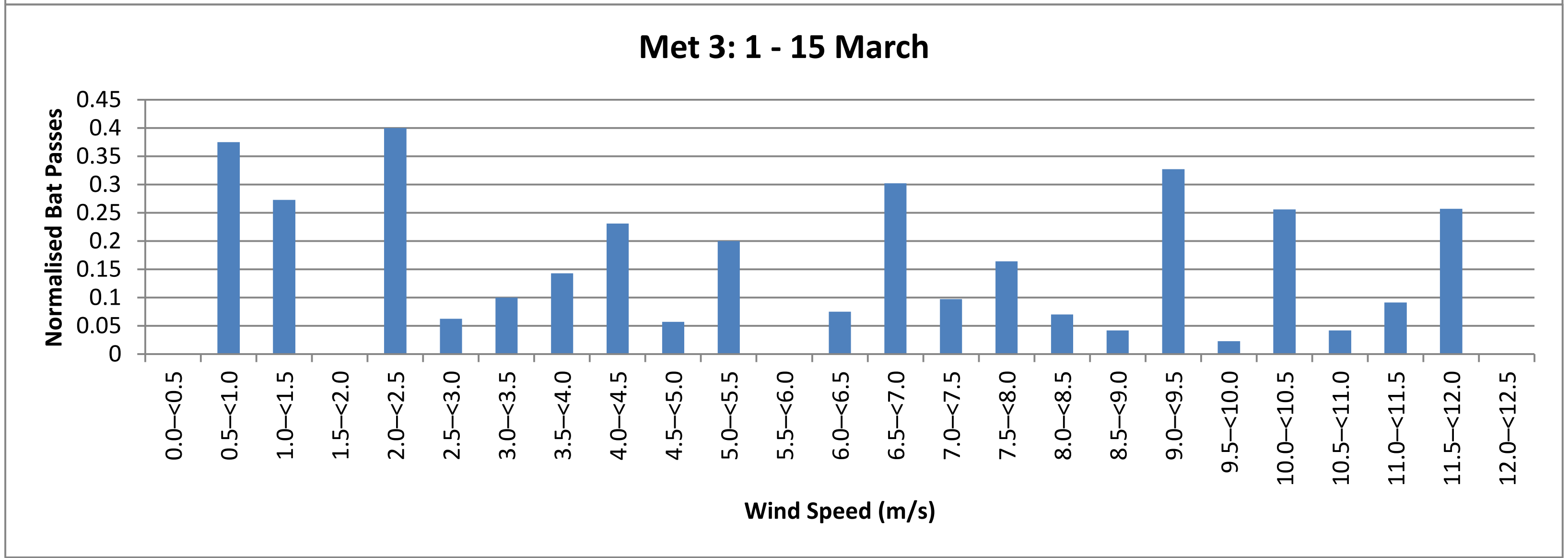


Figure 66: Sum of bat passes (top) and normalised passes (bottom) per wind speed category

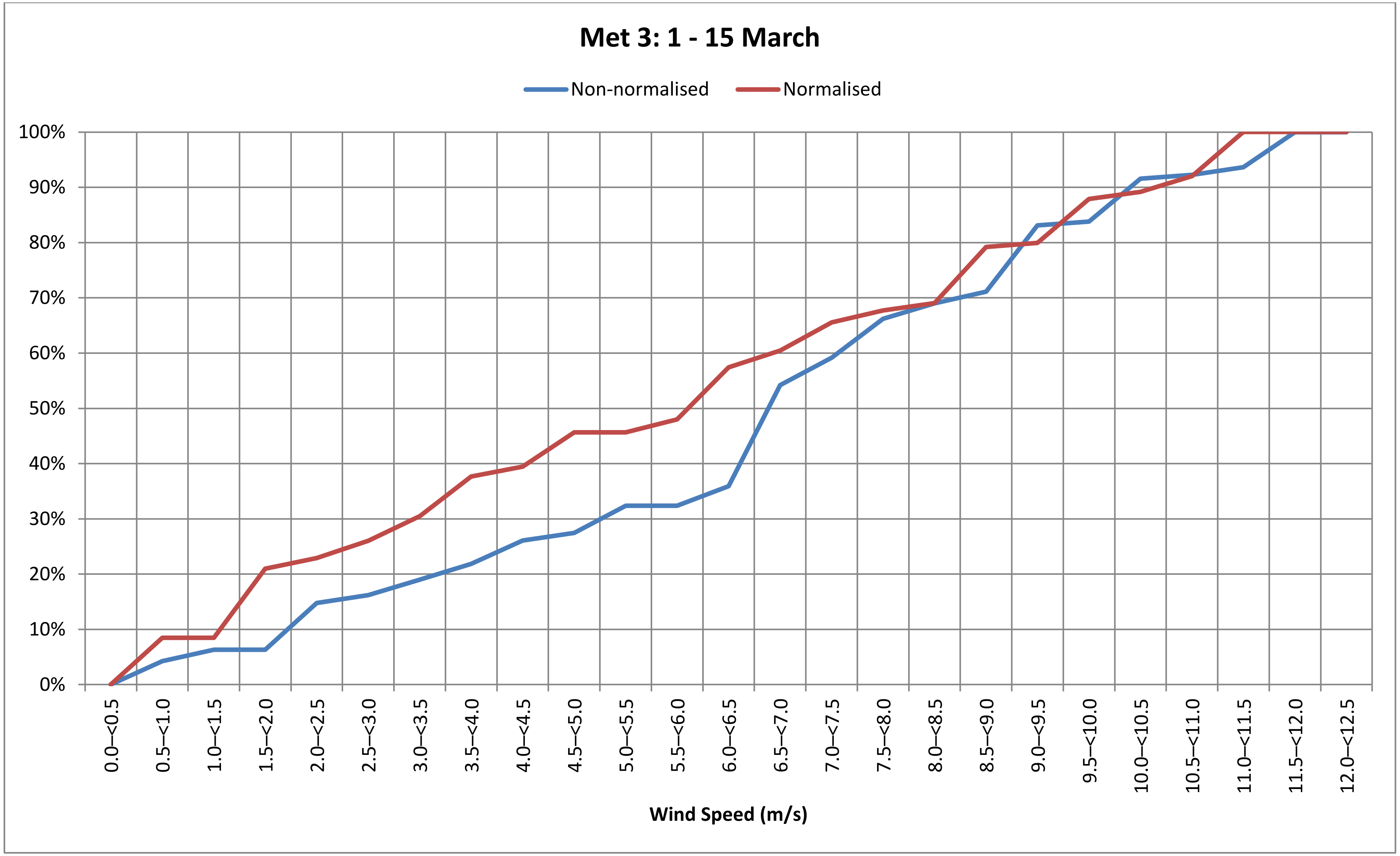


Figure 67: Cumulative percentage of normalised and non-normalised bat passes per wind speed category

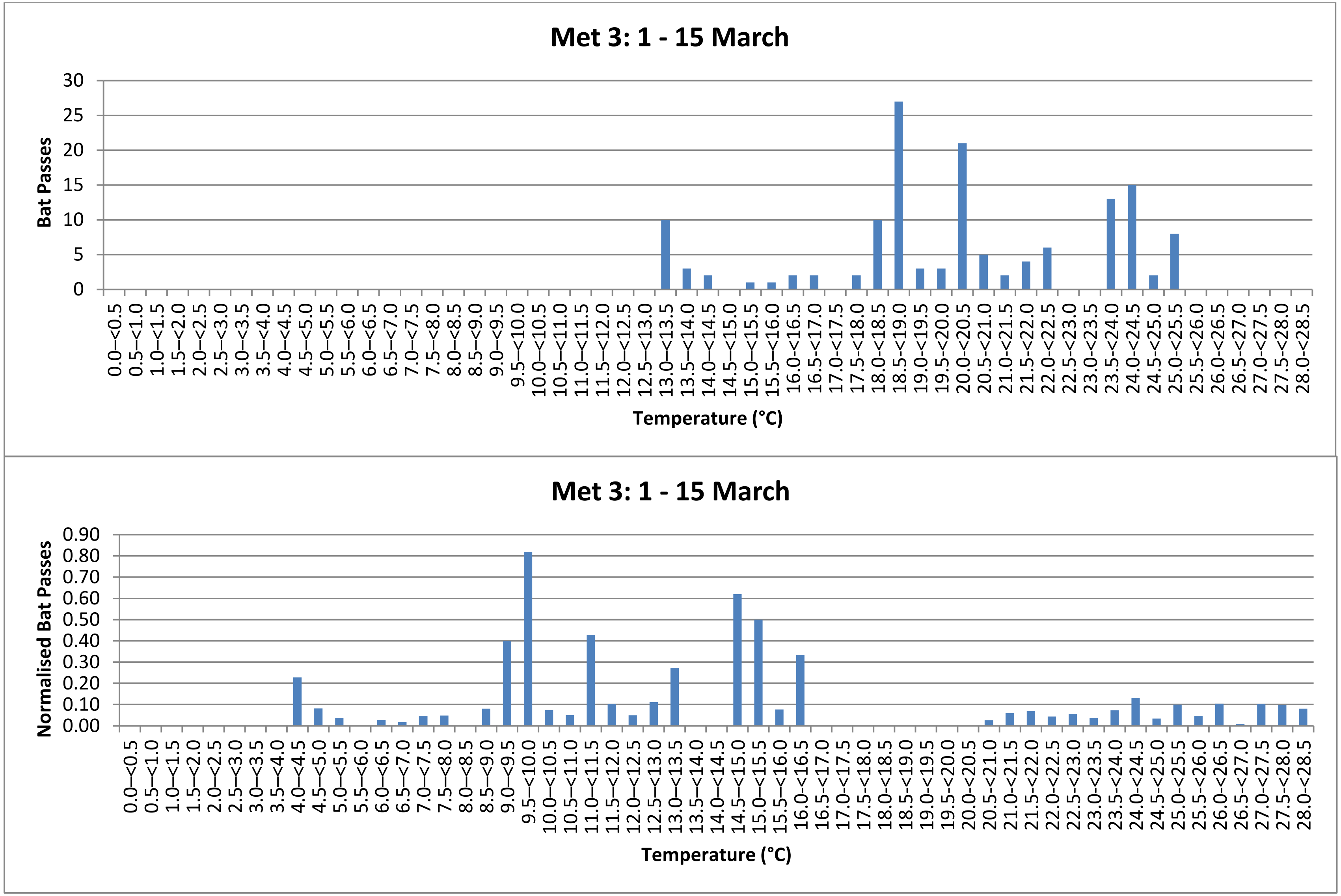


Figure 68: Sum of bat passes (top) and normalised passes (bottom) per temperature category

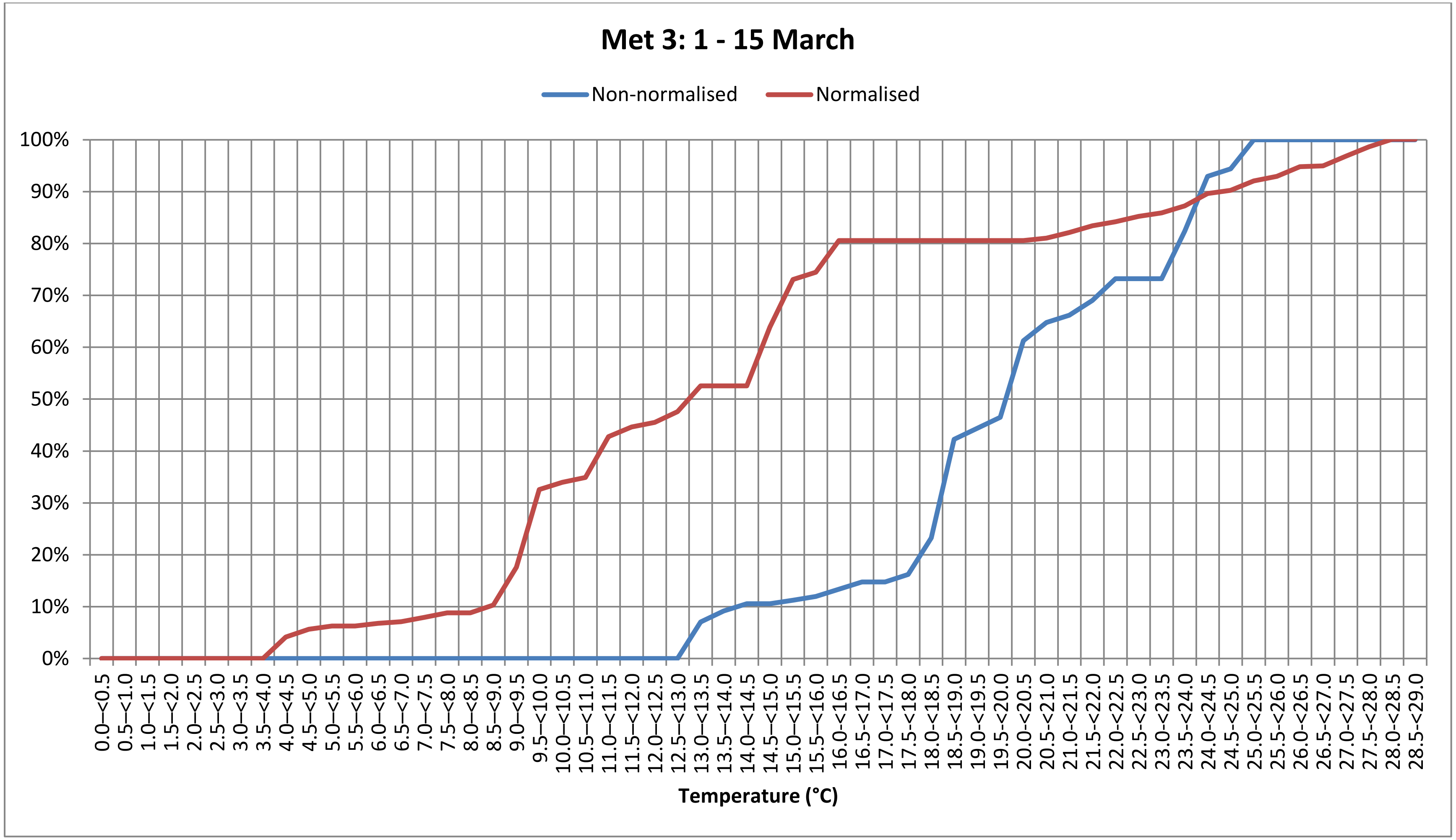


Figure 69: Cumulative percentage of normalised and non-normalised bat passes per temperature category

5 CUMULATIVE IMPACTS OF WIND FARMS ADJACENT TO KARREEBOSCH WEF

The impact of a single wind energy facility on the resident and migratory bat populations in South Africa is not currently well understood but, if properly mitigated, is not expected to jeopardise viable populations. However, as wind energy facilities become substantially more numerous and begin to populate certain areas, bat fatalities and thus biologically-significant impacts to the populations will increase. Bats have low reproductive rates and wind farms may impact them to the point of elimination from the local area. Since population estimates are poorly known, it is difficult to determine whether bat fatalities due to wind turbines are a significant threat to South African bat populations.

Due to the high number of proposed wind farms across South Africa, it is important to adopt a precautionary approach in the assessment of cumulative impacts in order to reduce them where possible. **Figure 70** below displays the map of proposed wind farms within a 100km radius of the Karreebosch wind farm. This map was taken from the Department of Environmental Affairs website, Renewable Energy Applications and is dated March 2015. There are nine proposed wind farms within the area. **Table 17** below lists the project names, EA holders and project statuses. A number of these projects will undergo division into smaller entities. It must be noted that not all of the listed wind farms have been approved and those that have will become operational. The uncertainty as to which projects will be constructed, hampers the assessment of the cumulative impacts. Thus adopting the precautionary approach assumes a worst case scenario of all of the approved projects becoming operational. With this in mind, the cumulative impact is considerably large and significant and has been included in the Impact Assessment section of this report.

Table 17: Wind farm developments within a 100km radius of Karreebosch Wind Farm

Project Name	**EA holder**	**Status**
Perdekraal	South Africa Mainstream Renewable Power	Approved
Konstabel	South Africa Mainstream Renewable Power	Approved
Witberg	Witberg Wind Power Pty Ltd	Approved
Laingsburg	BioTherm Energy Pty Ltd	Withdrawn/Lapsed
Komsberg	Inca Komsberg Wind Pty Ltd	Withdrawn/Lapsed
Roggeveld	G7 Renewable Energies Pty Ltd	Approved
Hidden Valley	ACED Renewables	Approved
Sutherland	South Africa Mainstream Renewable Power	Approved
Suurplaat	Moyeng Energy Pty Ltd	Approved

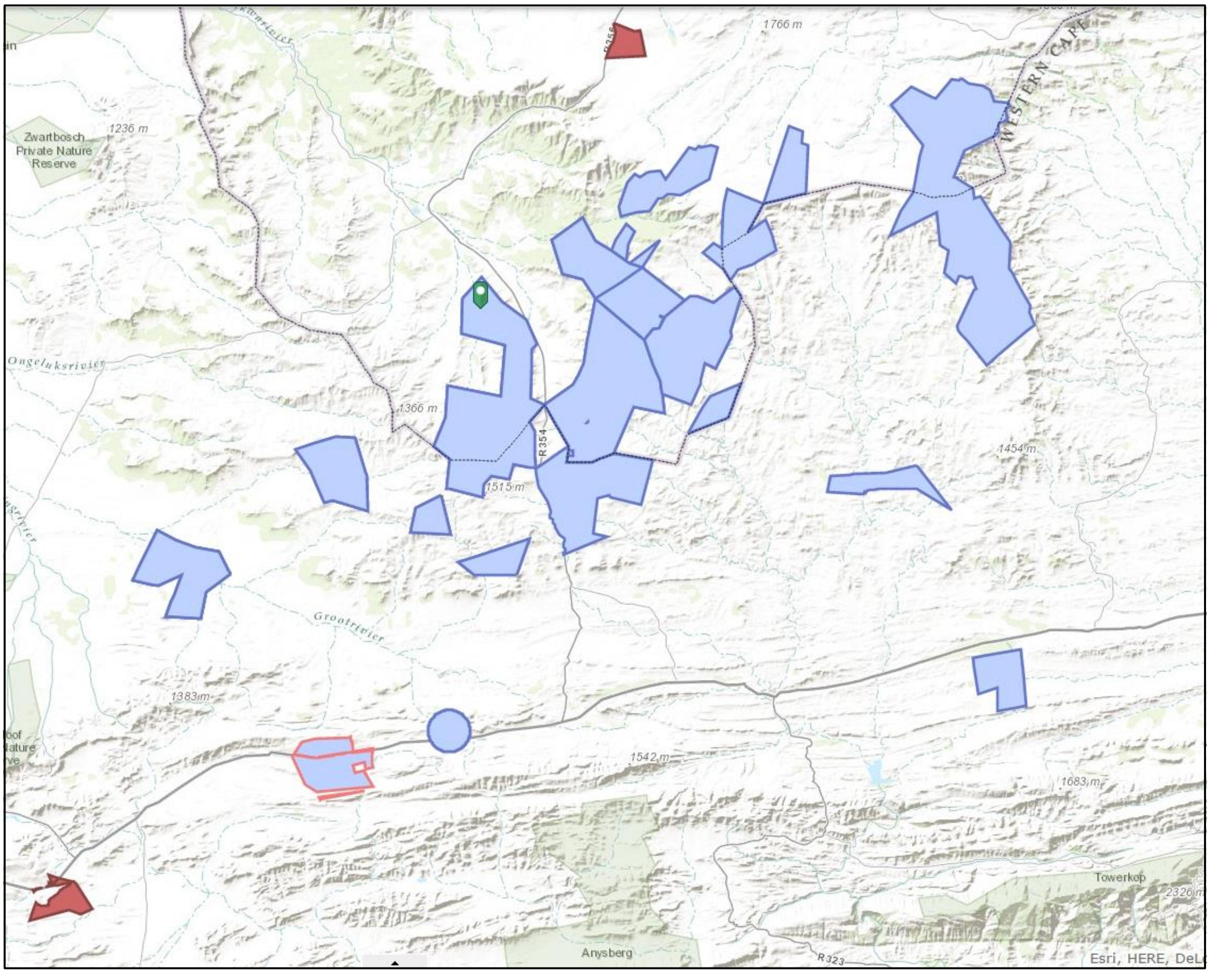


Figure 70: Map of the proposed wind farm developments (blue polygons) in the area surrounding the Karreebosch wind farm (green pointer).

6 IMPACT ASSESSMENT OF PROPOSED WEF ON BAT FAUNA

6.1 Construction phase

Impact: Destruction of bat roosts due to earthworks and blasting

During construction, the earthworks and especially blasting can damage bat roosts in rock crevices. Intense blasting close to a rock crevice roost can cause mortality to the inhabitants of the roost.

Pre-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Only turbine footprints and access roads will contribute to possible roost destruction
Duration	Long term	Roosts will be permanently destroyed forcing bats to relocate
Intensity	Medium	Rocky habitat forms a significant roosting habitat for several bat species in the larger site area. Roost destruction leads to increased inter and intra-specific competition resulting in decreased bat population sizes. Bat populations may be slow to recover resulting in depressed bat numbers over several years.

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Mitigation: Adhere to the sensitivity map during turbine placement. Blasting should be minimised and used only when necessary.

Post-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Only turbine footprints and access roads will contribute to possible roost destruction
Duration	Long term	Roosts will be permanently destroyed forcing bats to relocate
Intensity	Low	If blasting is not conducted in bat sensitive areas, the impact on bat roosting habitat is significantly lower.

SIGNIFICANCE				
		Unlikely	Likely	Definite
MAGNITUDE	Negligible	Negligible	Negligible	Minor
	Low	**Negligible**	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Cumulative Impact: The impact significance after application of mitigations for Karreebosch WEF is considered negligible. However the destruction of bat roosts and potential roosting space will be of a moderate significance when considering the cumulative earthworks and blasting to be carried out with the adjacent wind farms.

Impact: Artificial lighting

During construction strong artificial lights used at the work environment during night time will attract insects and thereby also bats. However only certain species of bats will readily forage around strong lights, whereas others avoid such lights even if there is insect prey available.

This can draw insect prey away from other natural areas and thereby artificially favour certain species, affecting bat diversity in the area.

Pre-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Impact is limited to within the site boundary
Duration	Temporary	Impact will persist only through the construction phase
Intensity	Low	The use of artificial lighting during construction will change the diversity and abundances of bat species within the immediate vicinity

SIGNIFICANCE				
		Unlikely	Likely	Definite
MAGNITUDE	Negligible	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Mitigation: Utilise lights with wavelengths that attract less insects (low thermal/infrared signature), such lights generally have a colour temperature of 5000k (Kelvin) or more. If not required for safety or security purposes, lights should be switched off when not in use.

Post-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Impact is limited to within the site boundary
Duration	Temporary	Impact will persist only through the construction phase
Intensity	Very low	The use of artificial lighting during construction will change the diversity and abundances of bat species within the immediate vicinity

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	**Negligible**	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Cumulative Impact: The cumulative impact of artificial lighting with adjacent wind farms remains negligible due to the short term and low intensity nature of the impact.

Impact: Loss of foraging habitat

Some foraging habitat will be permanently lost by construction of turbines and access roads. Temporary foraging habitat loss will occur during construction due to storage areas and movement of heavy vehicles.

Pre-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Turbine footprints, access roads and storage areas will contribute to habitat loss
Duration	Long term	Will persist as long as structures and roads are present.

Intensity	Medium	Loss of foraging habitat will modify bat activity

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Mitigation: Adhere to the sensitivity map. Keep to designated areas when storing building materials, resources, turbine components and/or construction vehicles and keep to designated roads with all construction vehicles. Damaged areas not required after construction should be rehabilitated by an experienced vegetation succession specialist.

Post-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Turbine footprints, access roads and storage areas will contribute to habitat loss
Duration	Long term	Will persist as long as structures and roads are present.
Intensity	Low	Rehabilitating vegetation may restore normal bat activity

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Cumulative Impact: The prime foraging habitat for bats in this area are the lower lying valley areas. It is assumed that majority of turbine placement in the greater area will be on higher mountainous areas. Thus the impact is minor for the Karreebosch WEF. However the greater the foraging area to be cleared for wind energy facility development over such a broad scale as is proposed, the more severe the impact will be on bat populations. Thus the cumulative impact will be of a moderate significance.

6.2 Operational phase

Impact: Bat mortalities due to direct blade impact or barotrauma during foraging activities (not migration)

The concerns of foraging bats in relation to wind turbines is discussed in Section 2.2. If the impact is too severe (e.g. in the case of no mitigation) local bat populations will not recover from mortalities.

Pre-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	Local	All bat populations in the local ecosystem will be affected.
Duration	Long term	Impact can persist during operation for the lifetime of the WEF.
Intensity	High	The ecological roles of local bat species affected will temporarily or permanently cease. There is a significant potential for a long-term reduction in the size of the population of all impacted bat species due to the low birth rates of bat populations.

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Mitigation*:* Adhere to the sensitivity maps, apply proposed mitigations to any further layout revisions, avoid areas of High bat sensitivity and their buffers as well as preferably avoid areas of Moderate bat sensitivity and their buffers. Also see Section 6 below on mitigation options and recommendations for minimising risk of mortalities.

Post-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	Local	All bat populations in the local ecosystem will be affected.
Duration	Long term	Impact can persist during operation for the lifetime of the WEF.
Intensity	Low - Medium	If mitigations are implemented the potential for a significant reduction in the size of the population of all impacted bat species is largely reduced.

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Cumulative Impact: It is common knowledge that the greater the number of turbines in an area, the greater the risk of collision by bat species. The cumulative impact across the general area will be major unless there is strict implementation of site specific mitigations advised by the relevant Bat Specialists applied to all wind farms.

Impact: Bat mortalities due to direct blade impact or barotrauma during foraging – cumulative impact (resident and migrating bats affected).

Mortalities of bats due to wind turbines during foraging and migration can have significant ecological consequences as the bat species at risk are insectivorous and thereby contribute significantly to the control of flying insects at night. On a project specific level insect numbers in a certain habitat can increase if significant numbers of bats are killed off. But if such an impact is present on multiple projects in close vicinity of each other, insect numbers can increase regionally and possibly cause outbreaks of colonies of certain insect species.

Additionally if migrating bats are killed off it can have detrimental effects on the cave ecology of the caves that a specific colony utilises. This is due to the fact that bat guano is the primary form of energy input into a cave ecology system, given that no sunshine that allows photosynthesis exists in cave ecosystems.

Pre-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	National	Mortality of migratory bats will affect population levels in all areas they inhabit and migrate to
Duration	Long term	Impact can persist during operation for the lifetime of the WEF.
Intensity	High	The ecological roles of these bat species affected will temporarily or permanently cease. There is a significant potential for a long-term reduction in the size of the population of all impacted bat species.

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Mitigation*:* Adhere to the sensitivity map during any further turbine layout revisions, and preferably do not move any turbines into even Moderate sensitivity areas, where possible. The High sensitivity valley areas can serve as commuting corridors for bats in the larger area, potentially lowering the cumulative effects of several WEF's in an area. Also adhere to recommended mitigation measures for this project during operation. It is essential that project specific mitigations be applied and adhered to for each project, as there is no overarching mitigation that can be recommended on a regional level due to habitat and ecological differences between project sites.

Post-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	National	Mortality of migratory bats will affect population levels in all areas they inhabit and migrate to
Duration	Long term	Impact can persist during operation for the lifetime of the WEF.

Intensity	Low - Medium	If mitigations are implemented the potential for a significant reduction in the size of the population of all impacted bat species is largely reduced.

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Cumulative Impact: It is common knowledge that the greater the number of turbines in an area, the greater the risk of collision by bat species. The cumulative impact across the general area will be major unless there is strict implementation of site specific mitigations advised by the relevant Bat Specialists applied to all wind farms.

6.3 Decommissioning phase

Impact: Artificial lighting

During decommission strong artificial lights used at the work environment during night time will attract insects and thereby also bats. However only certain species of bats will readily forage around strong lights, whereas others avoid such lights even if there is insect prey available.

This can draw insect prey away from other natural areas and thereby artificially favour certain species, affecting bat diversity in the area.

Pre-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Impact is limited to within the site boundary
Duration	Temporary	Impact will persist only through the decommission phase
Intensity	Low	The use of artificial lighting during decommission will change the diversity and abundances of bat species within the immediate vicinity

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Mitigation: Utilise lights wavelengths that attract less insects (low thermal/infrared signature), such lights generally have a colour temperature of 5000k (Kelvin) or more. If not required for safety or security purposes, lights should be switched off when not in use.

Post-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Impact is limited to within the site boundary
Duration	Temporary	Impact will persist only through the decommission phase
Intensity	Very low	The use of artificial lighting during decommission will change the diversity and abundances of bat species within the immediate vicinity

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	**Negligible**	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Cumulative Impact: The cumulative impact of artificial lighting with adjacent wind farms remains negligible due to the short term and low intensity nature of the impact.

Impact: Loss of foraging habitat

Some foraging habitat will be permanently during decommission of wind farm. Temporary foraging habitat loss will occur due to storage areas and movement of heavy vehicles.

Pre-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Turbine footprints, access roads and storage areas will contribute to habitat loss
Duration	Long term	Will persist as long as structures and roads are present.
Intensity	Low	Loss of foraging habitat will modify bat activity

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Mitigation: Adhere to the sensitivity map. Keep to designated areas for vegetation removal and keep to designated roads with all construction vehicles. Damaged areas should be rehabilitated by an experienced vegetation succession specialist.

Post-mitigation:

Characteristics of impact that inform magnitude informants		
Characteristic	**Nature of impact and score**	**Rationale/Explanation**
Extent	On-site	Turbine footprints, access roads and storage areas will contribute to habitat loss
Duration	Long term	Will persist as long as structures and roads are present.
Intensity	Low	Rehabilitating vegetation may restore normal bat activity

SIGNIFICANCE				
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	**Negligible**	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Cumulative Impact: The cumulative impact of foraging habitat loss during decommission with adjacent wind farms remains negligible due to the short term and low intensity nature of the impact.

7 PROPOSED INITIAL MITIGATION MEASURES AND DETAILS

The correct placement of wind farms and of individual turbines can significantly lessen the impacts on bat fauna in an area, and should be considered as the preferred option for mitigation. The tables below are based on the passive data collected. They infer mitigation be applied during the peak activity periods and times, and when the advised wind speed and temperature ranges are prevailing simultaneously (considering conditions in which 80% of bat activity occurred).

Bat activity at 10m height is used, since bats are expected to move in an upwards fashion towards turbine blades (bat activity negatively correlated with height above ground). Additionally, the higher bat activity levels at 10m provides more robust and accurate relations between climate and bat activity, and is therefore considered as the precautionary approach in determining the initial parameters with which mitigation should commence.

The following turbines are linked to the passive systems below and are thus affected by the below mitigation schedule:

Short mast 1: Turbines 56 – 64

Short mast 2: Turbines 1 – 4, 12, 18 – 20, 25, 27, 29, 30, 33 – 35

Met mast 3: Turbines 44, 45, 47 – 55, 65, 66, 68, 70, 71

Table 18: The times of implementation of mitigation measures is preliminarily recommended (considering more than 80% bat activity, normalised data) as follows:

	Terms of mitigation implementation
Winter peak activity (times to implement curtailment/ mitigation)	**None**

Spring peak activity (times to implement curtailment/ mitigation)	**Short Mast 1** 15 September - 15 October Sunset – 22:00
Environmental conditions in which to implement curtailment/ mitigation	Below 11m/s measured at nacelle height Above 13.5°C

Summer peak activity (times to implement curtailment/ mitigation)	**Short Mast 2** 1 December - 28 February Sunset - 00:00		
Environmental conditions in which to implement curtailment/ mitigation	Below 9m/s measured at nacelle height Above 16.5°C		
Autumn peak activity (times to implement curtailment/ mitigation)	**Short mast 1** Full month of March 23:00 – sunrise	**Short mast 2** 15 March - 15 April 00:00 – sunrise	**Met mast 3** 1 – 15 March 20: 30 - 00:00
Environmental conditions in which to implement curtailment/ mitigation	Below 10m/s measured at nacelle height Above 13.5°C	Below 9m/s measured at nacelle height Above 12.5°C	Below 8.5m/s measured at nacelle height Above 10°C

Where mitigation by location is not possible, other options that may be utilized include curtailment, blade feathering, blade lock, acoustic deterrents or light lures. The following terminology applies:

Curtailment:

Curtailment is defined as the act of limiting the supply of electricity to the grid during conditions when it would normally be supplied. This is usually accomplished by locking or feathering the turbine blades.

Cut-in speed:

The cut-in speed is the wind speed at which the generator is connected to the grid and producing electricity. For some turbines, their blades will spin at full or partial RPMs below cut-in speed when no electricity is being produced.

Feathering or Feathered:

Adjusting the angle of the rotor blade parallel to the wind, or turning the whole unit out of the wind, to slow or stop blade rotation. Normally operating turbine blades are angled almost perpendicular to the wind at all times.

Free-wheeling:

Free-wheeling occurs when the blades are allowed to rotate below the cut-in speed or even when fully feathered and parallel to the wind. In contrast, blades can be "locked" and cannot rotate, which is a mandatory situation when turbines are being accessed by operations personnel.

Increasing cut-in speed:

The turbine's computer system (referred to as the Supervisory Control and Data Acquisitions or SCADA system) is programmed to a cut-in speed higher than the manufacturer's set speed, and turbines are programmed to stay locked or feathered at 90° until the increased cut-in speed is reached over some average number of minutes (usually 5 – 10 min), thus triggering the turbine blades to pitch back "into the wind" and begin to spin normally and produce power.

Blade locking or feathering that renders blades motionless below the manufacturers cut in speed, and don't allow free rotation without the gearbox engaged, is more desirable for the conservation of bats than allowing free rotation below the manufacturer's cut in speed. This is because bats can still collide with rotating blades even when no electricity is being produced.

Acoustic deterrents are a developing technology and will need investigation closer to time of wind farm operation.

Light lures refer to the concept where strong lights are placed on the periphery (or only a few sides) of the wind farm to lure insects and therefore bats away from the turbines. However, the long term effects on bat populations and local ecology of this method is unknown.

Habitat modification, with the aim of augmenting bat habitat around the wind farm in an effort to lure bats away from turbines, is not recommended. Such a method can be adversely intrusive on other fauna and flora and the ecology of the areas being modified.

Additionally it is unknown whether such a method may actually increase the bat numbers of the broader area, causing them to move into the wind farm site due to resource pressure.

Currently the most effective method of mitigation, after correct turbine placement, is alteration of blade speeds and cut-in speeds under environmental conditions favourable to bats.

A basic "6 levels of mitigation" (by blade manipulation or curtailment), from light to aggressive mitigation is structured as follows:

1. No curtailment (free-wheeling is unhindered below **manufacturer's** cut in speed so all momentum is retained, thus normal operation).
2. Partial feathering (45 degree angle) of blades below **manufacturer's** cut-in speed in order to allow the free-wheeling blades half the speed it would have had without feathering (some momentum is retained below the cut in speed).
3. Ninety degree feathering of blades below **manufacturer's** cut-in speed so it is exactly parallel to the wind direction as to minimize free-wheeling blade rotation as much as possible without locking the blades.
4. Ninety degree feathering of blades below **manufacturer's** cut-in speed, with partial feathering (45 degree angle) between the **manufacturer's** cut-in speed and **mitigation** cut-in conditions.
5. Ninety degree feathering of blades below **mitigation** cut in conditions.
6. Ninety degree feathering throughout the entire night.

It is recommended that curtailment be applied initially at the start of operation at **Level 3** during the climatic conditions and time frames outlined in **Table 17.** However, actual impacts on bats will be monitored during the operational phase monitoring, and the recommended mitigation measures and levels of curtailment will be adjusted according to the results of the operational monitoring. This is an adaptive management approach, and it is crucial that any suggested changes to the initial proposed mitigation schedule be implemented within maximum 2 weeks from the date of the recommendation, unless the recommendation refers to a time period later in the future (e.g. the following similar season/climatic condition).

8 OPERATIONAL MONITORING PRELIMINARY METHODOLOGY OUTLINE

8.1 Introduction

Operational phase monitoring and research programs across North America and Europe have identified bats to be vulnerable to mortality due to wind turbines. Bats are particularly vulnerable to non-natural causes of mortality as they are long-lived animals with low reproductive fecundity. Additionally, there is relatively little scientific knowledge about bat populations and migration routes. It is recommended that a minimum of two year operational monitoring be undertaken as soon as turbines are functional, with auditing continuing throughout the lifespan of the Karreebosch WEF.

The primary objectives of the operational phase monitoring programme are to:

- Determine the bat fatality rates for the Karreebosch WEF
- Determine the fatality rates for species of concern
- Determine the fatality rates for migratory and resident bat species
- Study the relation of bat fatalities within all habitats, geology and vegetation types found in turbine areas
- Compare the bat fatality rates with those from wind farms in similar habitat types where possible
- Determine the relationship between bat activity and bat fatality
- Understand the relationship between bat fatality and weather conditions
- Study the temporal distribution of bat fatalities across the night and seasons
- Determine whether mitigation measures are necessary to reduce bat fatality rates, and if necessary recommend detailed mitigation measures

8.2 Methodology

Operational monitoring methodology is divided into two components, namely acoustic monitoring and carcass searches. <u>On conclusion of the first year an adapted methodology will be outlined for the second year of monitoring.</u>

Acoustic monitoring

Acoustics detectors and ultrasonic microphones will be used to monitor bat activity. They will be installed on the meteorological mast and/or a sub-sample of turbine nacelles to monitor activity in the rotor-swept path of high risk and select turbines.

Carcass searches

Carcass searches will be undertaken to determine bat fatality rates. This component of the methodology will be combined with that of the carcass searches for the bird monitoring programme.

Locals will be trained in proper search techniques to carry out the carcass searches and to record and collect all carcasses located. Searches will begin as early in the morning as possible to reduce carcass removal by scavengers. The order in which turbines are searched will ideally be randomly selected for each day to reduce carcass removal by predators from specific turbines before they can be searched. Search intervals will be a maximum of one week.

All necessary information will be recorded when a carcass is found. The carcass will then be bagged and labelled and kept refrigerated for species identification and to determine the cause of death by the specialist. Fatality monitoring will be carried out over all seasons of the year.

The necessary searcher efficiency and scavenger removal trials will be carried out at least once per season to calculate field bias and error estimation.

Wind turbine mitigation

Data collected throughout the monitoring programme will be used to inform and direct mitigation if the Karreebosch WEF or specific turbines is found to be causing significant bat mortality. If mitigations are implemented, monitoring the effectiveness of the applied techniques will be necessary to evaluate and refine the success and economic efficiency of the mitigation.

8.3 Deliverables

- Four monitoring reports will be submitted annually for the first year, on conclusion of the first year an adapted reporting and methodology schedule will be outlined for the second year of monitoring. Reports will include descriptions of the field protocols and sampling methods. Raw data will be included in the reports as appendices, and methods for data analysis shall be transparent.

- A contingency plan will be compiled which informs immediate actions to be taken in the case of a significant mortality event, or if mitigation measures fail. A contingency plan will consist of additional mitigation measures to be implemented in the event that significant negative impacts are observed from a single mortality survey.
- An adaptive management approach to the operational monitoring programme.

The methodology of the assessment will comply with requirements pertaining to the South African Good Practice Guidelines for Operational Monitoring for Bats at Wind Energy Facilities (the latest version available at the time of commencement), which will be a mandatory requirement for all specialists.

9 CONCLUSION

Altogether the eight monitoring systems detected five different bat species occurring on the proposed Karreebosch WEF site. *Neoromicia capensis* and *Tadarida aegyptiaca* are the most common and abundant insectivorous bat species found across South Africa. As expected, these two species dominated the bat assemblage and were detected by all of the monitoring systems. These common and more abundant species are of large value to the local ecosystems as they provide greater ecological services than the more rare species, due to their greater abundance.

Although *M. natalensis*, *E. hottentotus* and *S. petrophilus* were not detected nearly as frequently as the other two aforementioned species, they were detected in sufficient numbers to suggest healthy populations of these species on site. Hence, their value in terms of biodiversity cannot be ignored. Moreover, *M. natalensis* is a migratory species and occurs in large numbers when nearby cave-roosts are available. Therefore this species should be specifically monitored for migration events during the operational phase. However no such migration events were found in this study, and the proposed initial mitigation measures are applicable to all five bat species found on site.

There is a lack of reliable information regarding flight behaviours, flight heights and flight paths of South African bat species. This lack of information pertains to migratory, foraging and commuting behaviours. Thus the information used for preconstruction bat monitoring studies is gleamed from known ecological behaviours of species and/or genera. The South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments recommend bat monitoring be carried out with the use of passive bat monitoring systems spread across the proposed development area. These acoustic monitoring systems are incapable of tracking flight paths and flight height of passing bats. Radar units would need to be deployed on site to survey the passage rates, flight heights and flight direction of bats. However, this is not currently a requirement of the guidelines. This technology may become necessary if a significant migratory event was detected on site, but no such event was detected over the duration of the study. Thus, the flight paths and behaviours of bat species on site have not been documented over the preconstruction monitoring study.

The 50m microphone on Met mast 1 recorded 50% less *T. aegyptiaca* than the 10m microphone on the same Met mast and no *N. capensis* were recorded at 50m, indicating a negative correlation between bat activity and height above ground. In general the airspace around 50m were dominated by *T. aegyptiaca.*

Peak activity times across the night and monitoring period were identified, as well as wind speed and temperature parameters during which most bat activity was detected. **Section 5 & 6** outline the foreseen impacts from this WEF and the proposed initial mitigation measures derived from the results of this study. Mitigations are expected to be implemented once the turbines become operational. The proposed mitigation schedule follows the precautionary approach strongly and therefore the mitigations will be adjusted and refined during a post-construction bat monitoring study (operational bat monitoring), in order to account for mitigations being either too lenient or too strict.

A sensitivity map was drawn up indicating potential roosting and foraging areas. The sensitivity map shows that currently no turbines are located within High Sensitivity areas and only turbine 57 is positioned within a High Bat Sensitivity buffers. Also, turbine 27 is located within a Moderate Bat Sensitivity area and turbines 4 and 28 are located in the Moderate Bat Sensitivity Buffers. Turbines within the High Sensitivity Buffers will either require relocating or to be removed from the layout as these are 'no-go' areas. They are deemed critical for resident bat populations, capable of elevated levels of bat activity and support greater bat diversity than the rest of the site. The High sensitivity valley areas can also serve as commuting corridors for bats in the larger area, potentially lowering the cumulative effects of several WEF's in an area. The turbines within Moderate Sensitivity areas and buffers can either be relocated or must receive special attention during operational monitoring, not excluding all other turbines from operational monitoring.

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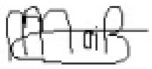

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