Fifth & Final Progress Report of a 12-month Long-Term Preconstruction Bat Monitoring Study, and Bat Impact Assessment

For the proposed Phezukomoya Wind Power (Pty) Ltd WEF

Compiled by: Daleen Burger

Reviewed by: Werner Marais

November 2016

Updated 17 January 2018

PREPARED FOR:

InnoWind (Pty) Ltd – EDF EN Group
16 Irvine Street, Richmondhill
Port Elizabeth
6001

www.innowind.com

☎ +27 (0)41 487 2418

Fax: +27 (0)41 484 3038

by

CK 2015/364493/07

Heldervue
Somerset West
Cape Town
7130
☎+27 78 190 3316

✉werner@animalia-consult.co.za

www.animalia-consult.co.za

Ref: R-1609-70

Appointment of Specialist

Specialist Company:	Animalia Zoological & Ecological Consultation (Pty) Ltd
Fieldwork conducted by:	Carel Malouf
Report done by:	Daleen Burger
Overseen/reviewed by:	Werner Marais
Appointed by:	InnoWind (Pty) Ltd
For:	12 Month pre-construction bat activity monitoring and Bat Impact Assessment

Independence:

Animalia Zoological & Ecological Consultation (Pty) Ltd has no connection with the developer. Animalia Zoological & Ecological Consultation (Pty) Ltd is not a legal or financial subsidiary 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 authorization of this project.

Applicable Legislation:

Legislation dealing with biodiversity applies to bats and includes the following:

NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004 (ACT 10 OF 2004; Especially sections 2, 56 & 97)

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

TABLE OF CONTENTS

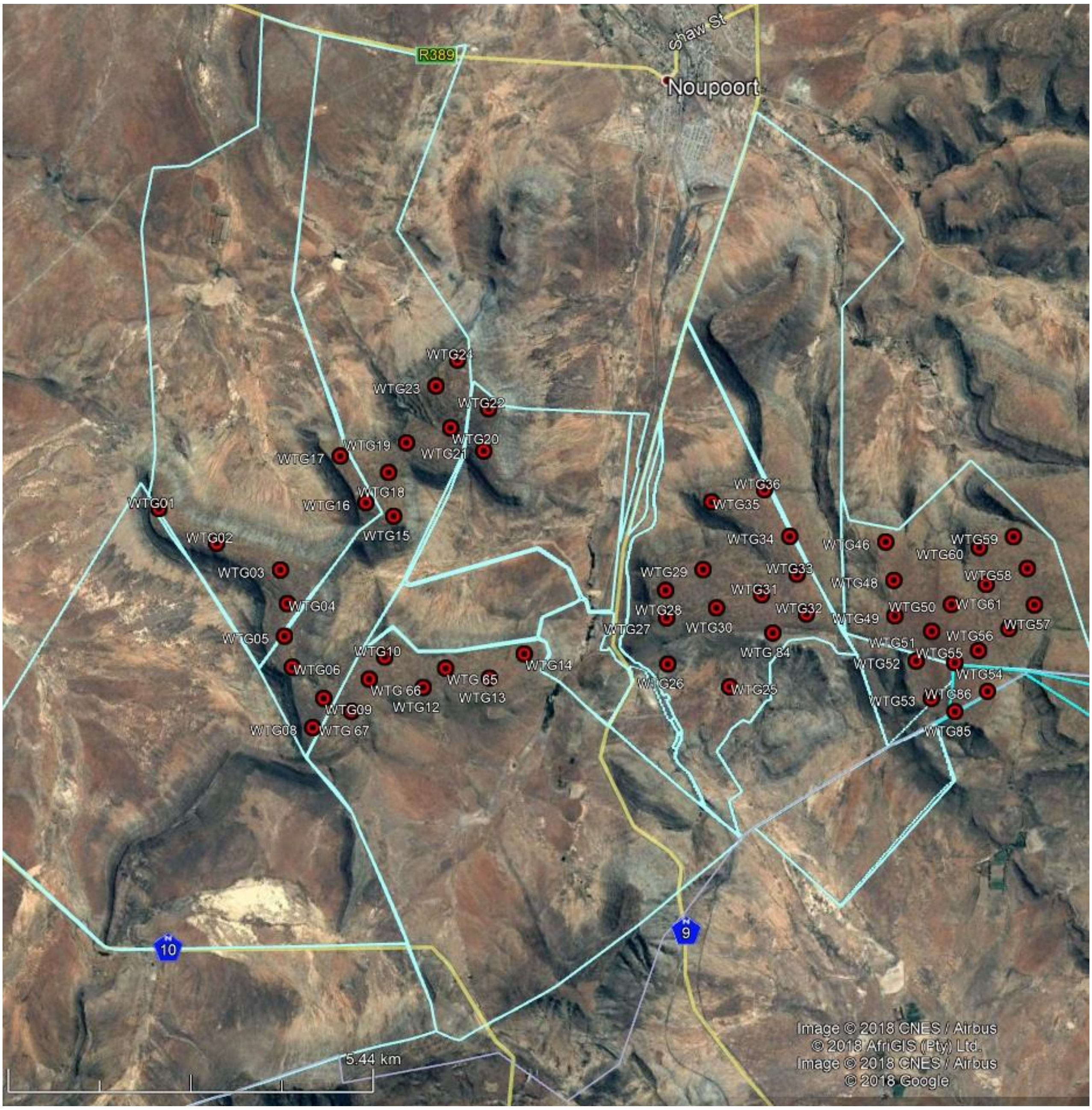


Figure 1: Map overview of the proposed Phezukomoya Wind Power (Pty) Ltd affected properties.

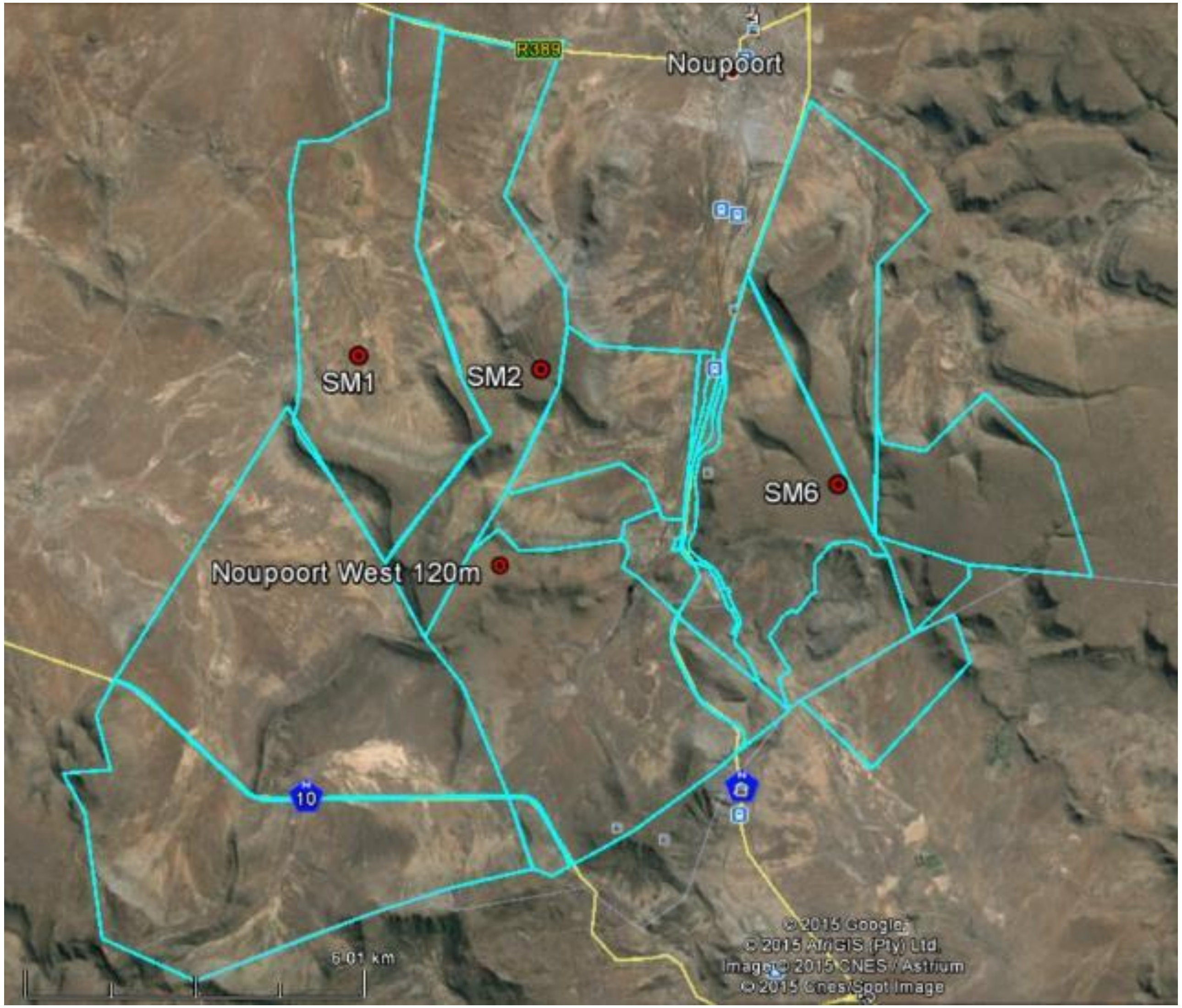


Figure 2: Overview of the passive monitoring systems on the Phezukomoya Wind Power (Pty) Ltd.

1 OVERVIEW OF THE PROPOSED DEVELOPMENT

The proposed 315MW Phezukomoya WEF would consist of the following infrastructural components:

- Up to 63 wind turbines with a generation capacity between 3 – 5MW and a rotor diameter of up to 150m, a hub height of up to 150m and blade length of up to 75m;
- Foundations and hardstands associated with the wind turbines;
- Internal access roads of between 8 m (during operation) and 14m (during construction) wide to each turbine;
- Two 10 000m^2 on-site switching stations
- Medium voltage underground electrical cables will be laid to transmit electricity generated by the wind turbines to the on-site switching station or substation;
- Overhead medium voltage cables between turbine rows where necessary;
- An on-site substation and OMS area (180 000m^2) to facilitate stepping up the voltage from medium to high voltage (132kV) to enable the connection of the WEF to proposed Umsobomvu WEF 132/400kV Substation, from which the generated power will be fed into the national grid;
- Two medium voltage overhead powerlines (approximately 3km and 5.6km in length) connecting the on-site switching stations with the on-site medium voltage/132kV substation;
- An approximately 16 km 132kV voltage overhead power line from the on-site substation to the proposed 132/400kV Umsobomvu Substation where the electricity will be transferred to the national grid;
- A 90 000m^2 area for batching plant, temporary laydown area and construction compound;
- Temporary infrastructure including a site camp; and a laydown area approximately 7500m^2 in extent, per turbine.

The total size of the development site is 15 271 hectares. The footprint of the proposed development is estimated to be less than 1% of this area.

Description	Dimensions		
	Length (m)	Breadth (m)	Area (sqm)
Eskom 400kV Umsobomvu substation	600	600	360000
Phezukomoya medium voltage/132 kV substation and OMS area	600	300	180000
Construction compound, temporary laydown area and batching plant	300	300	90000

2 OBJECTIVES AND TERMS OF REFERENCE FOR PRECONSTRUCTION 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 identify if any turbines occur in sensitive areas and need to be shifted into less sensitive areas or removed from the layout.
- Detail the types of mitigation measures that are possible if bat mortality rates are found to be unacceptable, including the potential times/circumstances which may result in high mortality rates.
- The sensitivity of the site and its associated infrastructure to bats.
- A discussion of anticipated cumulative impacts.
- An assessment of impacts and risks of the project to bats.

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
(a) details of the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a *curriculum vitae*;	Provided separately
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Provided separately
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 2
(cA) an indication of the quality and age of base data used for the specialist report;	Section 5
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 5.1, Section 6, Section 8,
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 4
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4

(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 6
(g) an identification of any areas to be avoided, including buffers;	Section 5.5
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 5.5
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4.2
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment, or activities;	Section 5
(k) any mitigation measures for inclusion in the EMPr;	Section 7, Section 8.1
(l) any conditions for inclusion in the environmental authorisation;	Section 7, Section 8.1
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 7, Section 8.1
(n) a reasoned opinion— i. as to whether the proposed activity, activities or portions thereof should be authorised; iA. Regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr or Environmental Authorization, and where applicable, the closure plan;	Section 7, Section 8.1, Section 9
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(p) any other information requested by the competent authority	All information provided
Where a government notice gazetted by thye Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

3 INTRODUCTION

This is the fifth and final progress report, and impact assessment for a twelve-month bat monitoring study at the proposed Phezukomoya Wind Power (Pty) Ltd WEF near Noupoort, Northern Cape.

Three factors need to be present for most South African bats to be prevalent in an area: availability of roosting space, food (insects/arthropods or fruit), and accessible open water sources. The importance of these factors can vary greatly between bat species, their respective behaviour and ecology. Nevertheless, bat activity, abundance and diversity are likely to be higher in areas supporting all three above-mentioned factors.

The site was evaluated in terms of 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. This evaluation is done chiefly by studying the geographic literature of each site, available satellite imagery and observations during site visits. Species probability of occurrence, based on the above-mentioned factors, is estimated for the site and the surrounding larger area (see Section 4.2).

General bat diversity, abundance and activity are determined by the use of bat detectors. 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 retain 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.

3.1 The Bats of South Africa

Bats form the Order Chiroptera and are the second largest group of mammals after rodents (Rodentia). They are the only mammals to have developed true powered flight and have undergone various skeletal changes to accommodate this. The forelimbs are elongated, whereas the hind limbs are compact and light, thereby reducing the total body weight. This unique wing profile allows for the manipulation of wing camber and shape, facilitating functions such as agility and manoeuvrability. This adaption 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 histories – particularly as a result of the various foraging and echolocation strategies evident among bats. 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 (e.g. spiders and scorpions). 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 and economic value 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 (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. Moreover, according to O'Shea *et al*. (2003), bats may live for up to 30 years thereby limiting the number 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 of bats when compared to other small mammals. However, in contrast the relatively low reproduction rates of bats results in populations having a low recovery rate from mass mortalities and major roost disturbances.

3.2 Bats and Wind Turbines

Although most bats are highly capable of advanced navigation through the use of echolocation and excellent sight, they are still at risk of physical impact with the blades of wind turbines. The carcasses of bats have been found in close proximity to wind turbines and, in a case study conducted by Johnson *et al*. (2003), were found to be directly related to collisions. The incident of bat fatalities for migrating species has been found to be directly related to turbine height, increasing exponentially with altitude, as this disrupts the migratory flight paths (Howe *et al*. 2002, Barclay *et al*. 2007). Although the number of fatalities of migrating species increased with turbine height, this correlation was not found for increased rotor sweep (Howe *et al*. 2002, Barclay *et al*. 2007). In the USA it was hypothesized that migrating bats may navigate without the use of echolocation, rather using vision as their main sense for long distance orientation (Johnson *et al*. 2003, Barclay *et al*. 2007). Despite the high incidence of deaths caused by direct impact with the blades, numerous bat fatalities have been found to be caused by barotrauma (Baerwald *et al*. 2008). This is a condition where low air pressure found around the moving blades of wind turbines, causes the lungs of a bat to collapse, resulting in fatal internal haemorrhaging (Kunz *et al*. 2007). Baerwald *et al*. (2008) found that 90% of bat fatalities around wind turbines involved internal haemorrhaging consistent with barotrauma. A study conducted by Arnett (2005) during migrations 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 to 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 (e.g. Horn *et al*. 2008) suggest that bats may be attracted to the large turbine structure to investigate perceived potential 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 of disorientation for 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 scavenging, the rate of which differs from site to site as a result of habitat type, species of scavenger 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, 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.

4 METHODOLOGY

All methodologies for the preconstruction study were initiated and designed according to the “South African good practice guidelines for surveying bats in wind farm developments (2014, Sowler & Stoffberg)”, but also complies with all requirements of the 2016 version of “South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments - Pre-construction: 4th Edition (Sowler, et al.). Bat activity was monitored using active and passive bat monitoring techniques. Active monitoring was done through site visits, with transects made throughout the site with a vehicle-mounted bat detector. Passive detection was completed with the mounting of passive bat monitoring systems placed on four monitoring masts on site. Specifically, three short 10m masts and one meteorological mast (**Figure 2**).

The monitoring systems consisted of SM2BAT+ time expansion bat detectors that were powered by 12V, 18Ah, sealed lead acid batteries and 20W solar panels which provided recharging power to the batteries. Each system also had an 8-amp low voltage protection regulator and SM3PWR step down transformer. Four SD memory cards, class 10 speed, with 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 the short masts, while two microphones were mounted at 10m and 50m on the meteorological mast. 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 -18dB 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 setup.

4.1 Site Visit Information

<table>
<tr><td colspan="2" rowspan="5">Site visit dates</td><td>First Visit</td><td>6 – 12 July 2015</td></tr>
<tr><td>Second Visit</td><td>19 - 25 October 2015</td></tr>
<tr><td>Third Visit</td><td>25 – 30 January 2016</td></tr>
<tr><td>Fourth Visit</td><td>5 – 10 April 2016</td></tr>
<tr><td>Fifth Visit</td><td>29 August – 3 September 2016</td></tr>
<tr><td rowspan="3">Met mast passive bat detection systems</td><td>Amount on site</td><td colspan="2">1</td></tr>
<tr><td>Microphone heights</td><td colspan="2">10m; 50m</td></tr>
<tr><td>Coordinates</td><td colspan="2">Met West: 31°15'46.80"S 24°54'29.10"E</td></tr>
<tr><td rowspan="3">Short mast passive bat detection systems</td><td>Amount on site</td><td colspan="2">3</td></tr>
<tr><td>Microphone height</td><td colspan="2">9m</td></tr>
<tr><td>Coordinates</td><td colspan="2">SM1: 31°13'47.80"S 24°52'51.00"E
SM2: 31°13'55.74"S 24°54'54.63"E
SM6: 31°14'58.87"S 24°58'10.67"E</td></tr>
<tr><td colspan="4">Replacements/ Repairs/ Comments</td></tr>
<tr><td colspan="2">First Site Visit</td><td colspan="2">The microphones were mounted such that they pointed approximately 30 degrees downward to avoid excessive water damage. Measures were taken for protection against birds, without compromising effectiveness significantly. Crows have been found to peck at microphones and damage them.
The bat detectors were mounted inside weather-proof boxes together with all peripherals, to provide protection against the elements.</td></tr>
<tr><td colspan="2">Second Site Visit</td><td colspan="2">Short Mast 6 displayed some minor software issues that prevented it from recording properly from the end of August 2015.</td></tr>
<tr><td colspan="2">Third Site Visit</td><td colspan="2">Short Mast 1 detected bat passes until late November 2015, thereafter the internal batteries maintaining the time and date clock of the bat detector expired. The system did not function from late November 2015 to January 2016. Short Mast 6 did not detect any bat passes over the monitoring</td></tr>
</table>

	period, this seems to be due to an issue with microphone functionality.
Fourth Site Visit	The internal batteries used to keep the internal clock of SM1 needed replacement and was replaced.
Fifth Site Visit	The Met Mast West gathered enough data to allow for a full 12 month record of bat activity. SM6 had a faulty microphone. All the masts were decommissioned except for the Met Mast system which was left until the microphone removal.
Type of passive bat detector	SM2BAT+, Real Time Expansion (RTE) type.
Recording schedule	Each detector was set to operate in continuous trigger mode from dusk each evening until dawn (times were automatically adjusted with latitude, longitude and season).
Trigger threshold	>16KHz, 18dB
Trigger window (time of recording after trigger ceased)	500ms
Microphone gain setting	36dB
Compression	WAC0
Single memory card size (each systems uses 4 cards)	32GB
Battery size	18Ah; 12V
Solar panel output	20 Watts
Solar charge regulator	8 Amp with low voltage/deep discharge protection
Other methods	Terrain was investigated during the day.

All site visits were conducted following the same methodology as mentioned above, over the course of the 12-month preconstruction monitoring period.

During the second site visit, the passive data of the bat activity was downloaded from each monitoring system. The data was analysed by classifying (as near to species level as possible) and counting positive bat passes detected by the passive systems. A bat pass is defined as a sequence of ≥1 echolocation calls where the duration of each pulse is ≥2ms (one echolocation call can consist of numerous pulses). A new bat pass will be identified by a >500ms period between pulses. These bat passes have been summed into 10 minute intervals which was used to calculate nocturnal distribution patterns over time and provide a means of determining bat activity per 10-minute period. Only nocturnal, dusk and dawn values of environmental parameters from the weather data were used, as this is the only time bats are active. Times of sunset and sunrise will be adjusted with the time of year.

The bat activity was correlated with the environmental parameters; wind speed and air temperature to identify optimal foraging conditions and periods of high bat activity at the end of the study.

4.2 Assumptions and Limitations

- Distribution maps of South African bat species still require further refinement such that the bat species proposed to occur on the site (that were not detected) are assumed accurate. If a species has a distribution marginal to the site it was assumed to occur in the area. The literature based table of species probability of occurrence may include a higher number of bat species than actually present.
- 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. Attempts to overcome this limitation, however, will be made during 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 a very certain and 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 as well as a measure of relative abundance.
- Spatial distribution of bats over the study area cannot be accurately determined by means of transects, although the passive systems can provide comparative data for different areas of the site. Transects may still possibly uncover high activity in areas where it is not necessarily expected and thereby increase insight into the site.

- Exact foraging distances from bat roosts or exact commuting pathways cannot be determined by the current methodology. Radio telemetry tracking of tagged bats is required to provide such information if needed.
- Costly radar technology is required to provide more quantitative data on actual bat numbers as well as spatial distribution of multiple bats.

4.3 Assessment Methodology

The assessment methodology will be in accordance with the recent revised 2014 EIA regulations. The significance of environmental impacts is a function of the environmental aspects that are present and to be impacted on, the probability of an impact occurring and the consequence of such an impact occurring before and after implementation of proposed mitigation measures.

a) Extent (spatial scale):

Ranking criteria

L	M	H
Impact is localized within site boundary	Widespread impact beyond site boundary; Local	Impact widespread far beyond site boundary; Regional/national

b) Duration:

Ranking criteria

L	M	H
Quickly reversible, less than project life, short term (0-5 years)	Reversible over time; medium term to life of project (5-15 years)	Long term; beyond closure; permanent; irreplaceable or irretrievable commitment of resources

c) **Intensity (severity):**

Type of Criteria	Negative			Positive		
	H-	**M-**	**L-**	**L+**	**M+**	**H+**
Qualitative	Substantial deterioration, death, illness or injury, loss of habitat/diversity or resource, severe alteration or disturbance of important processes.	Moderate deterioration, discomfort, Partial loss of habitat/biodiversity/ resource or slight or alteration	Minor deterioration, nuisance or irritation, minor change in species/habitat/diversity or resource, no or very little quality deterioration.	Minor improvement, restoration, improved management	Moderate improvement, restoration, improved management, substitution	Substantial improvement, substitution
Quantitative	Measurable deterioration Recommended level will often be violated (e.g. pollution)	Measurable deterioration Recommended level will occasionally be violated	No measurable change; Recommended level will never be violated	No measurable change; Within or better than recommended level.	Measurable improvement	Measurable improvement

d) Probability of occurrence:

Ranking criteria

L	M	H
Unlikely; low likelihood; Seldom No known risk or vulnerability to natural or induced hazards.	Possible, distinct possibility, frequent Low to medium risk or vulnerability to natural or induced hazards.	Definite (regardless of prevention measures), highly likely, continuous High risk or vulnerability to natural or induced hazards.

e) Status of the impact:

Describe whether the impact is positive, negative or neutral for each parameter. The ranking criteria are described in negative terms. Where positive impacts are identified, use the opposite, positive descriptions for criteria.

Based on a synthesis of the information contained in (a) to (e) above, the specialist will be required to assess the significance of potential impacts in terms of the following criteria:

f) Significance: (Duration X Extent X Intensity)

Intensity = L				
Duration	**H**			
	M			Medium
	L	Low		
Intensity = M				
Duration	**H**			High
	M		Medium	
	L	Low		
Intensity = H				
Duration	**H**			
	M			High
	L	Medium		
		L	**M**	**H**
		Extent		

Positive impacts would be ranked in the same way as negative impacts, but result in high, medium or low positive consequence.

g) Degree of confidence in predictions:

State the degree of confidence in the predictions, based on the availability of information and specialist knowledge.

5 RESULTS AND DISCUSSION

5.1 Land Use, Vegetation, Climate and Topography

The Besemkaree Koppies Shrubland vegetation unit forms part of the Grassland biome (**Figure 3**

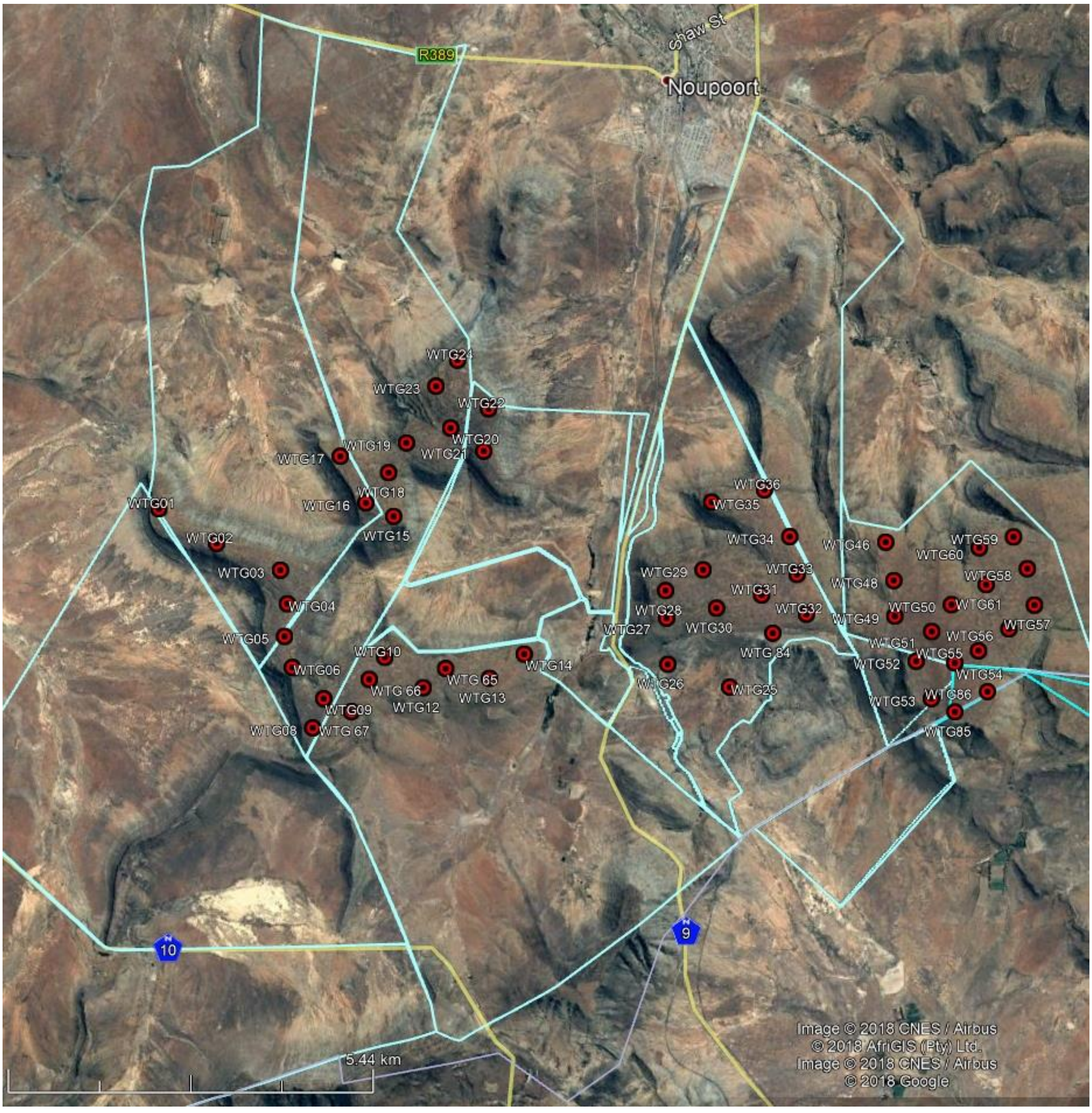


Figure 1). This vegetation unit occurs at altitudes between 1120 m – 1680 m and consists of two-layered karroid shrubland. The lower layer comprises of mostly dwarf, small-leaved shrubs and abundant grasses, particularly in wet years; while the upper layer is mostly tall shrubs e.g. *Rhus* sp (Mucina and Rutherford 2006). The dolerite-dominated geology is the result of extensive volcanic activity. In some areas, the slopes of mesas and butts may be a mix of dolerite, sandstones and mudstones. Climatic conditions show hints of the bimodal pattern typical of the Nama-Karoo. Overall Mean Annual Precipitation (MAP)is 400 mm but ranges from 280 mm in the west of the unit to 580 mm in the east (the site is situated in the south west portion of this unit). Mean annual temperature is 15°C. The unit is considered Least Threatened as it is largely excluded from major agricultural activities (Mucina and Rutherford 2006). About 5% is statutorily conserved.

The site mostly falls in the Eastern Upper Karoo vegetation unit which forms part of the Nama-Karoo biome and is mostly present in the western parts of the site (**Figure 3**). This unit is found at an altitude of 1000 m – 1700 m. The unit is characterised by flat and gently sloping plains dominated by dwarf microphyllous shrubs and 'white' grasses of the genera *Aristida* and *Eragrostis* (Mucina and Rutherford 2006). Mostly sandstones and mudstones, which support duplex soils and some shallow Glenrosa and Mispah soils, dominate the unit but some areas may have prominent dolerites. Rainfall occurs mainly in autumn and summer with MAP ranging from 180 mm in the west of the unit to 430 mm in the east (the site is situated in the eastern third of the unit). Mean maximum and minimum temperatures are 36.1°C and -7.2°C for January and July, respectively. Frost incidence is relatively high and ranges from <30 to >80 days but are likely closer to the lower end at this site. The Eastern Upper Karoo is Least Threatened but veld managers perceive the unit to be experiencing species composition changes hence high-priority action is required (Mucina and Rutherford 2006).

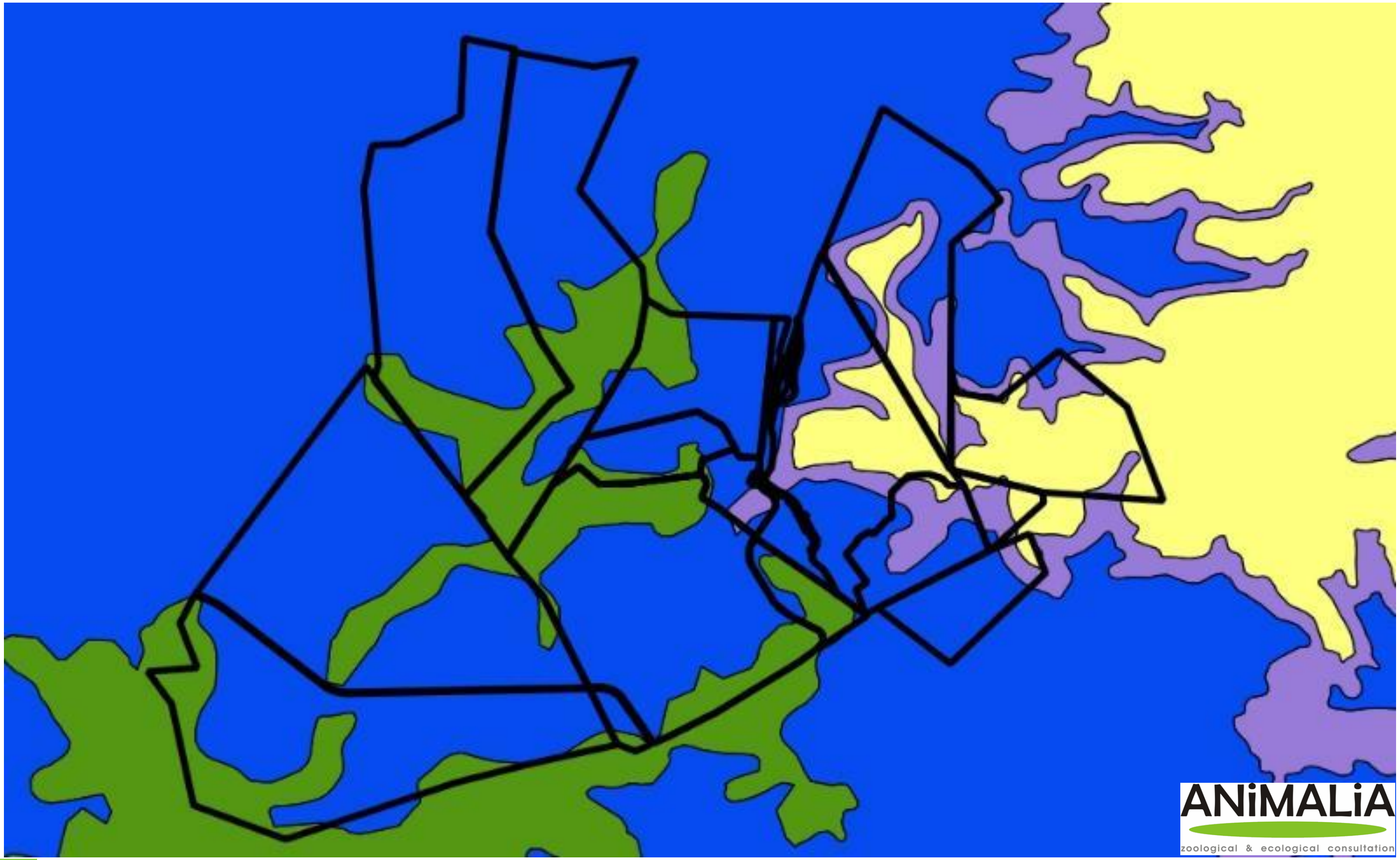
The Karoo Escarpment Grassland vegetation unit is mostly present in the eastern parts of the site (**Figure 3**). The unit consists of mountain summits, low mountains and hills with wiry tussock grasslands usually dominated by Merxmuellera Disticha. An important low shrub component occurs throughout this unit. Geology consists of shallow on mudstones and sandstones of the Beaufort Group (Karoo Supergroup). Rainfall shows minor peaks in March and November – December, and it has very dry winters. MAP ranging from 300 mm to 580 mm increasing from west to east as well as with increasing elevation. Frost incidence is from less than 20 days to more than 100 days, higher values occur at higher elevations. There may be occurrences of a number of days of snow per year, especially at higher elevations and on the edge of the escarpment. The Karoo Escarpment Grassland is Least Threatened with nearly 3% statutorily conserved in the Mountain Zebra and Karoo National parks. Slightly higher portions are protected in game farms and private game reserves. (Mucina and Rutherford 2006).

The Tarkastad Montane Schrubland vegetation unit is mostly present in the eastern parts of the site (**Figure 3**). The unit is characterised by ridges hills and isolated mountain slopes, characterised by high surface rock cover, consisting of large boulders most of the time. The vegetation is low semi-open, mixed shrubland with 'white' grasses and dwarf shrubs forming a prominent component of the vegetation. The geology of the site consists mostly of sedimentary rocks of the Tarkastad Subgroup. Rainfall occurs mainly in late summer and autumn peaking in February and March. MAP 280 – 720 mm increasing from west to east. Frost occurs on average 39 days a year increasing with proximity to the escarpment. The unit is Least Threatened. Around 1 – 2% is statutorily conserved in conservation areas. About 2% is transformed for cultivation or by building of dams. (Mucina and Rutherford 2006).

Vegetation units and geology are of great importance as these may serve as suitable sites for the roosting of bats and support of their foraging habits (Monadjem *et al.* 2010). Houses and buildings may also serve as suitable roosting spaces (Taylor 2000; Monadjem *et al.* 2010). The importance of the vegetation units and associated geomorphology serving as potential roosting and foraging sites have been described in **Table 1**.

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

Vegetation Unit	Roosting Potential	Foraging Potential	Comments
Besemkaree Koppies Shrubland	Moderate	Moderate-High	The tall and dolerite outcrops have roosting potential while the vegetation provides foraging potential for insectivorous bats.
Eastern Upper Karoo	Low - Moderate	Moderate - High	The presence of sandstone and some dolerite outcrops may provide potential roost sites while the variety of plant species and open grasslands can attract a variety of insect species for insectivorous bat species to feed on.
Karoo Escarpment Grassland	Low	Low - Moderate	Large flat open areas make for good foraging for livestock which acts as a lure for different insects making it a good foraging area for insectivorous bats.
Tarkastad Montane Schrubland	Moderate -High	Moderate - High	The presence of large boulders and rock overhangs as well as crevices in cliffs could provide roost sites.



Besemkaree Koppies Shrubland
Eastern Upper Karoo
Site boundary
Karoo Escarpment Grassland
Tarkastad Montane Schrubland

Figure 3: Vegetation units present on the site (Mucina and Rutherford 2006).

5.2 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 with 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 *et al.* (2016) based on species distributions, altitudes at which they fly and distances they travel; 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: Table of species that may be roosting or foraging on the study area, the possible site specific roosts, and their probability of occurrence based on literature (Monadjem *et al.* 2010).

Species	**Common name**	**Probability of occurrence (%)**	**Conservation status**	**Possible roosting habitat on site**	**Possible foraging habitat utilised on site**	**Likelihood of risk of fatality (Sowler *et al.*, 2016)**
Eptesicus hottentotus	Long-tailed serotine	70 - 80	Least Concern	It is a crevice dweller roosting in rock crevices, expansion joints in bridges and road culverts	It seems to prefer woodland habitats, but has been caught in granitic hills and near rocky outcrops. Clutter edge forager	Medium
Cistugo lesueuri	Lesueur's Wing- gland bat	10 - 20	Vulnerable	Roosts in rock crevices near water. Associated with broken terrain in high-altitude montane grasslands.	Not well known, probably near water.	Not known
Miniopterus natalensis	Natal long-fingered bat	90 - 100	Near Threatened	It is mostly cave/mine dependent and hence the availability of suitable roosting sites is a critical factor in determining its presence. It may be found in the Noupoort copper mines. Have been found roosting singly or in small groups inside culverts and manmade hollows.	Forages around the edge of clutters of vegetation, and may therefore avoid most of the site and may only be found at the denser drainage systems. It is also dependant on open surface water sources.	Medium - High
Myotis tricolor	Temmink's myotis	20 - 30	Least Concern	Roosts gregariously in caves, but have been found roosting singly or in small groups inside culverts and manmade hollows.	It is restricted to areas with suitable caves or hollows, which may explain its absence from flat and featureless terrain; its close association with mountainous areas may therefore be due to its roosting requirements.	Medium - High
Neoromicia capensis	Cape serotine	90 - 100	Least Concern	Roosts under the bark of trees, at the base of aloe leaves, and inside the roofs of houses. The farm buildings are the most likely roosting space.	It appears to tolerate a wide range of environmental conditions from arid semi-desert areas to montane grasslands, forests, and savannas. Highly adaptable species, but a clutter edge forager limiting its utilisation of the site.	Medium - High
Nycteris thebaica	Egyptian slit-faced bat	10 - 20	Least Concern	Roosts in caves, aardvark burrows, culverts under roads and the trunks of large trees and hollows (manmade or natural). Roosting space unlikely on site.	It appears to occur throughout the savanna and karoo biomes, but avoids open grasslands. May be found in denser drainage systems. Relatively small foraging range and an open space forager	Low

Rhinolophus clivosus	Geoffroy’s horseshoe bat	10 - 20	Least Concern	Roosts in caves, mine adits and hollows (manmade and natural).	Arid savanna, woodland and riparian forest. Clutter forager that may only possibly be found in denser drainage systems. Relatively small foraging range	Low
Rhinolophus capensis	Cape horseshoe bat	40 - 50	Near Threatened	Roosts in caves and mine adits	Forages predominantly in the canopy of trees	Low
Sauromys petrophilus	Roberts's flat-headed bat	60 - 70	Least Concern	Roosts in narrow cracks and under slabs of exfoliating rock. Closely associated with rocky habitats in dry woodland, mountain fynbos or arid scrub.	Open space forager with relatively large foraging range.	High
Tadarida aegyptiaca	Egyptian free-tailed bat	90 - 100	Least Concern	Roost in rock crevices, under exfoliating rocks, in hollow trees, and behind the bark of dead trees. The species has also taken to roosting in buildings, in particular roofs of houses.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of natural and urbanised habitats with a relatively large foraging range. Open space forager	High

5.3 Ecology of bat species that may be largely impacted by the Phezukomoya Wind Power (Pty) Ltd WEF

There are three bat species recorded in the vicinity of the site that occurs commonly in the area due to their probability of occurrence and widespread distribution. These species are of importance based on 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 *et al.* 2016). 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 *Miniopterus 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. A study by Vincent *et al.* (2011) on the activity and foraging habitats of the family Miniopteridae found that the individual home ranges of lactating females were significantly larger than that of pregnant females. It was also found that the bats predominately made use of urban areas (54%) followed by open areas (19.8%), woodlands (15.5%) orchards and parks (9.1%) and water bodies (1.5%) when selecting habitats. Foraging areas were also investigated with the majority again occurring in urban areas (46%); however a lot of foraging also occurred in woodland areas (22%), crop and vineyard areas (8%), pastures, meadows and scrubland (4%) and water bodies (4%).

Sowler *et al.* (2016) advise that *Miniopterus 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 *Neoromicia 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 described to have a Medium-High likelihood of risk of fatality due to wind turbines (Sowler *et al.* 2016).

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. *Tadarida 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 *et al.* 2016). 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).

5.4 Transects

In general, during transects, bat activity was markedly higher in low lying terrain than on the high-rise turbine areas.

5.4.1 First Site Visit

No transects were carried out over the first site visit, due to equipment installation receiving priority. Transects were carried out over the following site visits, covering all four seasons.

5.4.2 Second Site Visit

The driven transect was done using a Wildlife Acoustics SM2BAT+ detector. The routes were chosen randomly based on the condition of the roads and location at time of sunset.

Table 3: Average weather conditions experienced during the driven transects (Weather information taken from www.worldweatheronline.com for Teebus, NC).

Date	Temperature (°C)	Rain (mm)	Wind (km/h)	Humidity (%)
20 October 2015	30	0.0	16	35
21 October 2015	18	0.1	14	74
22 October 2015	23	0	13	73
23 October 2015	24	0	11	76
24 October 2015	31	0.7	13	32

Four bat species were detected during transects, namely *Eptesicus hottentotus, Miniopterus natalensis, Neoromicia capensis* and *Tadarida aegyptiaca*. Bat activity detected across the site shows quite a large dispersion with concentrated activity occurring in specific areas (**Figure 4**). A concentration of activity was detected in a central to north-west position within the site boundary, along an inclining road summiting a mountain. It is a relatively sheltered valley type habitat.

A large concentration of bat passes, predominantly *Tadarida aegyptiaca,* was detected across the south-west tip of the site boundary. It occurs along a variety of different habitat types of plateaus, sheltered valley areas and the curving contours of the mountains (**Figure 5)**.

5.4.3 Third Site Visit

The driven transect was done using a Wildlife Acoustics SM2BAT+ detector. The routes were chosen randomly based on the condition of the roads and location at time of sunset.

Table 4: Average weather conditions experienced during the driven transects (Weather information taken from www.worldweatheronline.com for Teebus, Northern Cape)

Date	Temperature (°C)	Rain (mm)	Wind (km/h)	Humidity (%)
25 January 2016	24	0.1	13	77
26 January 2016	25	0	3	44
27 January 2016	28	0	8	63
28 January 2016	24	0	10	60
29 January 2016	29	0	3	56

Figures 6 and 7 display the number of bat passes detected during transects of the third site visit. The passes were mostly clustered around high bat sensitivity features such as man-made buildings. The highly concentrated activity was detected mostly during the first portion of the night around the time of sunset with suitable weather conditions prevailing over the duration of the site visit.

5.4.4 Fourth Site Visit

The driven transect was done using a Wildlife Acoustics SM2BAT+ detector. The routes were chosen randomly based on the condition of the roads and location at time of sunset.

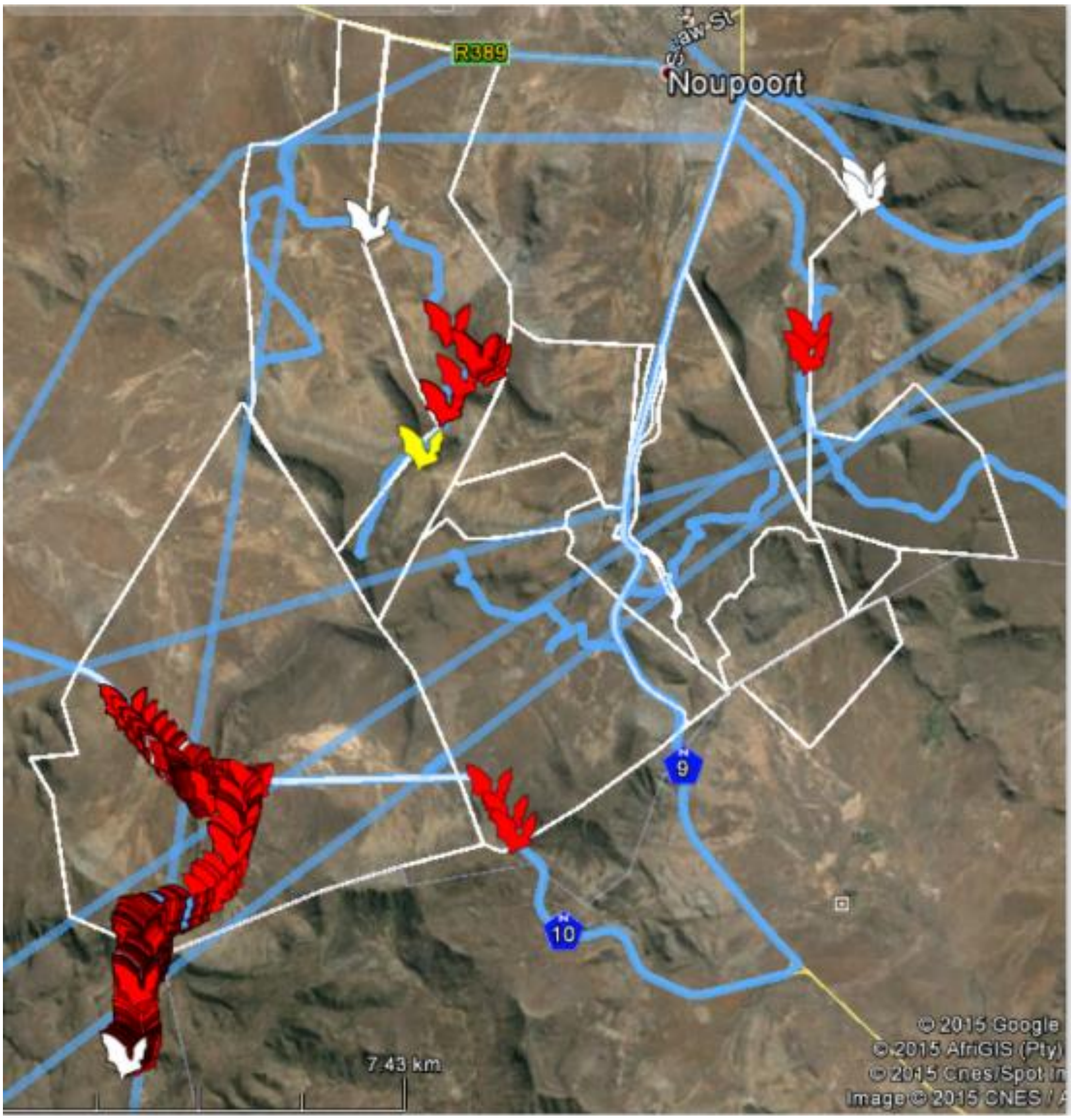
Table 5: Average weather conditions experienced during the driven transects (Weather information taken from www.worldweatheronline.com for Teebus, Northern Cape)

Date	Temperature (°C)	Rain (mm)	Wind (km/h)	Humidity (%)
06 April 2016	16	0	8	65
07 April 2016	19	0	4	45
08 April 2016	24	0	4	47
09 April 2016	24	0	4	40

Three bat species were detected during the fourth visits transects, namely *Miniopterus natalensis, Neoromicia capensis* and *Tadarida aegyptiaca*. Bat activity was detected across the northern and eastern areas of the site, with concentrated activity occurring in the central to northern section (**Figure 8 and 9**). The concentrated activity of bats is mostly comprised out of the species *Tadarida aegyptiaca* (**Figure 10**).

5.4.5 Fifth Site Visit

No transects were done during the fifth site visit due to locked gates. This does not influence the results or conclusion of the study significantly, since transects are not quantitive and therefore not used as a primary means of data gathering. It's only used to increase insight into the sight when required.



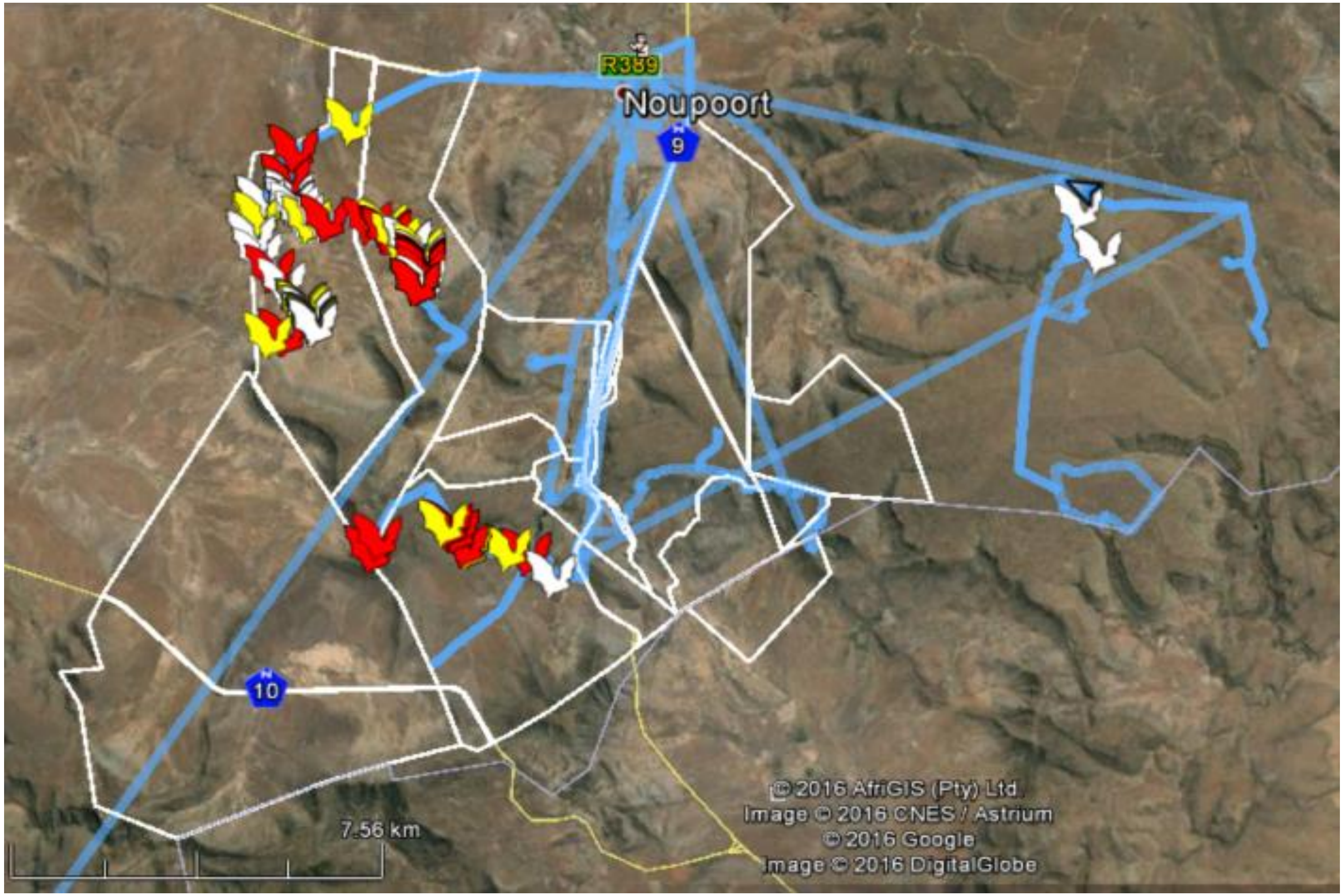
Neoromicia capensis *Tadarida aegyptiaca* *Miniopterus natalensis*

Eptesicus hottentotis Transect route driven

Figure 4: Results of transect of the Phezukomoya Wind Power (Pty) Ltd carried out over October 2015

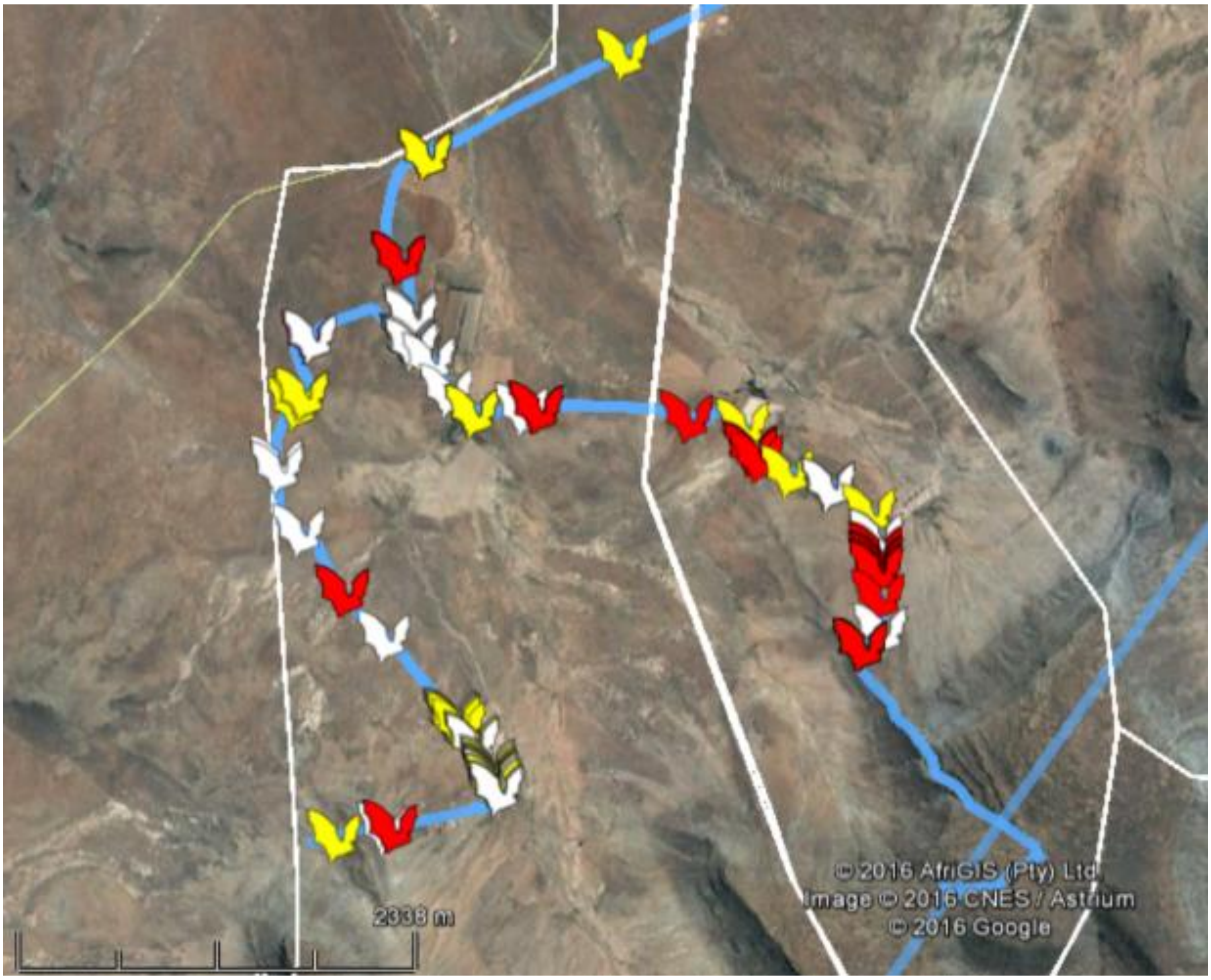
☐	*Neoromicia capensis*	■	*Tadarida aegyptiaca*	■	*Miniopterus natalensis*
■	*Eptesicus hottentotis*	—	Transect route driven		

Figure 5: High concentration of active bats on site found during transects over October 2015



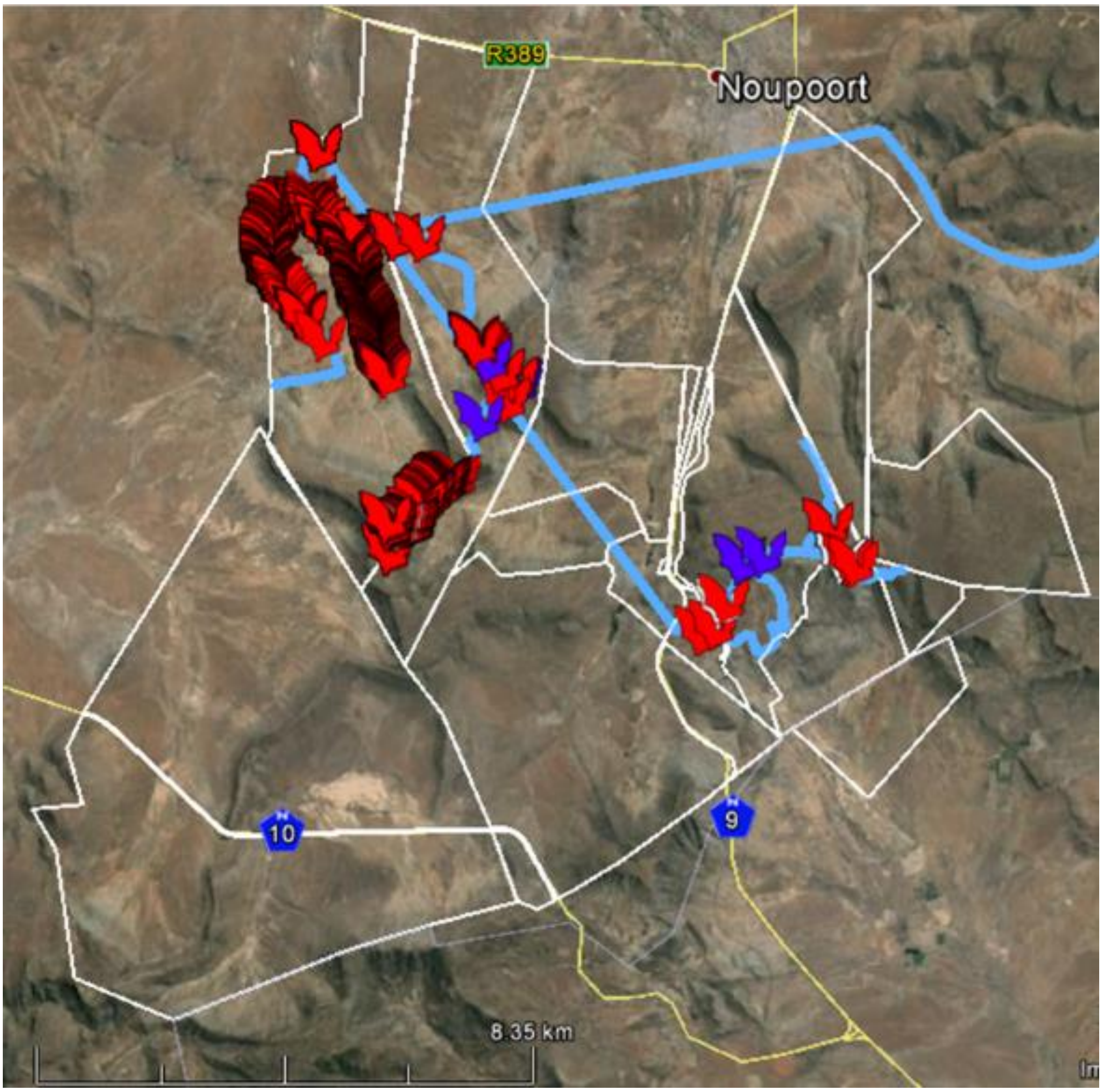
Neoromicia capensis *Tadarida aegyptiaca* *Eptesicus hottentotus* *Miniopterus natalensis*

Figure 6: Active bats on site found during transects of January 2016



Neoromicia capensis *Tadarida aegyptiaca* *Eptesicus hottentotus*
Miniopterus natalensis

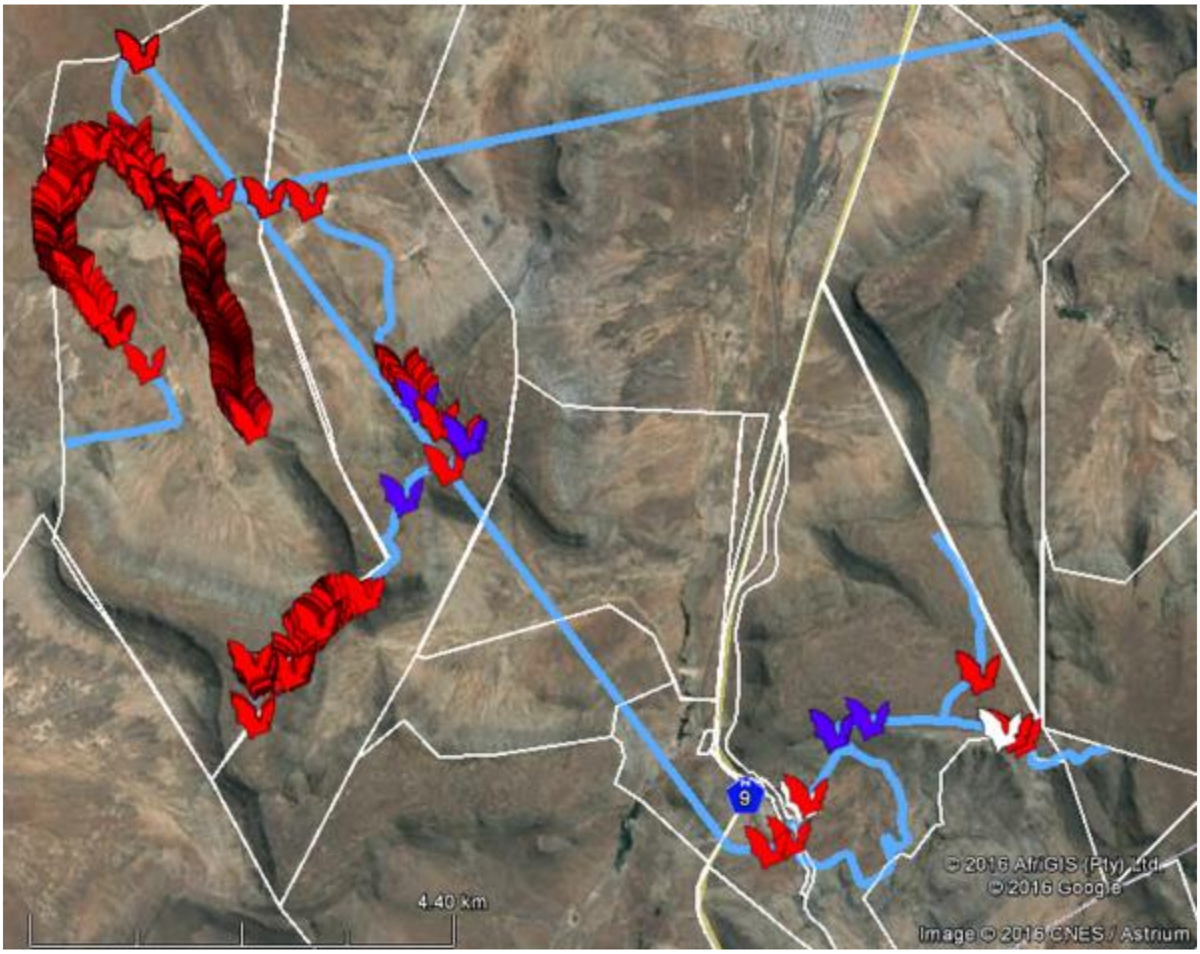
Figure 7: High concentration of active bats on site found during transects of January 2016



Tadarida aegyptiaca *Neoromicia capensis* *Miniopterus natalensis*

Transect route driven

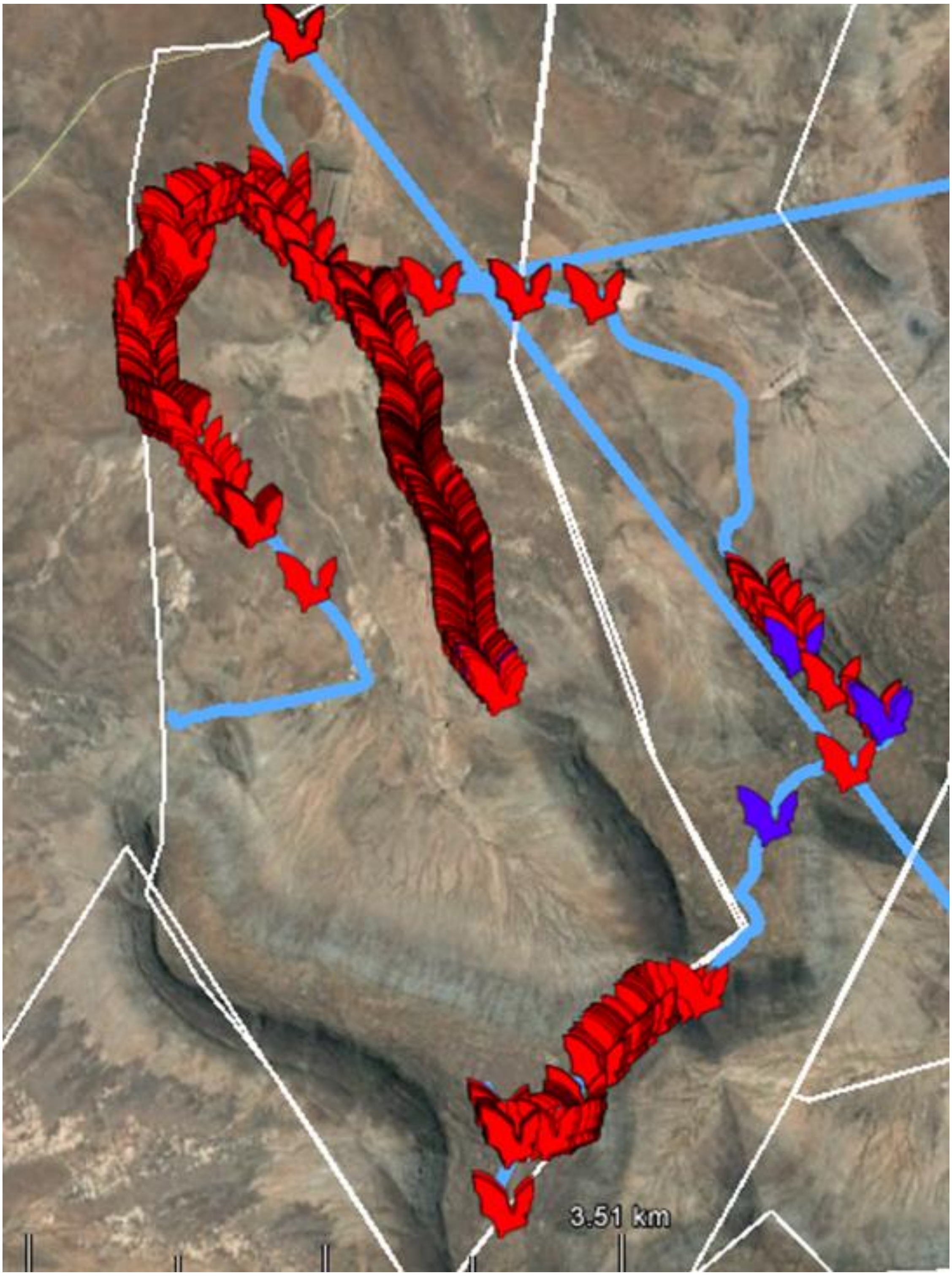
Figure 8: Active bats on site found during transects of April 2016



Tadarida aegyptiaca *Neoromicia capensis* *Miniopterus natalensis*

Transect route driven

Figure 9: Active bats on site found during transects of April 2016



Tadarida aegyptiaca *Neoromicia capensis* *Miniopterus natalensis*

Transect route driven

Figure 10: High concentration of active bats on site found during transects over April 2016

5.5 Sensitivity Map

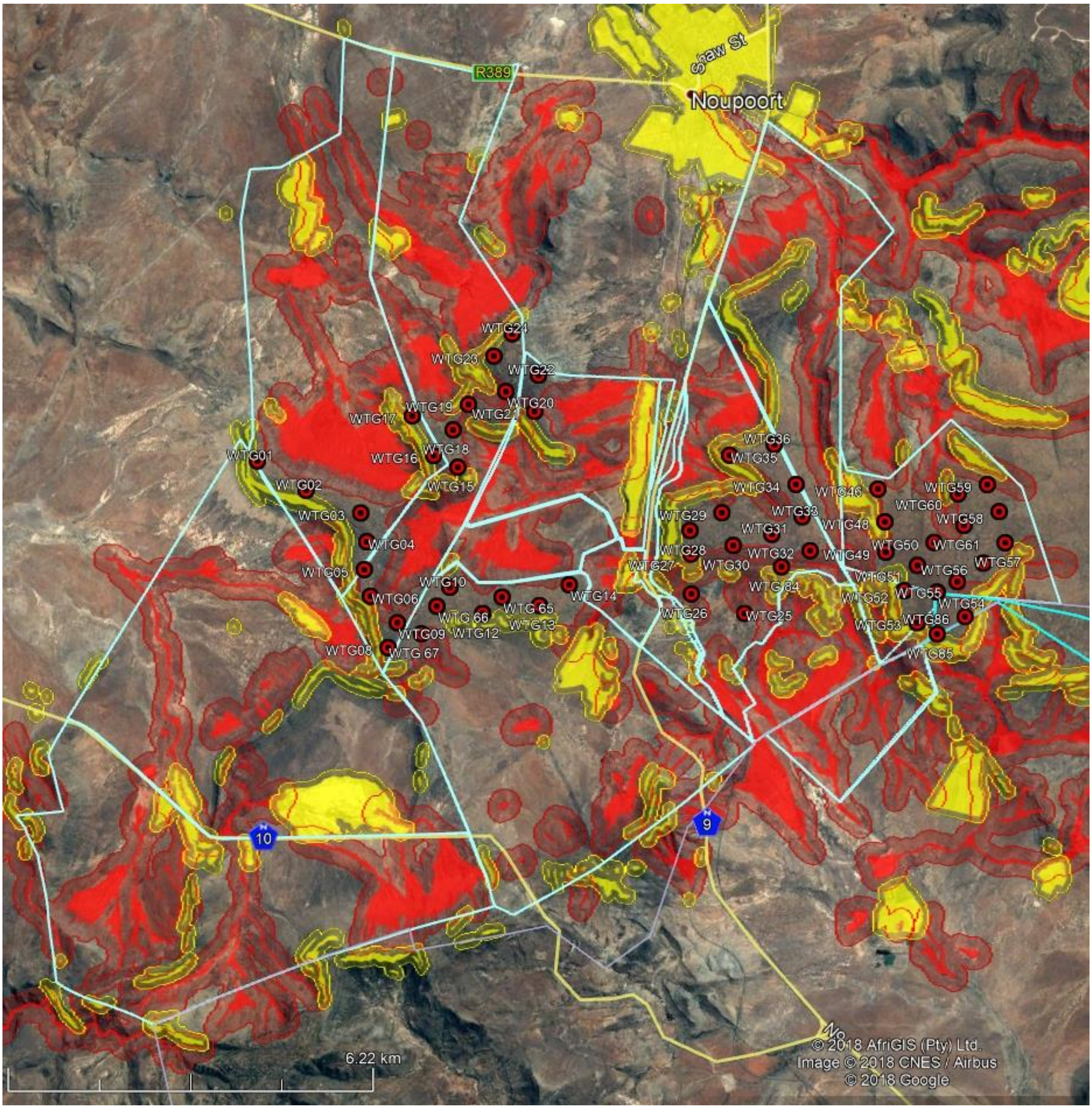
Figures 11 - 14 depict the sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that are confirmed and most probable to occur on site. Thus, the sensitivity map is based on species ecology and habitat preferences. This map can be used as a means of additional pre-construction mitigation in terms of improving turbine placement with regards to bat preferred habitats on site.

Last iteration	November 2016
High sensitivity buffer	200m
Moderate sensitivity buffer	100m
Features used to develop the sensitivity map	Manmade structures, such as farm houses, barns, sheds and road culverts, these structures provide easily accessible roosting sites.
	Rock faces, areas of exfoliating rock and clumps of larger woody plants. These habitats provide natural roosting spaces and tend to attract insect prey.
	The different vegetation types and presence of riparian/water drainage habitat is used as indicators of probable foraging areas.
	Open water sources, be it man-made farm dams or natural streams and wetlands, are important sources of drinking water and provide habitat that host insect prey.

The areas designated as having a High Bat Sensitivity **(Table 6)** implicates that no turbines should be placed in these areas and their respective buffer zones, due to the elevated impacts it can have on bat mortalities. If turbines are located within the Moderate Bat Sensitivity zone or buffer zone, they must receive special attention and preference for post-construction monitoring and implementation of mitigations during the operational phase (if mitigation is found to be required). **Table 7** indicates that no turbines are found within the sensitivity categories.

Table 6: Description of sensitivity categories utilized in the sensitivity map

Sensitivity	Description
Moderate Sensitivity and their buffers	Areas of foraging habitat or roosting sites considered to have significant roles for bat ecology. 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.

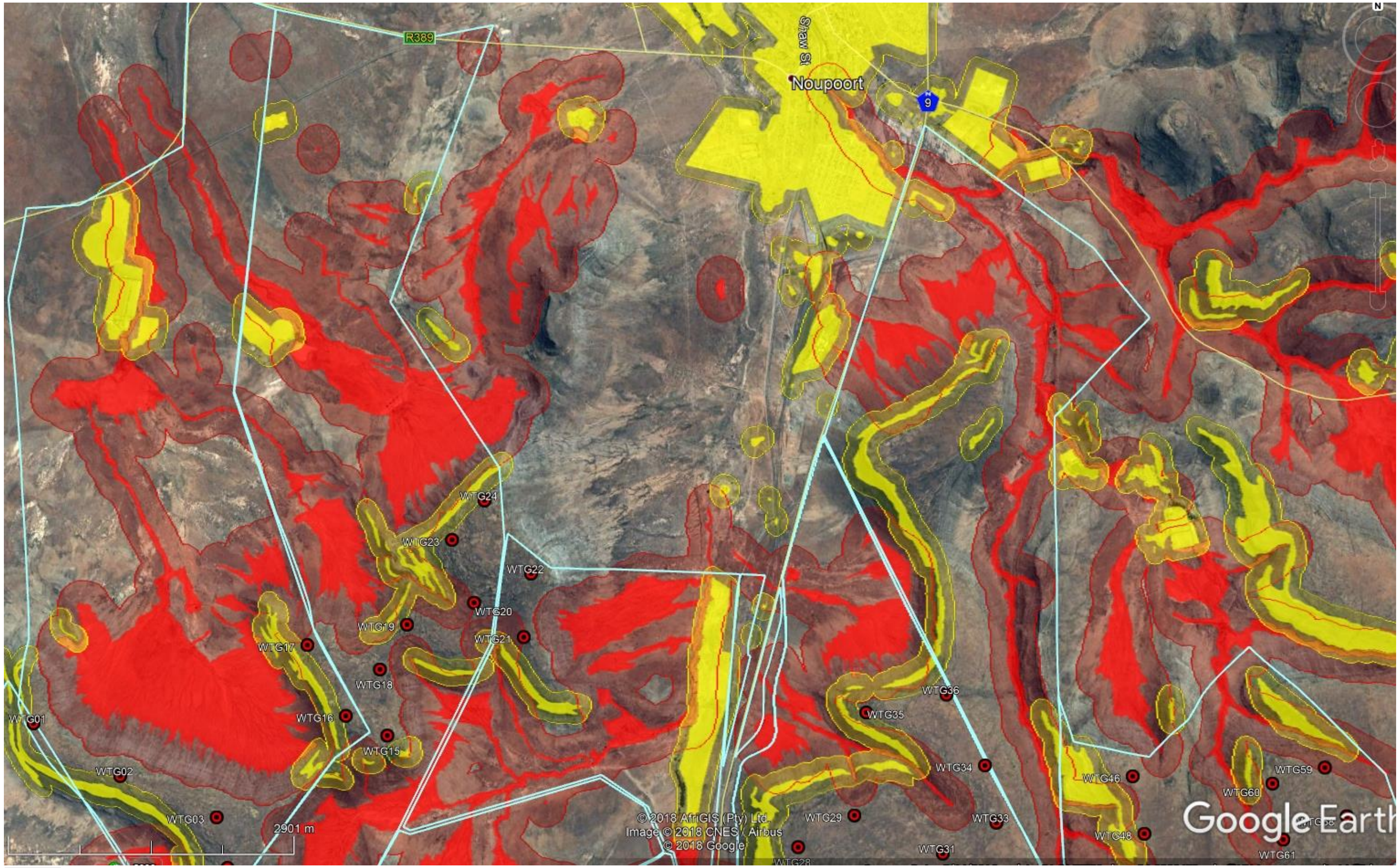


High bat sensitivity area
Moderate bat sensitivity area
High bat sensitivity buffer
Moderate bat sensitivity buffer

Figure 11: Bat sensitivity map of the Phezukomoya Wind Power (Pty) Ltd site.

Table 7: Turbines located in the various sensitivity categories

Sensitivity	Turbines
High Sensitivity	None
Moderate Sensitivity	None
High Sensitivity Buffer	None
Moderate Sensitivity Buffer	None



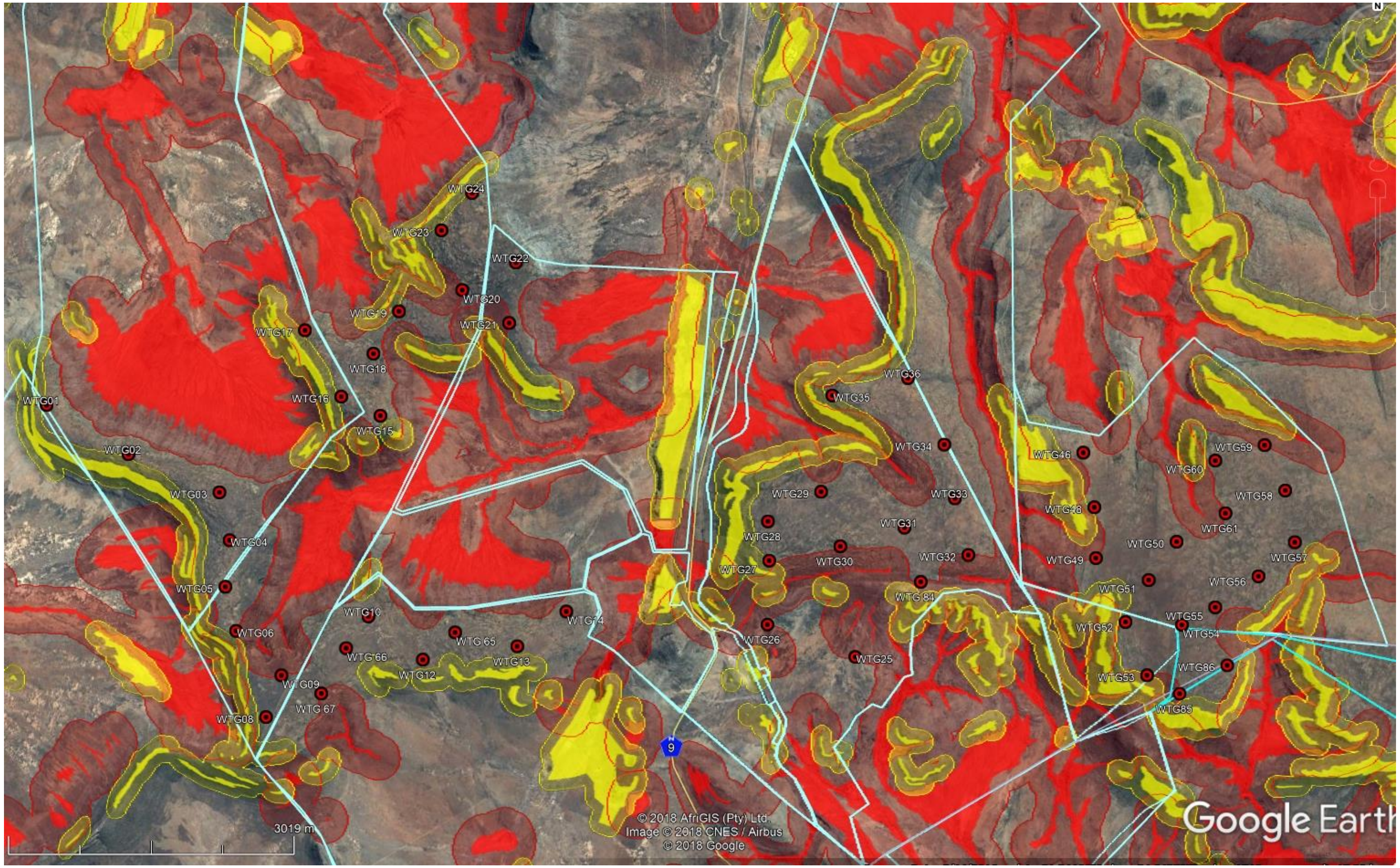
High bat sensitivity area

Moderate bat sensitivity area

High bat sensitivity buffer

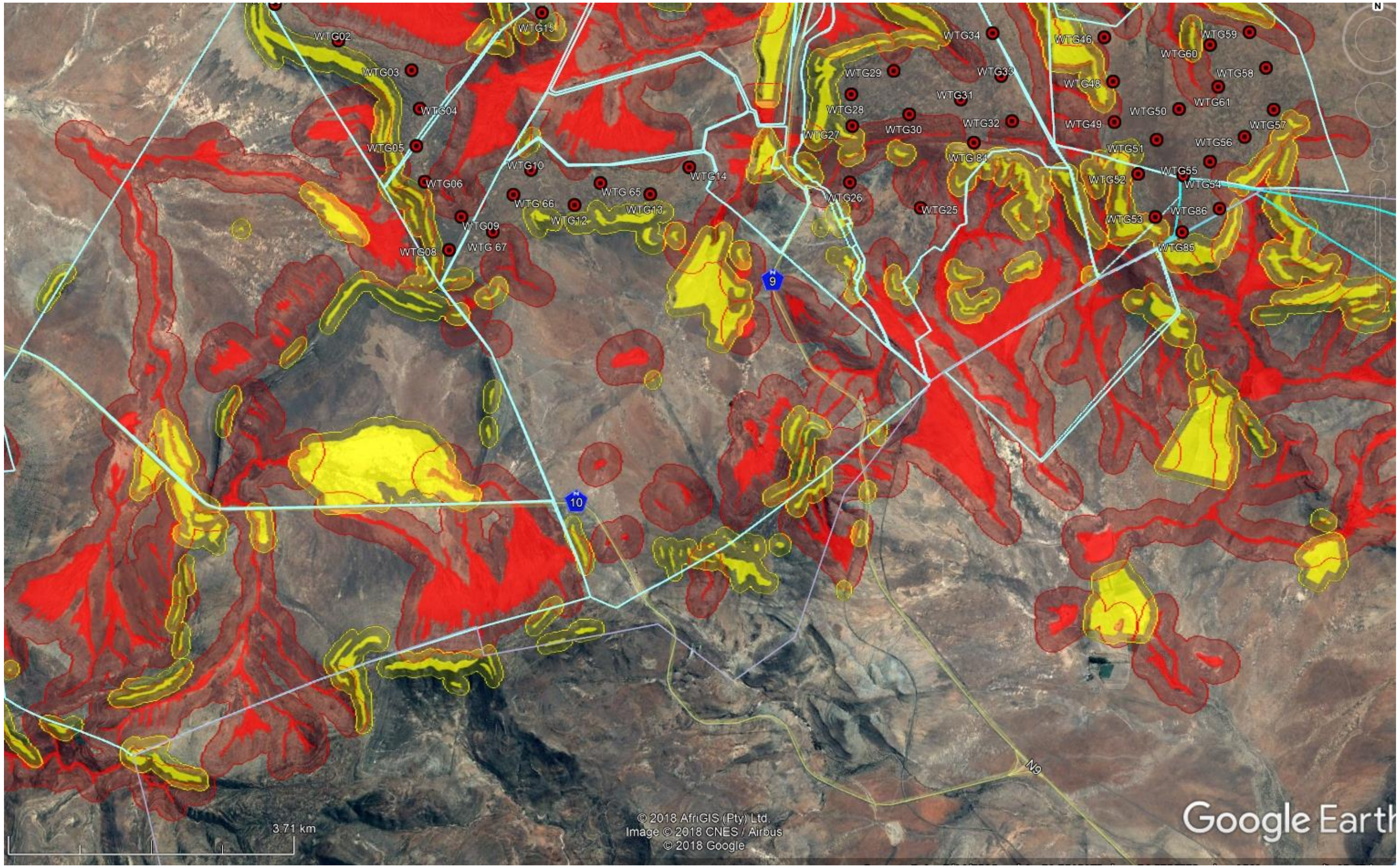
Moderate bat sensitivity buffer

Figure 12: Bat sensitivity map of the northern portion of the Phezukomoya Wind Power (Pty) Ltd site.



High bat sensitivity area
Moderate bat sensitivity area
High bat sensitivity buffer
Moderate bat sensitivity buffer

Figure 13: Bat sensitivity map of the central portion of the Phezukomoya Wind Power (Pty) Ltd site.



High bat sensitivity area

Moderate bat sensitivity area

High bat sensitivity buffer

Moderate bat sensitivity buffer

Figure 14: Bat sensitivity map of the southern portion of the Phezukomoya Wind Power (Pty) Ltd site.

5.6 Passive Data

5.6.1 Abundances and Composition of Bat Assemblages

Average bat passes detected per bat detector night (nights on which detectors recorded correctly - see **Table 8 - 11** for these time frames) and total number of bat passes detected over the monitoring period by all systems are displayed in **Figures 15 – 22.** Four bat species were detected by the passive monitoring systems, namely, *Eptesicus hottentotus, Miniopterus natalensis, Neoromicia capensis,* and *Tadarida aegyptiaca.*

Tadarida aegyptiaca and *Neoromicia capensis* are the most abundant bat species recorded by all systems. Common and abundant species, such as *Neoromicia capensis, Tadarida aegyptiaca* and *Miniopterus natalensis*, are of a larger value to the local ecosystems as they provide a greater contribution to most ecological services than the rarer species due to their higher numbers.

Miniopterus natalensis is the only migratory species detected on site. The results of the full 12 months have been analysed for the presence of a migratory event. However, no migratory event was detected by the four passive monitoring systems. Thus the results are indicative of the site not being within a migratory route.

Short Mast 2 monitoring systems detected a significantly higher number of bat passes than any of the other monitoring systems on this site **(Figure 17)**. Short Mast 2 indicates that they be situated within higher bat activity and sensitivity habitats. Short Mast 6 detected a comparatively low number of bat passes due to a software issue of the bat detector **(Figure 18).**

The Met Mast West, Short Mast 1 and 2 monitoring systems show the general trend of lowered bat activity over the winter months (July – August 2015), with a large increase in bat passes into the spring (September – November 2015) and summer months (December 2015 – February 2016), followed by a decrease during the autumn months (March – May 2016) into winter 2016 again (**Figures 19 - 21**). Met Mast West showed highest peak activity during the month of October 2015, and again in March 2016. Short Mast 1 also had a peak during October 2015, but due to no data during December 2015 – March 2016 it can't be fully informative. Short Mast 2 showed peaked activity over January 2016. Whereas Short Mast 6 monitoring system only detected bat passes over the month of August 2015 due to software issues on the bat detector **(Figure 22)**.

Table 8: Date ranges over which the monitoring systems were functioning for the first monitoring period

Mast	Date Range	Comments
Met Mast 100m	08/07/2015 – 22/10/2015	
SM 1	10/07/2015 – 22/10/2015	
SM 2	10/07/2015 – 25/10/2015	
SM 6	10/07/2015 – 24/08/2015	Software issue caused detector to cease on 24 August 2015

Table 9: Date ranges over which the monitoring systems were functioning for the second monitoring period

Mast	Date Range	Comments
Met Mast 100m	20/10/2015 – 28/01/2016	
SM 1	22/10/2015 – 20/11/2015	Internal batteries of bat detector expired
SM 2	25/10/2015 – 26/01/2016	
SM 6	24/10/2015 – 27/01/2016	Microphone issues caused lack of detection of bat passes

Table 10: Date ranges over which the monitoring systems were functioning for the third monitoring period

Mast	Date Range	Comments
Met Mast 100m	29/01/2016 – 05/04/2016	
SM 1		No bat passes detected
SM 2	26/01/2016 – 05/04/2016	
SM 6		No bat passes detected

Table 11: Date ranges over which the monitoring systems were functioning for the fourth monitoring period

Mast	Date Range	Comments
Met Mast West	08/04/2016 – 02/09/2016	
SM 1	07/04/2016 – 01/09/2016	
SM 2	07/04/2016 – 01/09/2016	
SM 6		Faulty microphone

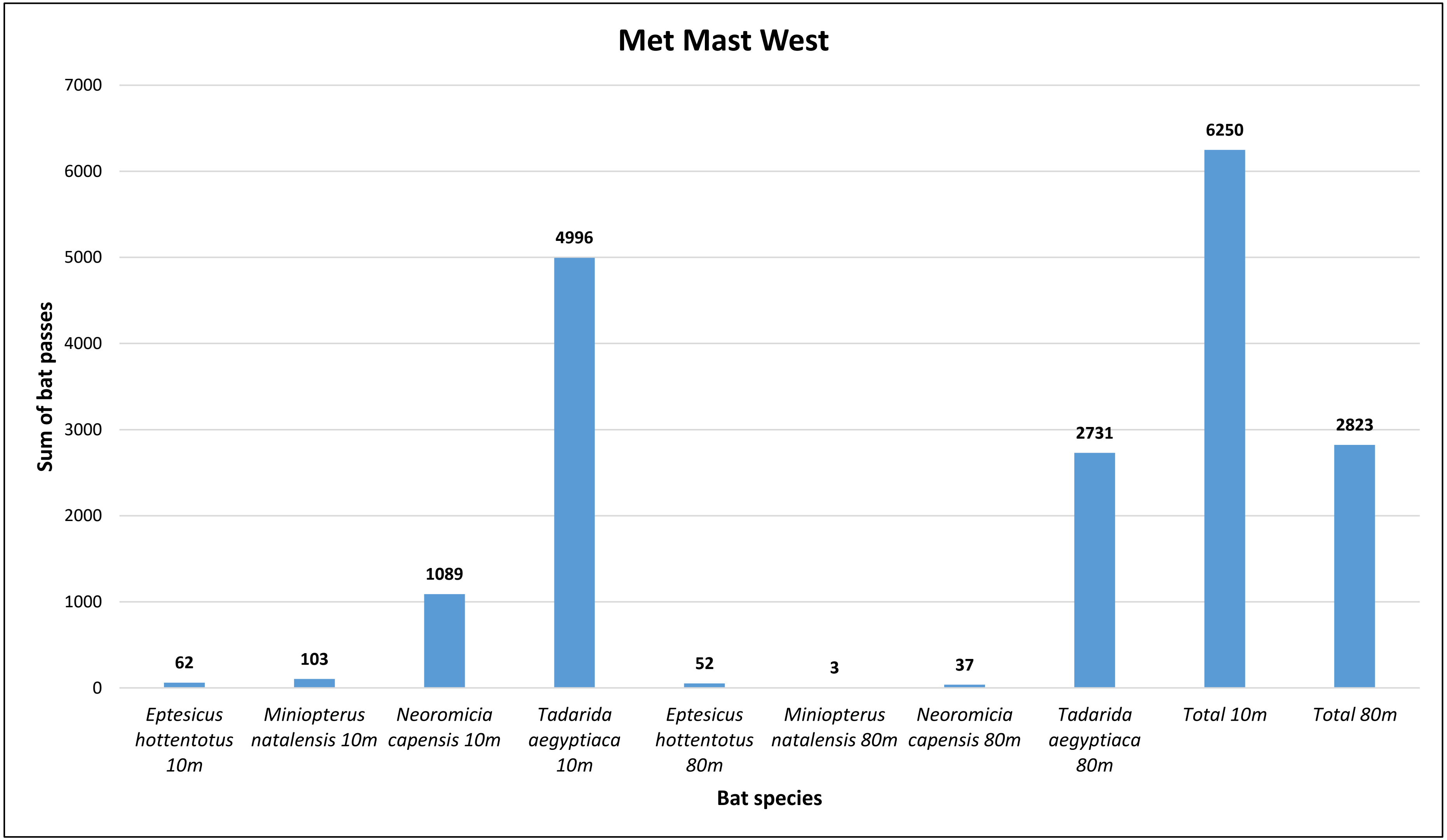


Figure 15: Sum of bat passes per species detected by the Met Mast West monitoring system.

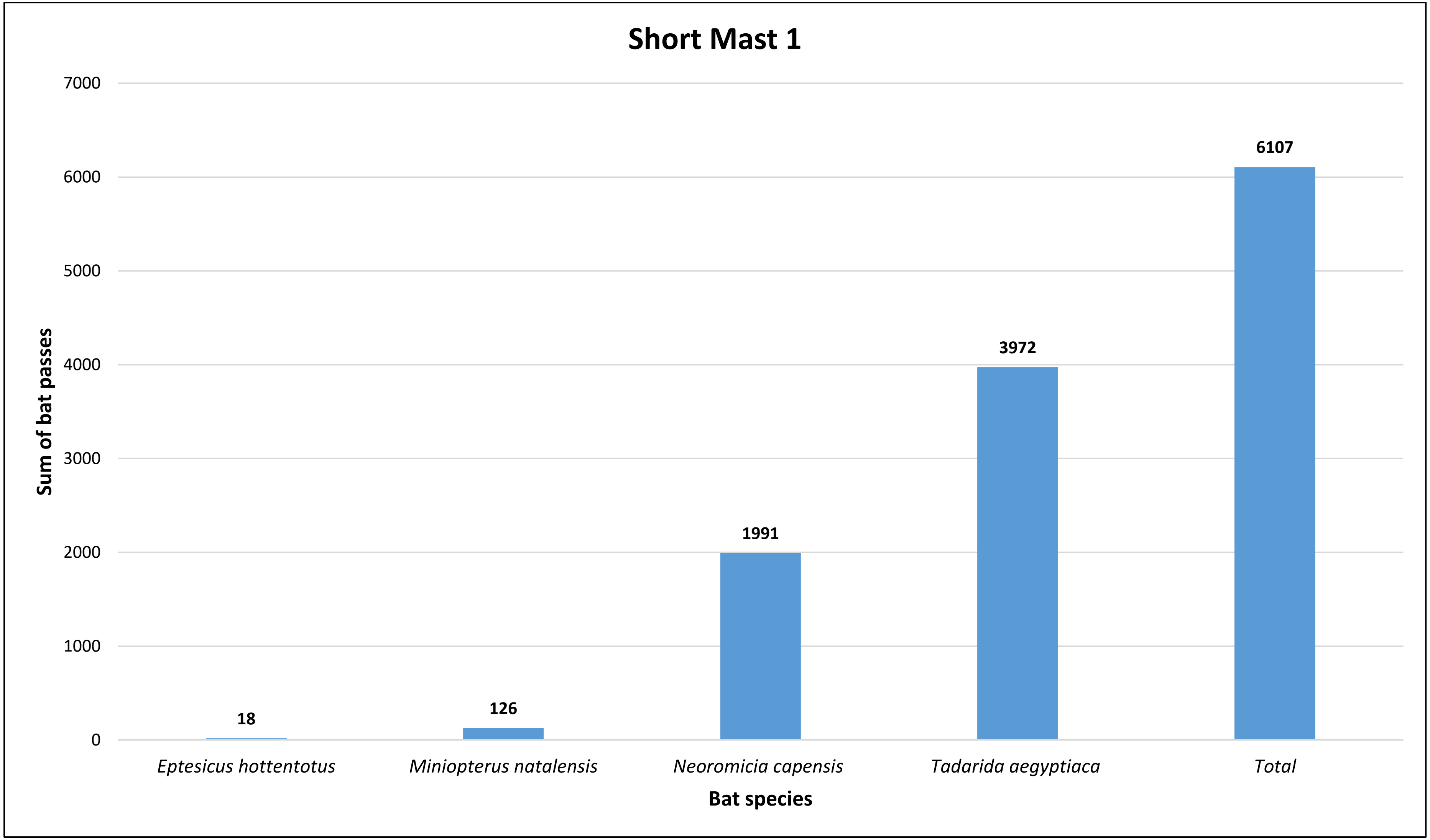


Figure 16: Sum of bat passes per species detected by the Short Mast 1 monitoring system

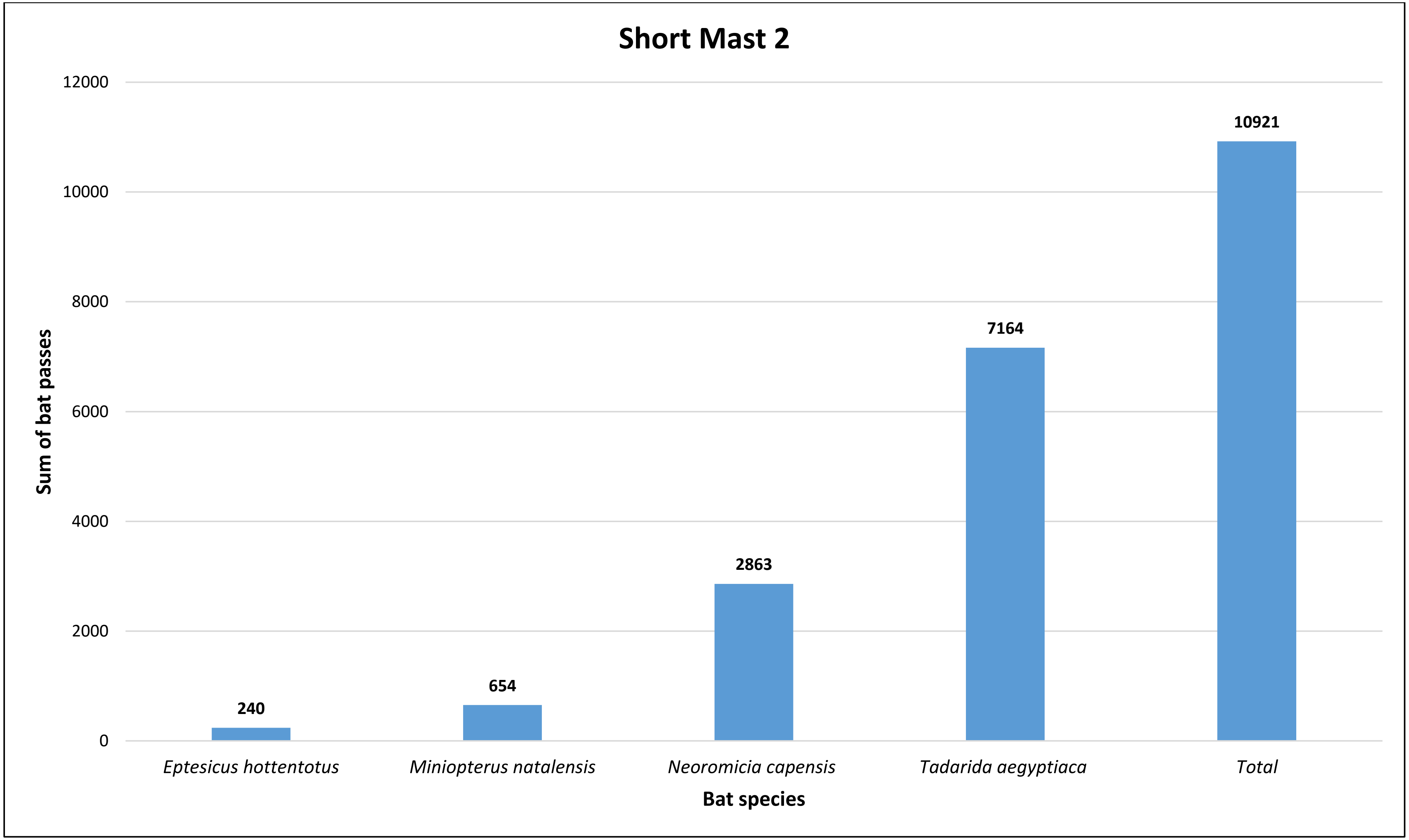


Figure 17: Sum of bat passes per species detected by the Short Mast 2 monitoring system

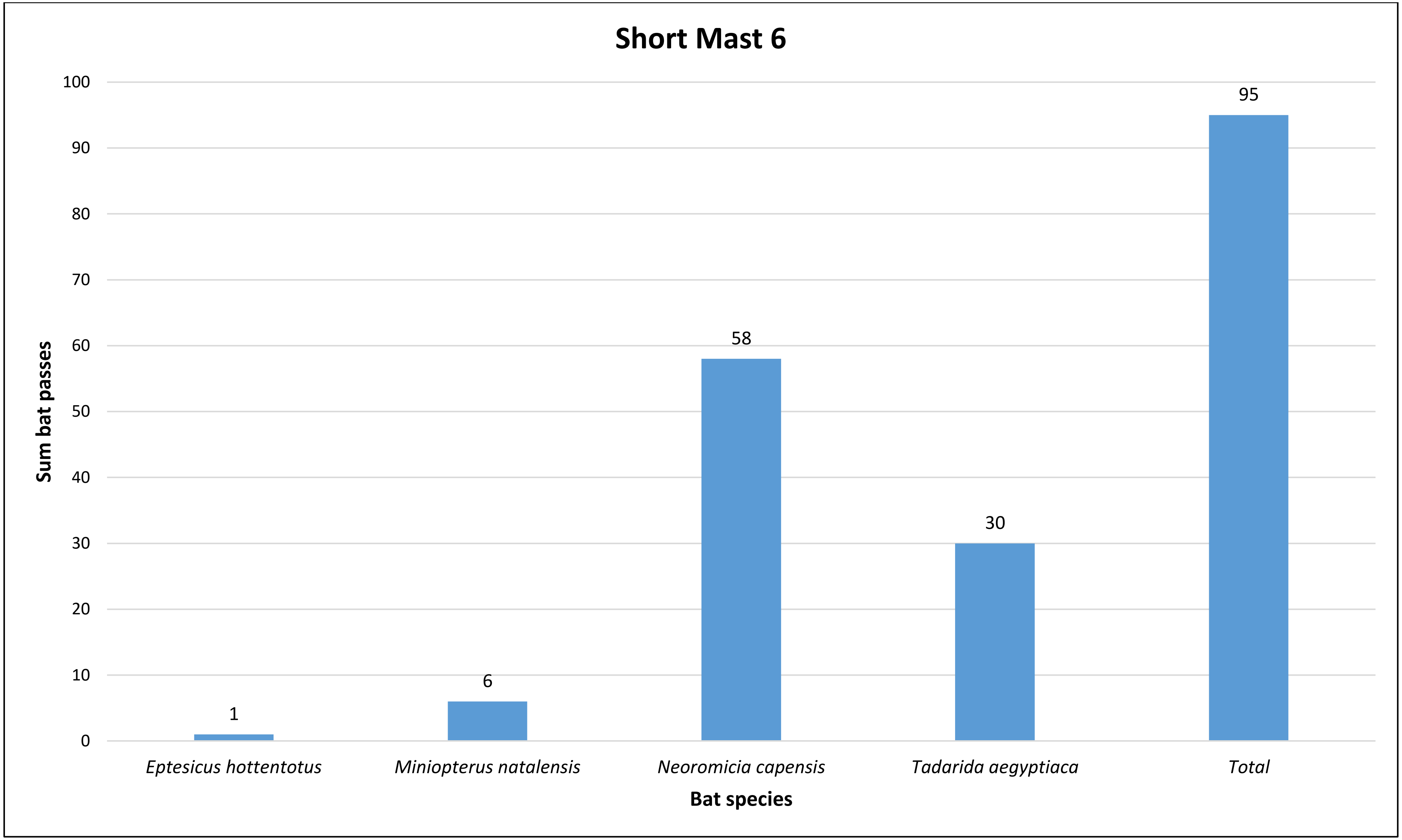


Figure 18: Sum of bat passes per species detected by the Short Mast 6 monitoring system

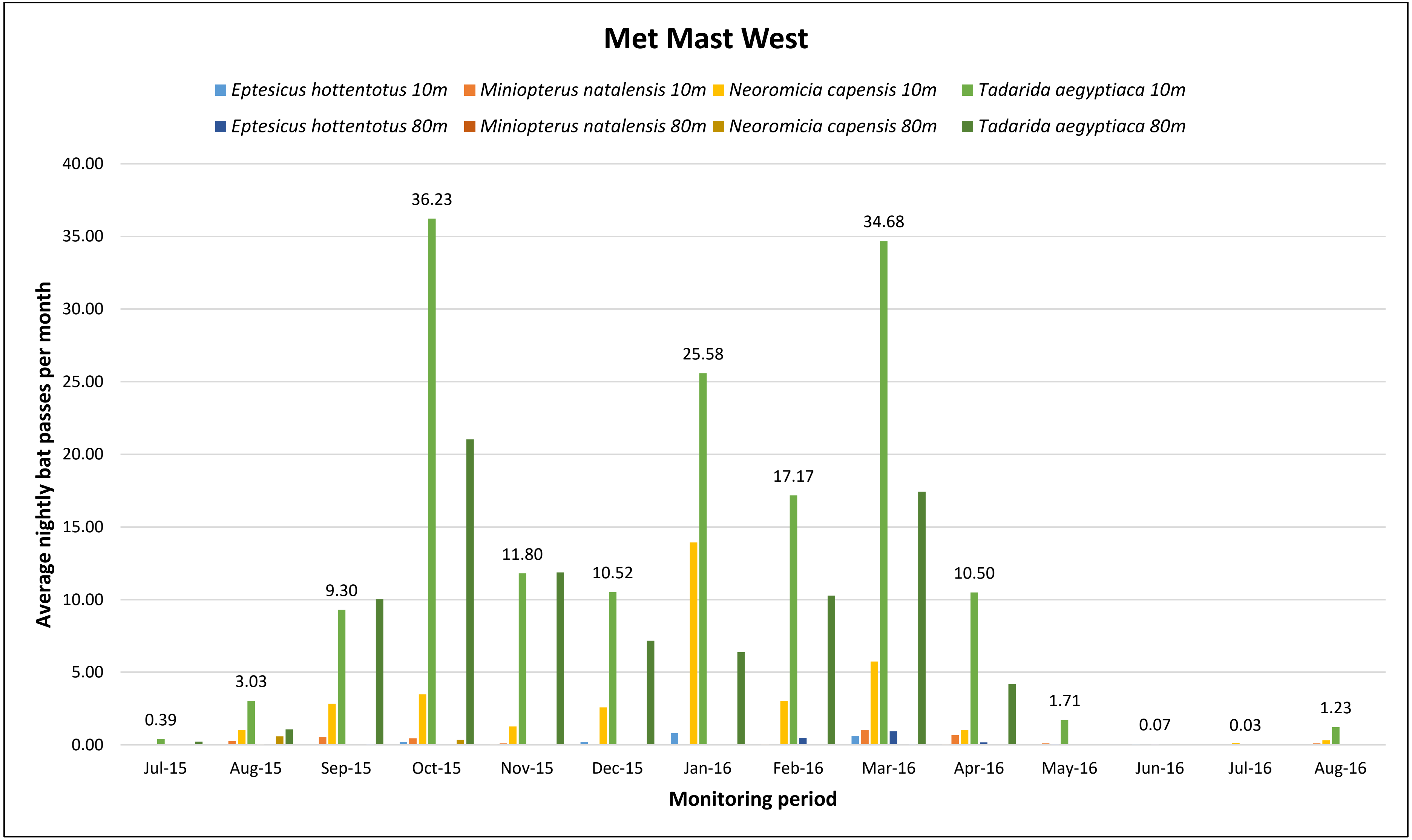


Figure 19: Average nightly bat passes detected per month by the Met Mast West monitoring system

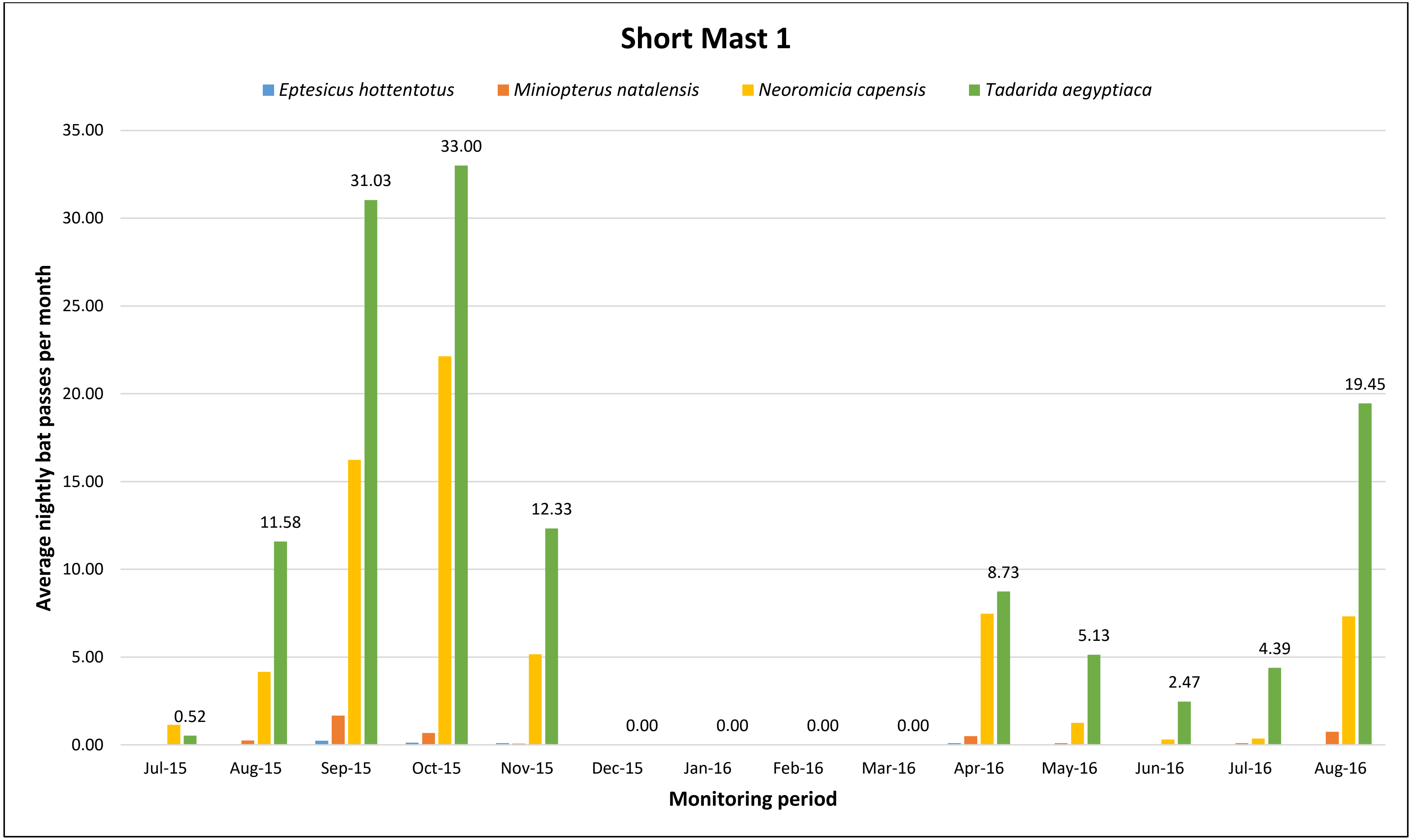


Figure 20: Average nightly bat passes detected per month by the Short Mast 1 monitoring system

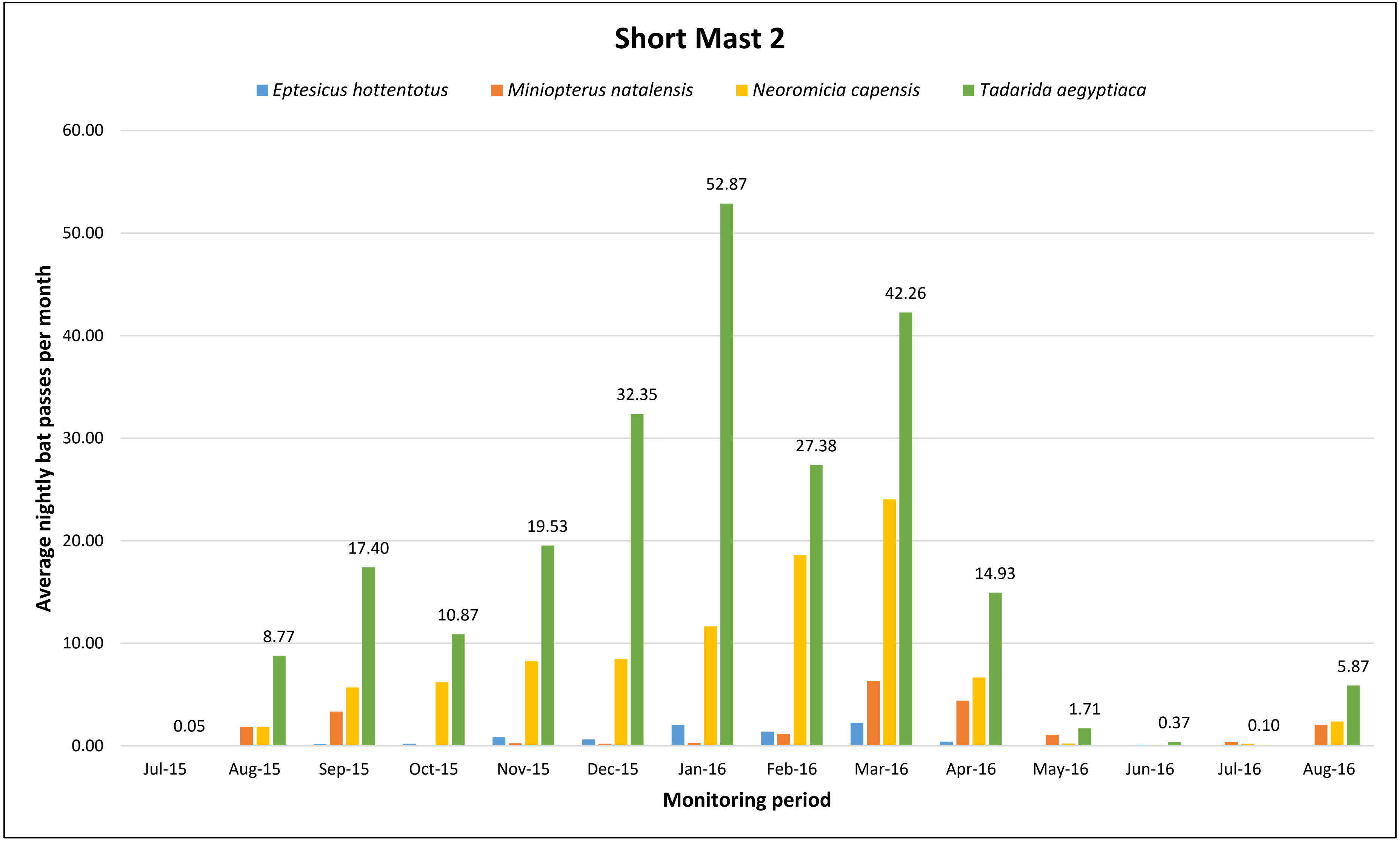


Figure 21: Average nightly bat passes detected per month by the Short Mast 2 monitoring system

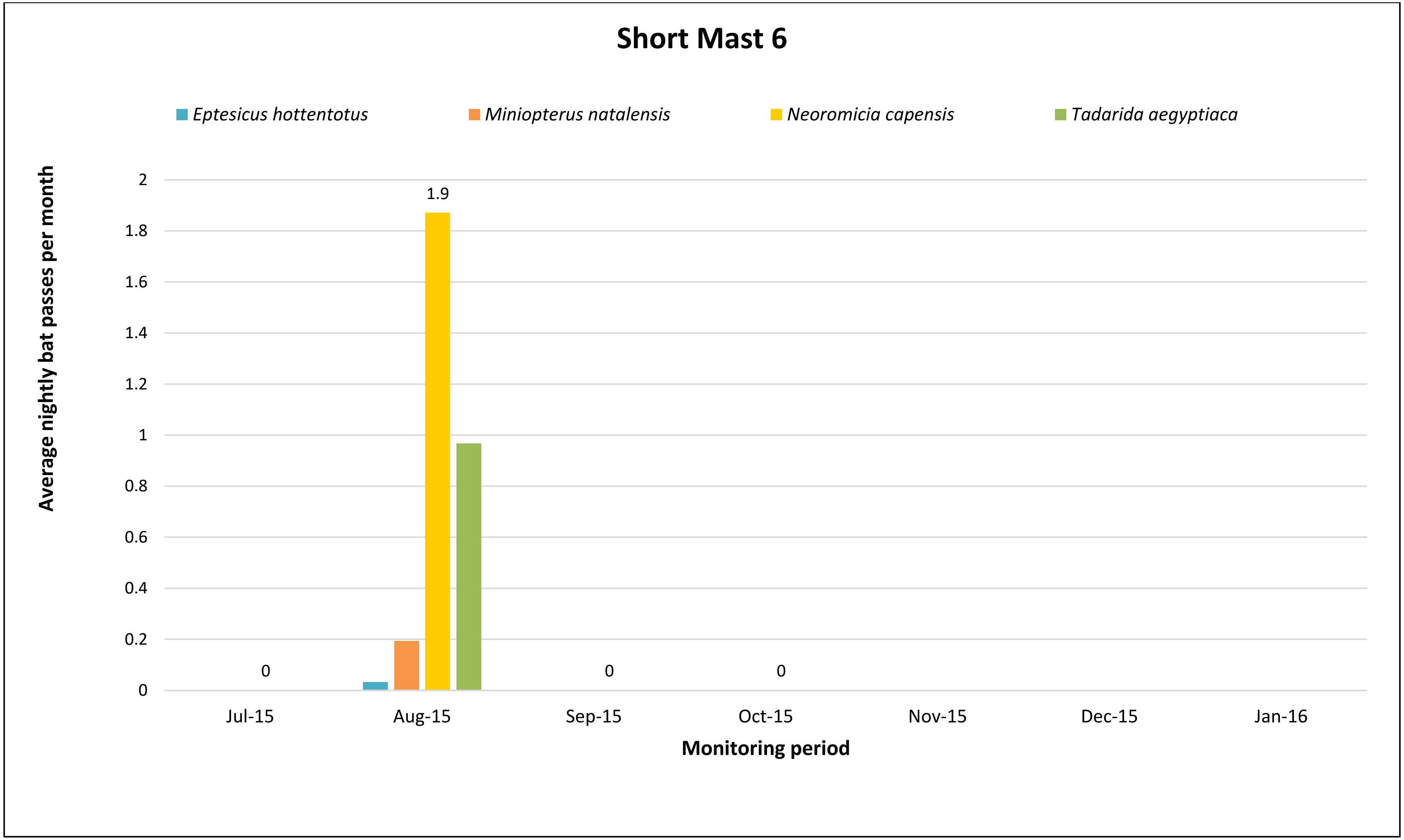


Figure 22: Average nightly bat passes detected per month by the Short Mast 6 monitoring system

5.6.2 Temporal Distribution

The sum of all bat passes recorded by the monitoring systems of the particular species is displayed per night over the entire monitoring period (**Figures 23 - 26**). The peak activity times identified are mostly an amalgamation of the temporal distribution of *Neoromicia capensis* and *Tadarida aegyptiaca* as they were the species detected more often by a substantial margin.

Periods of elevated bat activity as depicted in **Figures 23 - 26** are as follows:

Met Mast West

- Mid-September – Mid November 2015
- January 2016
- Mid-February – end March 2016

Short Mast 1

- Early August 2015 – end March 2016

Short Mast 2

- Mid-September 2015 – End April 2016

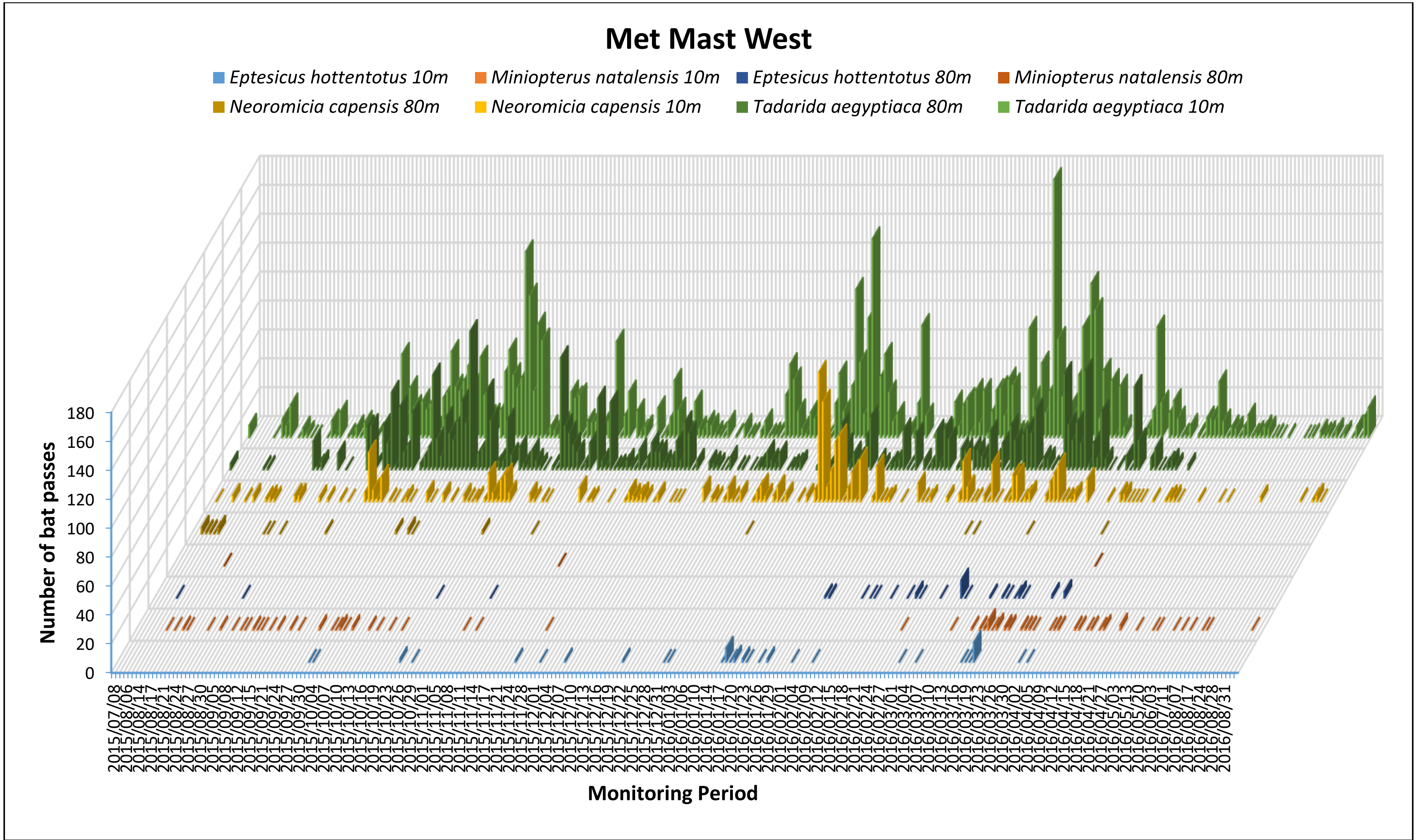


Figure 23: Temporal distribution of bat passes detected by Met Mast West over the entire monitoring period

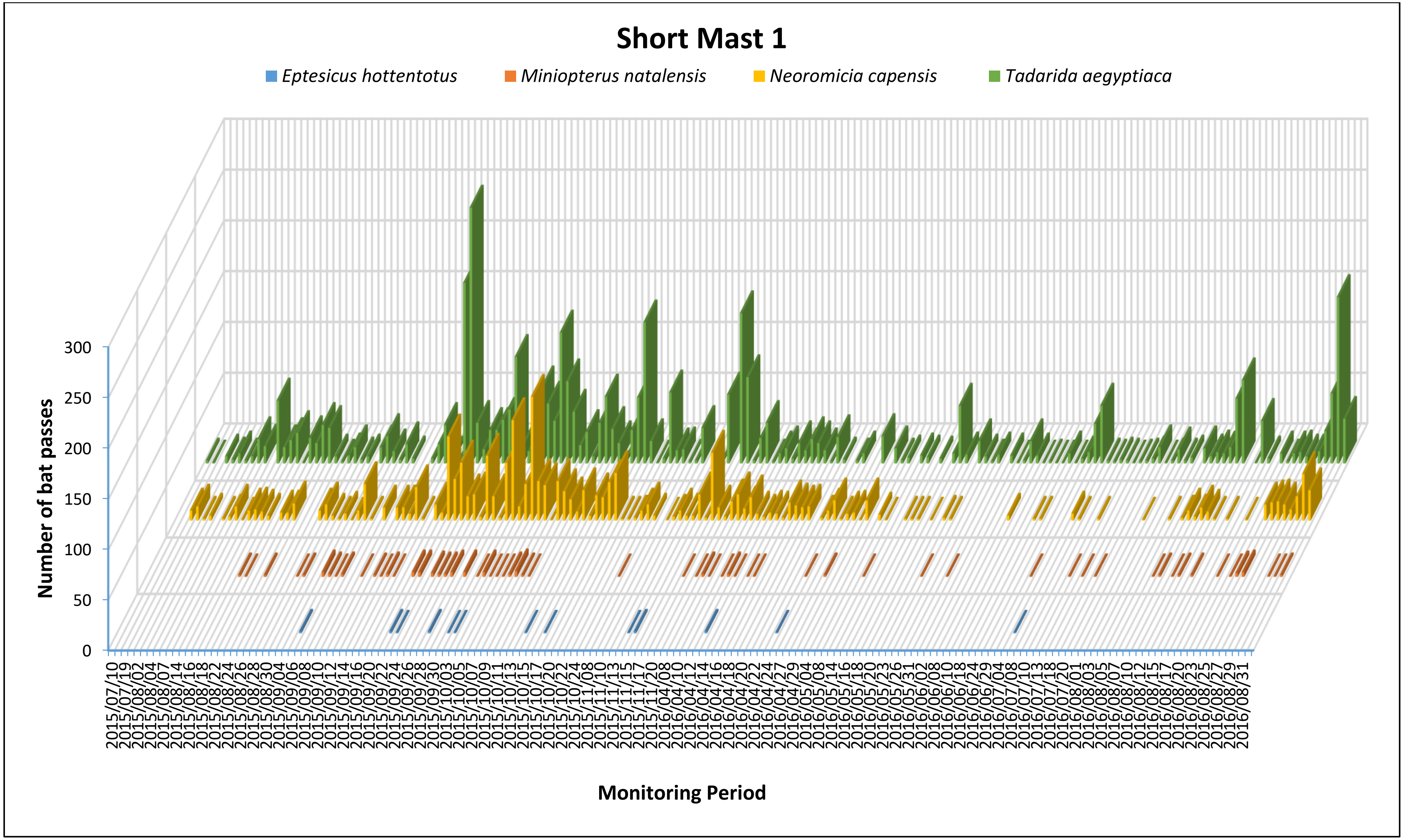


Figure 24: Temporal distribution of bat passes detected by Short Mast 1 over the entire monitoring period

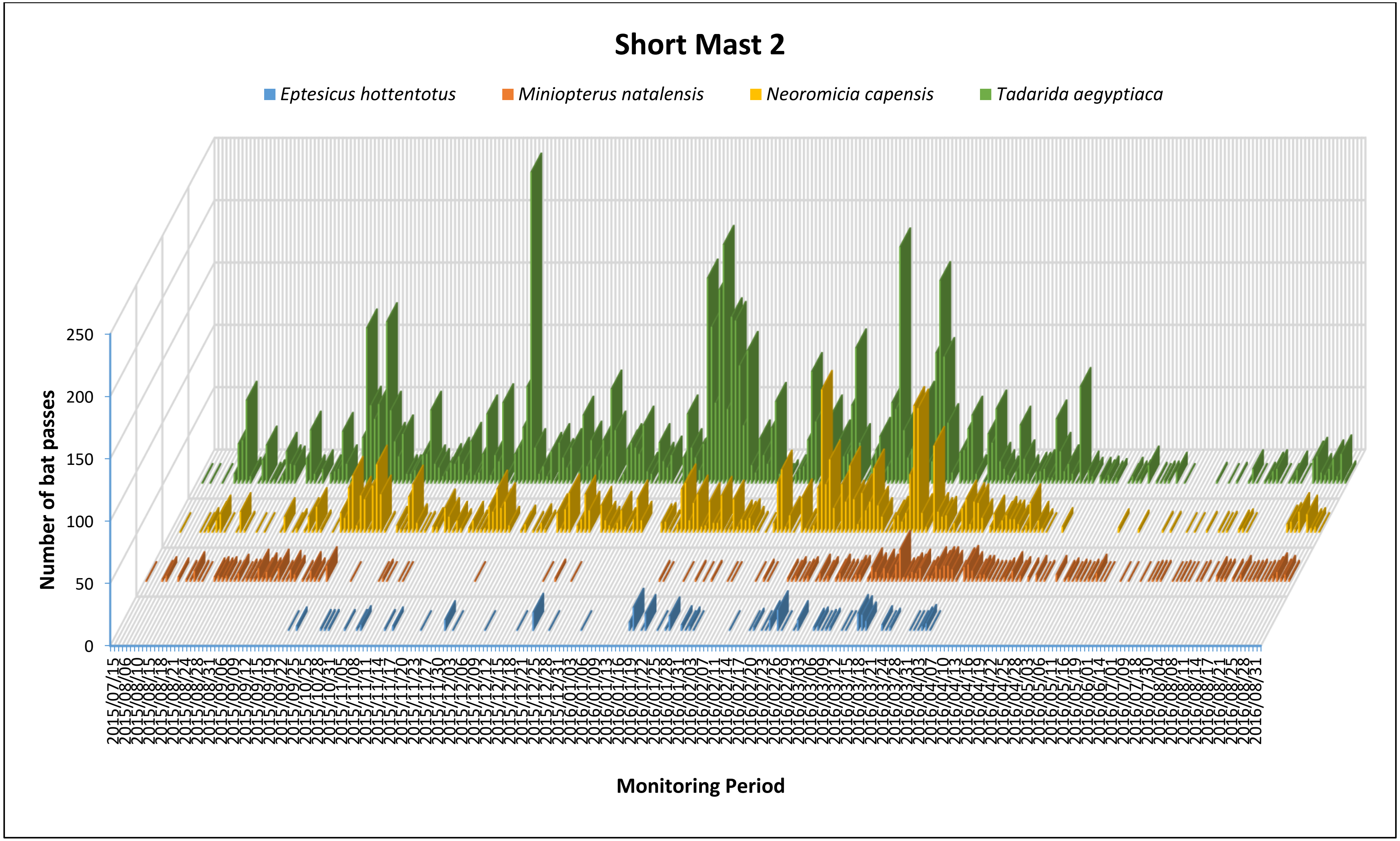


Figure 25: Temporal distribution of bat passes detected by Short Mast 2 over the entire monitoring period

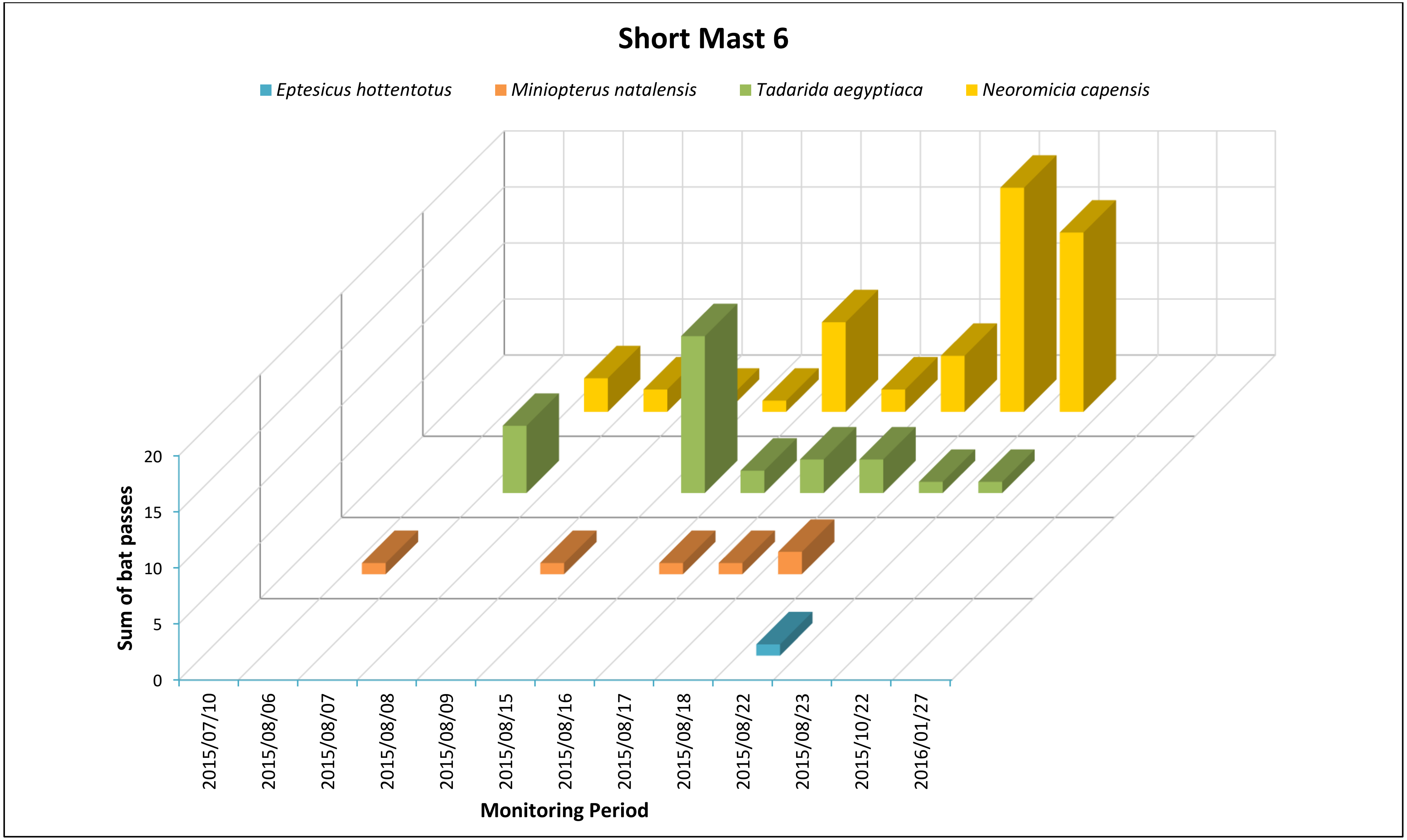


Figure 26: Temporal distribution of bat passes detected by Short Mast 6 over the entire monitoring period

5.6.3 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 **(Figure 27 - 37)**. The 12-month monitoring period was divided based on generic calendar seasons outlined **Table 12**.

Table 12: 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 were then used to inform mitigation implementation when and where needed.

Once again, peak activity times are mostly an amalgamation of the activity of *Tadarida. aegyptiaca* and *Neoromicia capensis,* especially at 10m height. 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.

Miniopterus natalensis showed activity during Winter (Short mast 2), Spring (Met Mast, Short mast 1 & 2), and Autumn (Met mast and Short mast 2). Their activity was highest during Autumn, near the Short mast 2 (**Figure 27 - 37**).

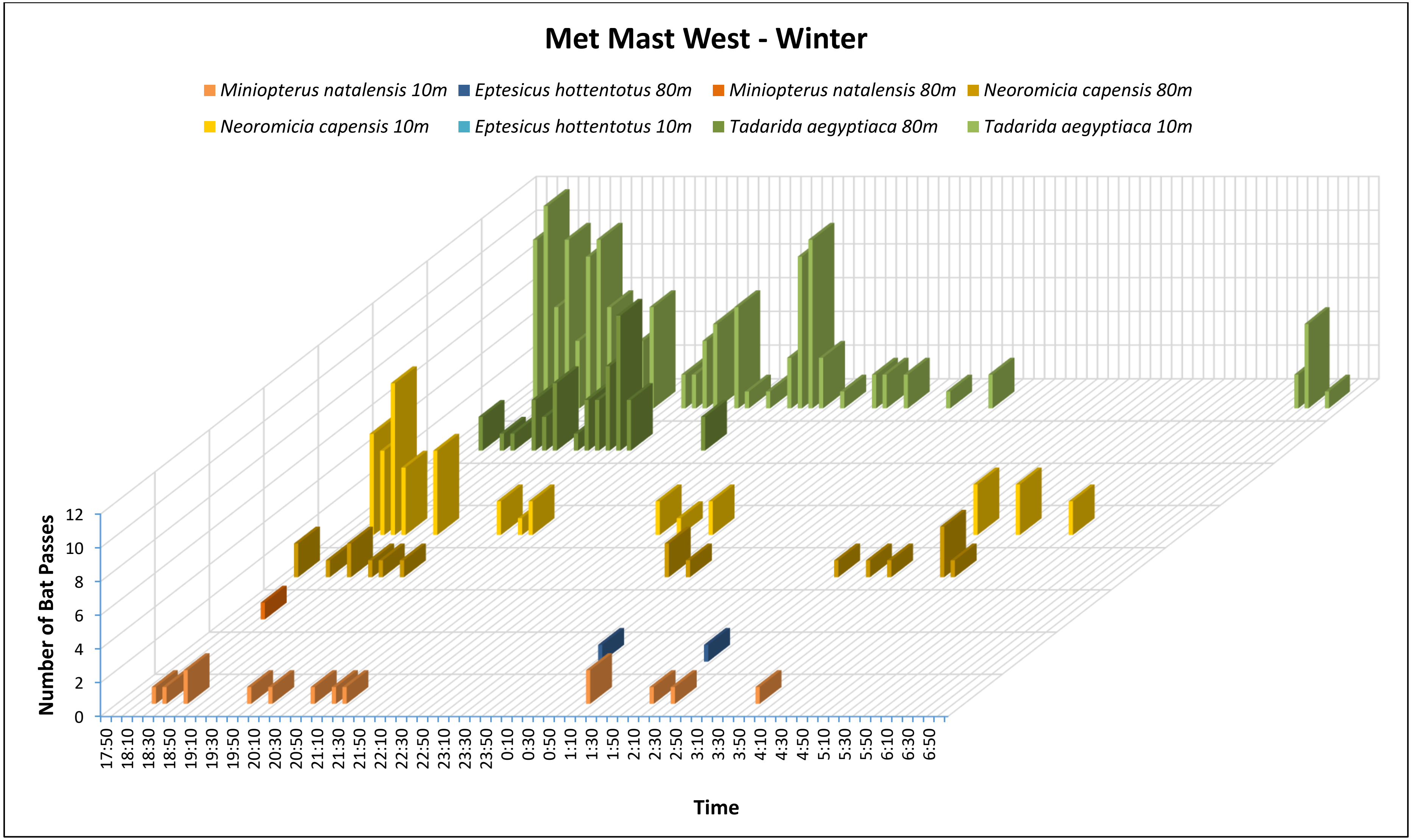


Figure 27: Sum of bat passes detected across the night by Met Mast West over the Winter period

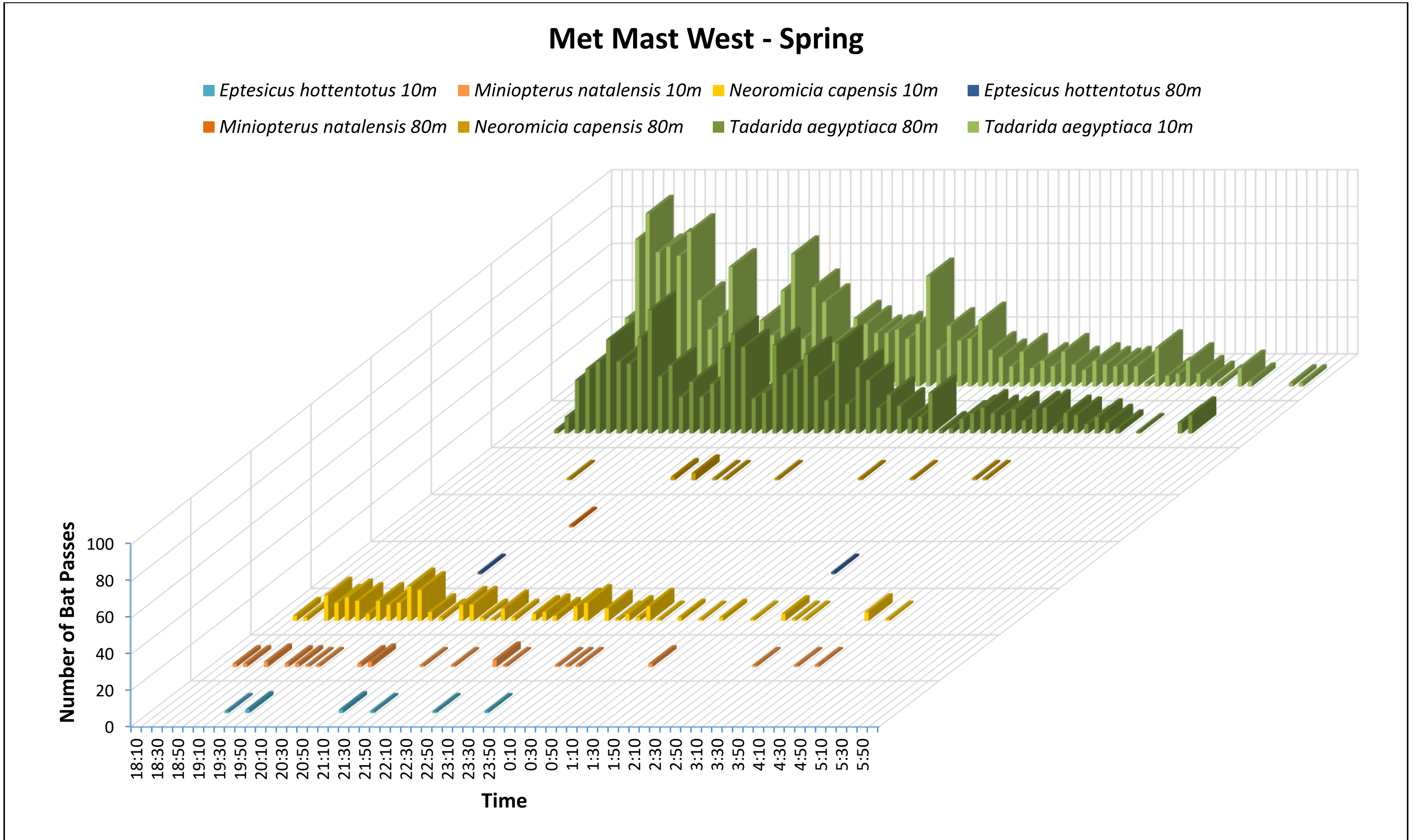


Figure 28: Sum of bat passes detected across the night by Met Mast West over the Spring period

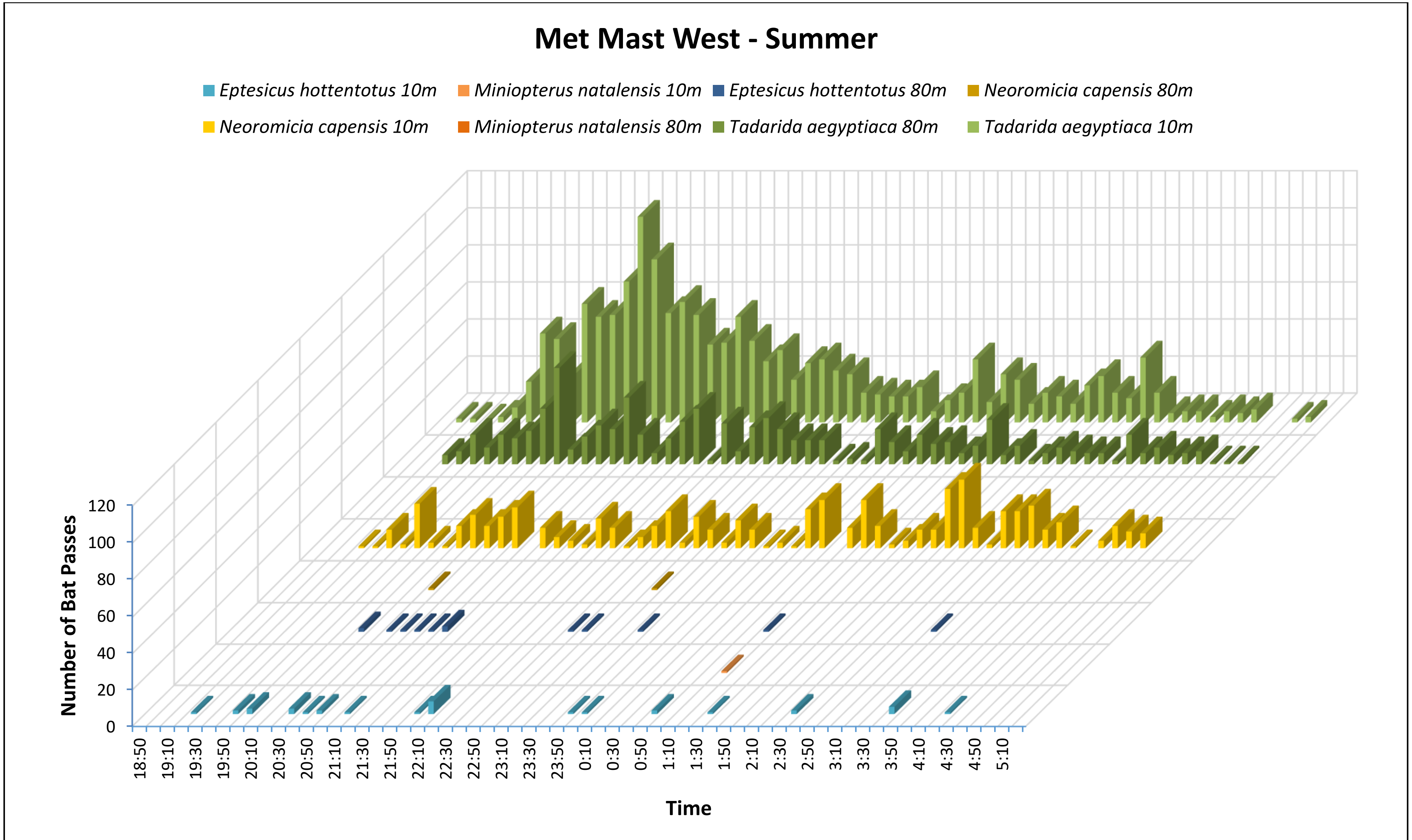


Figure 29: Sum of bat passes detected across the night by Met Mast West over the Summer period

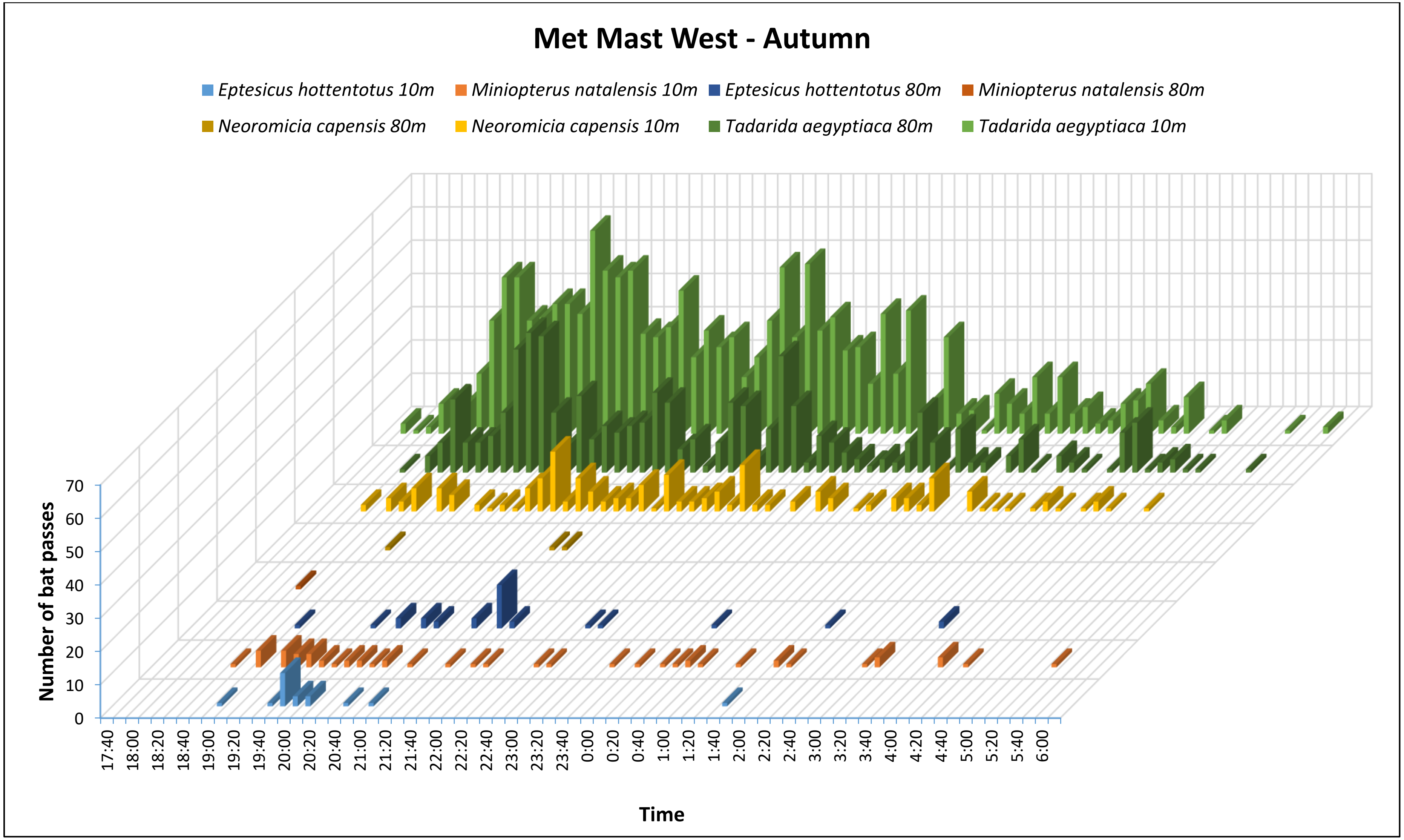


Figure 30: Sum of bat passes detected across the night by Met Mast West over the Autumn period

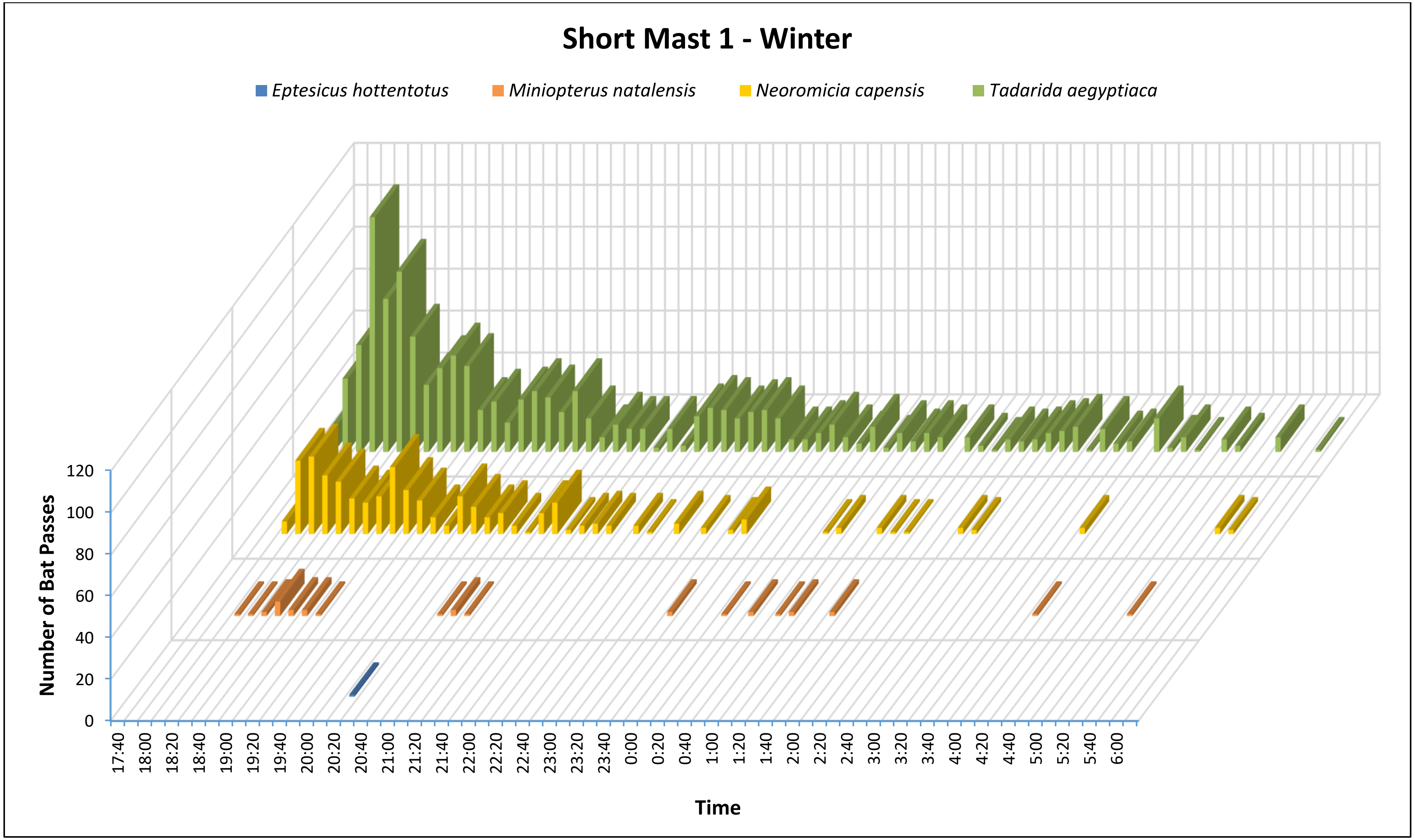


Figure 31: Sum of bat passes detected across the night by Short Mast 1 over the Winter period

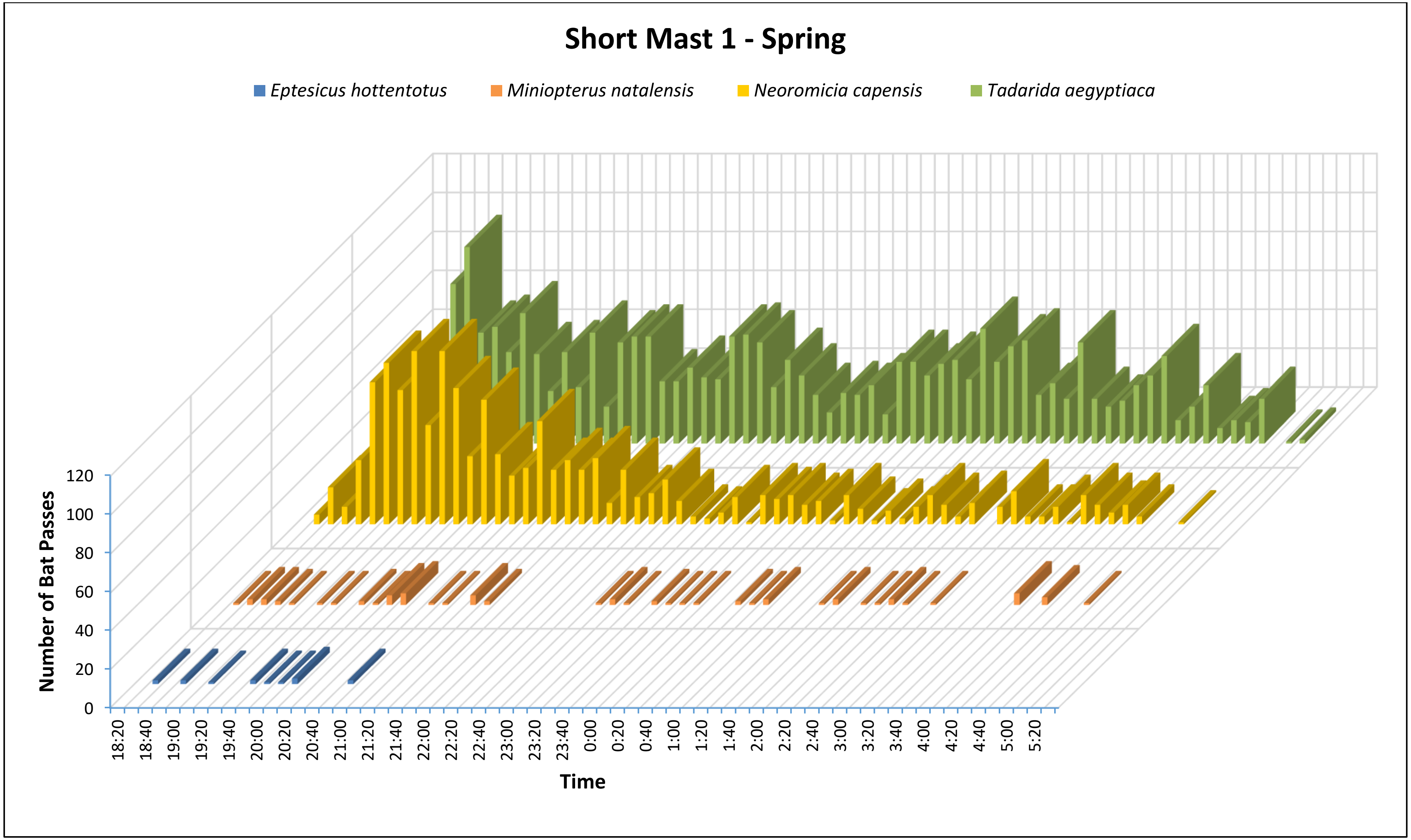


Figure 32: Sum of bat passes detected across the night by Short Mast 1 over the Spring period

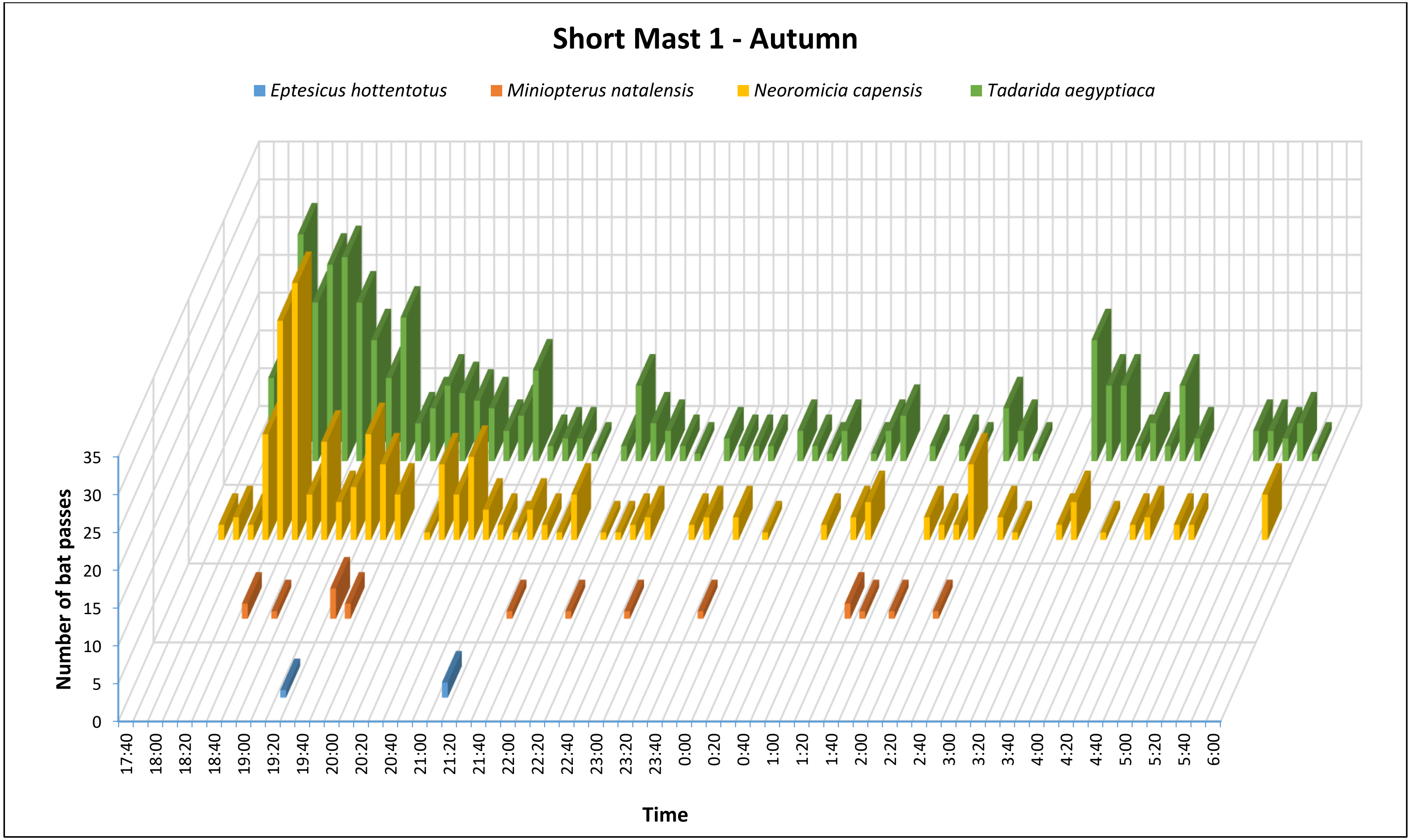


Figure 33: Sum of bat passes detected across the night by Short Mast 1 over the Autumn period

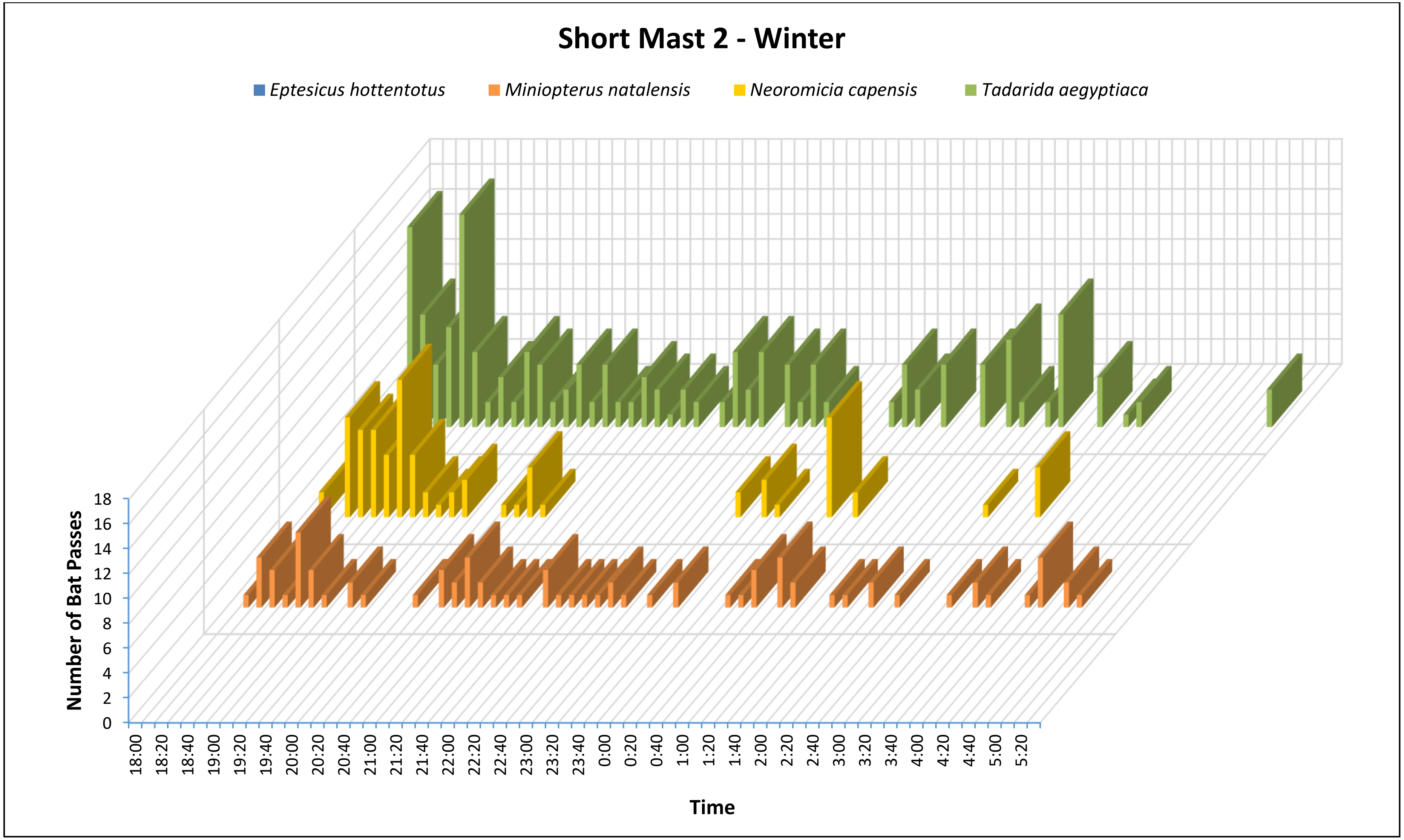


Figure 34: Sum of bat passes detected across the night by Short Mast 2 over the Winter period

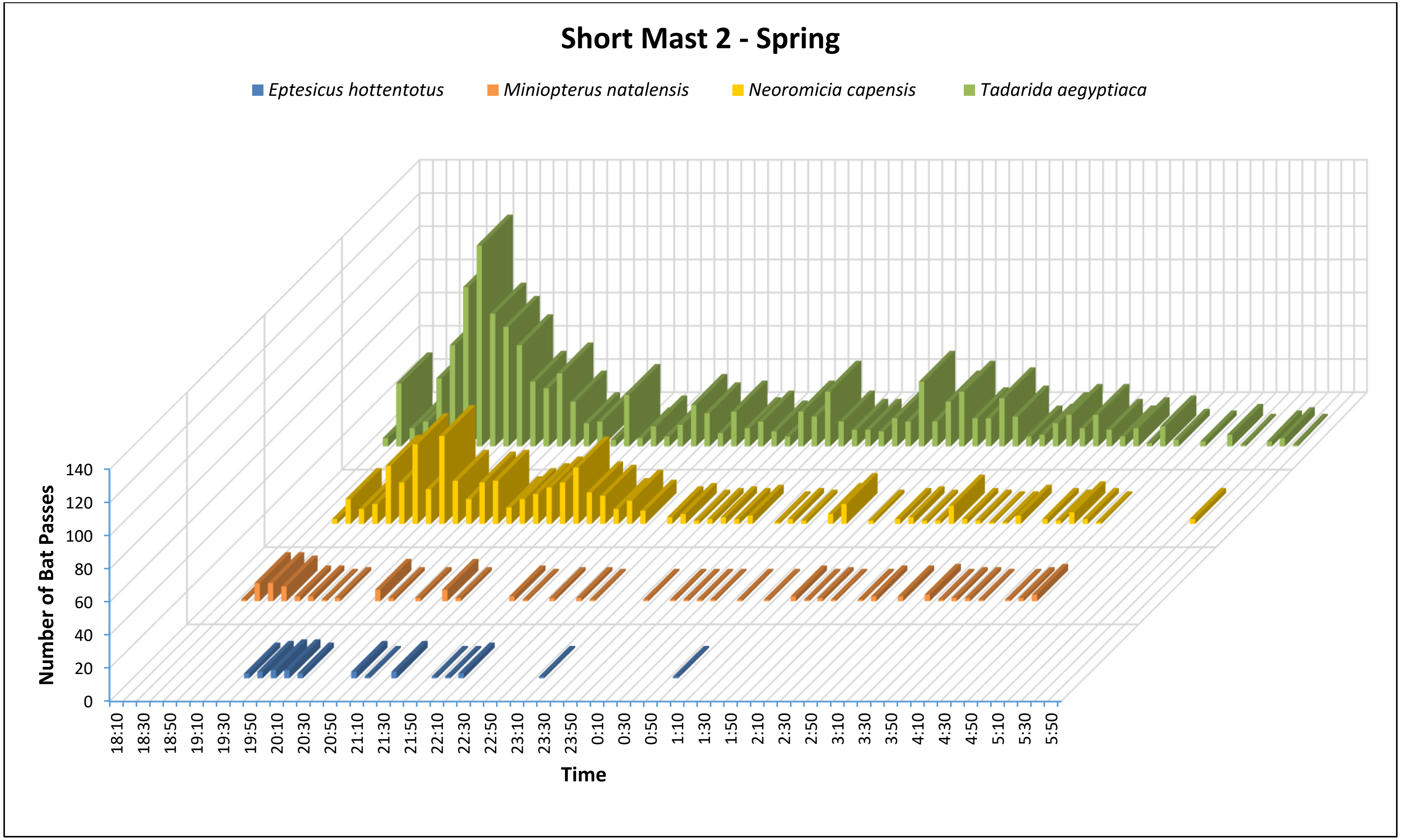


Figure 35: Sum of bat passes detected across the night by Short Mast 2 over the Spring period

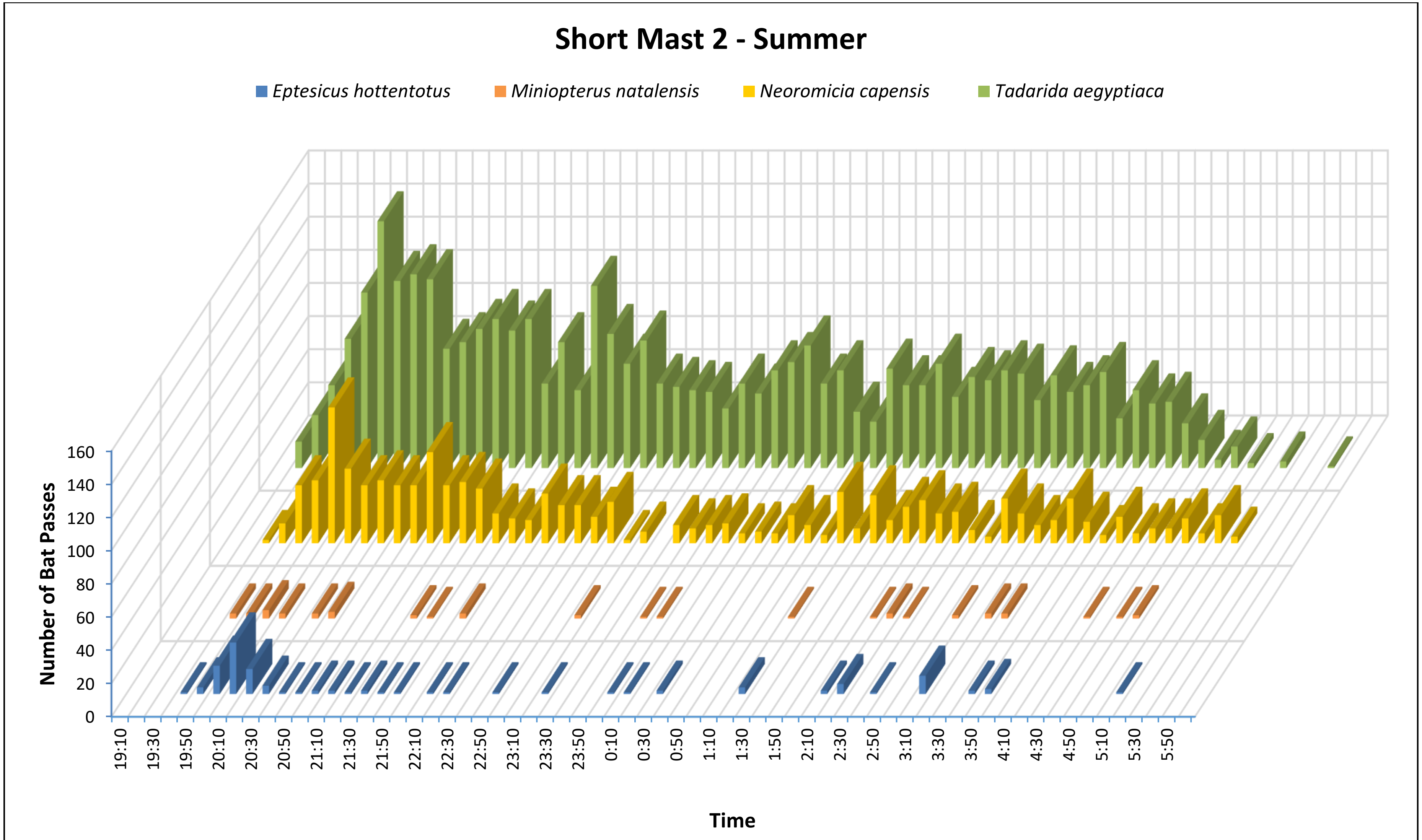


Figure 36: Sum of bat passes detected across the night by Short Mast 2 over the Summer period

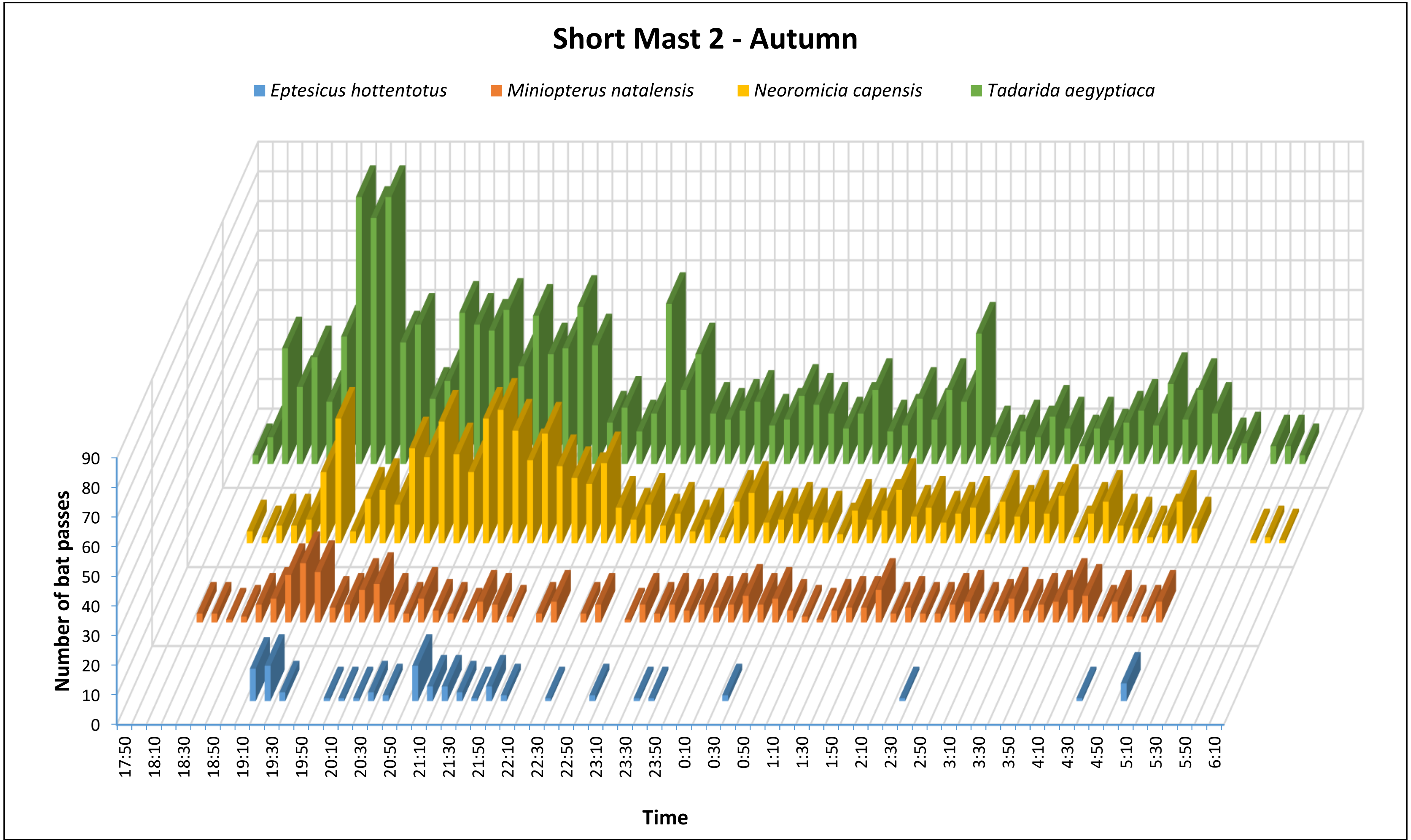


Figure 37: Sum of bat passes detected across the night by Short Mast 2 over the Autumn period

5.6.4 Relation between Bat Activity and Weather Conditions

Several sources of literature 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 note the environmental factors are never isolated and therefore a combination of the environmental factors can have synergistic or otherwise contradictory influences on bat activity. For 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, temperature and barometric pressure influences bat activity.

Wind speed

Some bat species show reduced activity in windy conditions. Strong winds have been found to suppress flight activity in bats by making flight difficult (O'Farrell *et al.* 1967). Several studies at proposed and operating wind facilities in the United States have documented discernibly lower bat activity during 'high' wind speeds (Arnett *et al*. 2009).

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

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) are used to inform mitigation, if needed.

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 where needed 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.

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 only performed for time frames of the highest activity levels. The time periods used in the analysis below corresponds with the time periods and systems used to inform mitigation in Section 6:

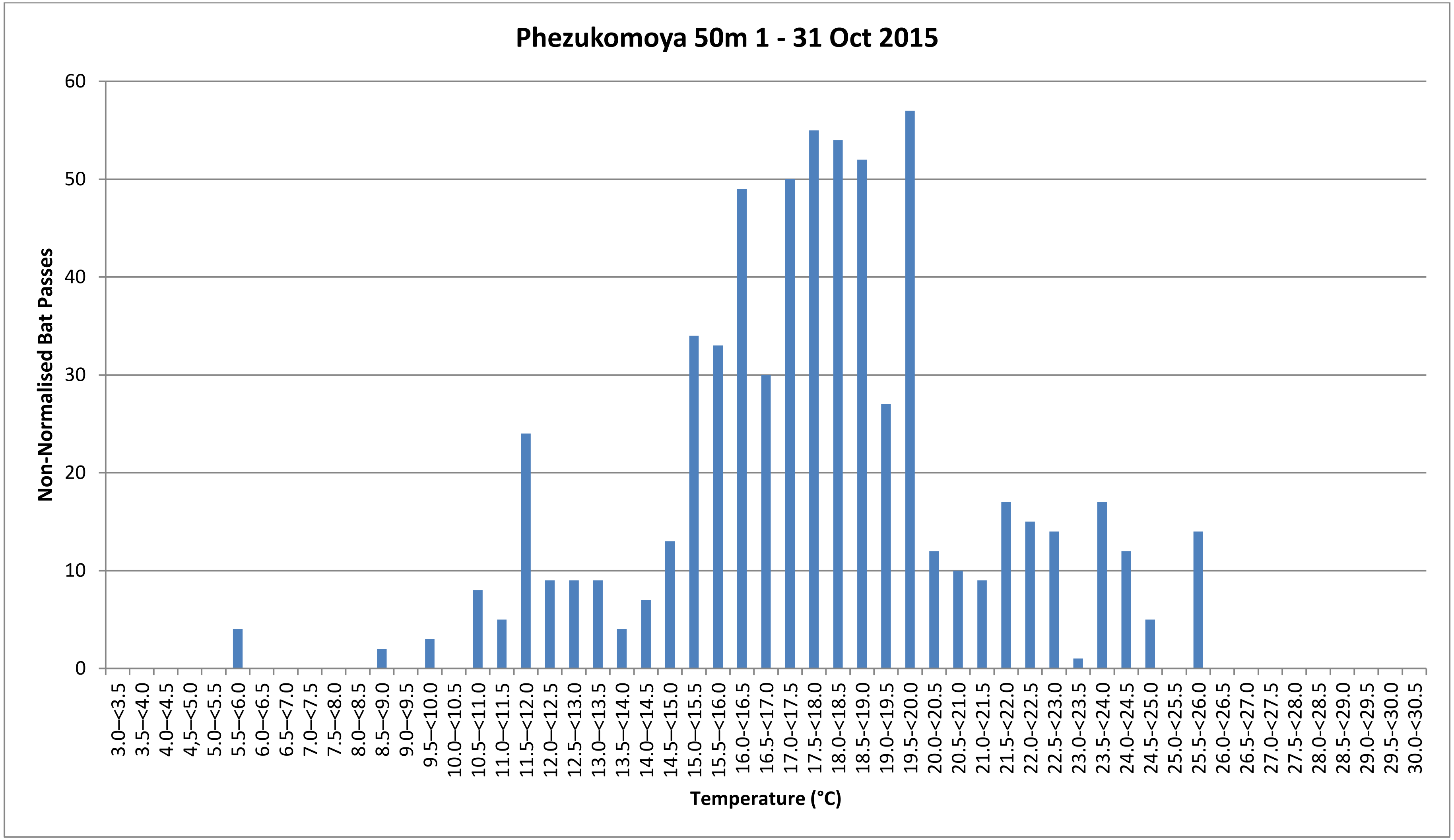


Figure 38: Sum of bat passes (Non-normalised) per Temperature category for Phezukomoya Met mast (1 – 31 Oct 2015).

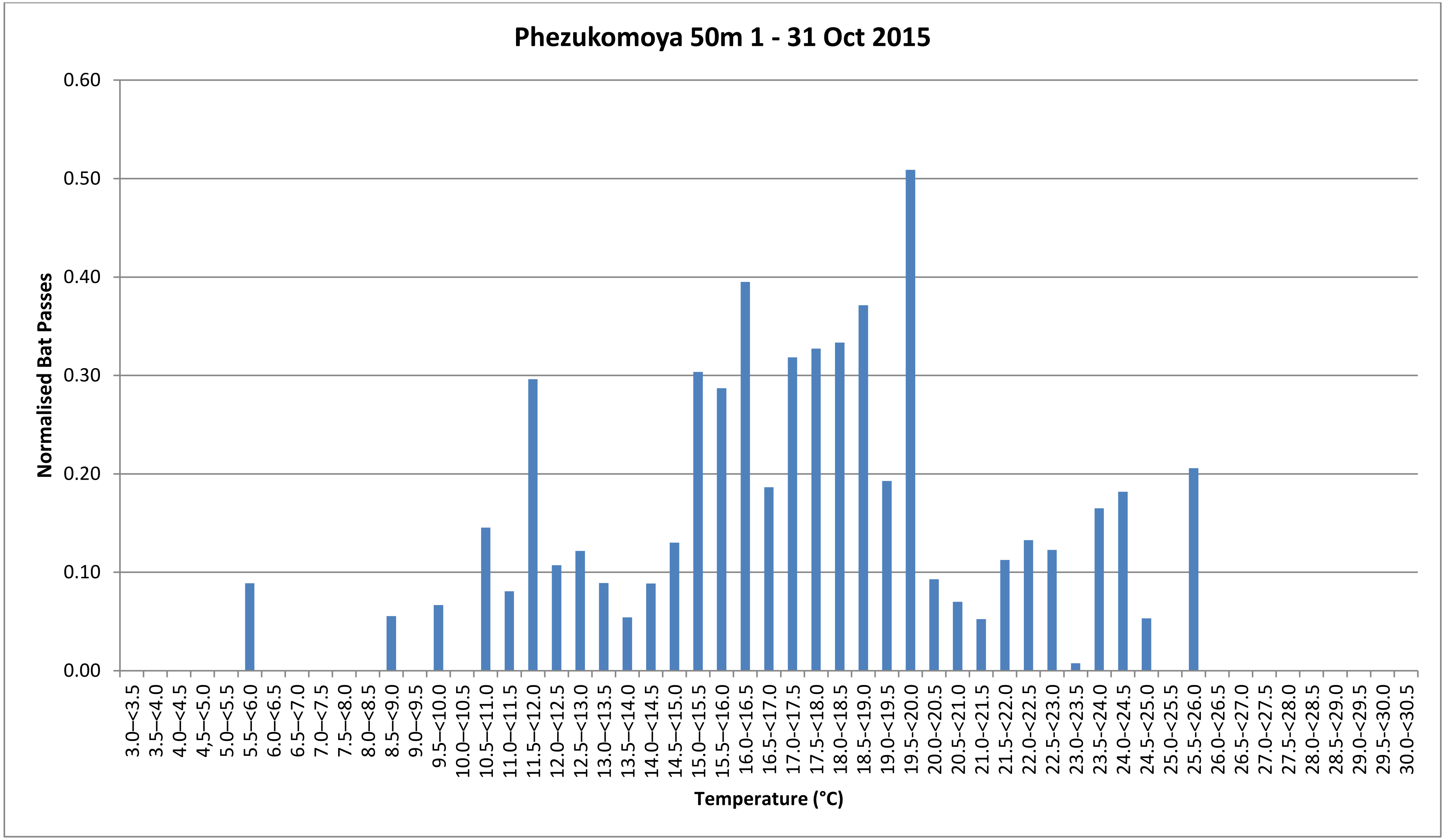


Figure 39: Sum of bat passes (Normalised) per Temperature category for Phezukomoya Met mast (1 – 31 Oct 2015).

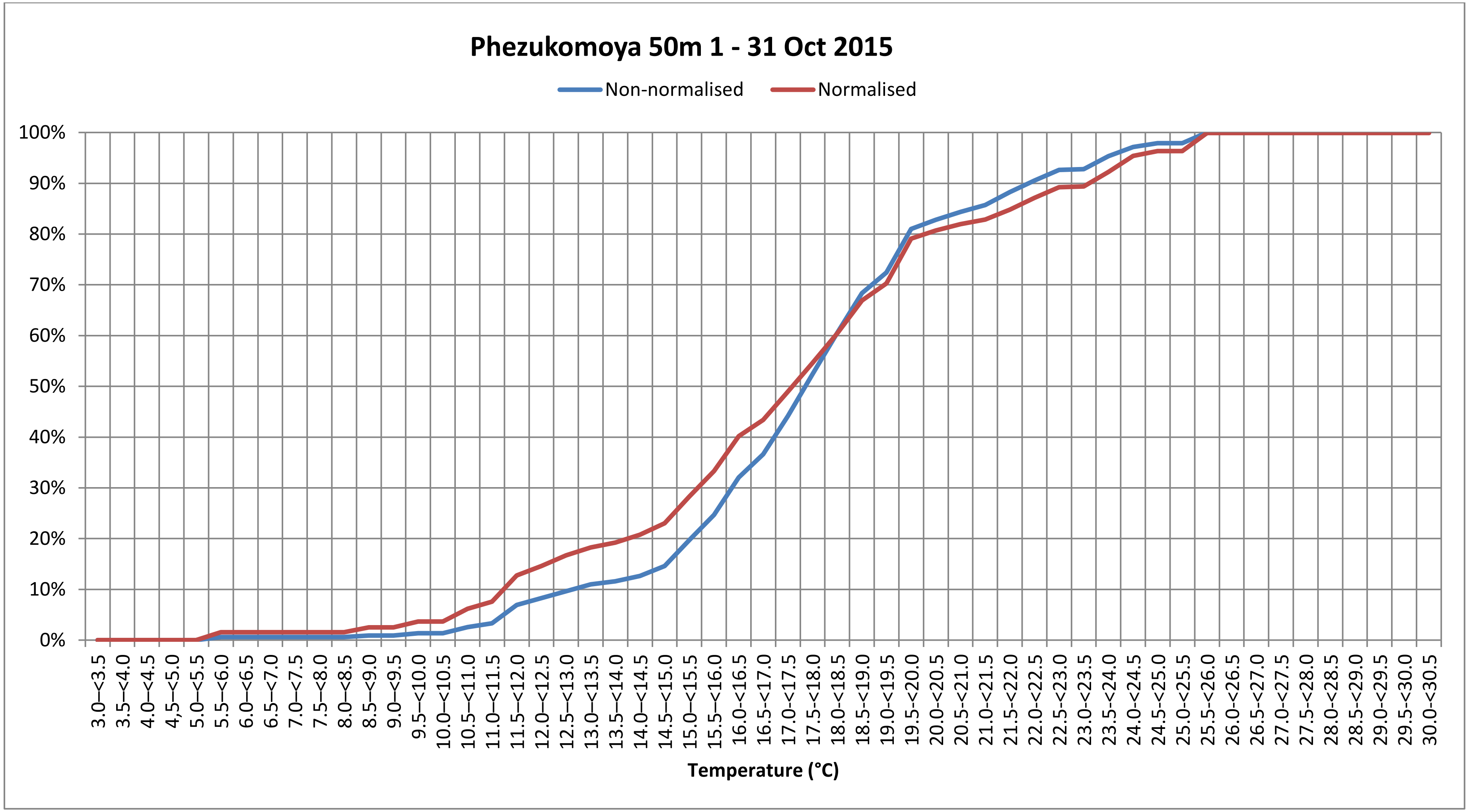


Figure 40: Cumulative percentage of normalised and non-normalised bat passes per temperature category for Phezukomoya met mast (1 – 31 Oct 2015).

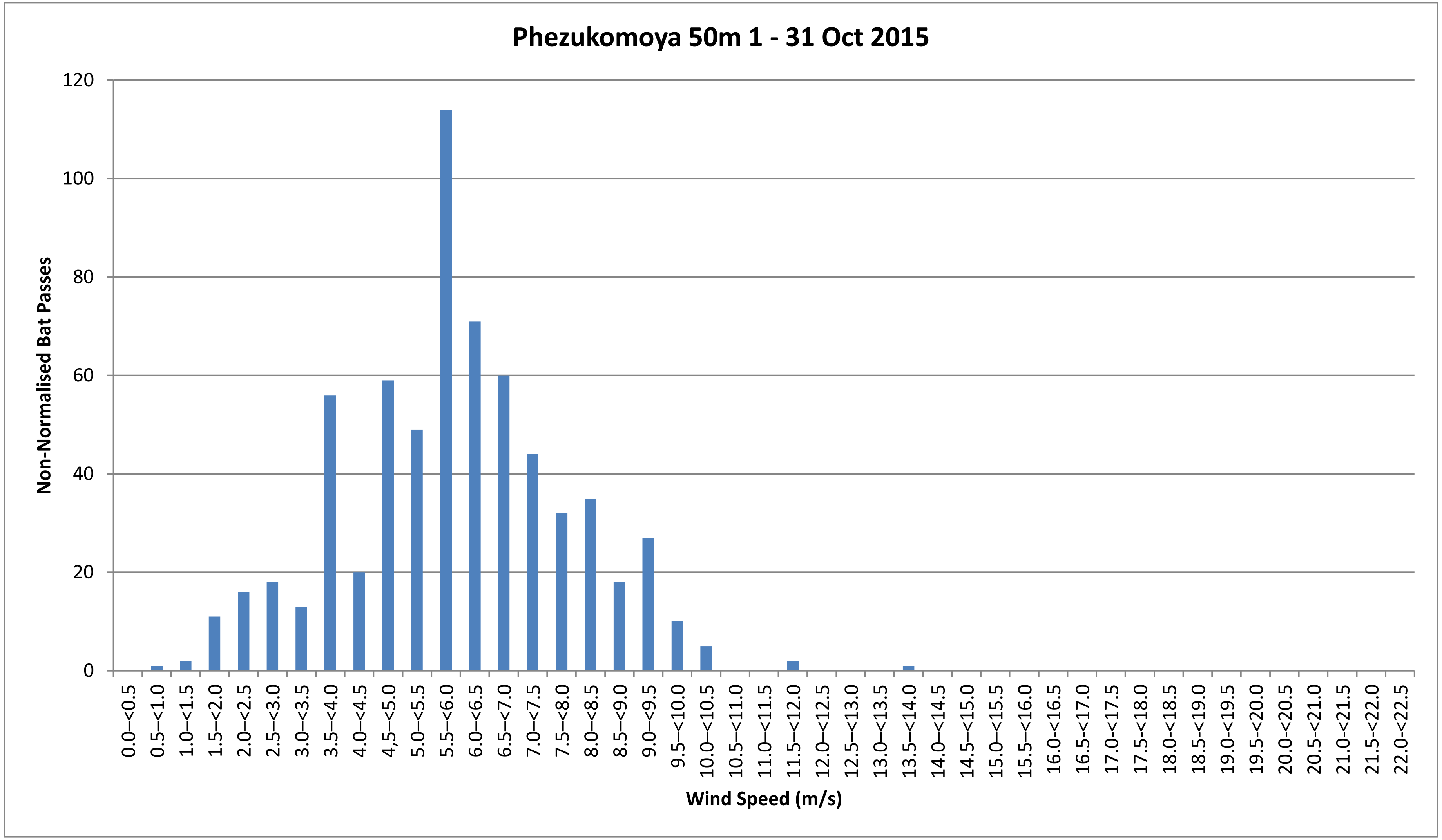


Figure 41: Sum of bat passes (Non-normalised) per Wind Speed category for Phezukomoya Met mast (1 – 31 Oct 2015).

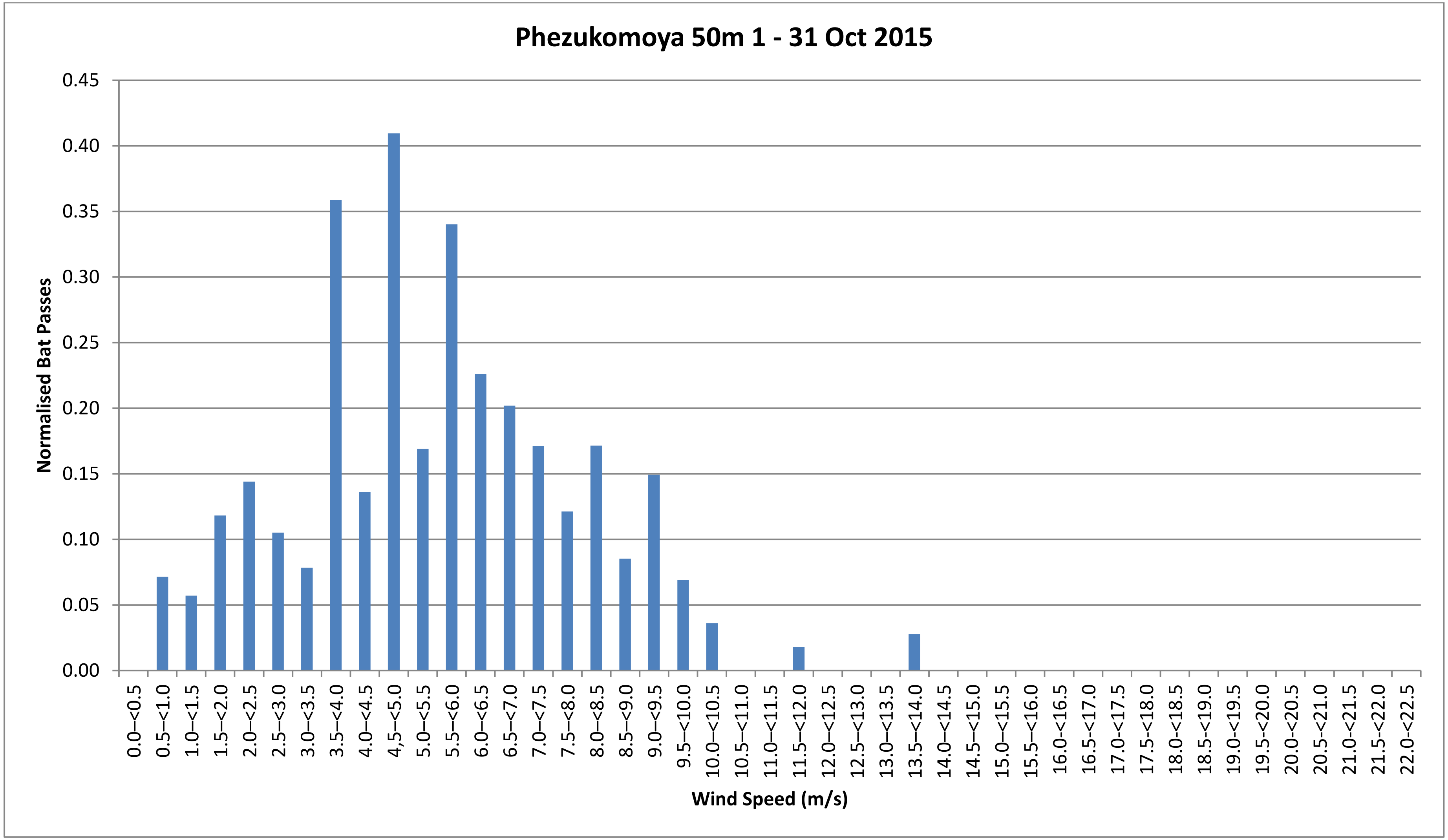


Figure 42: Sum of bat passes (Normalised) per Wind Speed category for Phezukomoya met mast (1 – 31 Oct 2015).

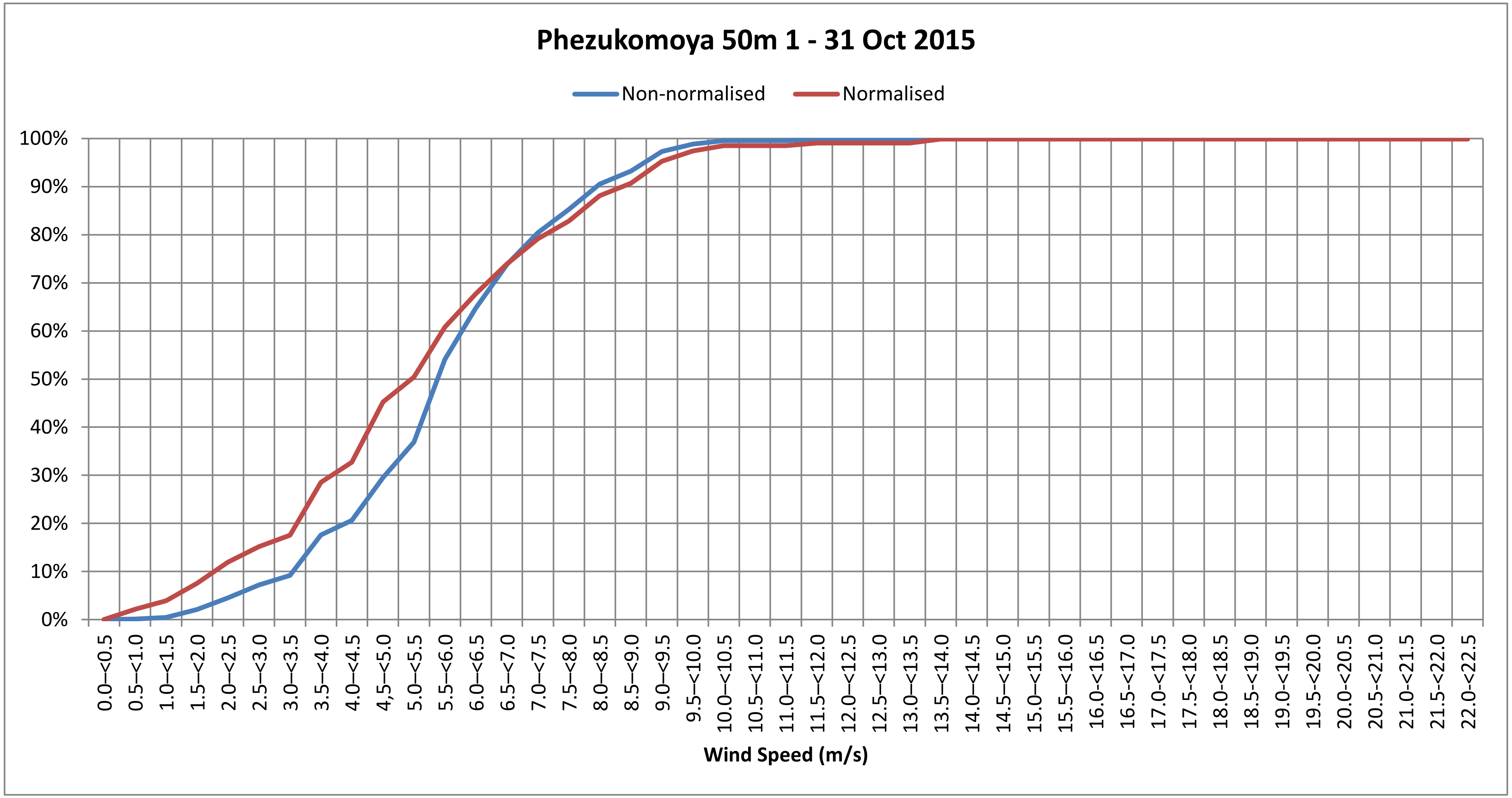


Figure 43: Cumulative percentage of normalised and non-normalised bat passes per Wind Speed category for Phezukomoya Met mast (1 – 31 Oct 2015).

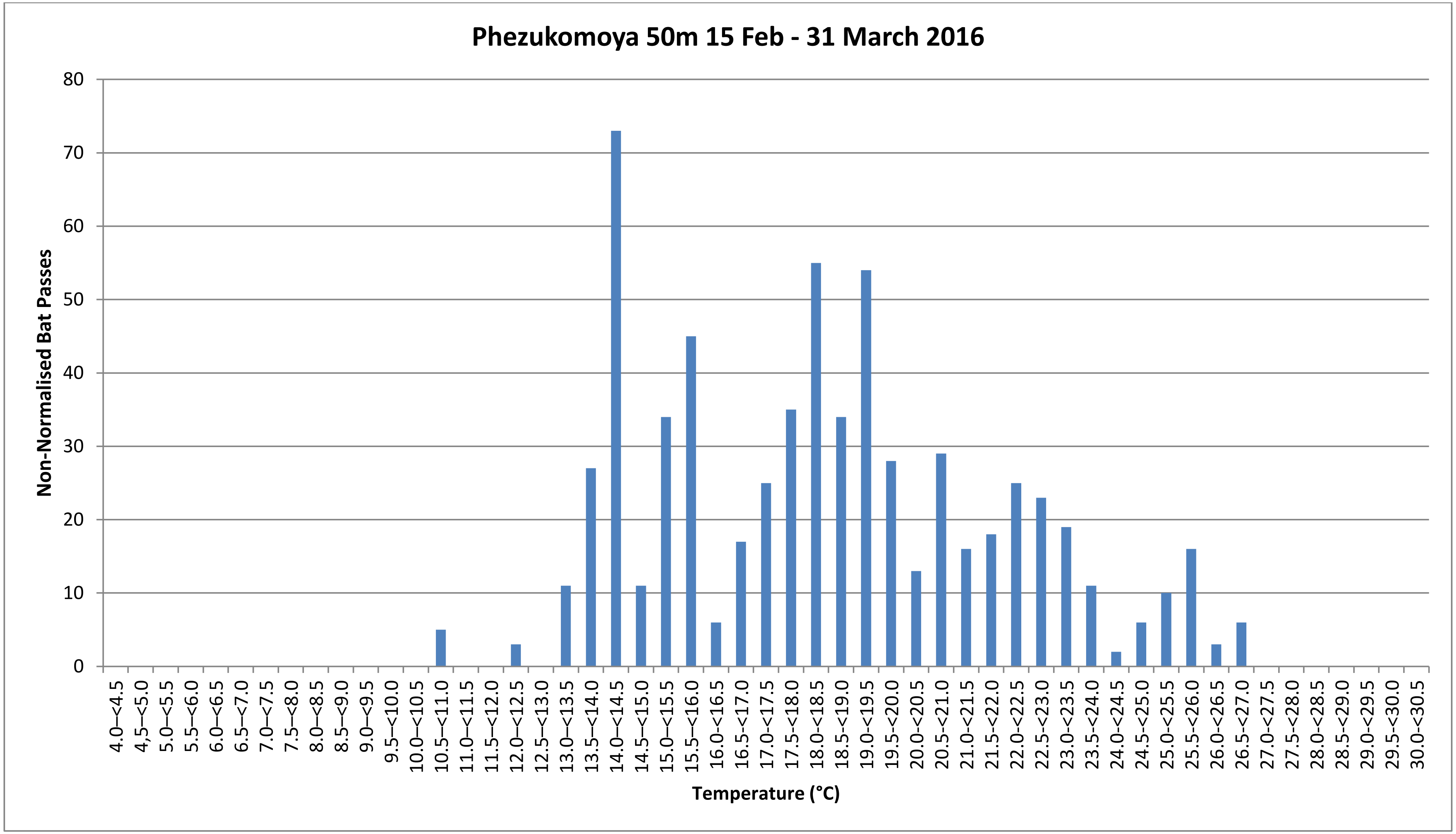


Figure 44: Sum of bat passes (Non-normalised) per Temperature category for Phezukomoya met mast (15 Feb – 31 March).

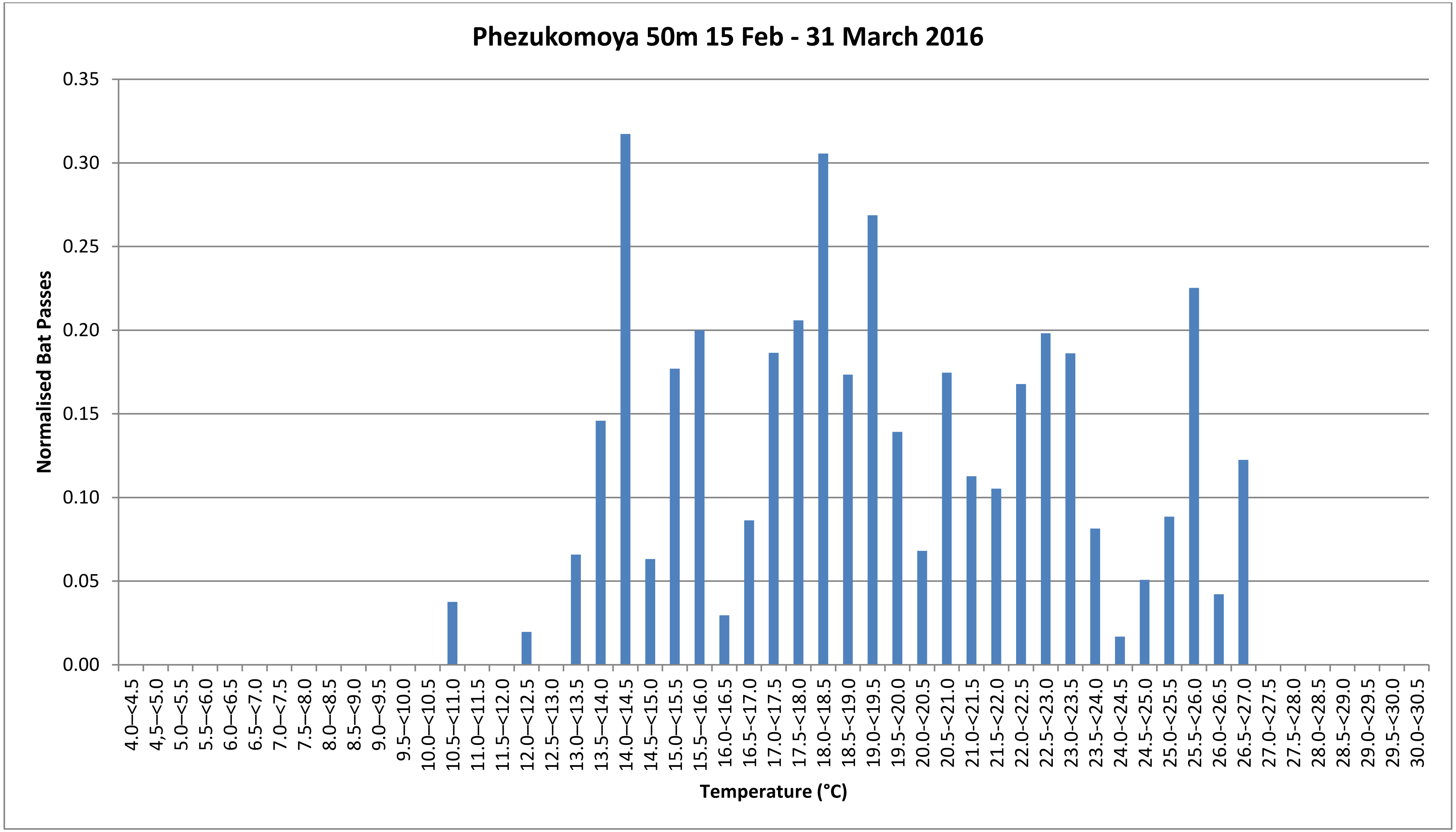


Figure 45: Sum of bat passes (Normalised) per Temperature category for Phezukomoya met mast (15 Feb – 31 March).

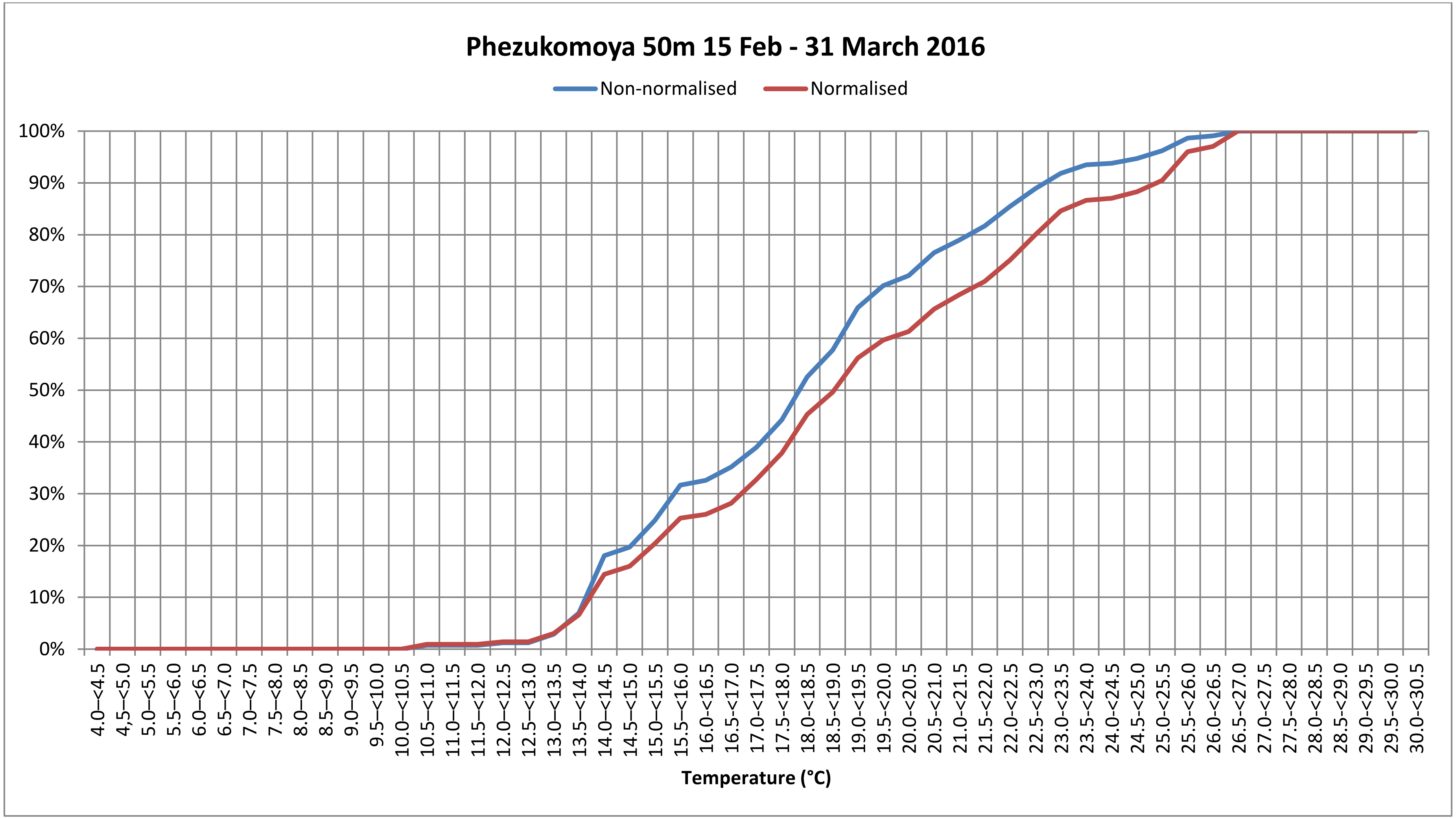


Figure 46: Cumulative percentage of normalised and non-normalised bat passes per temperature category for Phezukomoya met mast (15 Feb – 31 March).

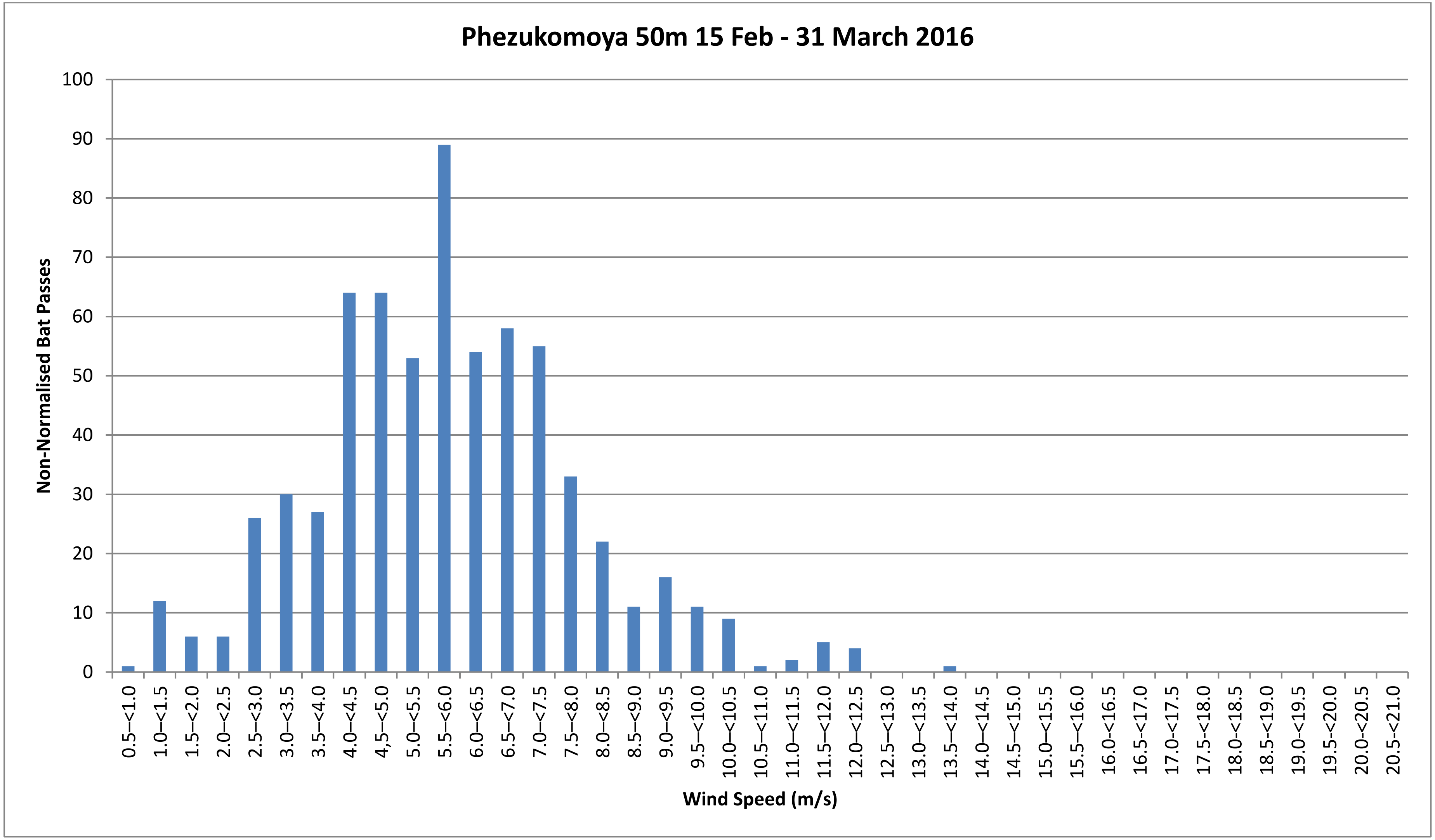


Figure 47: Sum of bat passes (Non-normalised) per Wind Speed category for Phezukomoya met mast (15 Feb – 31 March).

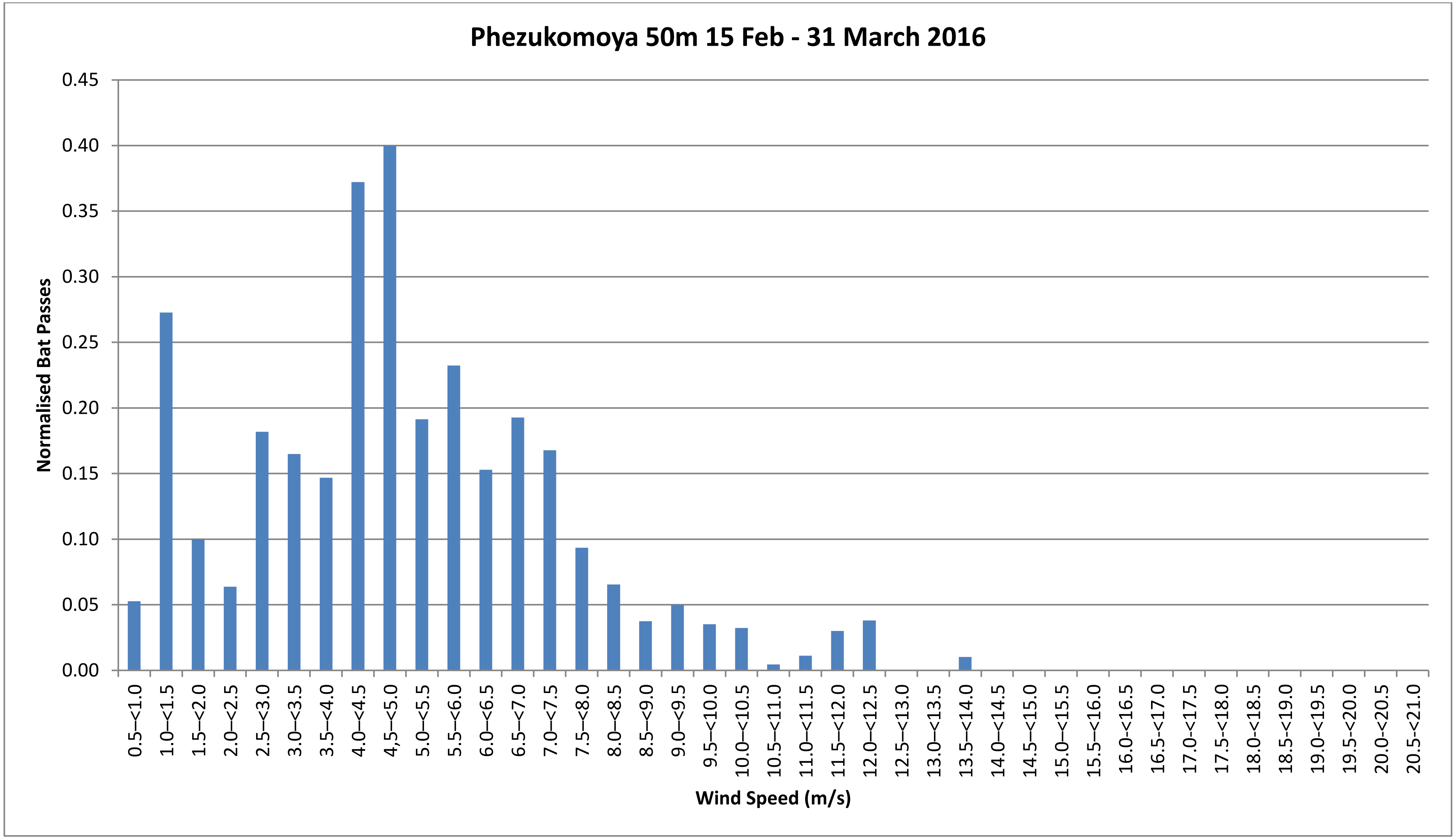


Figure 48: Sum of bat passes (Normalised) per Wind Speed category for Phezukomoya met mast (15 Feb – 31 March).

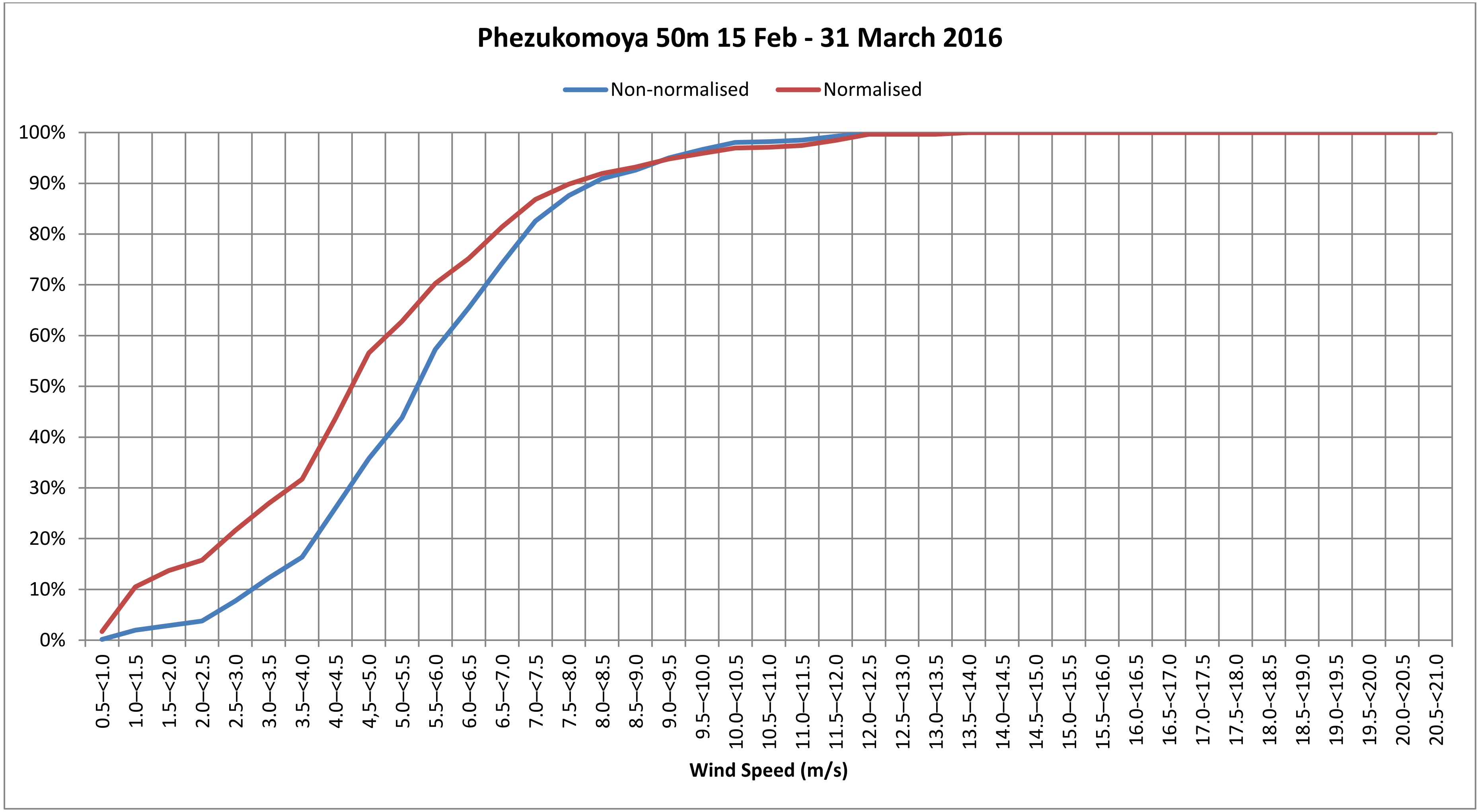


Figure 49: Cumulative percentage of normalised and non-normalised bat passes per Wind Speed category for Phezukomoya met mast (15 Feb – 31 March 2016).

6 IMPACT ASSESSMENT OF PROPOSED WEF ON BAT FAUNA

6.1 Construction phase

6.1.1 Impact: Destruction of bat roosts due to earthworks and blasting

Impact Phase: Construction phase							
Impact Description: 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, if applicable, can cause mortality to the inhabitants of the roost.							
	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Medium	Low	High	Negative	Medium	Medium	High
With Mitigation	Low	Low	Medium	Negative	Low	Low	High
Can the impact be reversed?			Yes, over a longer time period				
Will impact cause irreplaceable loss or resources?			Yes, if blasting occurs close to a rock crevice roost.				
Can impact be avoided, managed or mitigated?			Yes.				
Mitigation measures to reduce residual risk or enhance opportunities: Adhere to the sensitivity map during turbine placement. Blasting should be minimised and used only when necessary.							

6.1.2 Impact: Loss of foraging habitat

Impact Phase: Construction phase							
Impact Description: Loss of foraging habitat. Some minimal 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.							
	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Low	High	Low	Negative	Medium	Medium	High
With Mitigation	Low	Medium	Low	Negative	Low	Low	High

Can the impact be reversed?	No, as minimal foraging habitat will be permanently lost. When habitat is removed for temporary storage areas, the impact can be reversed through rehabilitation of the area.
Will impact cause irreplaceable loss or resources?	Yes, but the scale is insignificant
Can impact be avoided, managed or mitigated?	Yes
Mitigation measures to reduce residual risk or enhance opportunities: 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.	

6.2 Operational phase

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

Impact Phase: Operational phase							
Impact Description: 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 may not recover from mortalities easily.							
	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Low	High	High	Negative	High	High	High
With Mitigation	Low	High	Low	Negative	Medium	Medium	High
Can the impact be reversed?			The impact will occur throughout the lifespan of the wind facility, therefore population numbers may take very long to recover. Population and diversity genetics may be permanently altered.				
Will impact cause irreplaceable loss or resources?			Yes				
Can impact be avoided, managed or mitigated?			Yes				
Mitigation measures to reduce residual risk or enhance opportunities: Adhere to the sensitivity maps, avoid areas of high bat sensitivity and their buffers as well as preferably avoid areas of Moderate bat sensitivity and their buffers. Adhere to operational mitigation measures that may be deemed necessary during the operational monitoring assessment, if any is required.							

6.2.2 Impact: Artificial lighting

<table>
<tr><td colspan="8">Impact Phase: Operational phase</td></tr>
<tr><td colspan="8">Impact Description: During operation strong artificial lights that may be used at the turbine base or immediate surrounding infrastructure will attract insects and thereby also bats. This will significantly increase the likelihood of impact on bats foraging around such lights. Additionally, only certain species of bats will readily forage around strong lights, whereas others avoid such lights even if there are insect prey available, which can draw insect prey away from other natural areas and thereby artificially favour only certain species.</td></tr>
<tr><th></th><th>Extent</th><th>Duration</th><th>Intensity</th><th>Status</th><th>Significance</th><th>Probability</th><th>Confidence</th></tr>
<tr><td>Without Mitigation</td><td>Low</td><td>High</td><td>Medium</td><td>Negative</td><td>Medium</td><td>High</td><td>High</td></tr>
<tr><td>With Mitigation</td><td>Low</td><td>High</td><td>Low</td><td>Negative</td><td>Low</td><td>Low</td><td>High</td></tr>
<tr><td colspan="3">Can the impact be reversed?</td><td colspan="5">Yes</td></tr>
<tr><td colspan="3">Will impact cause irreplaceable loss or resources?</td><td colspan="5">No</td></tr>
<tr><td colspan="3">Can impact be avoided, managed or mitigated?</td><td colspan="5">Yes</td></tr>
<tr><td colspan="8">Mitigation measures to reduce residual risk or enhance opportunities:
If possible, utilise lights with wavelengths that attract less insects (low thermal/infrared signature). Lights should be switched off when not in use or equipped with passive motion sensors.</td></tr>
</table>

6.3 Decommissioning phase

No significant impacts have been identified for the decommissioning phase.

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 initial layer for mitigation.

Additional to mitigation by location, other options that may be utilized include curtailment, blade feathering, blade lock, acoustic deterrents or light lures. The following terminology applies:

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 be 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 further investigation closer to time of wind farm operation, opportunities to test such devices may be available during operation of the facility.

Light lures:

Refers 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 from the start of operation at Level 3 on all turbines for every night of the year from dusk until dawn.

Should robust and scientifically defendable data gathered during the operational study phase reveal higher bat mortalities than currently anticipated, the mitigations in **Table 13** should be applied to the turbines identified as causing the highest impacts. Such curtailment specified in **Table 13** will have to be at a maximum of Level 5. The turbine layout avoids all High and Moderate bat sensitivities and their buffers.

The **Table 13** below is based on the passive data collected. They infer mitigation be applied (only when needed as described above) 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 (normalised data). Bat activity at 50m height were used, with wind speed data at 50 m and temperature data at 37.5 m.

Table 13: The periods and weather conditions for implementation of mitigation

	Terms of mitigation implementation
Peak activity (times to implement curtailment/ mitigation)	**1 - 31 October; sunset – 00:00 (midnight)**

Environmental conditions in which to implement curtailment/ mitigation	**Wind speed below 7m/s** ***and simultaneously*** **Temperature above 14.5°C**
Peak activity (times to implement curtailment/ mitigation)	**15 February – 31 March; sunset – 00:00 (midnight)**
Environmental conditions in which to implement curtailment/ mitigation	**Wind speed below 6.5m/s** ***and simultaneously*** **Temperature above 15.5°C**

8 CUMULATIVE IMPACT ASSESSMENT

Several renewable energy development applications have been submitted and/or authorized within the immediate area of the proposed Phezukomoya WEF. **Figure 50** below displays these areas. The impact of the Phezukomoya wind energy facility was assessed in **Section 5** above; this section assesses the cumulative impact of all renewable energy developments within the area. The bat sensitivity assessment reports were obtained for the neighbouring wind energy developments, namely Noupoort WEF, San Kraal WEF and Umsobomvu WEF.

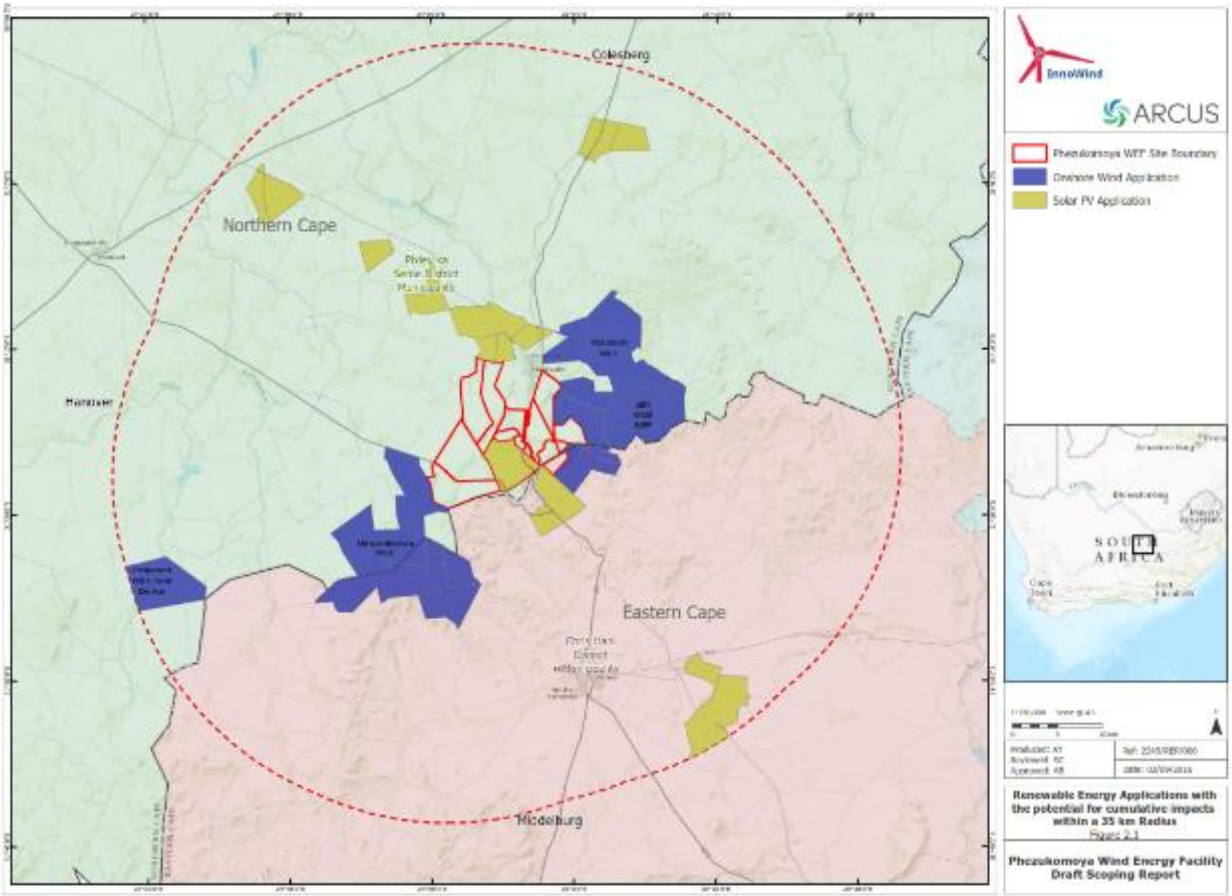
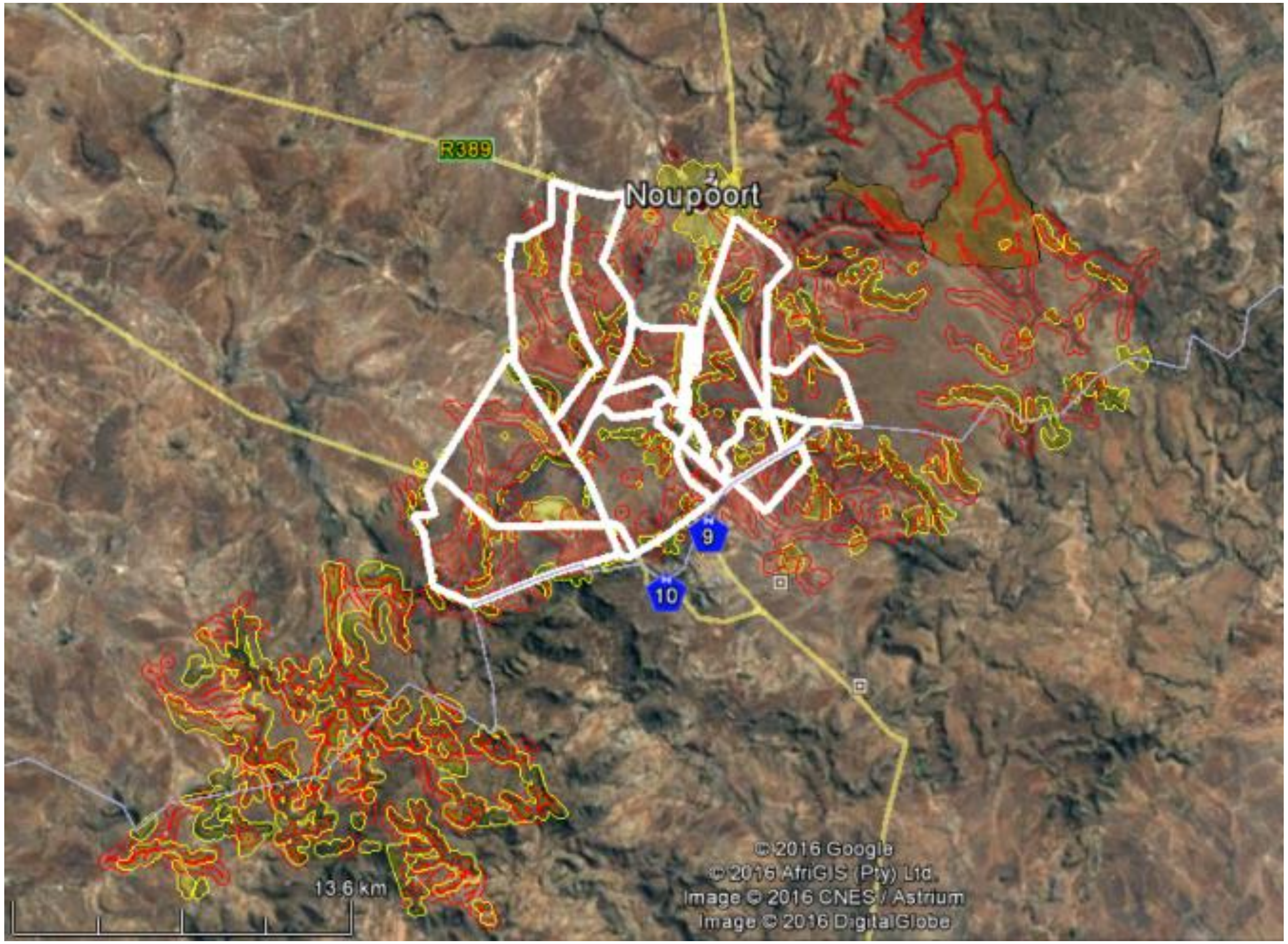


Figure 50: Proposed and approved renewable energy developments in a 35km radius of the Phezokomoya WEF site.

8.1 Bat Sensitivity Map

Figure 51 below displays bat sensitivity maps of the wind farms neighbouring the Phezukomoya WEF (namely Noupoort WEF, San Kraal WEF and Umsobomvu WEF). The bat sensitivity maps were inspected for congruency of sensitive areas and similarities in their buffer distances. The sensitivity map of the Phezukomoya WEF is sufficient when assessed with neighbouring site sensitivity maps.

The sensitivity maps were also used to assess whether the Phezukomoya WEF turbine layout intersects interlinking bat sensitivity habitats between the different sites i.e. valley areas, rivers and streams, mountain ridges. The topography and habitats across the larger area generally provide a lot of roosting opportunities for insectivorous bats. However, the sensitivity maps for all sites are stringent and thorough such that all bat important features are protected and buffered. The Phezukomoya WEF turbine layout does not traverse large scale ecological corridors or ecological areas of connectivity. Thus, the existing bat sensitivity map is sufficient in this regard.



High bat sensitivity area

Moderate bat sensitivity area

High bat sensitivity buffer

Moderate bat sensitivity buffer

Figure 51: Bat sensitivity maps of wind farm areas neighbouring Phezukomoya WEF (white boundary)

8.2 Cumulative Impact Assessment Rating

The main impact on bats that raises concern from a cumulative impact assessment point of view is the bat mortalities due to direct turbine blade collision or barotrauma during operation. There is potential for mass loss of locally active bats and migratory bats from the area due to cumulative mortality from wind turbines of several neighbouring wind farms. This impact is assessed below:

Impact Phase: Operational phase							
Impact Description: Cumulative bat mortalities due to direct blade collision 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 nocturnal flying insects. On a wind farm 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 wind farms in close vicinity of each other, insect numbers can increase regionally and possibly cause outbreaks of colonies of certain insect species. If large numbers of a population of a resident species are lost to this impact, it will most likely lead to destabilization of the species population and ultimately possible extinction from the area. If migrating bats are killed off it can have detrimental effects on the ecology of the caves that the specific colonies utilise. This is since bat guano is the primary form of energy input into a cave ecosystem, and no sunshine which is needed for photosynthesis exists in cave ecosystems.							
	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	High	High	High	Negative	High	Medium	High
With Mitigation	Medium	Medium	Medium	Negative	Medium	Medium	High
Can the impact be reversed?			The impact will occur throughout the lifespan of the wind energy facility as well as other facilities in the area, therefore bat population numbers may take very long to recover. There is a higher probability for population and diversity genetics to be permanently altered in cumulative impacts.				
Will impact cause irreplaceable loss or resources?			Yes				
Can impact be avoided, managed or mitigated?			Yes				
Mitigation measures to reduce residual risk or enhance opportunities: 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 if the valley areas are avoided during turbine placement and are well buffered. Also, adhere to recommended mitigation measures for this project during the operational phase study, and it is essential that project specific mitigations be applied and adhered to for each project. Adhere to the sensitivity map during any further turbine layout revisions, and avoid placement of turbines in bat sensitive areas and their buffers.							

8.1 Mitigation Measures

The final pre-construction bat monitoring reports of Noupoort WEF, Umsomovu WEF and San Kraal WEF identify peak bat activity periods that align with those identified in this report for the Phezukomoya WEF.

The identified high bat activity periods are:

- Noupoort WEF – October to February
- Umsobomvu WEF – Late October to mid-January, month of February, and mid-March to early April
- San Kraal WEF – 1 October to 15 November and 15 February to 31 March

At the proposed Phezukomoya WEF it is recommended that curtailment be applied from the start of operation at Level 3 (see Section 7) on all turbines for every night of the year from dusk until dawn.

Should robust and scientifically defendable data gathered during the operational study phase reveal higher bat mortalities than currently anticipated, the mitigations in **Table 14** should be applied to the turbines identified as causing the highest impacts. Such curtailment specified in **Table 14** will have to be at a maximum of Level 5. The turbine layout avoids all High and Moderate bat sensitivities and their buffers.

The **Table 14** below is based on the passive data collected. They infer mitigation be applied (only when needed as described above) 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 (normalised data). Bat activity at 50m height were used, with wind speed data at 50 m and temperature data at 37.5 m.

Table 13: The periods and weather conditions for implementation of mitigation

	Terms of mitigation implementation
Peak activity (times to implement curtailment/ mitigation)	**1 - 31 October; sunset – 00:00 (midnight)**
Environmental conditions in which to implement curtailment/ mitigation	**Wind speed below 7m/s** ***<u>and simultaneously</u>*** **Temperature above 14.5°C**
Peak activity (times to implement curtailment/ mitigation)	**15 February – 31 March; sunset – 00:00 (midnight)**
Environmental conditions in which to implement curtailment/ mitigation	**Wind speed below 6.5m/s** ***<u>and simultaneously</u>*** **Temperature above 15.5°C**

9 CONCLUSION

Monitoring of bats took place over the period form 6 July 2015 to 3 September 2016.Four bat species were detected by the passive monitoring systems, namely, *Eptesicus hottentotus, Miniopterus natalensis, Neoromicia capensis*, and *Tadarida aegyptiaca. Tadarida aegyptiaca* and *Neoromicia capensis* are the most abundant bat species recorded by all systems. *Miniopterus natalensis* is the only migratory species detected on site. The results of the full 12 months have been analysed for the presence of a migratory event, and no migratory event was detected by the passive monitoring systems.

The Short Mast 2 monitoring system detected a significantly higher number of bat passes than any of the other monitoring systems on this site **(Figure 17)**.

The Met Mast West, Short Mast 1 and 2 monitoring systems show the general trend of lowered bat activity over the winter months (July – August 2015), with a large increase in bat passes into the spring (September – November 2015) and summer months (December 2015 – February 2016), followed by a decrease during the autumn months (March – May 2016) into winter 2016 again (**Figures 19 - 21**). Met Mast West showed the highest peak activity during the month of October 2015, and again in March 2016. Short Mast 2 showed peaked activity over January 2016.

The guidelines request measurements at standard heights to cater for change in turbine dimensions later on and also make data sets across sites comparable. It is possible that increased turbine dimensions would increase potential impacts to bats, however based on the pre-construction monitoring data the specialist has no objection to the proposed hub height and rotor diameter, as assessed.

A sensitivity map was drawn up indicating potential roosting and foraging habitat (**Figures 11 - 14**). The Moderate bat sensitivity areas and associated buffer zones must be prioritised during operational monitoring and preferably be avoided during turbine placement. The High Bat Sensitivity areas are expected to have elevated levels of bat activity and support greater bat diversity. High Bat Sensitivity areas and their buffers are 'no – go' areas due to the expected elevated rates of bat fatalities due to wind turbines. No turbines are allowed to be placed in High Bat Sensitivity areas and their associated buffers. The Final Mitigated Layout avoids all High and Moderate bat sensitivities and their buffers, and is therefore acceptable. The proposed grid connection was not assessed during the study, as according to the best knowledge of the specialist, grid infrastructure does not pose a significant threat to bat conservation in South Africa if the site is not located in an area abundant with bat caves.

It is recommended that curtailment be applied from the start of operation at Level 3 (see Section 7) on all turbines for every night of the year from dusk until dawn.

Should robust and scientifically defendable data gathered during the operational study phase reveal higher bat mortalities than currently anticipated, the mitigations in **Table 13** should be applied to the turbines identified as causing the highest impacts. Such curtailment specified in **Table 13** will have to be at a maximum of Level 5.

10 REFERENCES

ACR. 2010. *African Chiroptera Report, 2010*. AfricanBats, Pretoria.

Arnett, E. B., Huso, M. M. P., Schirmacher, M. R and Hayes, J. P. 2009. Patterns of bat fatality at the Casselman Wind Project in south-central Pennsylvania. An annual report of the Bats and Wind Energy Cooperative and the Pennsylvania Game Commission. Bat Conservation International. Austin, Texas, USA.

Arnett, E. B., technical editor. 2005. Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Baerwald, E. F., D'Amours, G. H., Klug, B.J. and Barclay, R. M. R. 2008. Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology* 18: 695-695.

Barclay, R. M. R., Baerwald, E. F., and Gruver, J. C. 2007. Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* 85: 381-387.

Bernard, R. T. F. and Tsita, J. N. 1995. Seasonally monoestrous reproduction in the molossid bat, *Tadarida aegyptiaca,* from low temperature latitudes (35^{o}S) in South Africa. *South African Journal of Zoology* 30: 18-22.

Cryan, P. M. and Barclay, R. M. R. 2009. Causes of bat fatalities at wind turbines: Hypotheses and predictions. *Journal of Mammalogy* 90: 1330-1340.

Herselman, J. C. 1980. The distribution and status of bats in the Cape Province. International Report. Cape Department of Nature and Environmental Conservation.

Hester, S. G. and Grenier, M.B. 2005. *A conservation plan for bats in Wyoming*. Lander, WY: Wyoming Game and Fish Department, Nongame Program.

Horn, J. W., Arnett, E. B. and Kunz, T.H. 2008. Behavioural responses of bats to operating wind turbines. *Journal of Wildlife Management* 72: 123-132.

Howe, R. H., Evans, W. and Wolf, A. T. 2002. Effects of wind turbines on Birds and Bats on Northeastern Wisconsin. Report submitted to *Wisconsin Public Service Corporation and Madison Gas and Electric Company*.

Johnson, G. D., Erickson, W. P., Stickland, M. D., Shepherd, M. F., Shepherd, D. A. and Sarappo, S. A. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. *The American Midland Naturalist Journal* 150: 332-342.

Kunz, T. H., Arnett, E. B., Erickson, W. P., Hoar, A. R., Johnson, G. D., Larkin, R. P., Strickland, M. D., Thresher, R. W., Tuttle, M. D. 2007. Ecological impacts of wind energy development on bats: questions, research needs, and hypothesis. *Frontiers in Ecology and the Environment* 5: 315-324.

Lynch, C. D. 1989. The mammals of the north-eastern Cape Province. *Mem. Nas. Mus. Bloemfontein* 25: 1-116.

Monadjem, A., Taylor, P.J., Cotterill, F.P.D. & Schoeman, M.C. (2010). Bats of southern and central Africa – A biogeographic and taxonomic synthesis, Ultra Litho (Pty) Ltd, Johannesburg.

Mucina, L. and Rutherford, M. C. 2006. The Vegetation of South Africa, Lesotho and Swaziland- *Strelitzia 19,* South African National Biodiversity Institute, Pretoria.

Neuweiler, G. 2000. *The Biology of Bats*. Oxford University Press.

O'Shea, T. J., Bogan, M. A. and Ellison, L. E. (2003). *Monitoring trends in bat populations of the United States and territories: Status of the science and recommendations for the future*. Wildlife Society Bulletin, 31: 16-29.

Rautenbach, I.L. 1982. *Mammals of the Transvaal*. Pretoria: Ecoplan.

Sowler, S., Stoffberg, S., MacEwan, K., Aronson, J., Ramalho, R., Potgieter, K., Lötter, C. 2016. *South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments - Pre-construction: 4th Edition*. South African Bat Assessment Association.

Taylor, P. J. 2000. Bats of southern Africa, University of Natal Press, Pietermaritzburg.

Tuttle, M. D. and Hensley, D. L. 2001. *The Bat House Builder's Handbook*. (BCI) Bat Conservation International.

van der Merwe, M. 1979. Growth of ovarian follicles in the Natal clinging bat. *South African Journal of Zoology* 14: 111-117.

van der Merwe, M. 1994. Reproductive biology of the Cape serotine bat, *Eptesicus capensis,* in the Transvaal, South Africa. *South African Journal of Zoology* 29: 36-39.

Vincent, S., Nemoz, M. and Aulagnier, S. 2011. Activity and foraging habitats of *Miniopterus schreibersii* (Chiroptera: Miniopteridae) in southern France: implications for its conservation. *The Italian Journal of Mammalogy* 22: 57-72.

Reviewed and signed off by:

Werner Marais

MSc (Biodiversity & Conservation)

Pr.Sci.Nat. – SACNASP

(Zoological Science)

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

The Proposed 315 MW Phezukomoya Wind Energy Facility and associated 132 kV Grid Connection Transmission Line, Northern and Eastern Cape Province.. DEA Ref: 14/12/16/3/3/2/1028

Specialist:	Werner Marais		
Contact person:	Werner Marais		
Postal address:	3 Godetia str, Heldervue, Somerset West		
Postal code:	7130	Cell:	0781903316
Telephone:		Fax:	
E-mail:	werner@animalia-consult.co.za		
Professional affiliation(s) (if any)	Sacnasp Pr.Sci.Nat (Zoology)		

Project Consultant:			
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

4.2 The specialist appointed in terms of the Regulations_

I, Werner Marais, declare that --

General declaration:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Animalia Consultants (Pty) Ltd

Name of company (if applicable):

17 October 2017

Date: