Fifth and Final Progress Report of a 12-month Long-Term Bat Monitoring Study

- **For the proposed Maralla Wind Energy Facility, Northern Cape**

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For:	12 Month pre-construction bat sensitivity monitoring

Independence:

Animalia Zoological & Ecological Consultation (Pty) has no connection with the developer. Animalia Zoological & Ecological Consultation (Pty) is not a subsidiary, legally or financially of the developer; remuneration for services by the developer in relation to this proposal is not linked to approval by decision-making authorities responsible for permitting this proposal and the consultancy has no interest in secondary or downstream developments as a result of the 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

1 OBJECTIVES AND TERMS OF REFERENCE FOR PRECONSTRUCTION STUDY 8

2 PROJECT DESCRIPTION 8

3 INTRODUCTION 9

3.1 The Bats of South Africa 10

3.2 Bats and Wind Turbines 11

4 METHODOLOGY 13

4.1 First Site Visit 14

4.2 Assumptions and Limitations 17

4.3 Methodology 18

5 RESULTS AND DISCUSSION 21

5.1 Land Use, Vegetation, Climate and Topography..21

5.2 Species Probability of Occurrence 24

5.3 Ecology of bat species that may be largely impacted by the Maralla WEF 25

5.4 Transects 28

5.4.1 First Site Visit 28

5.4.2 Second Site Visit.. 28

5.4.3 Third Site Visit... 30

5.4.4 Fourth Site Visit 32

5.5 Sensitivity Map 35

5.6 Passive Data 39

5.6.1 Abundances and Composition of Bat Assemblages 39

5.6.2 Temporal Distribution 48

5.6.3 Distribution of bat activity across the night per season 53

5.6.4 Relation between Bat Activity and Weather Conditions 70

6 IMPACT ASSESSMENT OF PROPOSED WEF ON BAT FAUNA 102

6.1 Construction phase 102

6.2 Operational phase 104

6.3 Decommissioning phase..106

7 PROPOSED INITIAL MITIGATION MEASURES AND DETAILS 107

8 CUMULATIVE IMPACT ASSESSMENT.. 110

8.1 Bat Sensitivity Map..111

8.2 Cumulative Impact Assessment Rating 114

8.3 Mitigation Measures 120

9 STAKEHOLDER COMMENTS.. 123

10 CONCLUSION 127

11 REFERENCES 129

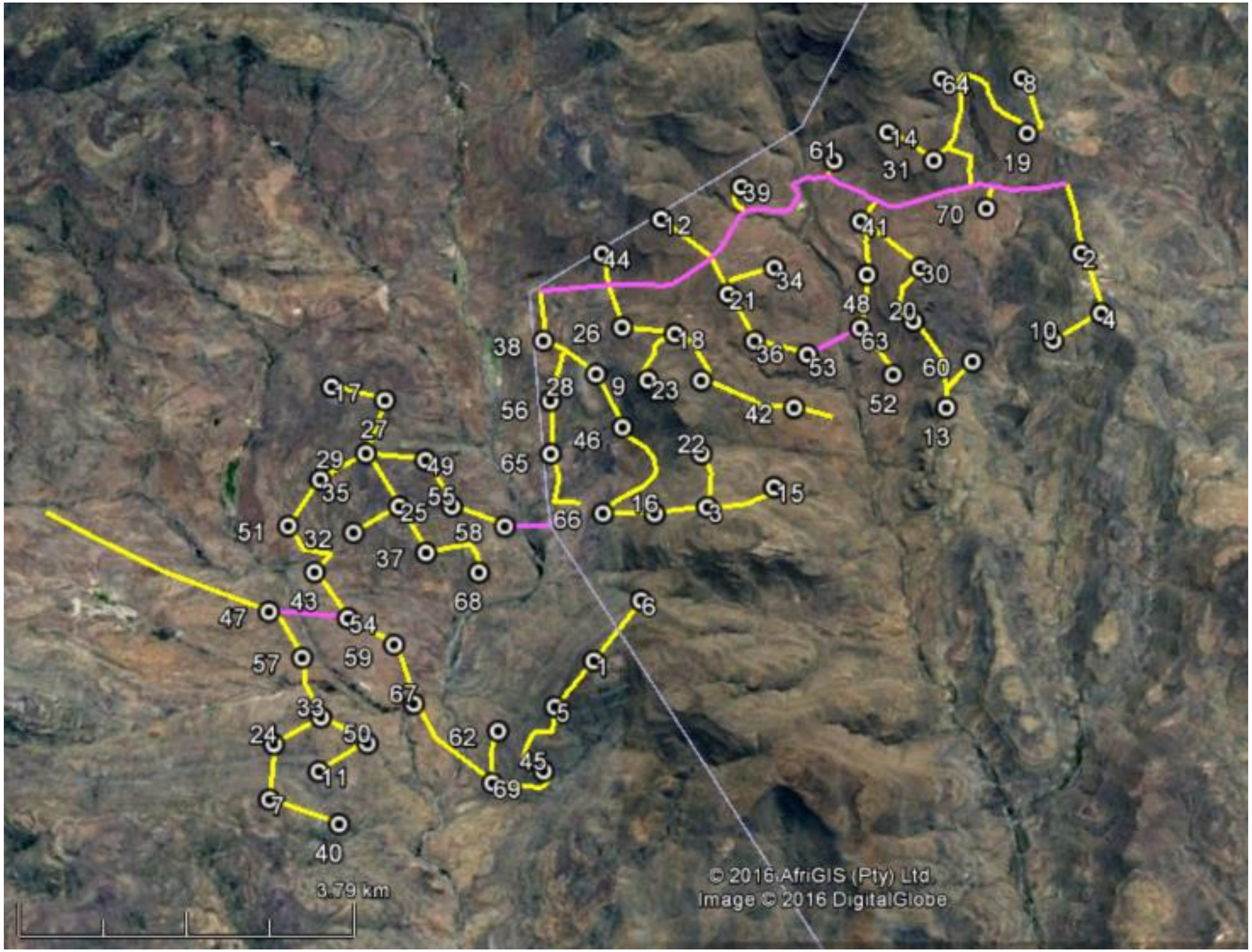


Figure 1: Map overview of the proposed Maralla East WEF turbine layouts.

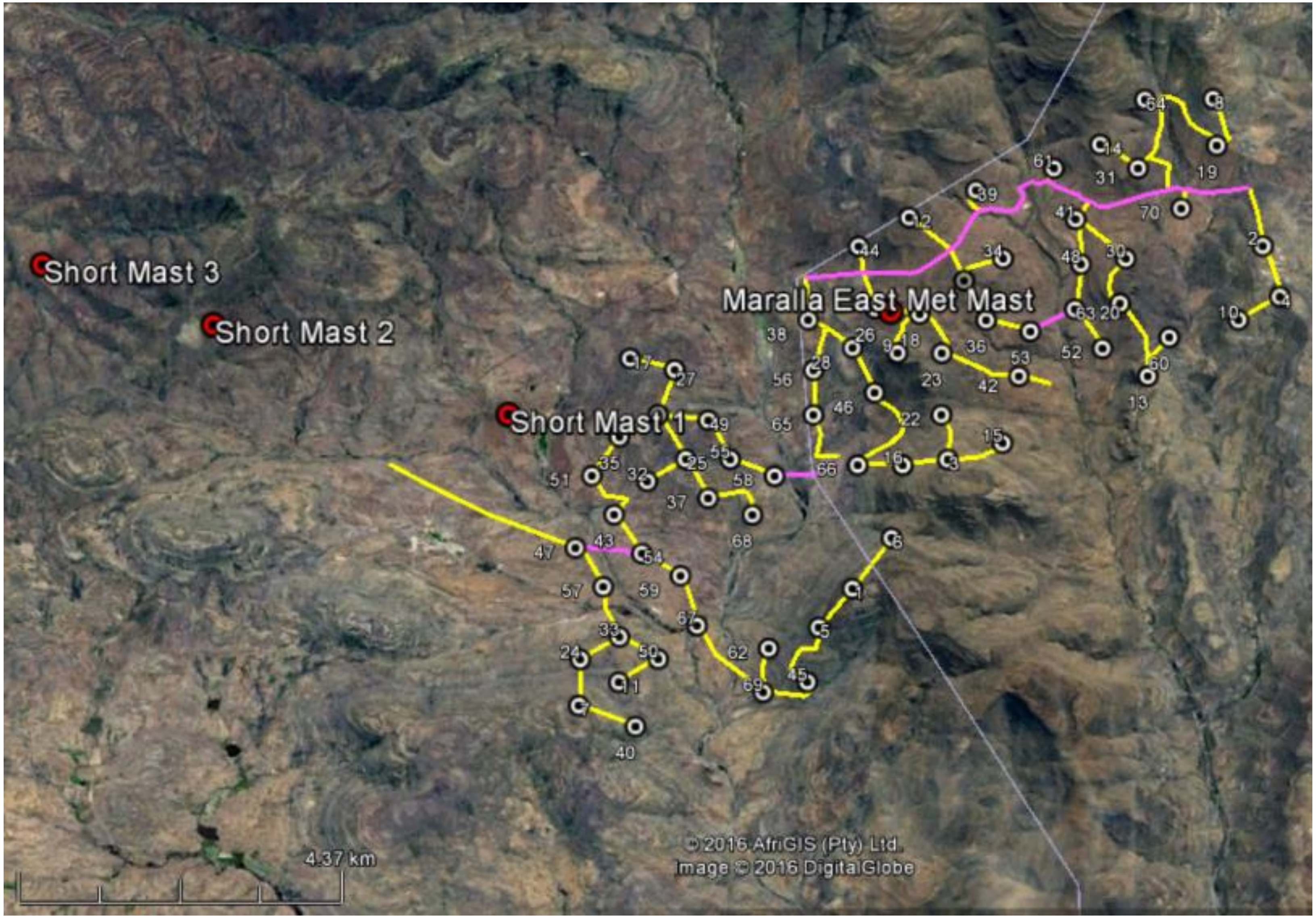


Figure 2: Overview of the passive bat monitoring system locations on the Maralla East WEFs.

1 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.
- Assess the turbine layout in respect of bat sensitive areas on site, and identify if any turbines located in sensitive areas require mitigation in the operational phase o the wind farm.
- 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.

2 PROJECT DESCRIPTION

Maralla East Wind Energy Facility (DEA ref: 12/12/20/1782 – approved) is located to the north of Laingsburg, between the Western Cape and Northern Cape. The WEF falls within the Unpublished Department of Environmental Affairs Renewable Energy Zone Region (DEA REDZ) (2015).

The WEF consists of the following infrastructure:

- Up to 125 wind turbines generators with a generating capacity of between 2 and 4MW each.
- The turbines will have a hub height of up to 120m and rotor diameter of up to 150m.
- Concrete foundation to support the turbines
- Onsite 132kV Substation, with the transformers for voltage step up from medium voltage to high voltage. Substation will occupy an area of 150mx 150m
- The medium voltage collector system will comprise of cables (1kV up to and including 33kV) that will be run underground, expect where a technical assessment suggests that overhead lines are applicable, in the facility connecting the turbines to the onsite substation
- A laydown area for the temporary storage of materials during the construction activities. The laydown area will be a maximum of 4ha in size
- Permanent laydown for turbine crane platforms
- Haul roads between 4 – 6m wide. Double width roads required in strategic places for passing

- Temporary site compound for contractors
- Operations and maintenance compound area including O&M building, car park and storage area

3 INTRODUCTION

This is the Bat Impact Assessment Report for the proposed Maralla East Wind Energy Facility near Sutherland in the Northern Cape. It incorporates the findings of the twelve-month preconstruction bat monitoring study.

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

The site is evaluated by comparing the amount of surface rock (possible roosting space), topography (influencing surface rock in most cases), vegetation (possible roosting spaces and foraging sites), climate (can influence insect numbers and availability of fruit), and presence of surface water (influences insects and acts as a source of drinking water) to identify bat species that may be impacted by wind turbines. These comparisons are made 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 are estimated for the site and the surrounding larger area.

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

3.1 The Bats of South Africa

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

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

Many bat species roost in large communities and congregate in small areas. Therefore, any major disturbances within and around the roosting areas may adversely impact individuals of different communities, within the same population, concurrently (Hester and Grenier 2005). Secondly, nativity rates of bats are much lower than those of most other small mammals. This is because, for the most part, only one or two pups are born per female per annum and per 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. This is due to the longevity and the relatively low predation of bats when compared to other small mammals. Therefore, bat populations are not able to adequately recover after 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 corpses of bats have been found in close proximity to wind turbines and, in a case study conducted by Johnson *et al*. (2003), were found to be directly related to collisions. The incident of bat fatalities for migrating species has been found to be directly related to turbine height, increasing exponentially with altitude, as this disrupts the migratory flight paths (Howe *et al*. 2002, Barclay *et al*. 2007). Although the number of fatalities of migrating species increased with turbine height, this correlation was not found for increased rotor sweep (Howe *et al*. 2002, Barclay *et al*. 2007). In the USA, it was hypothesized that migrating bats may navigate without the use of echolocation, rather using vision as their main sense for long distance orientation (Johnson *et al*. 2003, Barclay *et al*. 2007). Despite the high incidence of deaths caused by direct impact with the blades, most bat mortalities have been found to be caused by barotrauma (Baerwald *et al*. 2008). This is a condition where low air pressure found around the moving blades of wind turbines, causes the lungs of a bat to collapse, resulting in fatal internal haemorrhaging (Kunz *et al*. 2007). Baerwald *et al*. (2008) found that 90% of bat fatalities around wind turbines involved internal haemorrhaging consistent with barotrauma. A study conducted by Arnett (2005) recorded a total of 398 and 262 bat fatalities in two surveys at the Mountaineer Wind Energy Centre in Tucker County, West Virginia and at the Meyersdale Wind Energy Centre in Somerset County, Pennsylvania, respectively. These surveys took place during a 6-week study period from 31 July 2004 to 13 September 2004. In some studies, such as that taken in Kewaunee County (Howe *et al.* 2002), bat fatalities were found exceed bird fatalities by up to three-fold.

Although bats are predominately found roosting and foraging in areas near trees, rocky outcrops, human dwellings and water, in conditions where valleys are foggy, warmer air is drawn to hilltops through thermal inversion, which may result in increased concentrations of insects and consequently bats at hilltops, where wind turbines are often placed (Kunz *et al*. 2007). Some studies (Horn *et al*. 2008) suggest that bats may be attracted to the large turbine structure as roosting spaces or that swarms of insects may get trapped in low-pressure air pockets around the turbine, also encouraging the presence of bats. The presence of lights on wind turbines have also been identified as possible causes for increased bat fatalities for non-cave roosting species. This is thought to be due to increased insect densities that are attracted to the lights and subsequently encourage foraging activity of bats (Johnson *et al*. 2003). Clearings around wind turbines, in previously forested areas, may also improve conditions for insects, thereby attracting bats to the area and the swishing sound of the turbine blades has been proposed as possible sources for disorienting bats (Kunz *et al*. 2007). Electromagnetic fields generated by the turbine may also affect bats that 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.

A pilot wind turbine in the Coega Industrial Development Zone, Port Elizabeth, Eastern Cape, South Africa was surveyed for bird and bat carcasses. Over a period of one year, three surveys per week (total 154 inspections) were performed to search for bat and bird casualties. 17 bat fatalities and one live but injured bat was collected. Two bat species were involved, Cape serotine (*Neoromicia capensis*) and Egyptian free-tailed bat (*Tadarida aegyptiaca*). Of the 18 casualties, 15 were recorded mid-December to mid-March. One bird, a little swift (*Apus affinis*), was hit by a rotor blade. This is the first study to document bat and bird mortalities over the period of a year at a wind turbine in sub-Saharan Africa (Doty and Martin, 2013).

A pilot study was conducted at the Darling Wind Farm in the Western Cape to determine if bats are being killed by wind turbines at the facility. One bat carcass was found and identified as an adult female *Neoromicia capensis*. A necropsy showed that both lungs had pulmonary haemorrhaging and had collapsed. Histological examination revealed extensive haemorrhaging in the lungs consistent with barotrauma (Aronson et al., 2013).

Both South African studies point to South African bats being just as vulnerable to mortality from turbines as international studies have previously indicated. Thus, the two main species of concern are *Neoromicia capensis* and *Tadarida aegyptiaca*.

During a study by Arnett *et al*. (2009), 10 turbines monitored over a period of 3 months showed 124 bat fatalities in South-central Pennsylvania (America), which can cumulatively have a catastrophic long-term effect on bat populations if this rate of fatality continues. Most bat species only reproduce once a year, bearing one young per female, therefore their numbers are slow to recover from mass mortalities. It is very difficult to assess the true number of bat deaths in relation to wind turbines, due to carcasses being removed from sites through predation, the rate of which differs from site to site as a result of habitat type, species of predator and their numbers (Howe *et al*. 2002, Johnson *et al*. 2003). Mitigation measures are being researched and experimented with globally, but are still only effective on a small scale. An exception is the implementation of curtailment processes, where the turbine cut-in speed is raised to a higher wind speed. This relies on the principle that the prey of bats will not be found in areas of strong winds and more energy is required for the bats to fly under these conditions. It is thought, that by the implementation of such a measure, that bats in the area are not likely to experience as great an impact as when the turbine blades move slowly in low wind speeds. However, this measure is currently not effective enough to translate the impact of wind turbines on bats to a category of low concern.

4 METHODOLOGY

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 through the mounting of passive bat monitoring systems placed on four monitoring masts on site, specifically three short 10m masts (**Figure 3**) and an 80m meteorological mast.

The study was initiated while the Third Edition of the South African Good Practice Guidelines for Surveying Bats at Wind Energy Facilities was in effect. It recommends utilising one monitoring system per every 3 500ha of the site area with consideration to all unique vegetation units or relevant land uses. The Maralla East site is approximately 4411ha across one vegetation unit.

The monitoring systems consisted of SM2BAT+ time expansion type bat detectors that was 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 SM2PWR step down transformer. Four SD memory cards, class 10 speed, with a capacity of 32GB each were utilised within each SM2BAT+ detector; this was to ensure substantial memory space with high quality recordings even under conditions of multiple false wind triggers.

Three weatherproof ultrasound microphones were mounted at heights of 9.5 meters on the three 10m short masts, while two microphones were mounted at 10m and 80m heights on the met 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 18 dB will trigger the detector to record for the duration of the sound and 500 ms after the sound has ceased, this latter period is known as a trigger window. All signals were recorded in WAC0 lossless compression format.

The table below summarizes the above-mentioned equipment set up.

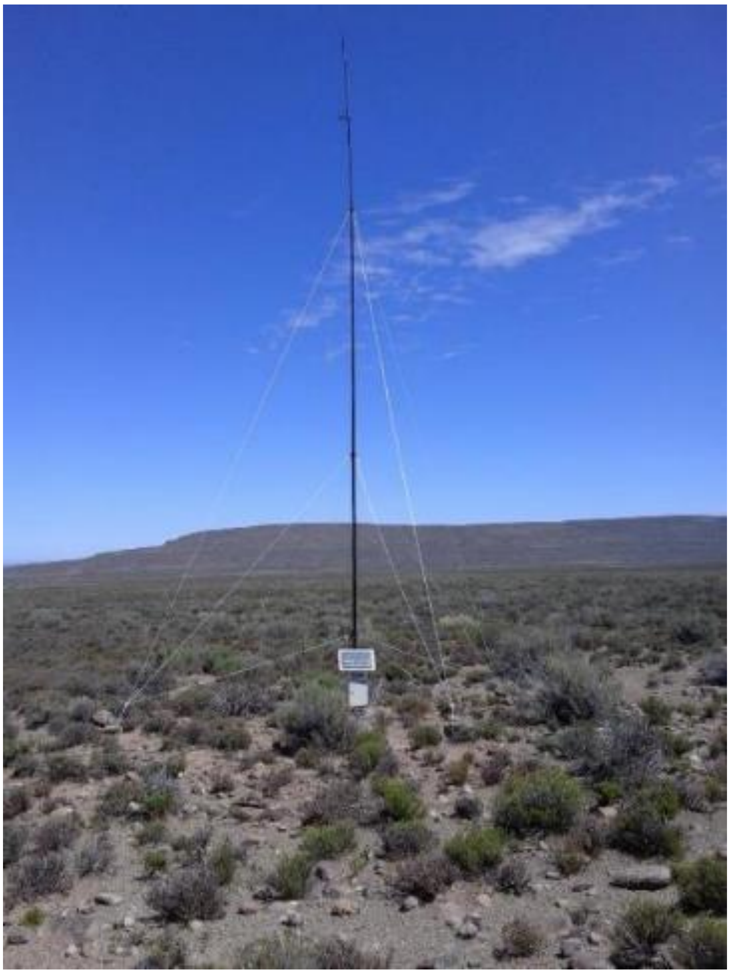


Figure 3: Short mast monitoring system set up

4.1 First Site Visit

Site visit dates		First Visit	2 – 9 November 2015
		Second Visit	8 – 15 February 2016
		Third Visit	16 – 26 May 2016
		Fourth Visit	9 – 15 August 2016
		Fifth Visit	7 – 11 November 2016
Met mast passive bat detection systems	**Amount on site**	2	
	Microphone heights	10m; 80m	
	Coordinates	Maralla East Met Mast: 32° 42.904'S 20° 48.215'E	
Short mast passive bat detection systems	**Amount on site**	3	
	Microphone height	9m	

	Coordinates	SM1: 32° 43.646'S 20° 44.907'E SM2: 32° 43.000'S 20° 42.398'E SM3: 32° 42.541'S 20° 40.827'E
Replacements/ Repairs/ Comments		
First Site Visit		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.
Second Site Visit		Short Mast 3 had fallen over due to anchor failure and was erected again. All other systems were operational.
Third Site Visit		The met mast was fully operational. Short Mast 1 had pivoted on its base changing the direction of the solar panel and as such the solar panel did not charge the battery sufficiently. Thus, the power to the bat detector was insufficient. The mast was corrected and braced and the system was functional on conclusion of the site visit. Short Mast 2 had fallen over due to the guy ropes being cut by an anchor rock, it had fallen with the solar panel facing into the ground and as such the system was off due to lack of solar charge. It was repaired and was functional on conclusion of the site visit. Short Mast 3 had fallen over due to the base of the mast having shifted in the wind. The system showed a microphone error and after diagnostic testing it was determined that the microphone cable requires replacement. This will be attended to during the next site visit.
Fourth Site Visit		Short Mast 1 had fallen over and the system was off due to not charging as the solar panel was pointing down. All other systems were operational and data was collected.
Fifth Site Visit		Short Mast 2 had fallen over due to the anchor rope breaking, the system was still functioning however there is a data gap, the system stopped recording on the 22nd of August 2016 and restarted on the 6th of November 2016. Short Mast 3 was still upright but on opening the box it was observed that the system screen showed the main menu as such the program was not running it had stopped on the 17th of August 2016. All other systems were functional.

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)	500 ms
Microphone gain setting	36dB
Compression	WAC0
Single memory card size (each system 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 for evidence of roosts and transects were driven in the evening with a mobile bat detector.

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

After each 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 ≥2 ms (one echolocation call can consist of numerous pulses). A new bat pass will be identified by a >500 ms period between pulses. These bat passes will be summed into 10 minute intervals which will be used to calculate nocturnal distribution patterns over time. Bat activity was grouped into 10 minute periods. Only nocturnal, dusk and dawn values of environmental parameters from the wind data will be used, as this is the only time insectivorous bats are active. Times of sunset and sunrise was 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.

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. This limitation however will be overcome with this long-term sensitivity assessment.

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

Species identification with the use of bat detection and echolocation is less accurate when compared to morphological identification, nevertheless it is 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.

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 Methodology

Impacts are assessed in terms of the following criteria:

a) The **nature**, a description of what causes the effect, what will be affected and how it will be affected.

NATURE OR TYPE OF IMPACT	DEFINITION
Beneficial / Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Adverse / Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that arise directly from activities that form an integral part of the Project (e.g. new infrastructure).
Indirect	Impacts that arise indirectly from activities not explicitly forming part of the Project (e.g. noise changes due to changes in road or rail traffic resulting from the operation of Project).
Secondary	Secondary or induced impacts caused by a change in the Project environment (e.g. employment opportunities created by the supply chain requirements).
Cumulative	Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.

b) The physical **extent**, wherein it is indicated whether:

SCORE	DESCRIPTION
1	The impact will be limited to the site;
2	The impact will be limited to the local area;
3	The impact will be limited to the region;
4	The impact will be national; or
5	The impact will be international;

c) The **duration**, wherein it is indicated whether the lifetime of the impact will be:

SCORE	DESCRIPTION
1	of a very short duration (0 to 1 years)
2	of a short duration (2 to 5 years)
3	Medium term (5–15 years)
4	Long term (> 15 years)
5	Permanent

d) The **magnitude of impact on ecological processes**, quantified on a scale from 0-10, where a score is assigned:

SCORE	DESCRIPTION
0	Small and will have no effect on the environment.
2	Minor and will not result in an impact on processes.
4	Low and will cause a slight impact on processes.
6	Moderate and will result in processes continuing but in a modified way.
8	High (processes are altered to the extent that they temporarily cease).
10	Very high and results in complete destruction of patterns and permanent cessation of processes.

e) The **probability of occurrence**, which describes the likelihood of the impact occurring. Probability is estimated on a scale where:

SCORE	DESCRIPTION
1	very improbable (probably will not happen.
2	improbable (some possibility, but low likelihood).
3	probable (distinct possibility).
4	highly probable (most likely).
5	definite (impact will occur regardless of any prevention measures).

f) the **significance**, which is determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high;

g) the **status**, which is described as either positive, negative or neutral;

h) the degree to which the impact can be reversed;

i) the degree to which the impact may cause irreplaceable loss of resources; and

j) the *degree* to which the impact can be mitigated.

The **significance** is determined by combining the criteria in the following formula:

$$S = (E+D+M)*P$$

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

OVERALL SCORE	SIGNIFICANCE RATING	DESCRIPTION
< 30 points	**Low**	where this impact would not have a direct influence on the decision to develop in the area
31-60 points	**Medium**	where the impact could influence the decision to develop in the area unless it is effectively mitigated
> 60 points	**High**	where the impact must have an influence on the decision process to develop in the area

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the Project's actual extent of impact, and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures, and is thus the final level of impact associated with the development of the Project. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this EIA Report.

5 RESULTS AND DISCUSSION

5.1 Land Use, Vegetation, Climate and Topography

The site is situated in three vegetation units: Central Mountain Shale Renosterveld, Tanqua Escarpment Shrubland and Roggeveld Shale Renosterveld. Central Mountain Shale Renosterveld occupies the largest part of the site with Tanqua Escarpment Shrubland mostly in the west of the site and Roggeveld Shale Renosterveld in a small area of the northeast. (**Figure 4**).

The Central Mountain Shale Renosterveld vegetation unit consists of slopes and broad ridges of low mountains and escarpments, with tall shrubland dominated by renosterbos. Also, there are large suites of mainly non-succulent karoo shrubs with rich geophytic flora in the undergrowth. The geology of the area consists of clayey soils overlaying Adelaide subgroup mudstones and subordinate sandstones. Glenrosa and Mispah forms are prominent. The area has an Arid to Semi-arid climate with relatively even rainfall but still showing an increase in autumn and winter. Temperatures in the area range from a maximum of 29.9°C in January and a minimum of 0.9°C in July. There is a frost incidence 20-50 days a year. None of the unit is conserved. Only 1% of the unit has undergone transformation due to cultivation, urban development or plantations. Erosion is moderate.

Tanqua Escarpment Shrubland consists of steep flanks below an escarpment overlooking a basin generally facing southwest supporting succulent scrubland of medium height with an undergrowth of both succulent and non-succulent shrubs. Geology consists of mud rocks of the Adelaide subgroup and Permian Volksrust formation as well as brown to grey shale, siltstone and sandstone of the Permian Waterford formation broken by an intrusion of Jurassic Karoo dolerites. Less pronounced winter rainfall regime with most of the rain between March and August (peaking from June to August). Average temperature is 16° with the incidence of frost relatively high 30 days a year. Very small portions of the unit are conserved in the Tankwa Karoo National Park. No visible signs of transformation or invasion of alien plants. Erosion is moderate (59%)and low (41%).

The Roggeveld Shale Renosterveld vegetation unit consists of undulating slightly sloping plateau landscape with low hills and broad shallow valleys supporting mainly moderately tall shrubland dominated by renosterbos, with a rich geophytic flora in the wetter and rocky habitats. Mudrocks and sandstone of the Adelaide subgroup dominate the geology with some intrusions of the Karoo Dolerite Suite also present. Glenrosa and Mispah forms are prominent. MAP 180 - 430mm even throughout the year with a peak in March. Maximum and minimum temperatures are 29.3°C and 0.2°C in January and July, respectively. Frost is remarkably high for a Renosterveld type (30 - 70 days per year). None of the unit is conserved. Only 1% of the unit has undergone transformation but danger of overgrazing is locally high. Erosion is moderate (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
Central Mountain Shale Renosterveld	Moderate - High	Moderate - High	The mountain ridges, slopes and escarpments provide a wide variety of landscape features to enable the successful roosting and foraging of several insectivorous bat species.
Roggeveld Shale Renosterveld	Moderate	Moderate	The landscape features provide roosting space for bat species inhabiting rock crevices and caverns. The shrub vegetation provides a foraging niche which can be filled by clutter-edge and open air foraging bat species.
Tanqua Escarpment Shrubland	Moderate - High	Moderate	The mountain ridges, cliffs and escarpments provide suitable roosting and foraging habitat for several insectivorous bat species.

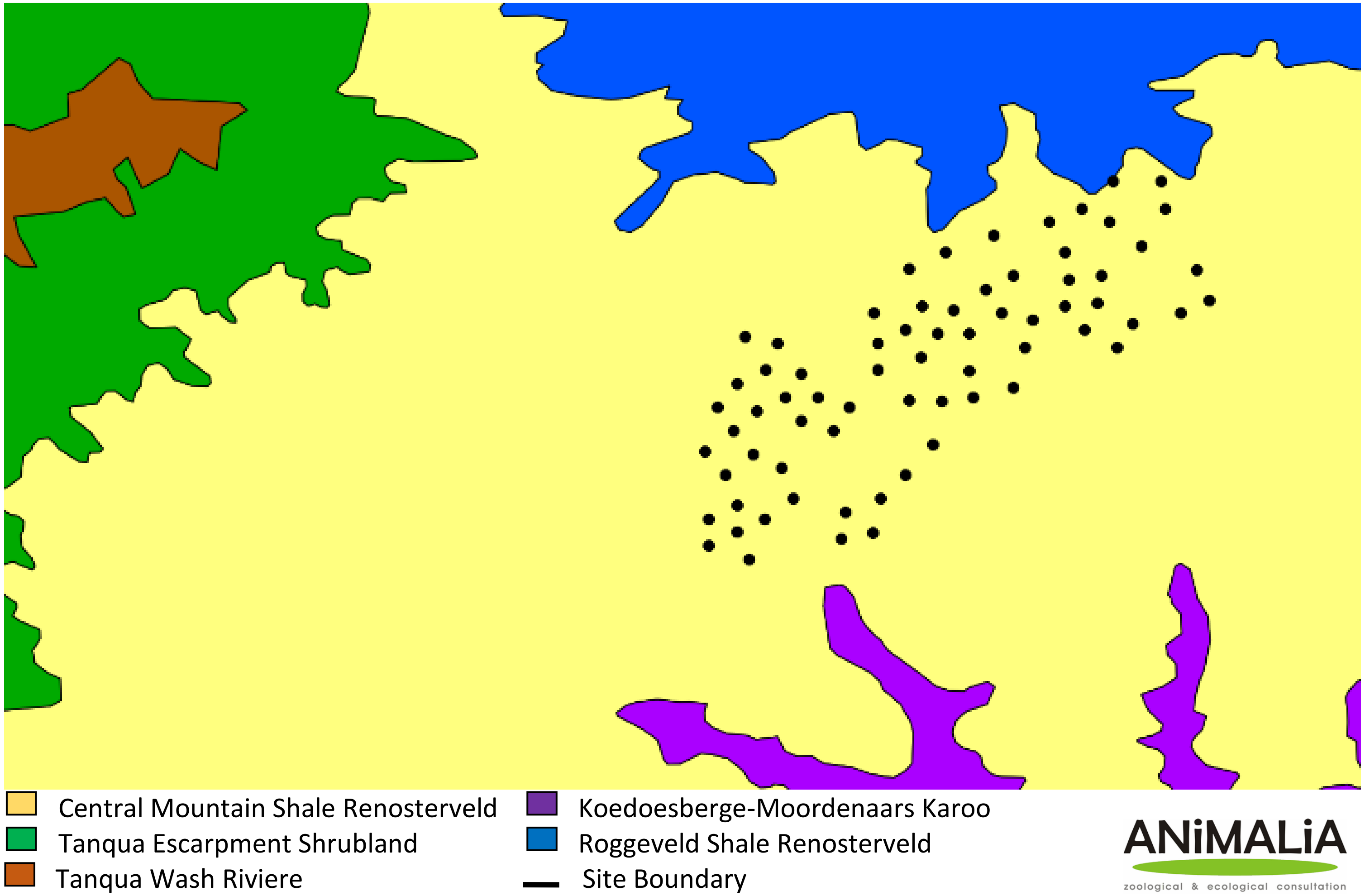


Figure 4: Vegetation units present on the site (Mucina and Rutherford 2006).

5.2 Species Probability of Occurrence

"Probability of Occurrence" is assigned based on consideration of the presence of roosting sites and foraging habitats on the site. The probability of occurrence is indicative of the likelihood of encountering the bat species on site.

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 traverse; and assumes a 100% probability of occurrence. The ecology of most applicable bat species recorded in the vicinity of the site is discussed below.

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

Species	Common name	Probability of occurrence	Conservation status	Possible roosting habitat on site	Possible roosting habitat utilized on site	Likelihood of risk of fatality
Tadarida aegyptiaca	Egyptian free-tailed bat	Confirmed	Least Concern	Caves, rock crevices, under exfoliating rocks, in hollow trees, and behind the bark of dead trees	Open-air forager	High
Sauromys petrophilus	Robert's flat-headed bat	90-100	Least Concern	Narrow cracks and slabs of exfoliating rock. Rocky habitat in dry woodland, mountain fynbos or arid scrub.	Open-air forager	High
Miniopterus natalensis	Natal long-fingered bat	Confirmed	Near Threatened	Cave and hollow dependent, but forage abroad. Also, take refuge in culverts and vertical hollows, holes.	Clutter-edge forager	Medium - High
Eptesicus hottentotus	Long-tailed serotine	Confirmed	Least Concern	Roosts in rock crevices	Clutter-edge forager	Medium - High
Neoromicia capensis	Cape serotine	Confirmed	Least Concern	Roosts under the bark of trees and under roofs of houses.	Clutter-edge forager	Medium - High

5.3 Ecology of bat species that may be largely impacted by the Maralla WEF

There are several bat species in the vicinity of the site that occur commonly in the area. These species are of importance based on their likelihood of being impacted by the proposed WEF, due to high abundances and certain behavioural traits. The relevant species are discussed below.

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, and is part of the Free-tailed bat family (Molossidae). It occurs from the Western Cape of South Africa, north through to Namibia and southern Angola; and through Zimbabwe to central and northern Mozambique (Monadjem *et al*. 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 caves, rock crevices, under exfoliating rocks, in hollow trees and behind the bark of dead trees. *Tadarida aegyptiaca* has also adapted to roosting in buildings, in particular roofs of houses (Monadjem *et al*. 2010). Thus, man-made structures and large trees on the site would be important roosts for this species.

Tadarida aegyptiaca forages over a wide range of habitats, flying above the vegetation canopy. It appears that the vegetation has little influence on foraging behaviour as the species forages over desert, semi-arid scrub, savanna, 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 due to wind turbines (Sowler and Stoffberg 2014). Due to the high abundance and widespread distribution of this species, high mortality rates due to wind turbines would be a cause of concern as these species have more significant ecological roles than the rarer bat species.

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

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 thought to have a Medium-High likelihood of risk of fatality due to wind turbines (Sowler and Stoffberg 2014).

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

Miniopterus natalensis

Miniopterus natalensis, also commonly referred to as the Natal long-fingered bat, occurs widely across the country but mostly within the southern and eastern regions and is listed as Near Threatened (Monadjem *et al*., 2010). This bat is a cave-dependent species and identification of suitable roosting sites may be more important in determining its presence in an area than the presence of surrounding vegetation. It occurs in large numbers when roosting in caves with approximately 260 000 bats observed making seasonal use of the De Hoop Guano Cave in the Western Cape, South Africa. Culverts and mines have also been observed as roosting sites for either single bats or small colonies. Separate roosting sites are used for winter hibernation activities and summer maternity behaviour, with the winter hibernacula generally occurring at higher altitudes in more temperate areas and the summer hibernacula occurring at lower altitudes in warmer areas of the country (Monadjem *et al*., 2010)

Mating and fertilisation usually occur during March and April and is followed by a period of delayed implantation until July/August. Birth of a single pup usually occurs between October and December as the females congregate at maternity roosts (Monadjem *et al.,* 2010 & Van Der Merwe, 1979).

The Natal long-fingered bat undertakes short migratory journeys between hibernaculum and maternity roosts. Due to this migratory behaviour, they are considered to be at high risk of fatality from wind turbines if a wind farm is placed within a migratory path (Sowler and Stoffberg, 2013). 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. This will be examined over the course of the 12-month monitoring survey.

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

Sowler and Stoffberg (2014) 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.

5.4 Transects

5.4.1 First Site Visit

Transects were not carried out over the first site visit due to the demanding nature of monitoring system installation. Further transects will be carried out over the following site visits.

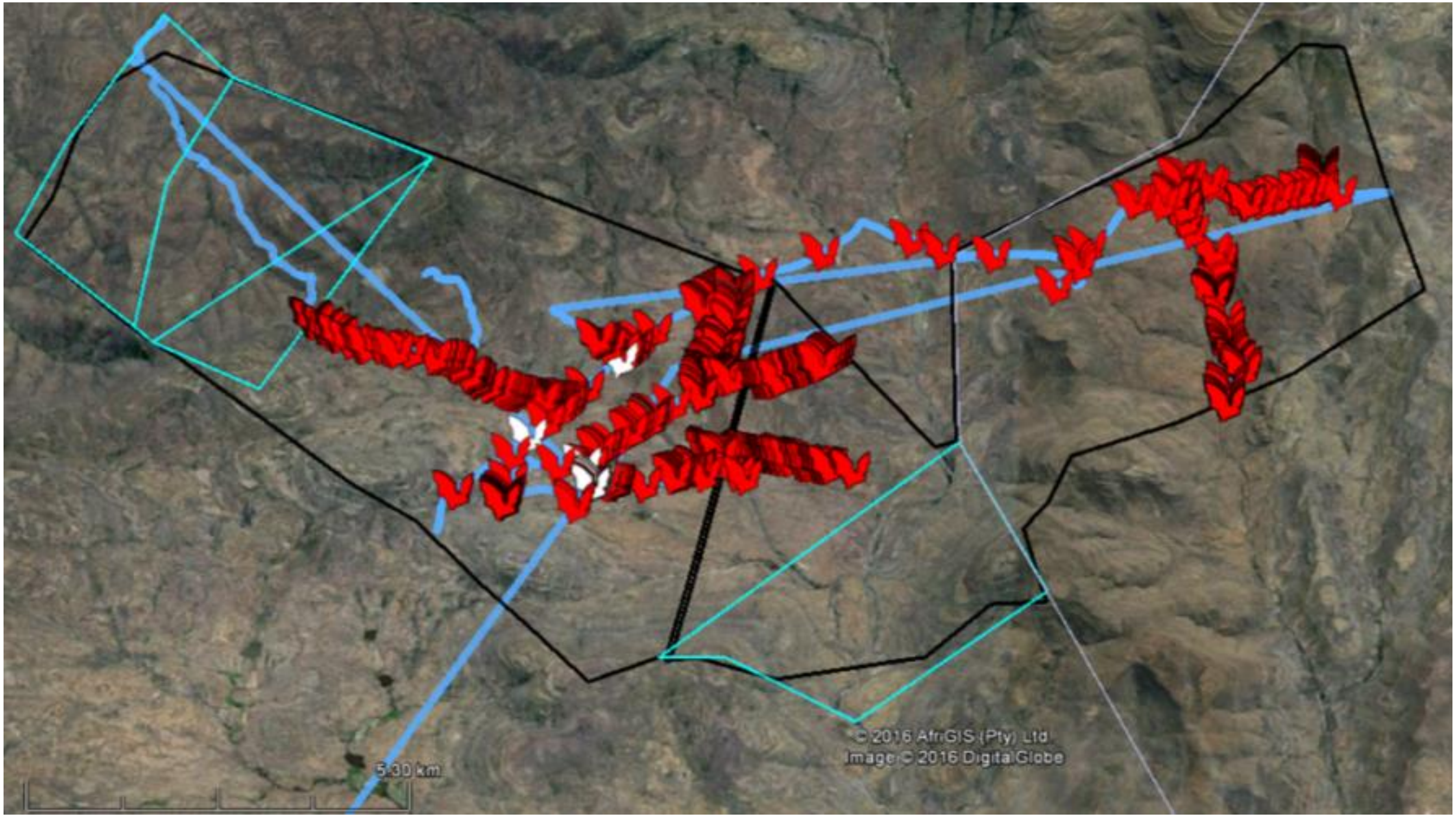
5.4.2 Second Site Visit

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 Sutherland, Northern Cape)

Date	Temperature (°C)	Rain (mm)	Wind (km/h)	Humidity (%)
8 February 2016	21.5	0	19	37.5
9 February 2016	27.5	0	8	22.5
10 February 2016	26.5	0	6.5	18
11 February 2016	27	0	6.5	36.5
12 February 2016	22	0	10	40.5
13 February 2016	21	0	17	52.5
14 February 2016	17.5	0	9.5	38
15 February 2016	17	0	13	43.5

Only two species, *Neoromicia capensis* and *Tadarida aegyptiaca*, were detected during transects across the site **(Figure 5 - 6).** *Tadarida aegyptiaca* was detected in relatively large abundance during the transect sampling period. The weather conditions were conducive to high bat activity.



Neoromicia capensis   Tadarida aegyptiaca   Transect route driven

Figure 5: Results of transect of the Maralla WEF site carried out over February 2016

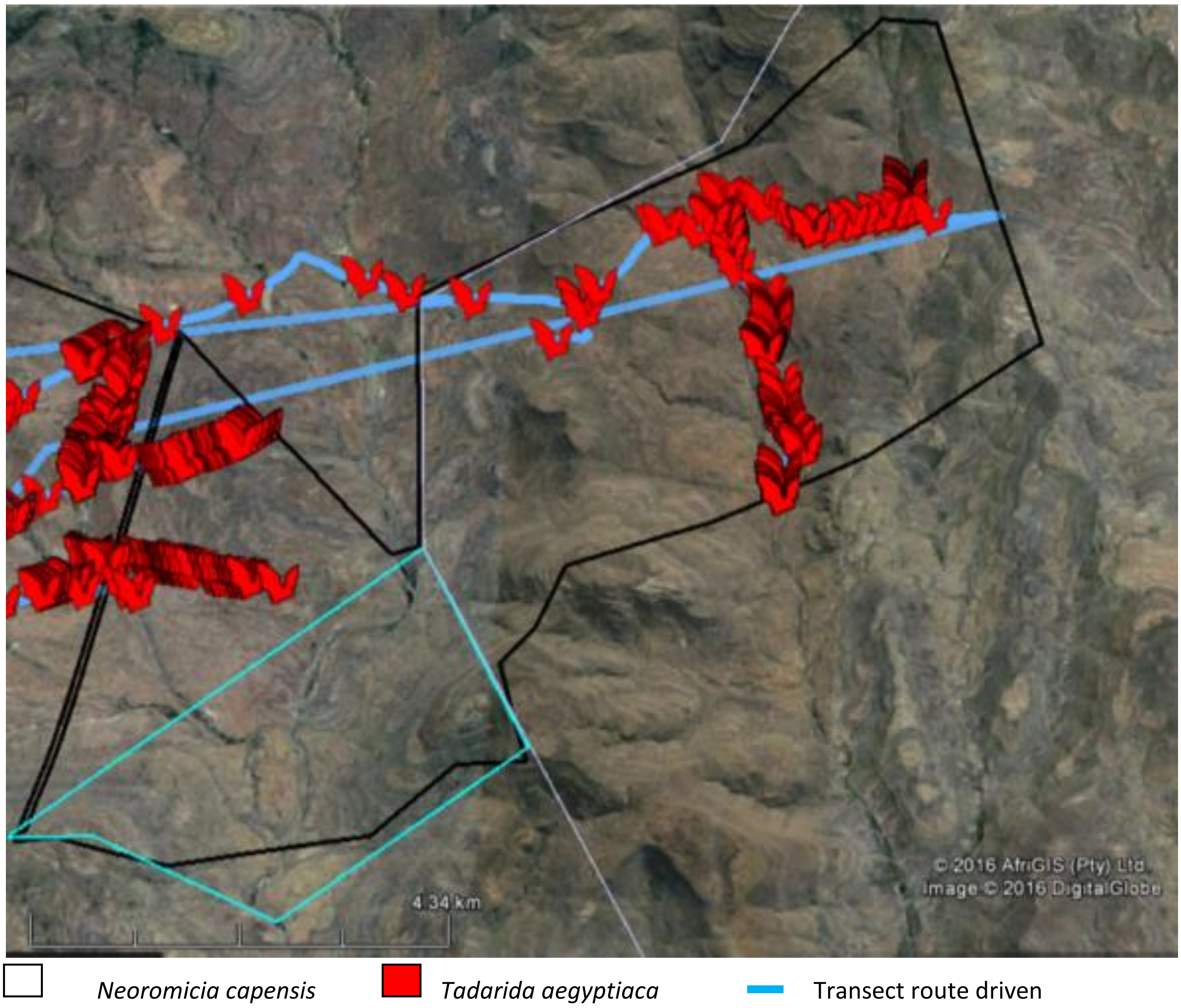


Figure 6: Results of transect of Maralla East WEF site carried out over February 2016

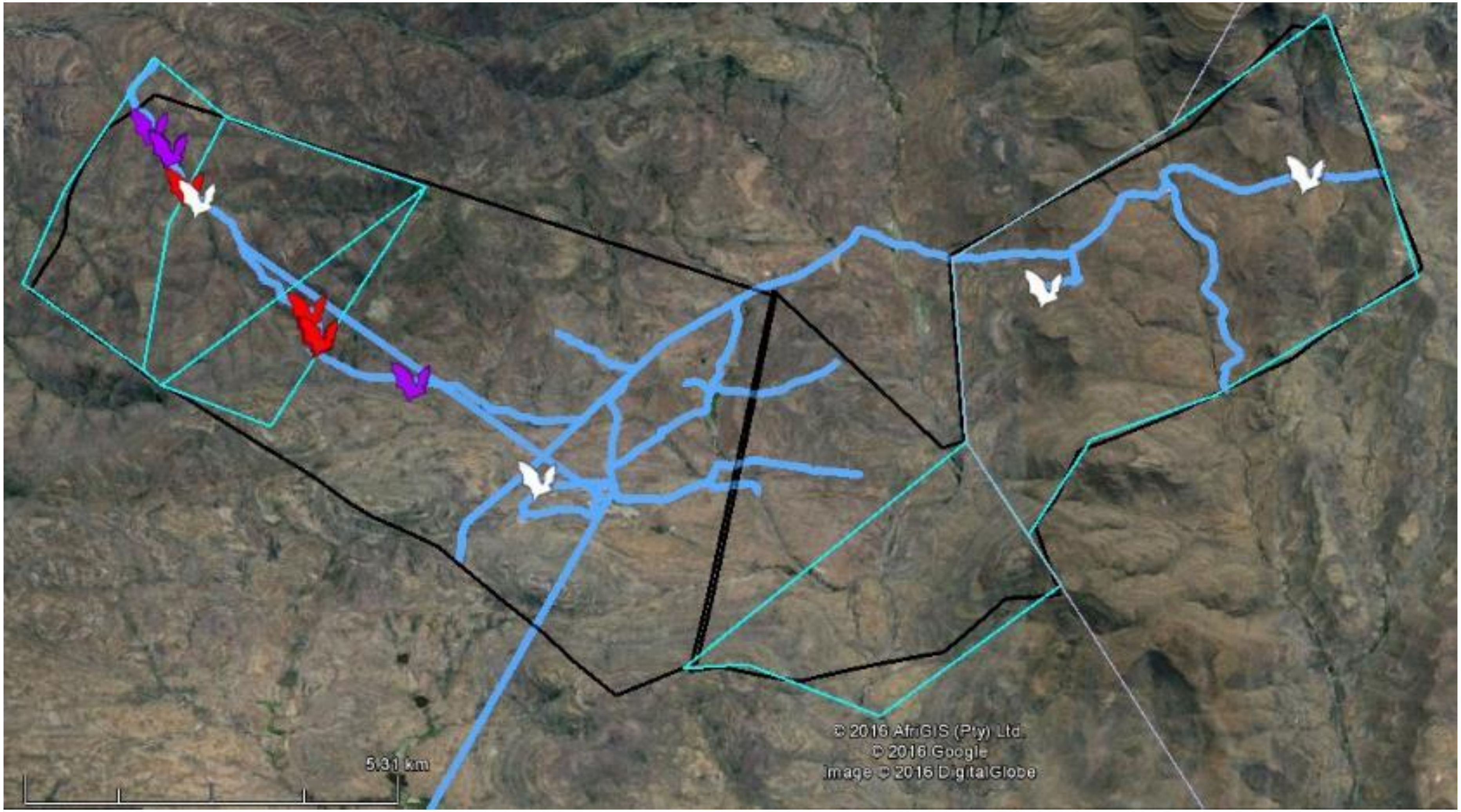
5.4.3 Third Site Visit

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 Sutherland, Northern Cape)

Date	Temperature (°C)	Rain (mm)	Wind (km/h)	Humidity (%)
21 May 2016	15.67	0	6	37.67
22 May 2016	15.67	0	13	41.33

Three species namely, *Neoromicia capensis, Tadarida aegyptiaca*, and *Miniopterus natalensis* were detected during transects across the site **(Figure 7 - 8).** Less bats were detected during the third transect, which could be due to the less hospitable weather conditions as the season changes, from autumn to winter.



Neoromicia capensis *Tadarida aegyptiaca* *Miniopterus natalensis* Transect route driven

Figure 7: Results of transect of the Maralla WEF site carried out over May 2016

Neoromicia capensis | Tadarida aegyptiaca | Miniopterus natalensis

Transect route driven

Figure 8: Results of transect of Maralla East WEF site carried out over May 2016

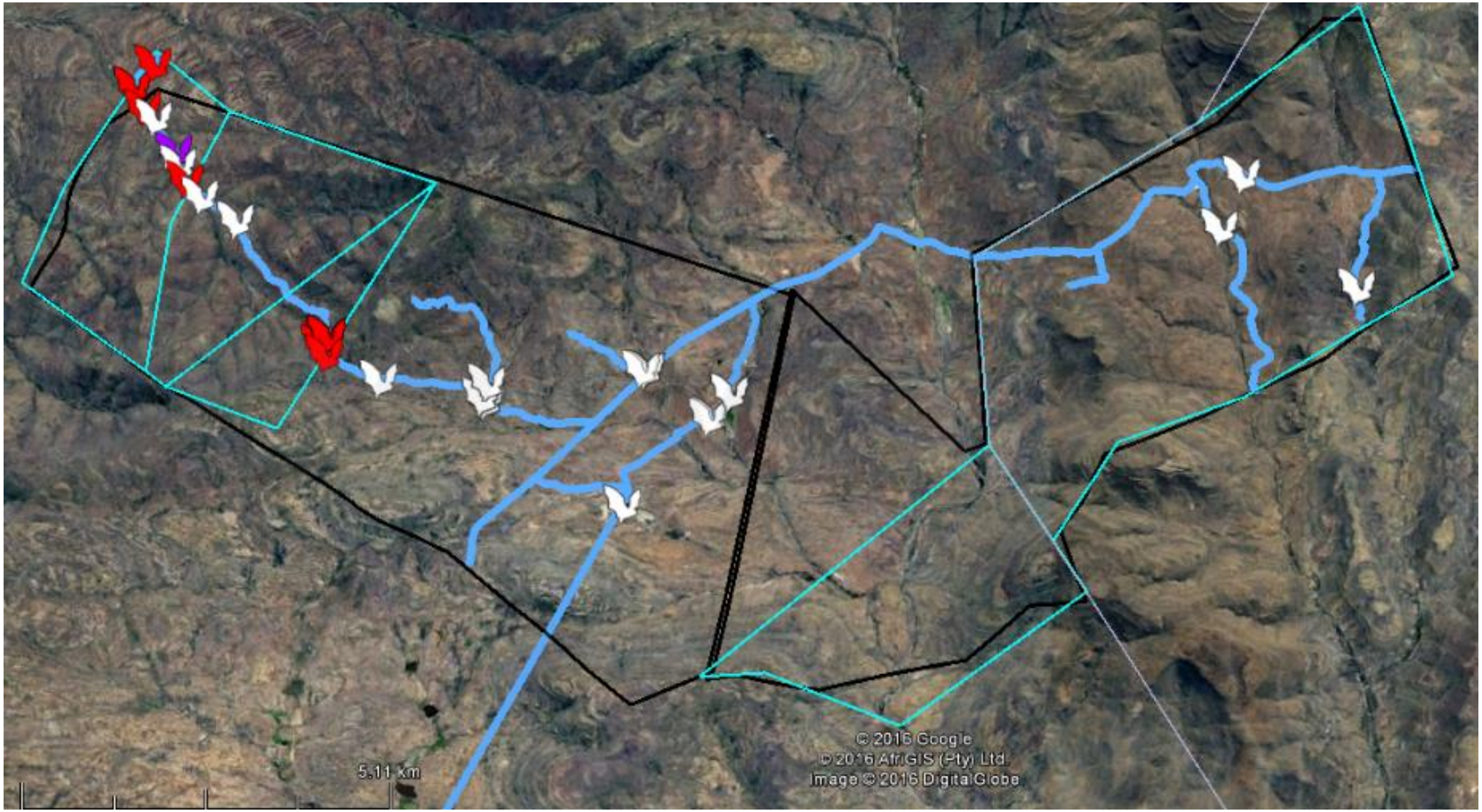
5.4.4 Fourth Site Visit

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 Sutherland, Northern Cape)

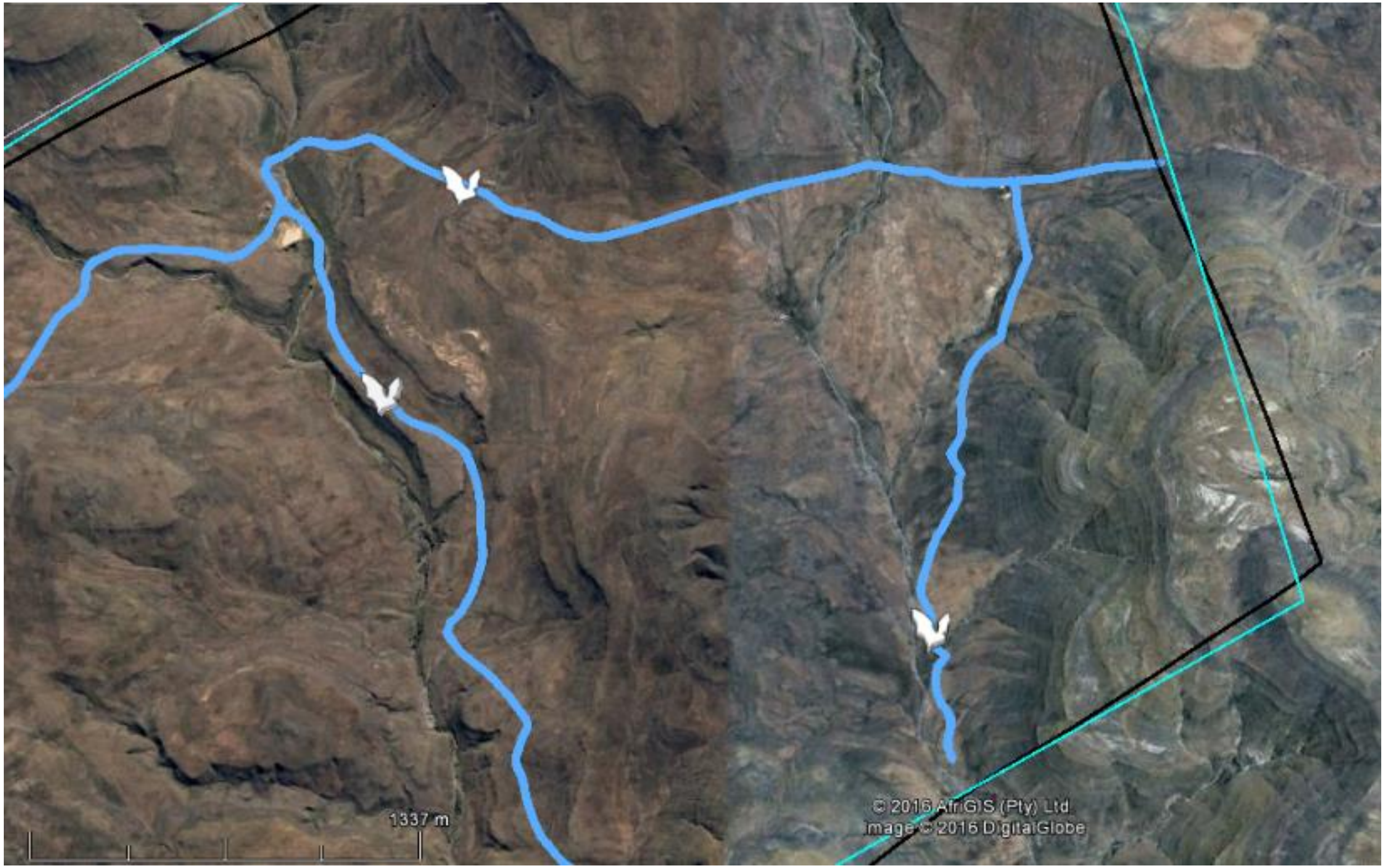
Date	Temperature (°C)	Rain (mm)	Wind (km/h)	Humidity (%)
10 August 2016	20	0.0	14.5	25
11 August 2016	19.5	0.0	10.5	32

Three species namely, *Neoromicia capensis, Tadarida aegyptiaca*, and *Miniopterus natalensis* were detected during transects across the site **(Figure 9 - 10).** A few more bats were detected during the fourth transect, compared to the third transect, which could be due to better weather conditions during the transect.



Neoromicia capensis *Tadarida aegyptiaca* *Miniopterus natalensis* Transect route driven

Figure 9: Results of transect of the Maralla WEF site carried out over August 2016



Neoromicia capensis *Tadarida aegyptiaca* *Miniopterus natalensis* Transect route driven

Figure 10: Results of transect of the eastern section of the Maralla East WEF site carried out over August 2016

5.5 Sensitivity Map

Figure 11 - 13 depicts the sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that are most probable to occur on site. Thus, the sensitivity map is based on species ecology and habitat preferences. This map can be used as a pre-construction mitigation in terms of improving turbine placement with regards to bat preferred habitats on site.

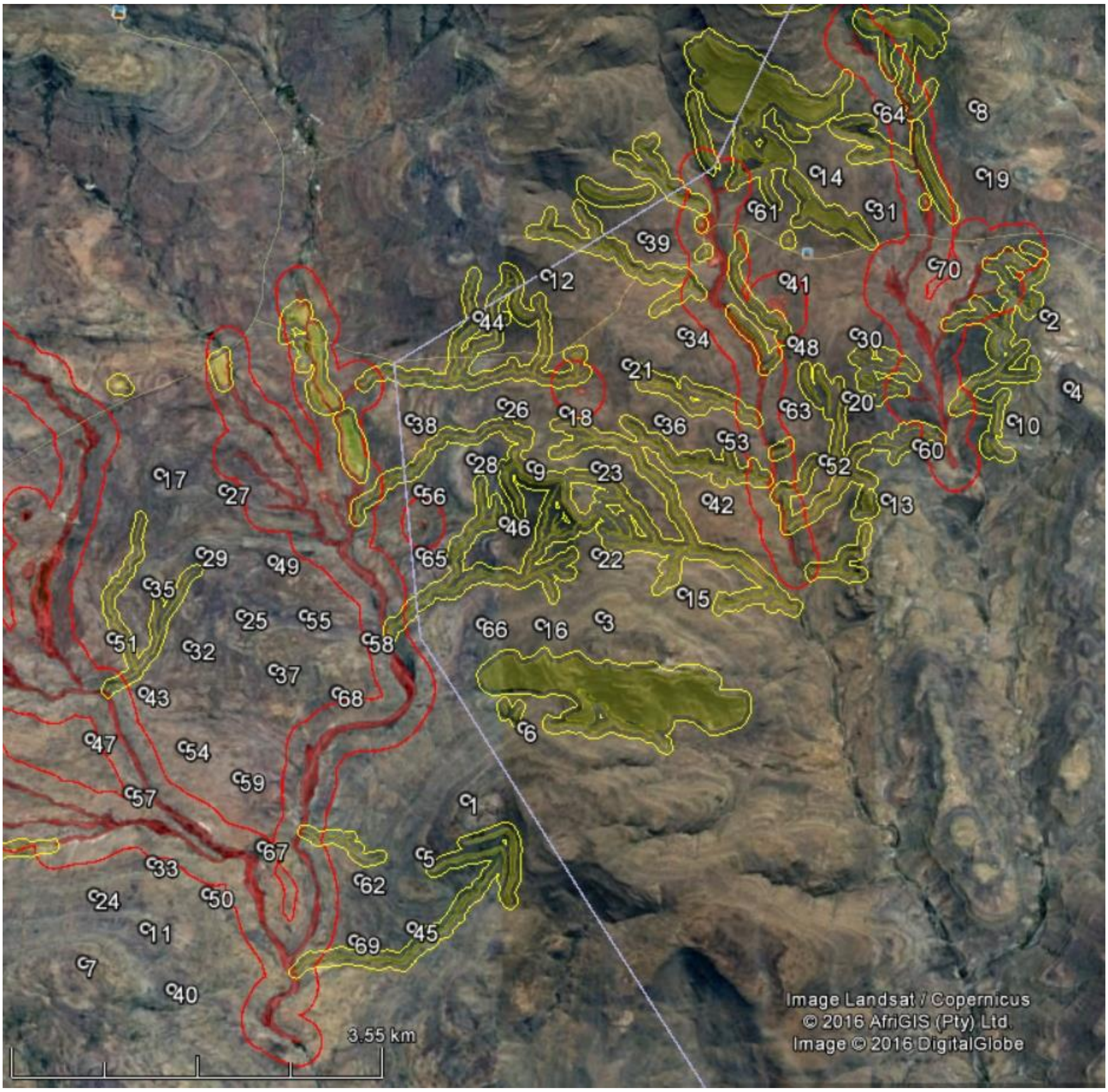
Table 6: Description of parameters used in the construction of a sensitivity map

Last iteration	March 2017
High sensitivity buffer	200m radial buffer
Moderate sensitivity buffer	50m radial buffer
Features used to develop the sensitivity map	Manmade structures, such as houses, barns, sheds and road culverts, these structures provide easily accessible roosting sites.
	The presence of probable hollows/overhangs, rock faces and clumps of larger woody plants. These features 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.
	Areas frequented often by cattle and livestock (e.g. congregation areas and kraal areas) were assigned a moderate sensitivity since large groups of animals tend to attract insects.
	Areas frequented often by cattle and livestock (e.g. congregation areas and kraal areas) were assigned a moderate sensitivity since large groups of animals tend to attract insects.

Table 7: Description of sensitivity categories utilized in the sensitivity map

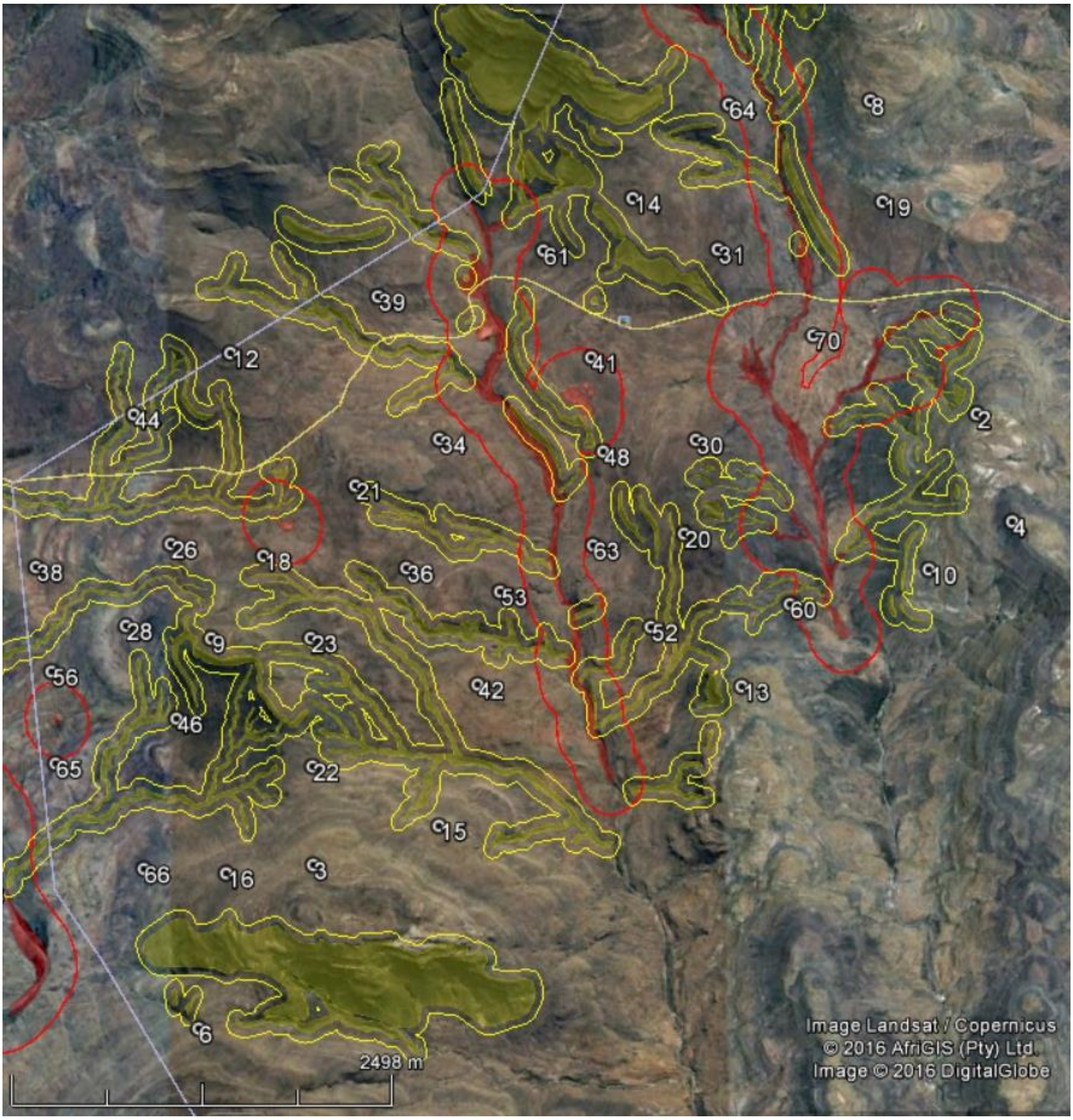
Sensitivity	Description
Moderate Sensitivity	Areas of foraging habitat or roosting sites considered to have significant roles for bat ecology. Turbines within or close to these areas must acquire priority (not excluding all other turbines) during pre/post-construction studies and mitigation measures will need to be applied immediately from the start of operation.
High Sensitivity	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 and their buffers.

The bat sensitivity map has been reviewed and revised from the original version compiled at the onset of the bat monitoring study. The map has been revised based on the results of this monitoring survey. Several high sensitivity areas have been downgraded to moderate sensitivity areas after ground truthing of the different types of water drainage areas. The moderate sensitivity buffer distances have also been reduced from 100m to 50m.



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

Figure 11: Bat sensitivity map of the Maralla East WEF site



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

Figure 12: Bat sensitivity map of the north east section of Maralla East WEF with proposed turbine layout

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

Figure 13: Bat sensitivity map of the south west section of Maralla East WEF with proposed turbine layout

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) and total number of bat passes detected over the monitoring period by all systems are displayed in **Figures 14 - 21**. 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* and *Tadarida aegyptiaca*, 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. It was detected by all the monitoring systems, except for Short Mast 3. The relative abundance of this species, as detected by the monitoring systems, was over the months of April – July 2016, with it being highest in June 2016 (Short Mast 2) (**Figures 18 – 21**). The data was assessed for evidence of a migratory event and none was found. The data depicts the wind energy facility site to not be located within a migratory route. However, a migratory event may occur in future. Thus, it is essential that a long-term bat monitoring study be implemented as soon as the wind farm becomes operational to mitigate the impacts in such an event.

Met Mast 2 monitoring system detected a significantly higher number of bat passes than any of the other monitoring systems, with 8949 passes at 10m **(Figure 14)**. Short Mast 1 followed it with 5515 bat passes at 10m **(Figure 15)**. There is a vertical gradient in bat activity across the two monitoring heights of 10m and 80m above the ground. Bat activity was greater at 10m above the ground, this is most likely due to better foraging and flying conditions.

Met Mast 2 monitoring system had its highest bat activity during the summer months, with a peak in December 2015, after which a decrease in activity was shown as the seasons changed from summer to autumn to winter. As the seasons changed to spring, bat activity increased again. March 2016 saw an increase in the average number of *Neoromicia capensis* passes and subsequently increased during the months that followed until May 2016 **(Figure 18)**. Short Mast 1 monitoring system showed high bat activity during the summer months, with a peak in January 2016 for *Tadarida aegyptiaca,* whereafter *Neoromicia capensis* increased in February and March 2016. Short Mast 1 bat activity for April 2016 could not be indicated due to system failure, but as seasons changed from winter to spring bat activity increased again with the highest peak in activity during October 2016 by *Neoromicia capensis* (**Figure 19**). Short Mast 2 and 3 had a peak in activity during December 2015 **(Figure 20 - 21)**.

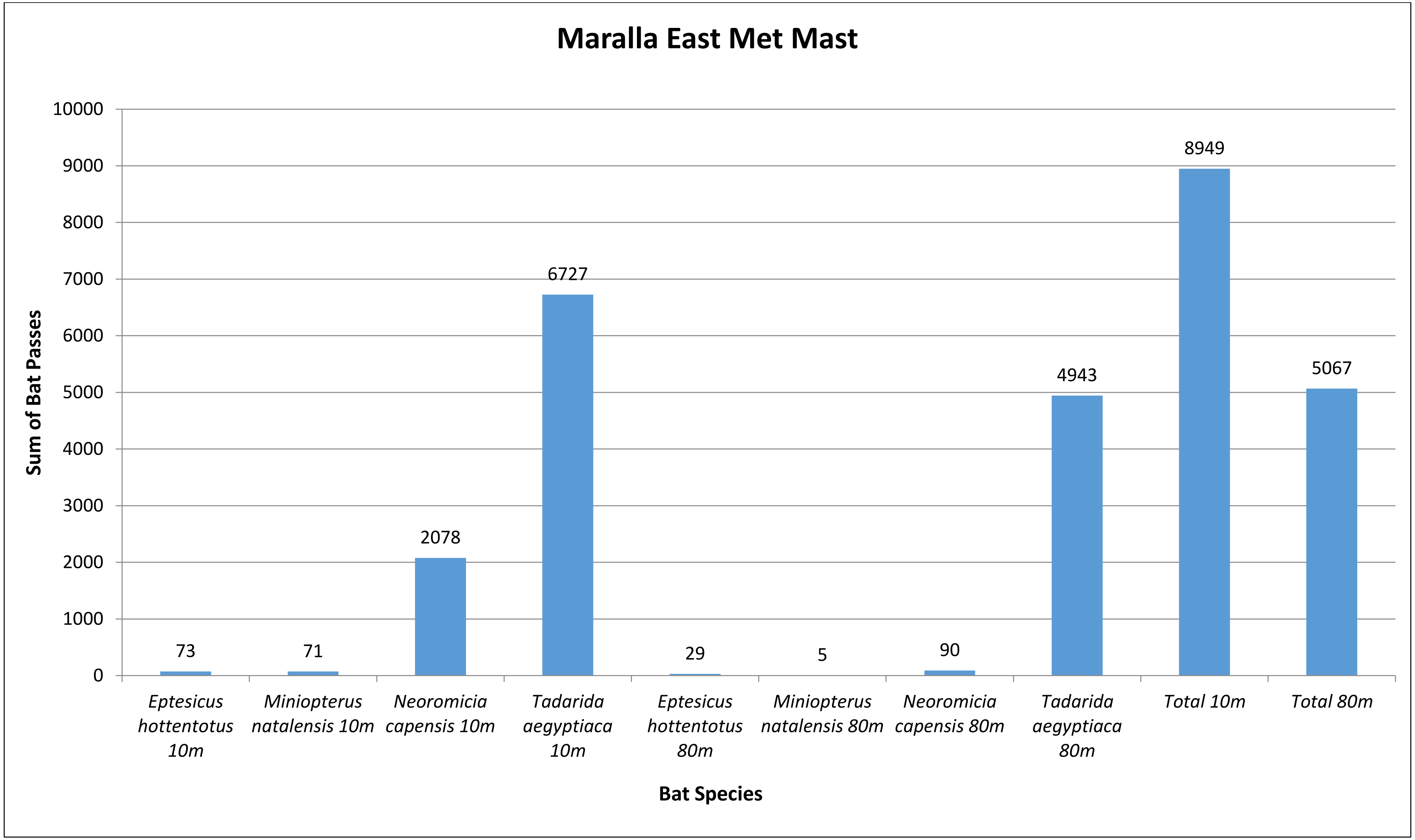


Figure 14: Sum of bat passes per species detected by the Maralla East Met Mast monitoring system.

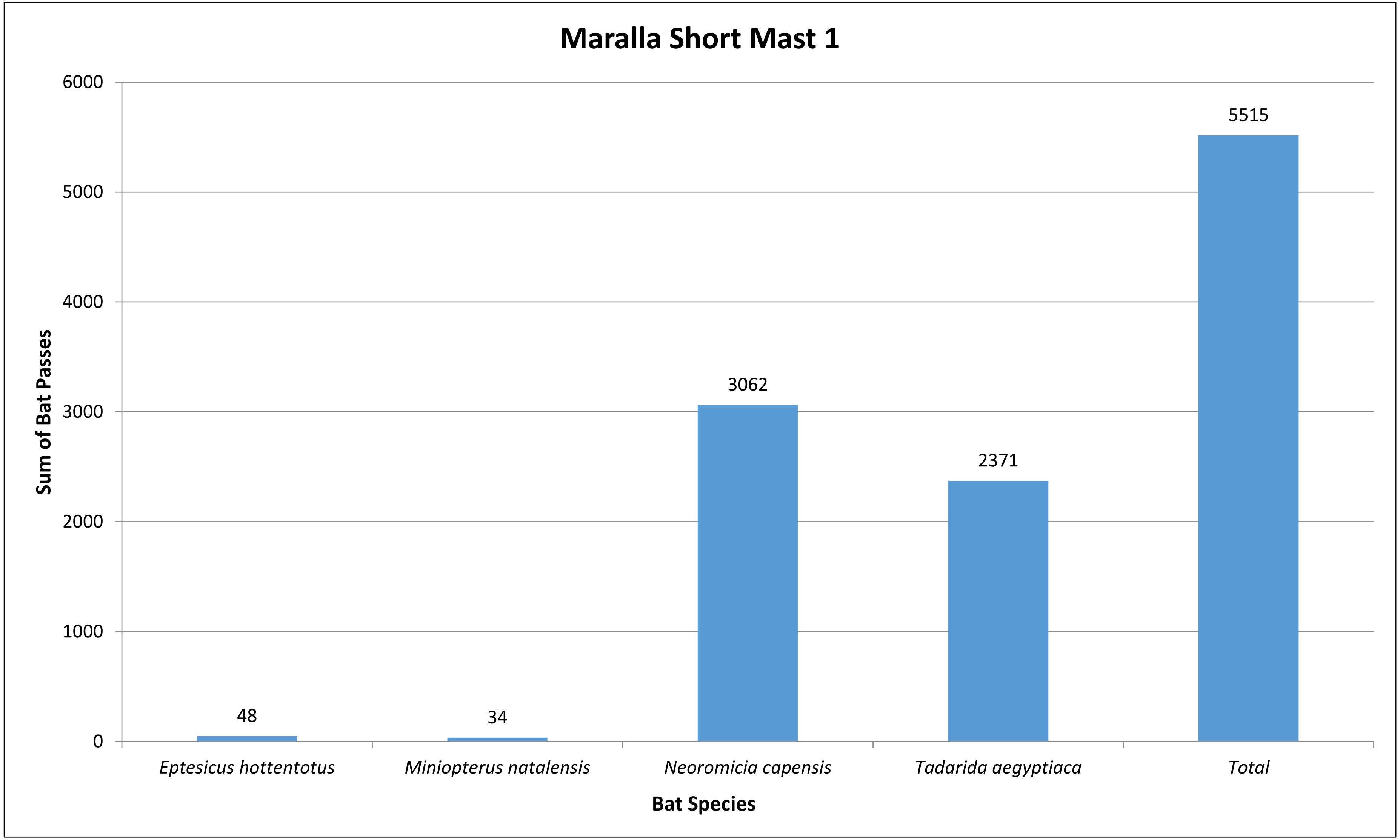


Figure 15: Sum of bat passes per species detected by the Maralla Short Mast 1 monitoring system.

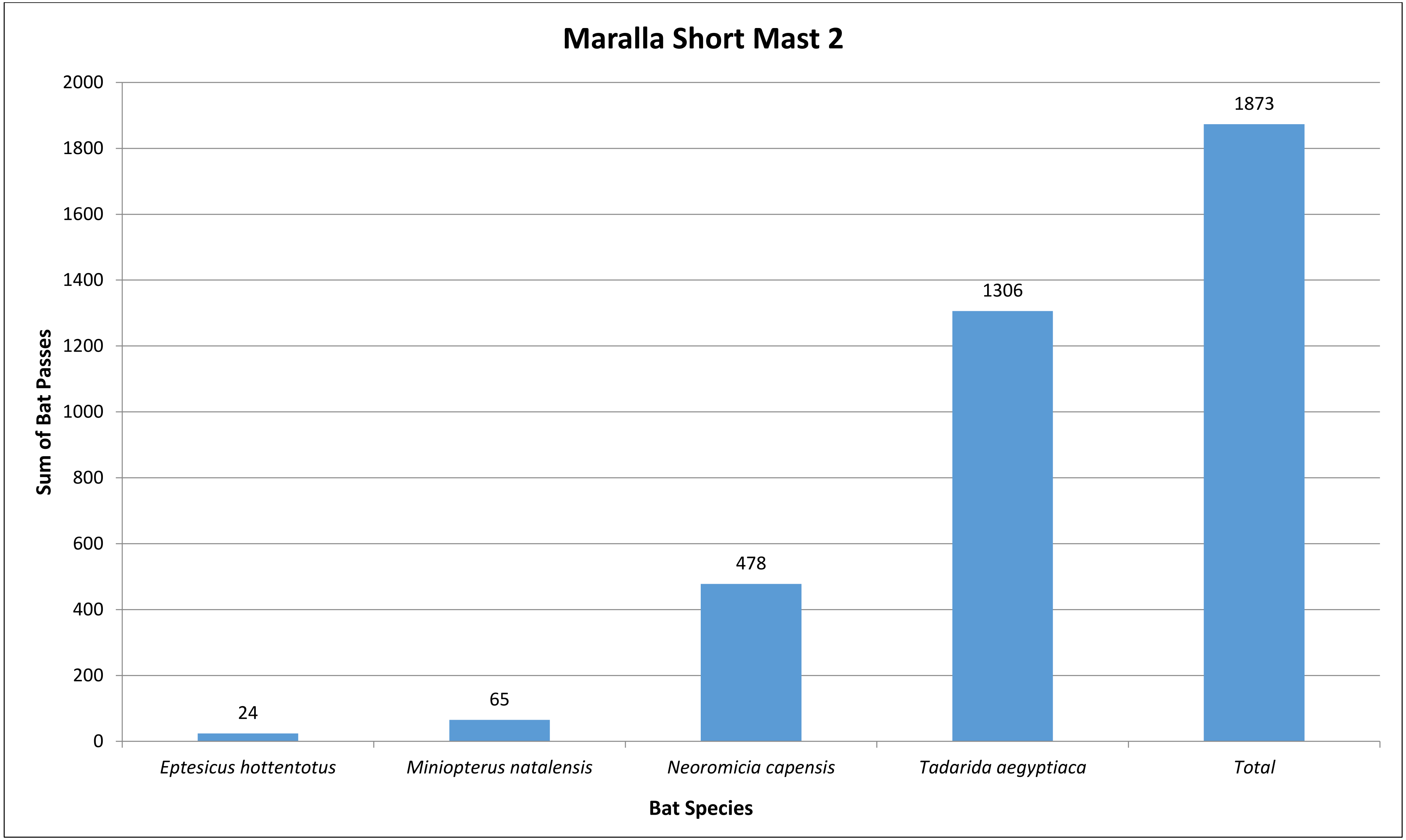


Figure 16: Sum of bat passes per species detected by the Maralla Short Mast 2 monitoring system.

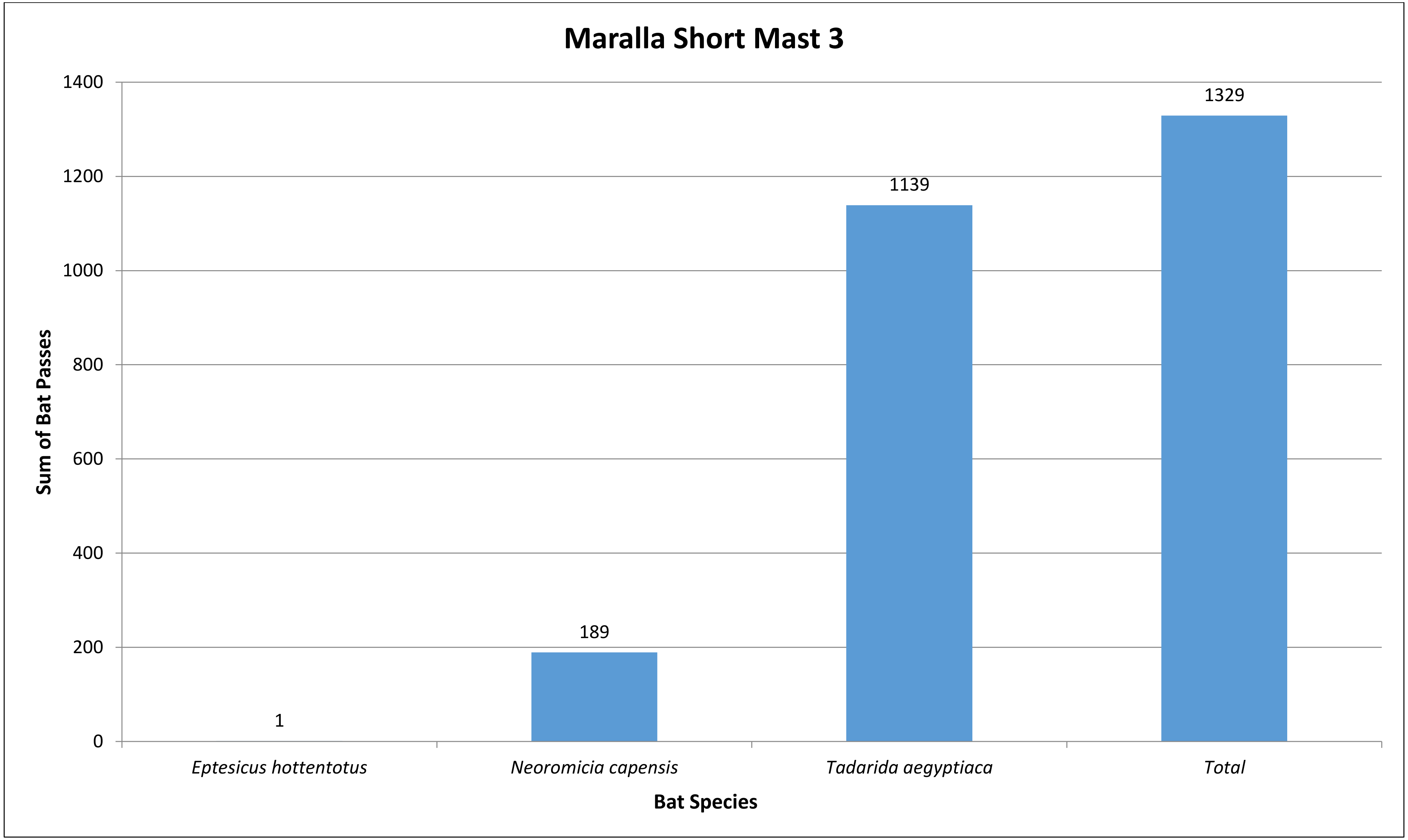


Figure 17: Sum of bat passes per species detected by the Maralla Short Mast 3 monitoring system.

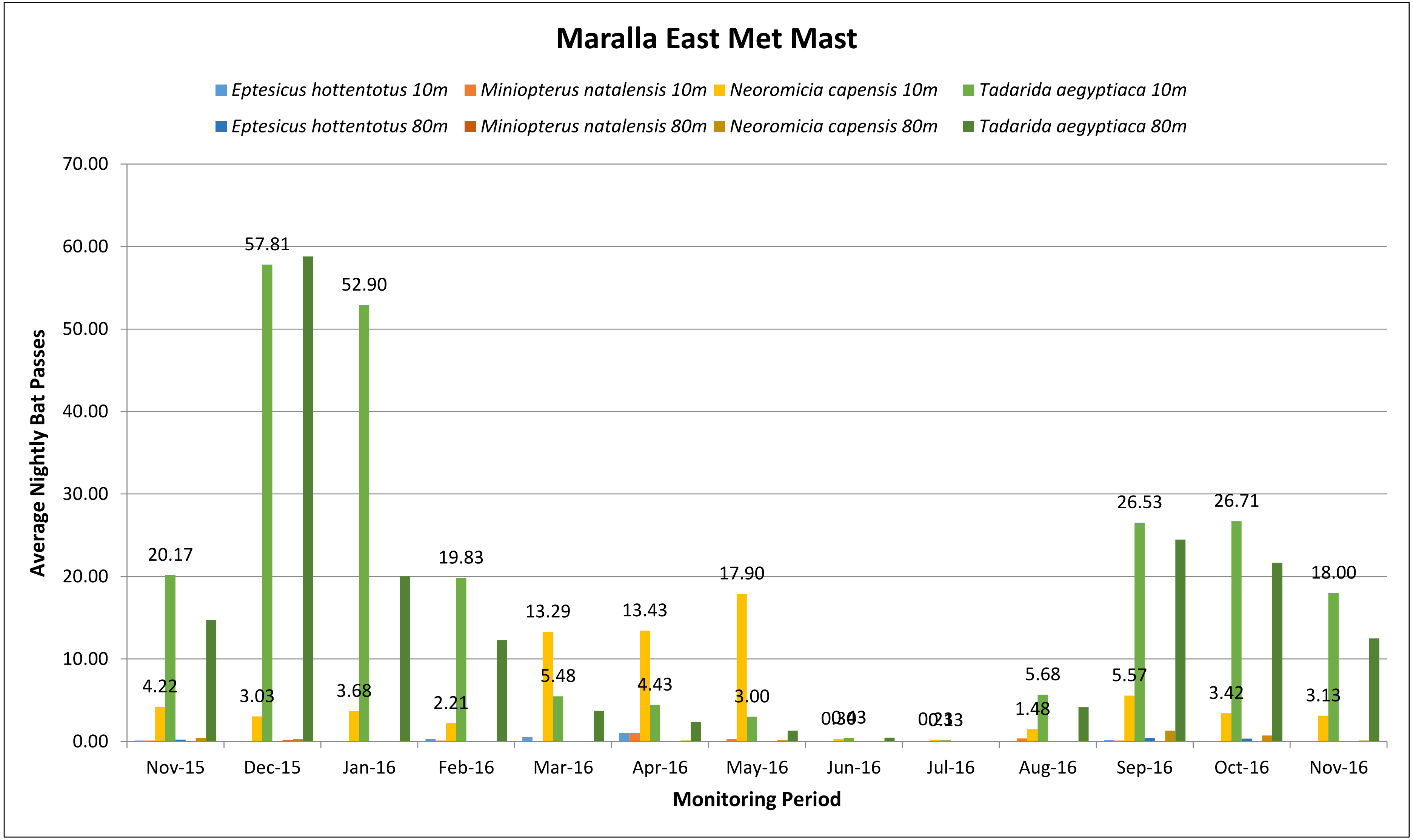


Figure 18: Average nightly bat passes detected per month by the Maralla East Met Mast monitoring system

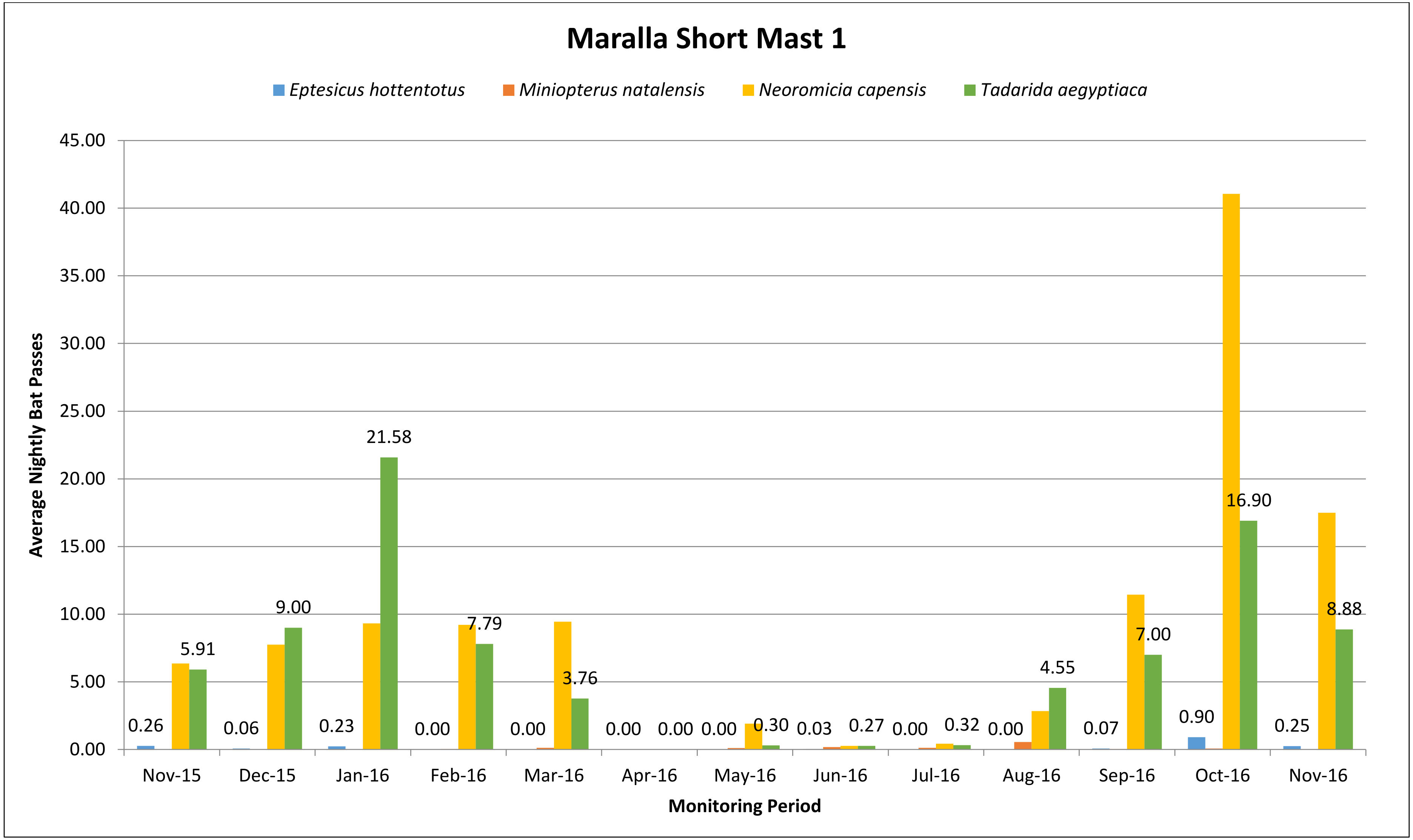


Figure 19: Average nightly bat passes detected per month by the Maralla Short Mast 1 monitoring system

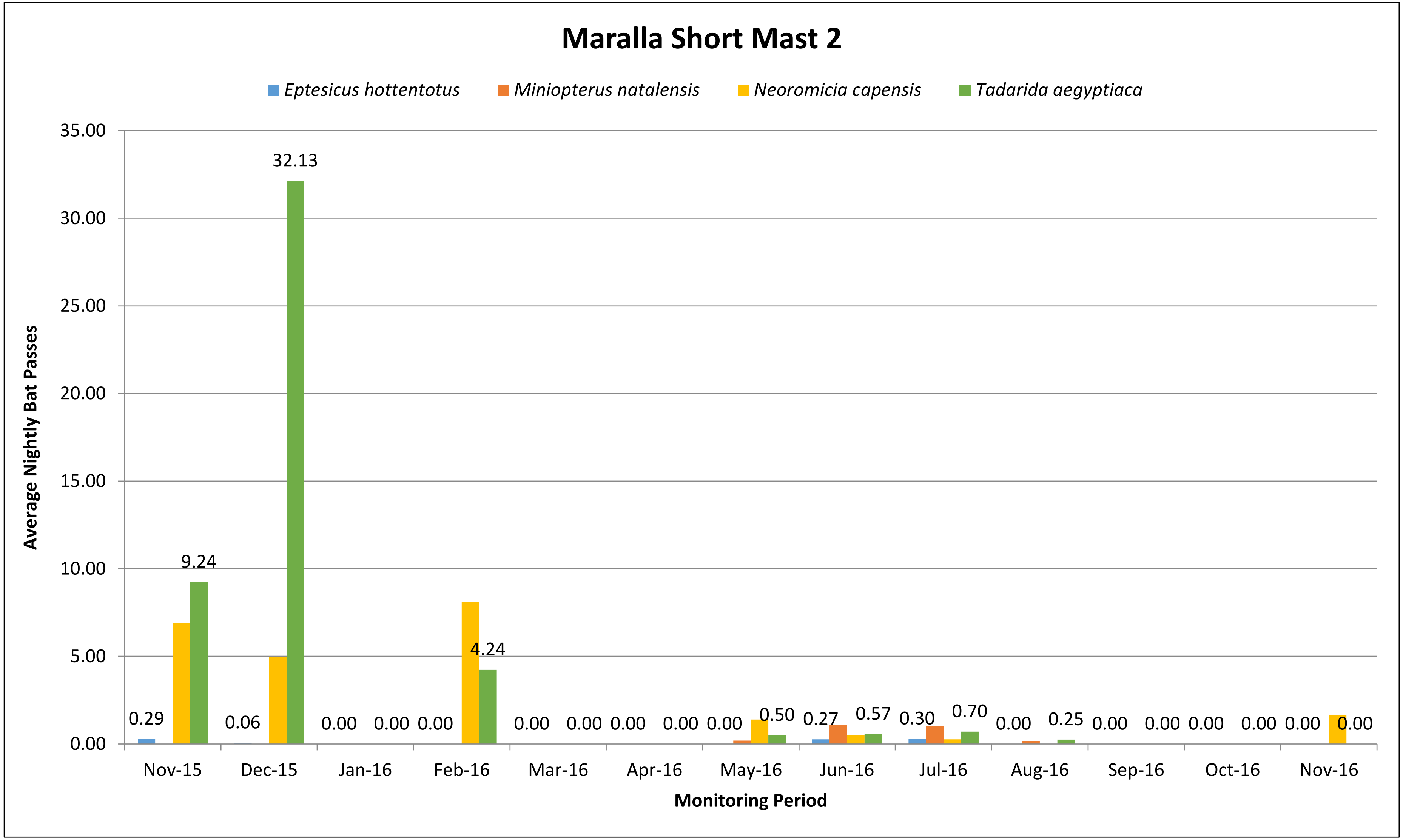


Figure 20: Average nightly bat passes detected per month by the Maralla Short Mast 2 monitoring system

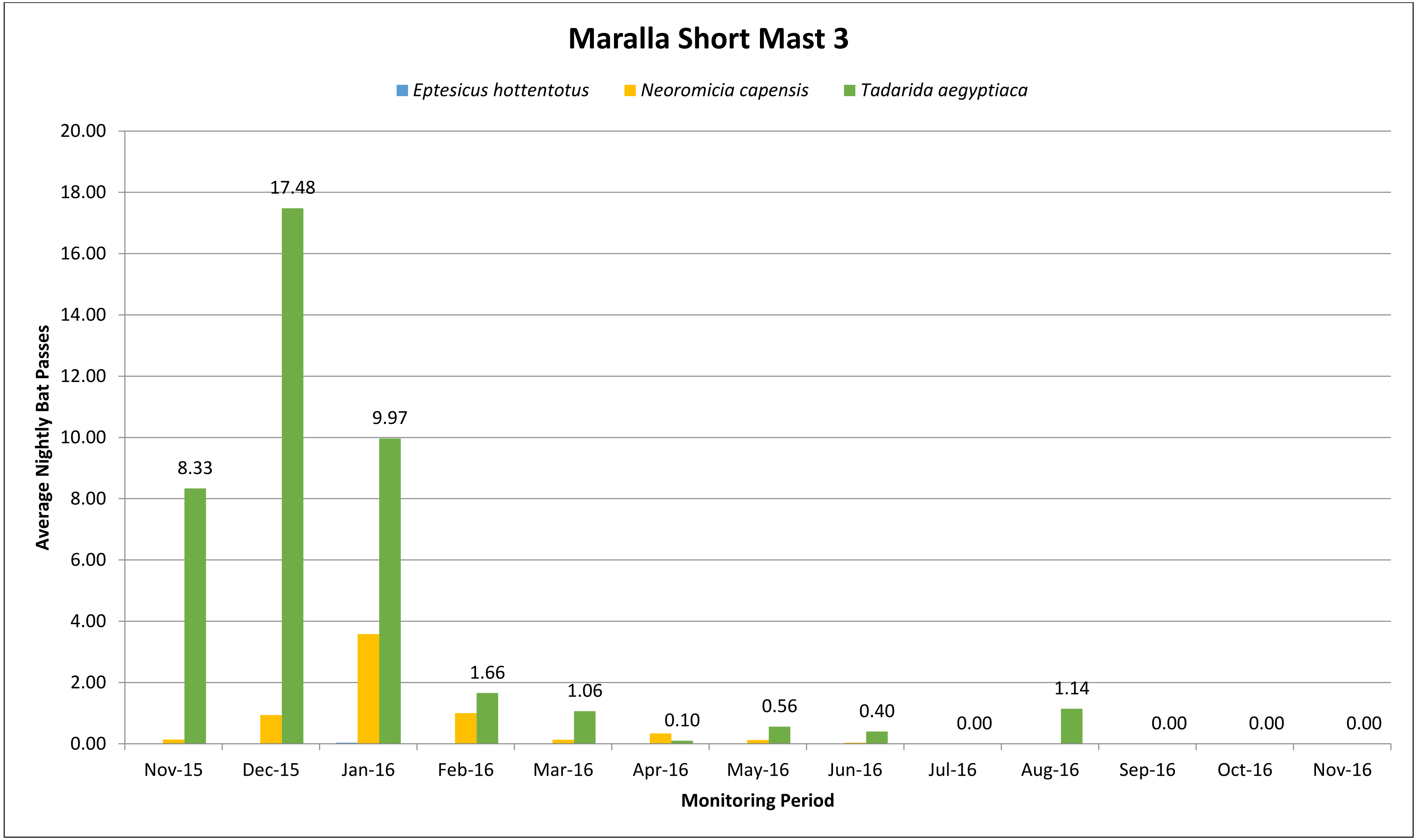


Figure 21: Average nightly bat passes detected per month by the Maralla Short Mast 3 monitoring system

5.6.2 Temporal Distribution

The sum of all bat passes recorded by the monitoring systems of the particular species are displayed per night over the entire monitoring period (**Figures 22 - 25**). The peak activity times identified are mostly the temporal distribution of *Tadarida aegyptiaca* as they were the species detected more often by a substantial margin. This data is used to inform the peak times that may inform mitigation, if needed.

Periods of elevated bat activity as depicted in **Figures 22 - 25** are as follows:

Maralla East Met Mast

- Mid November 2015 – early March 2016 **(highest peak in bat activity)**
- Mid-March – end May 2016
- Late August – early November 2016

Short Mast 1

- End November 2015 – early February 2016
- Mid-February – end March 2016
- End-August – early November 2016 **(highest peak in bat activity)**

Short Mast 2

- Mid November – end December 2015 **(highest peak in bat activity)**
- Mid-February 2016
- End June 2016

Short Mast 3

- Mid November 2015 – end January 2016 **(highest peak in bat activity)**
- Mid-February – early March 2016

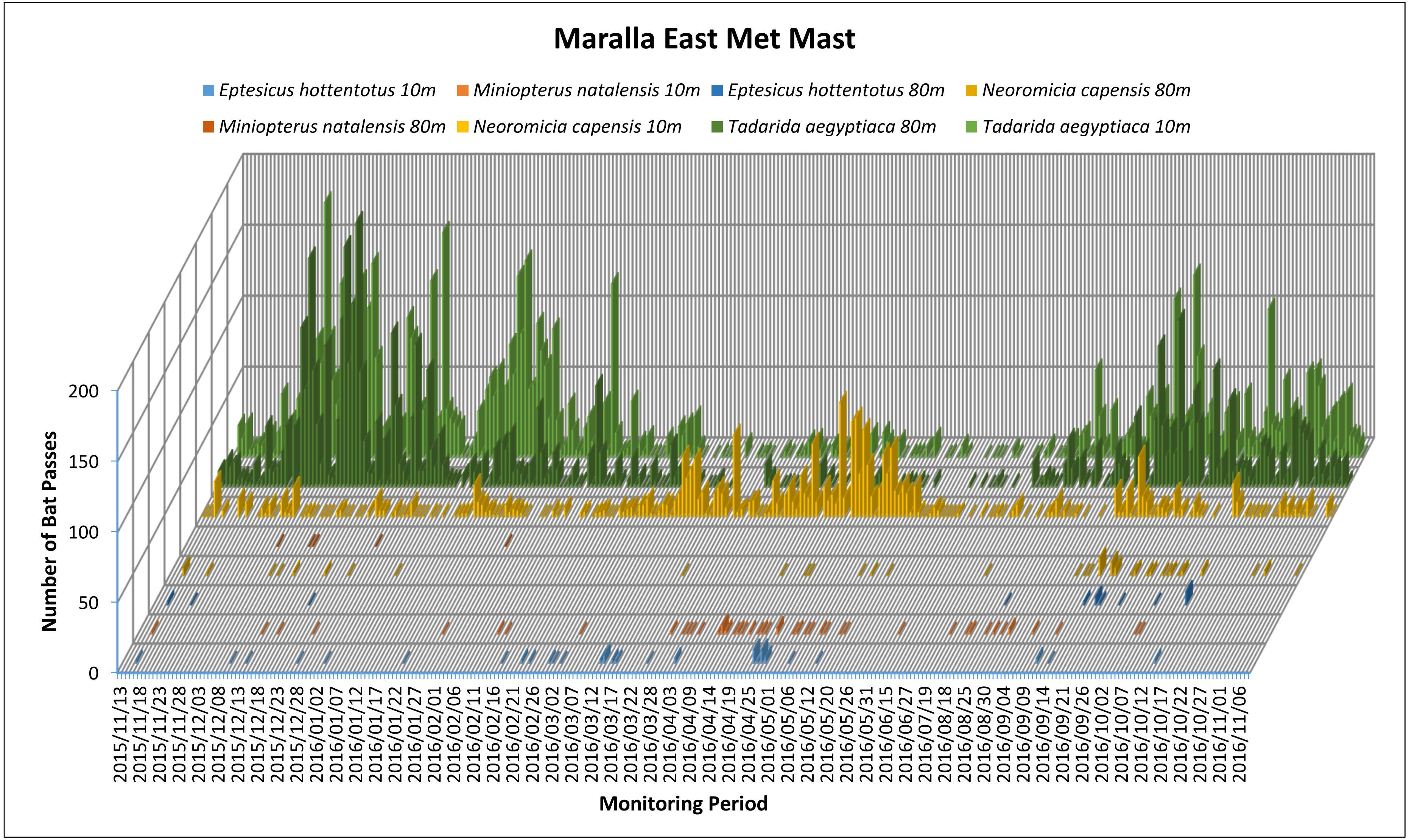


Figure 22: Temporal distribution of bat passes detected by Maralla East Met Mast over the monitoring period

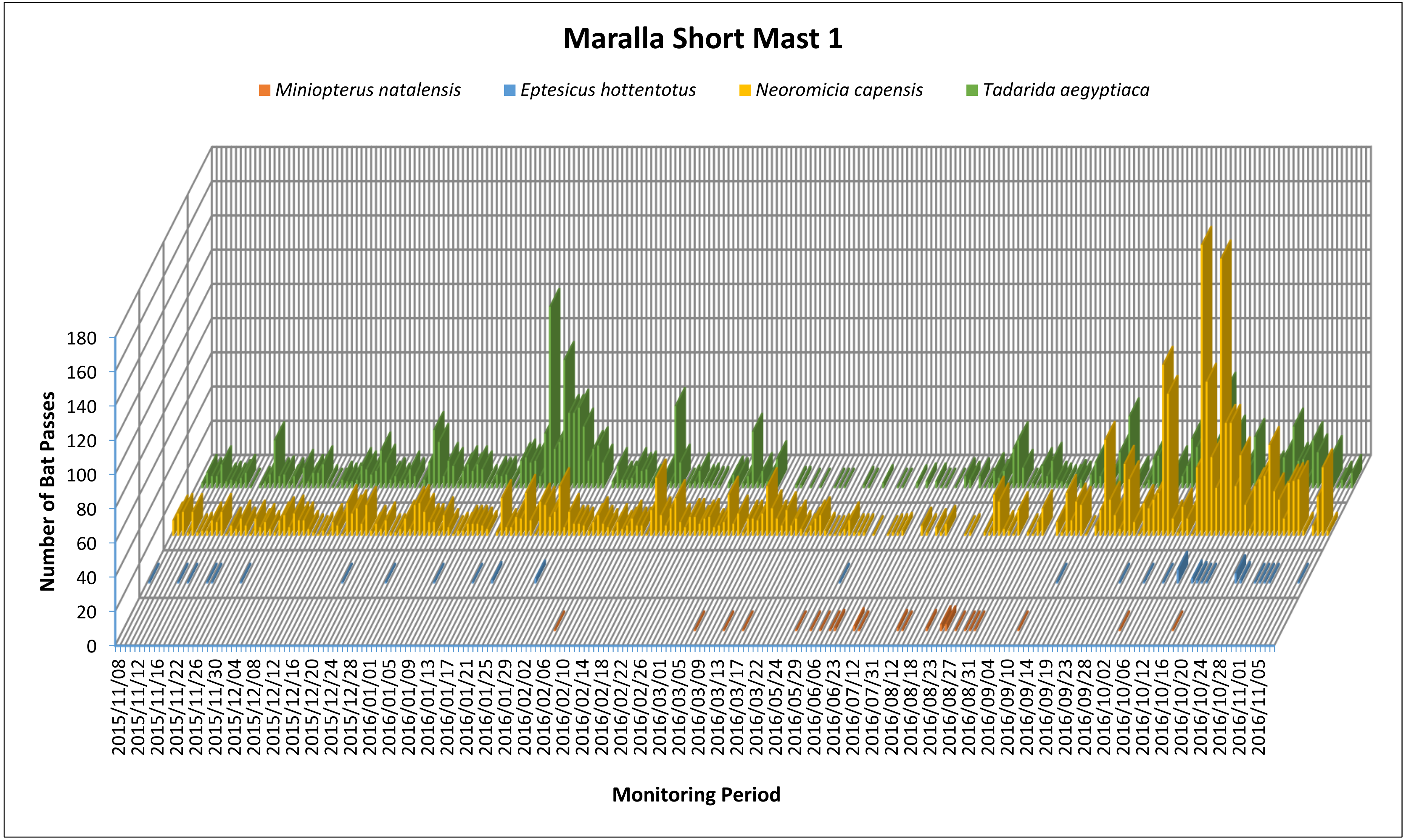


Figure 23: Temporal distribution of bat passes detected by Maralla Short Mast 1 over the monitoring period

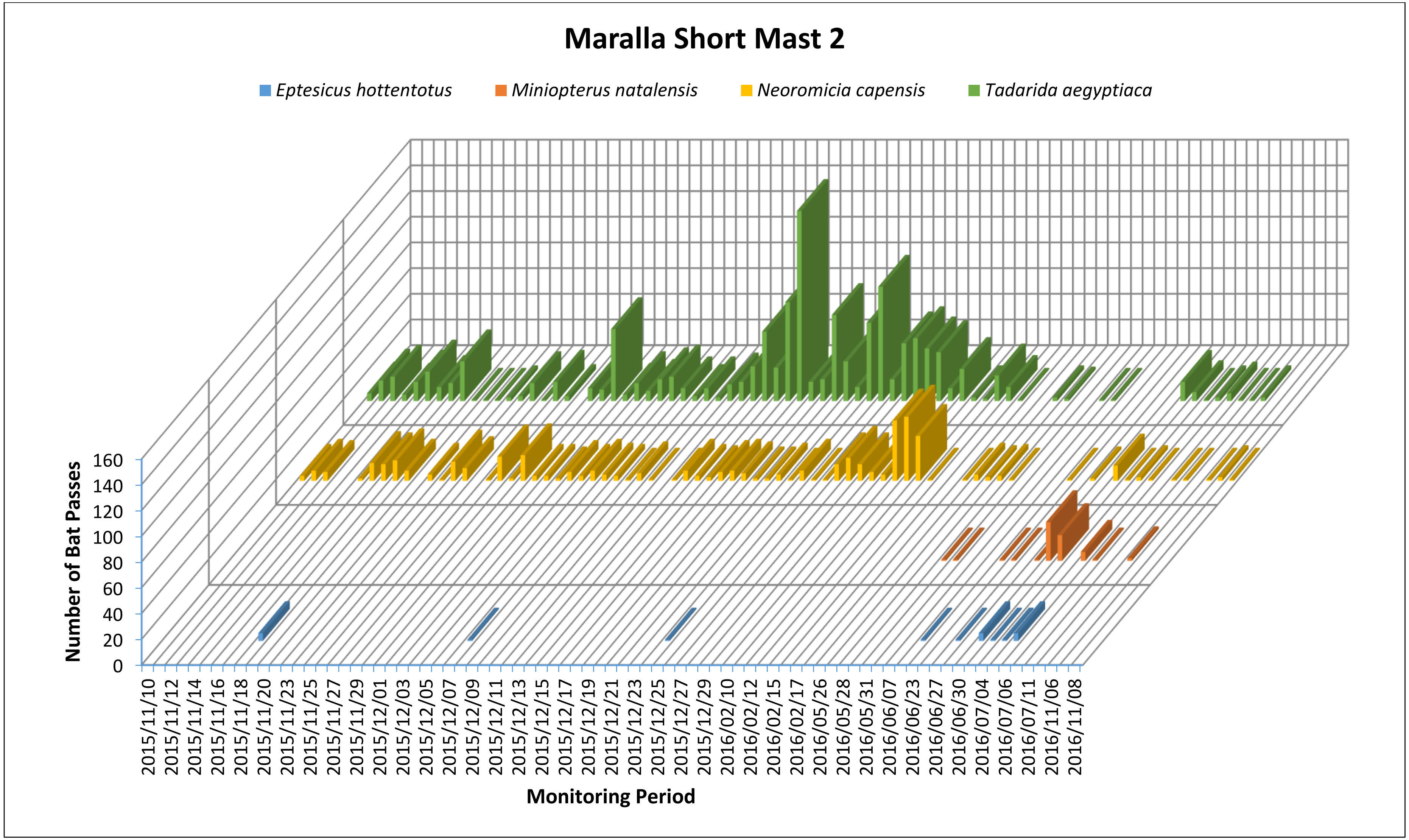


Figure 24: Temporal distribution of bat passes detected by Maralla Short Mast 2 over the monitoring period

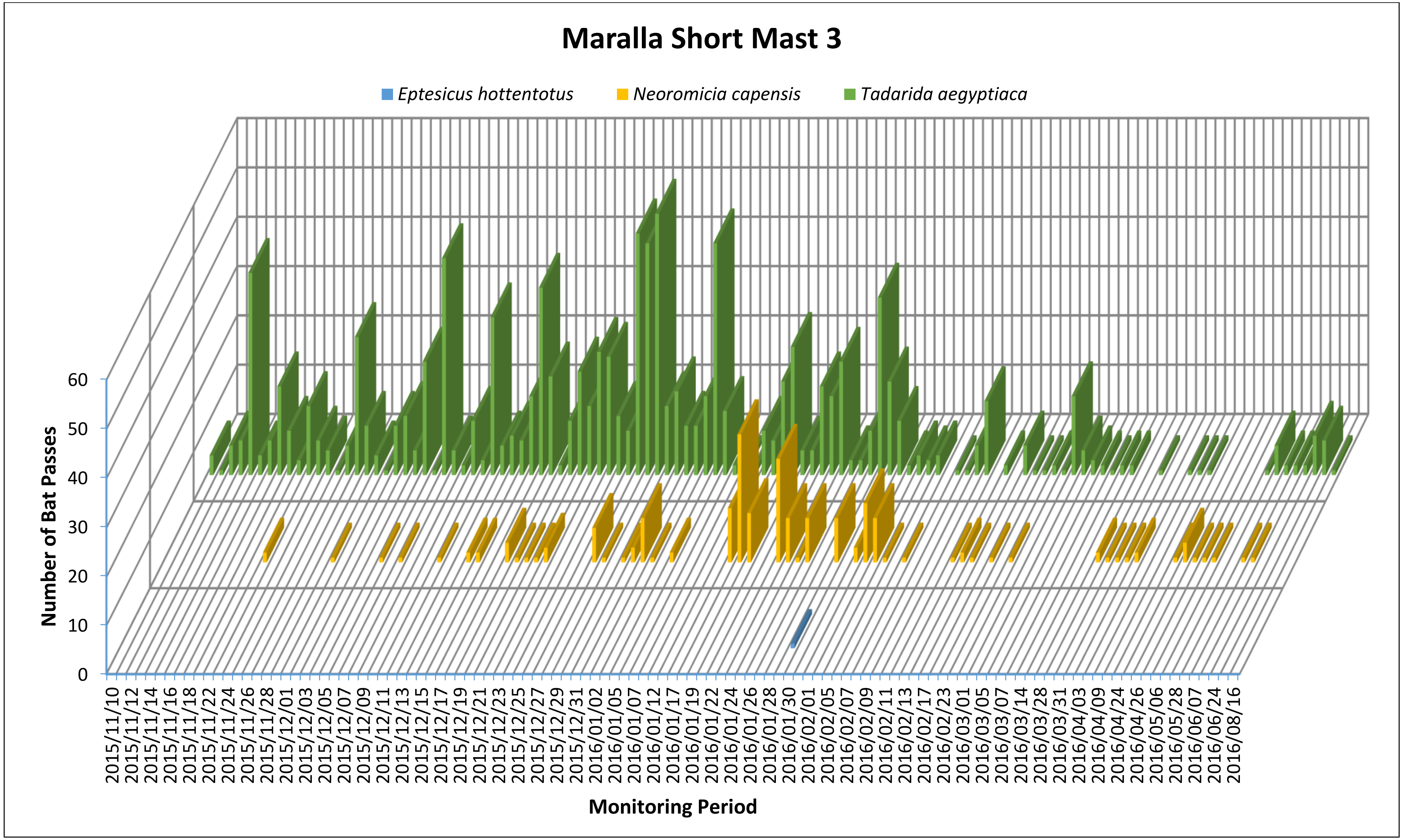


Figure 25: Temporal distribution of bat passes detected by Maralla Short Mast 3 over the monitoring period

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 26 – 41)**. The 12-month monitoring period was divided based on generic calendar seasons outlined **Table 8**.

Table 8: 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 will then be 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 this specie. Met Mast 2 indicates that during winter the bats are not as active, and an increase is seen from spring into summer with *Tadarida aegyptiaca* being most active. During autumn, the activity of *Neoromicia capensis* increased and was more active during the early hours of the night (**Figure 26 – 29**). *Neoromicia capensis* was mostly active near short mast 1 during all the seasons, except summer, and in the early hours of the night (**Figure 30 – 33**). Short mast 2 and 3 had an increase in activity from winter through to summer and a decrease into autumn, with *Tadarida aegyptiaca* being most active (**Figure 34 – 41**). *Miniopterus natalensis* is mostly active during winter near the Short Mast 2 and 1 (**Figure 34 and 30**).

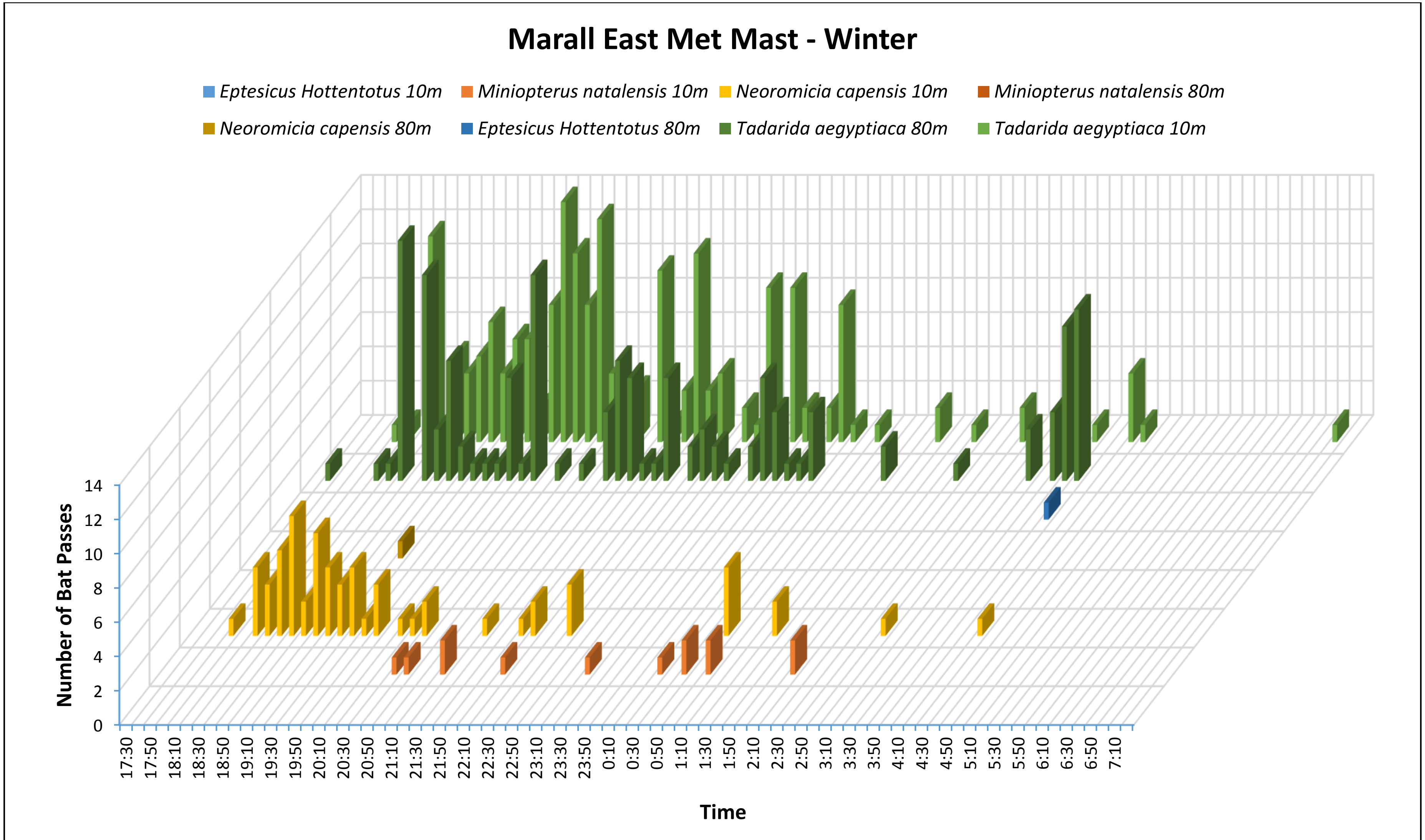


Figure 26: Temporal distribution of activity across the night as detected by Met Mast in winter.

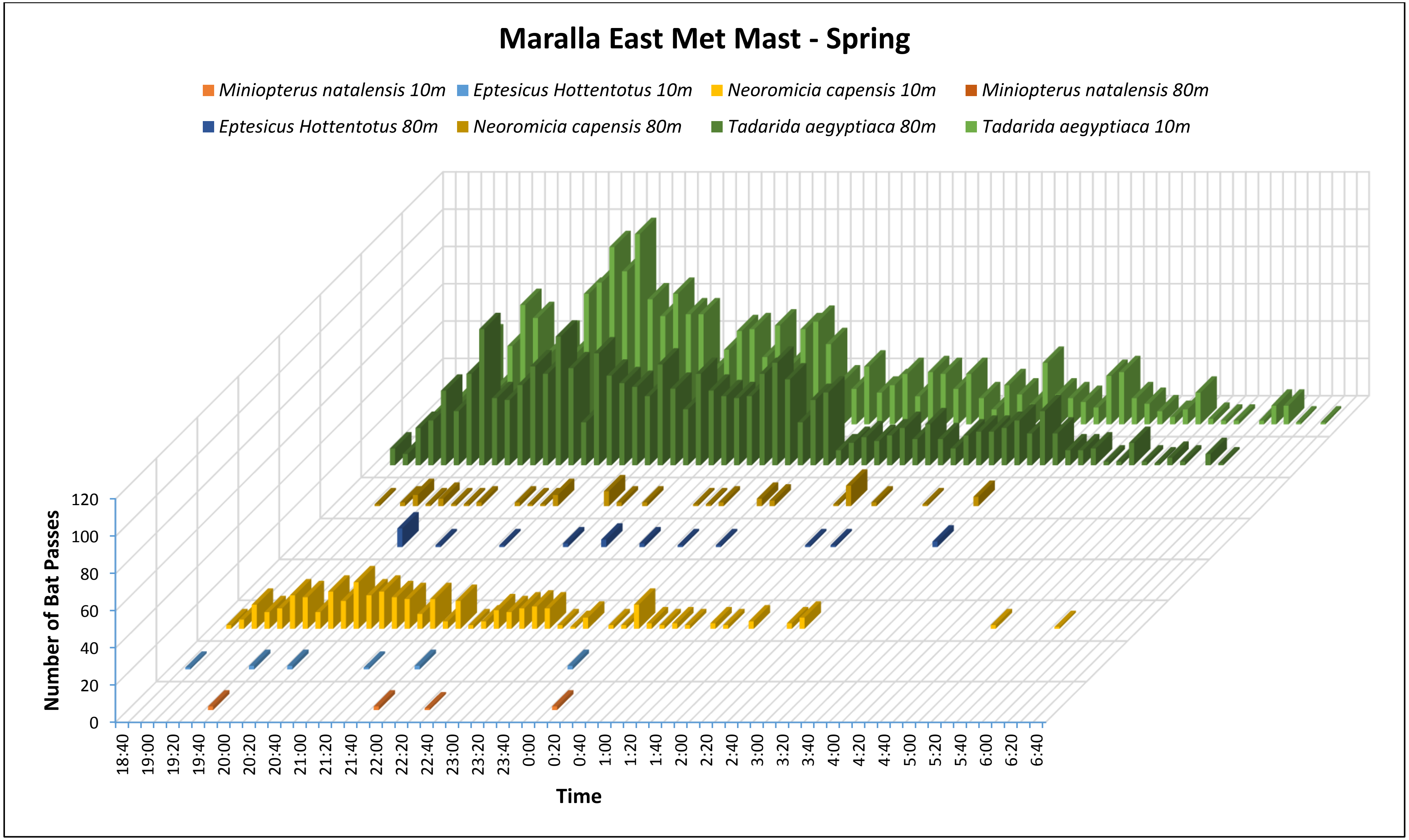


Figure 27: Temporal distribution of activity across the night as detected by Met Mast in spring.

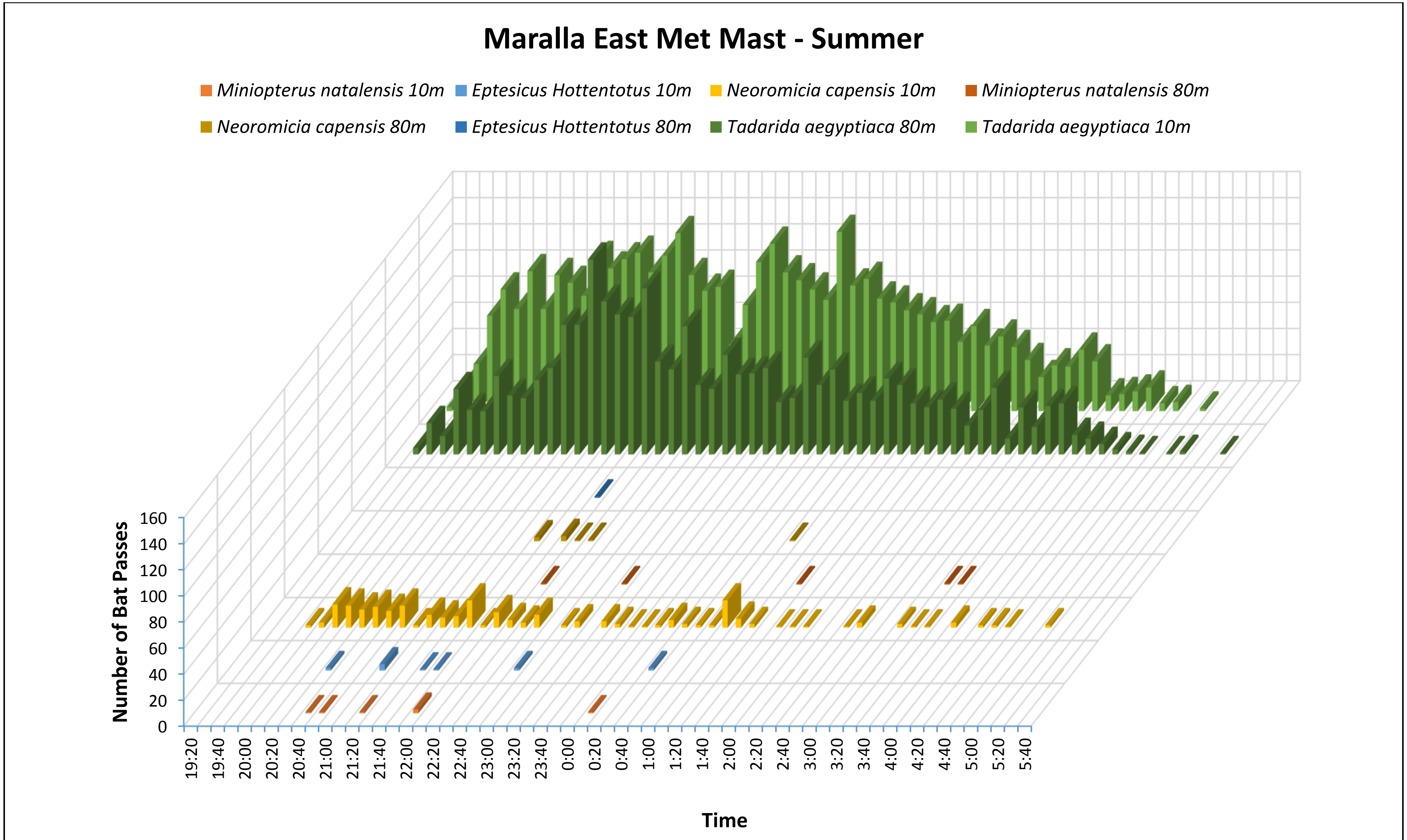


Figure 28: Temporal distribution of activity across the night as detected by Met Mast in summer.

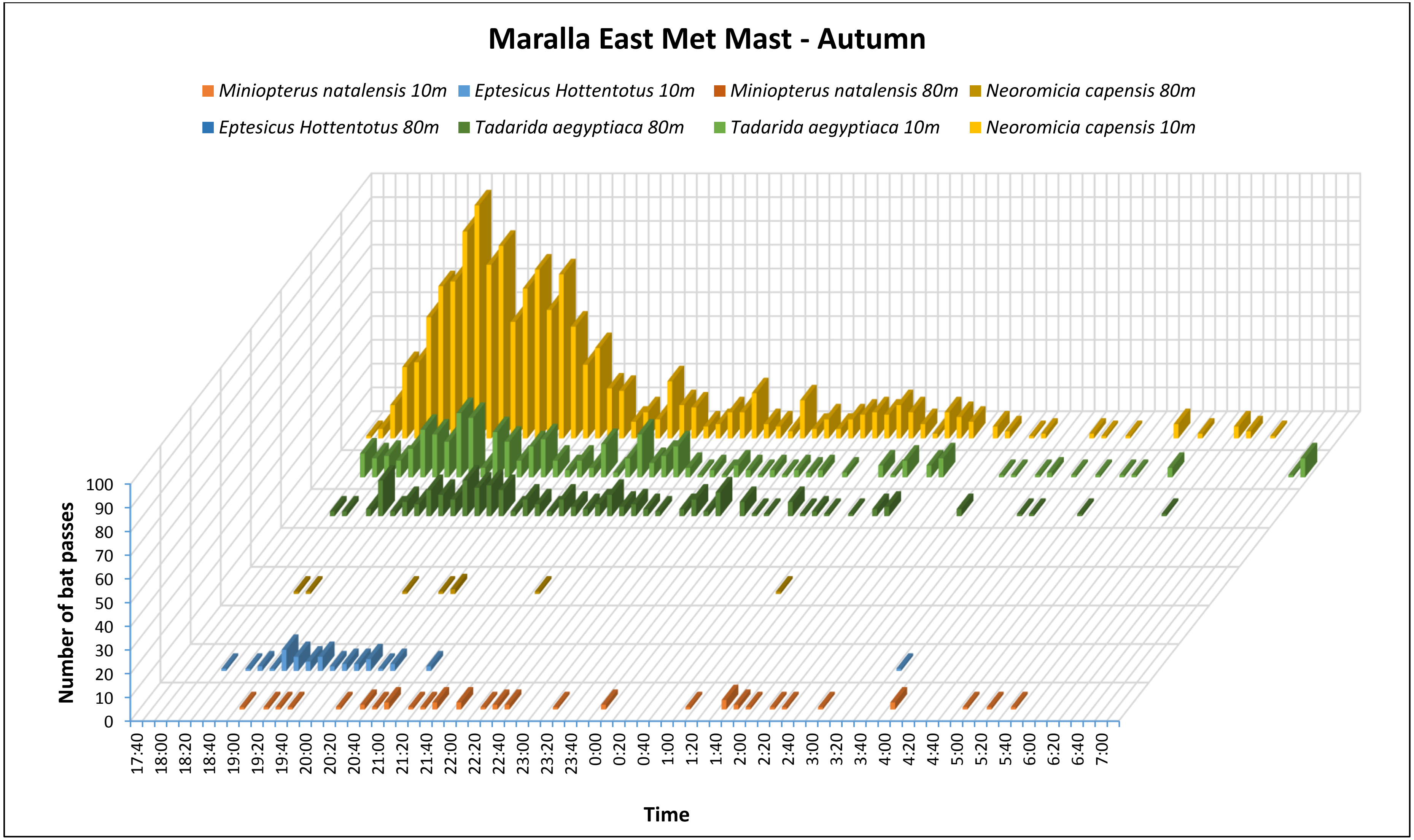


Figure 29: Temporal distribution of activity across the night as detected by Met Mast in autumn.

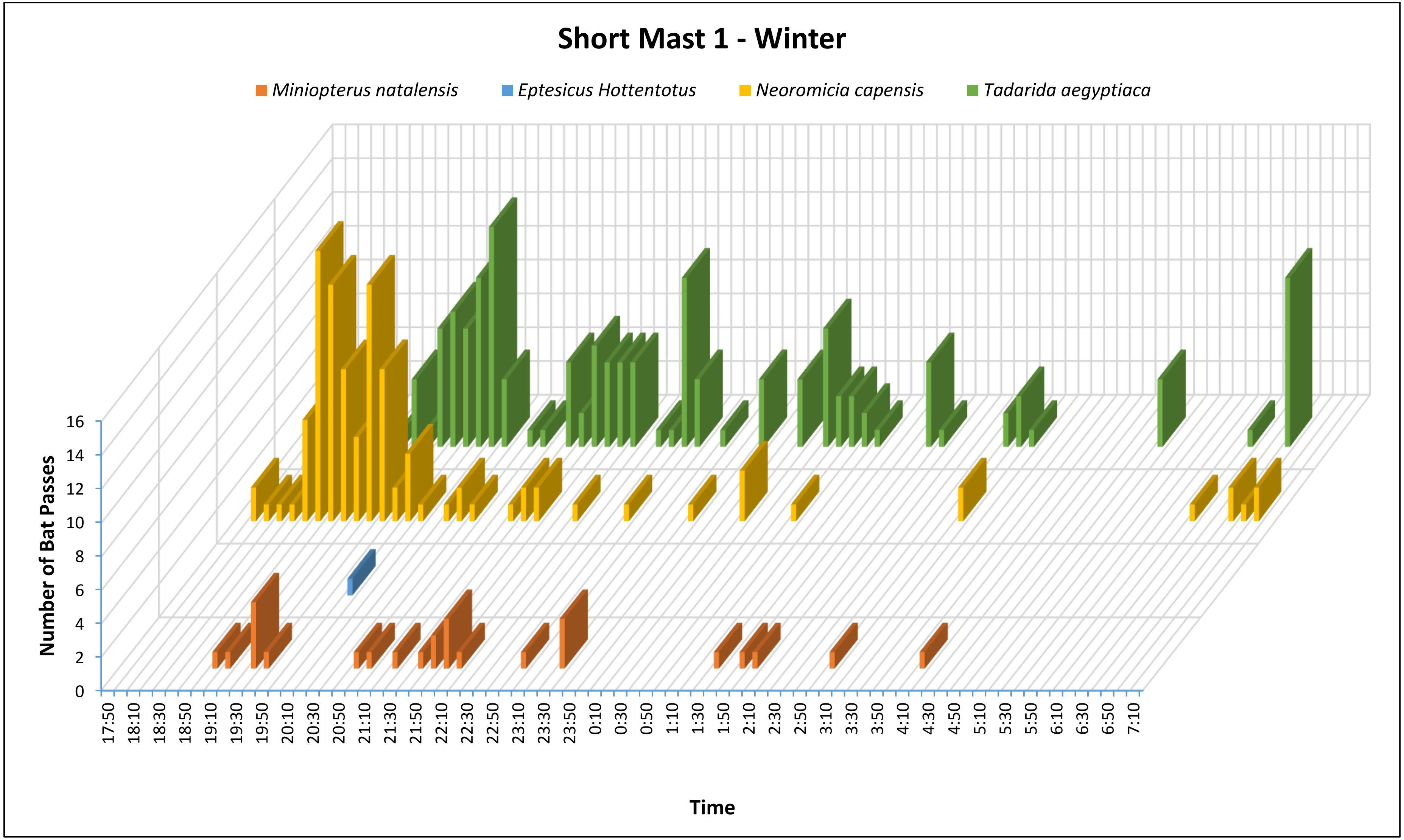


Figure 30: Temporal distribution of activity across the night as detected by Short Mast 1 in winter.

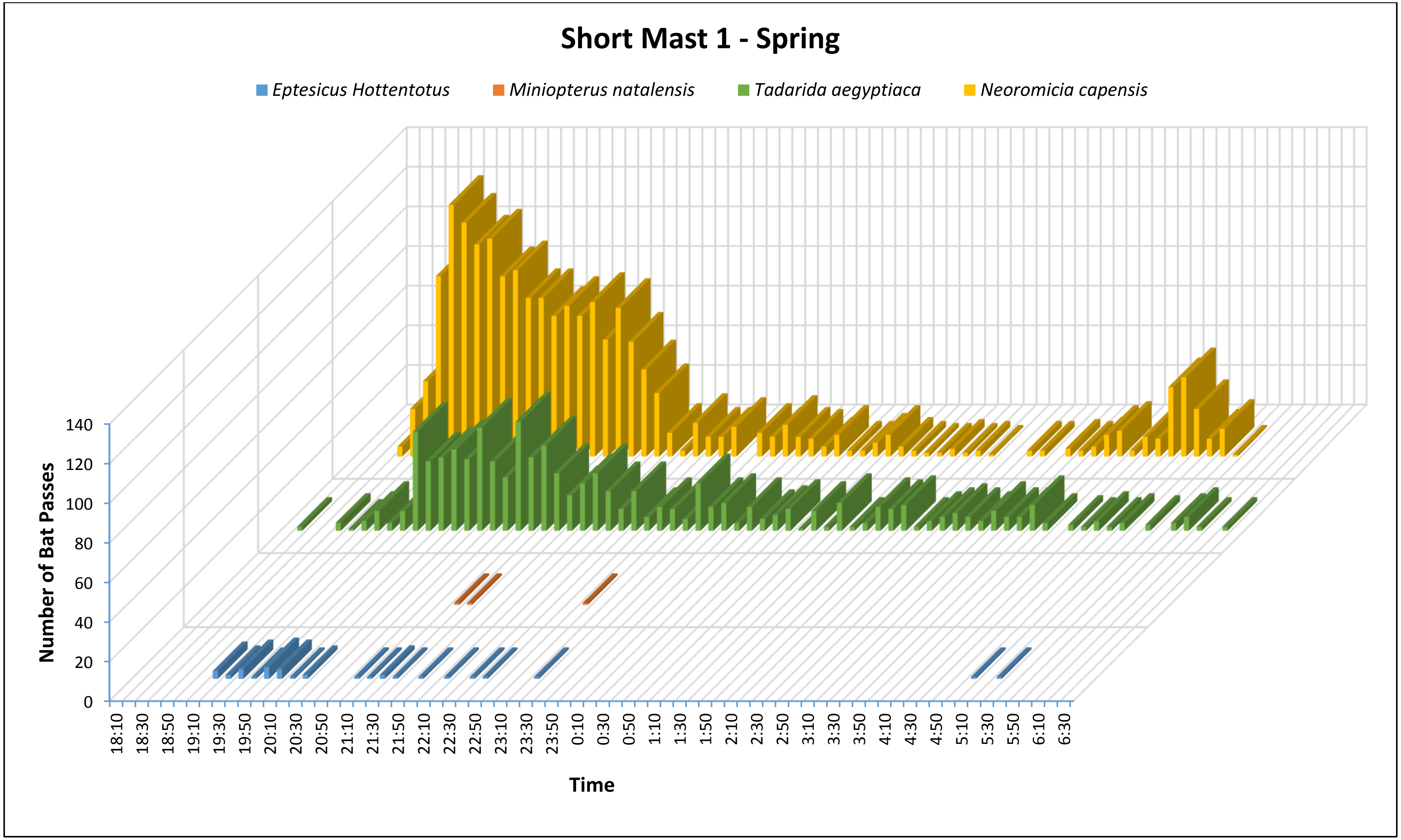


Figure 31: Temporal distribution of activity across the night as detected by Short Mast 1 in spring.

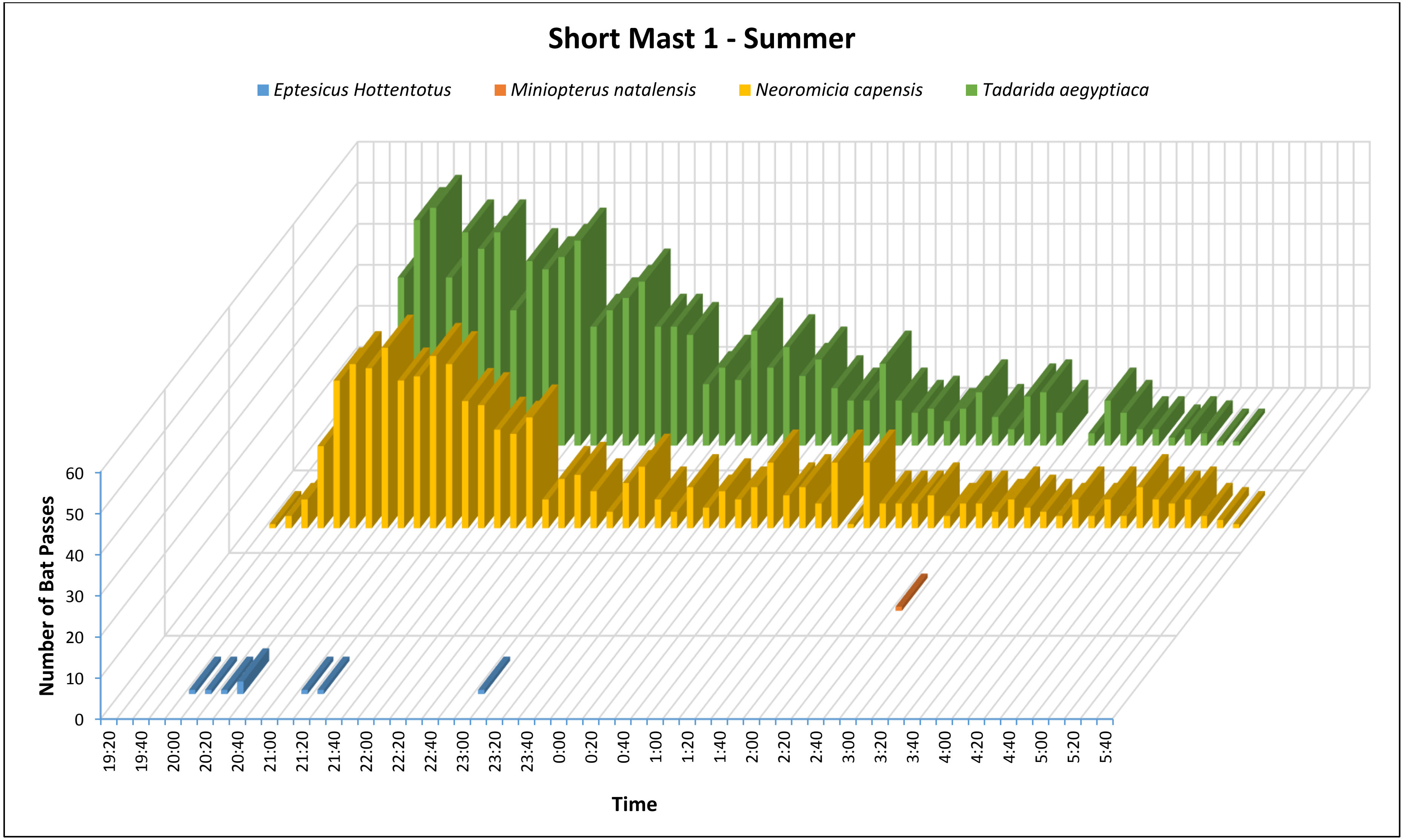


Figure 32: Temporal distribution of activity across the night as detected by Short Mast 1 in summer.

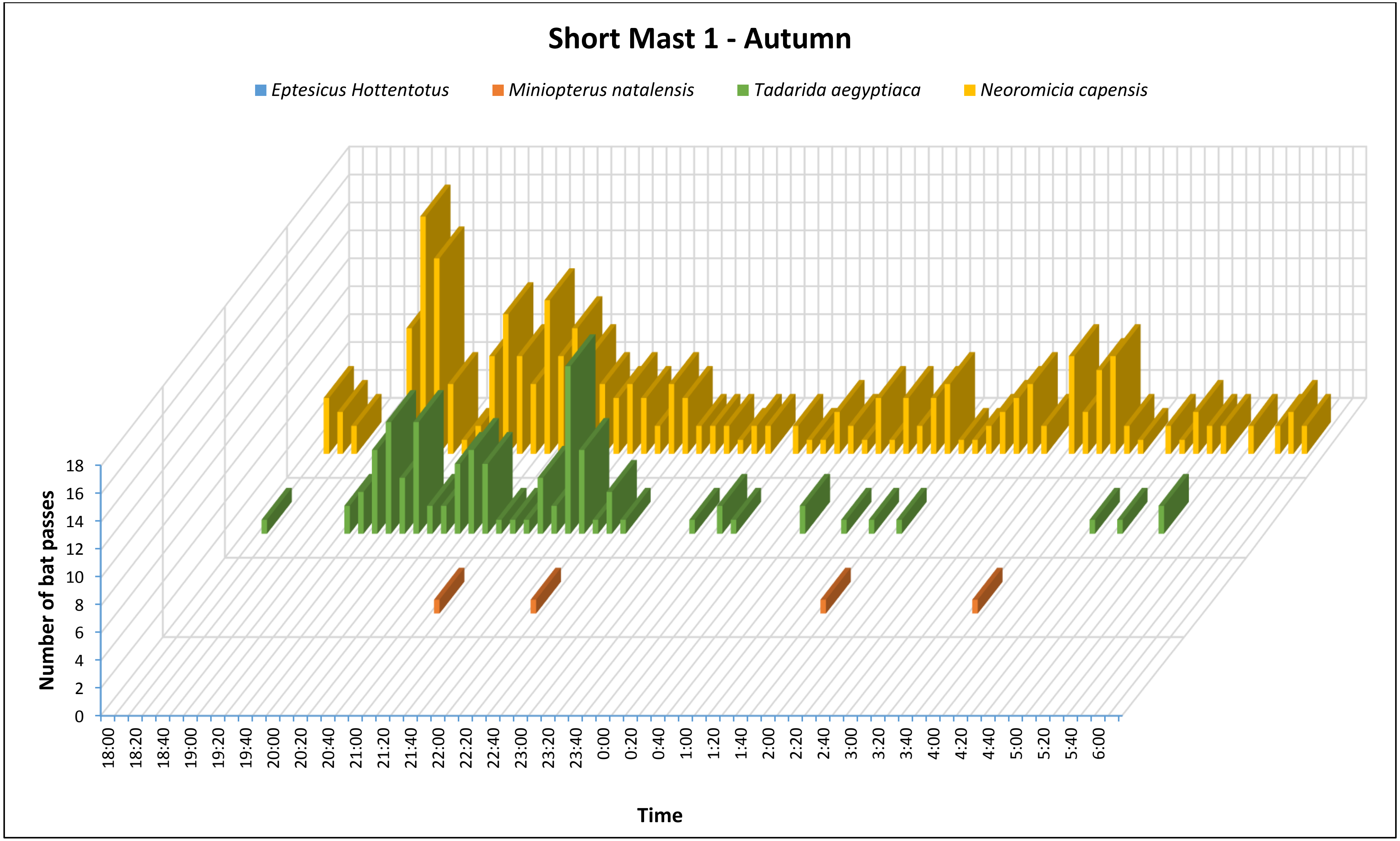


Figure 33: Temporal distribution of activity across the night as detected by Short Mast 1 in autumn.

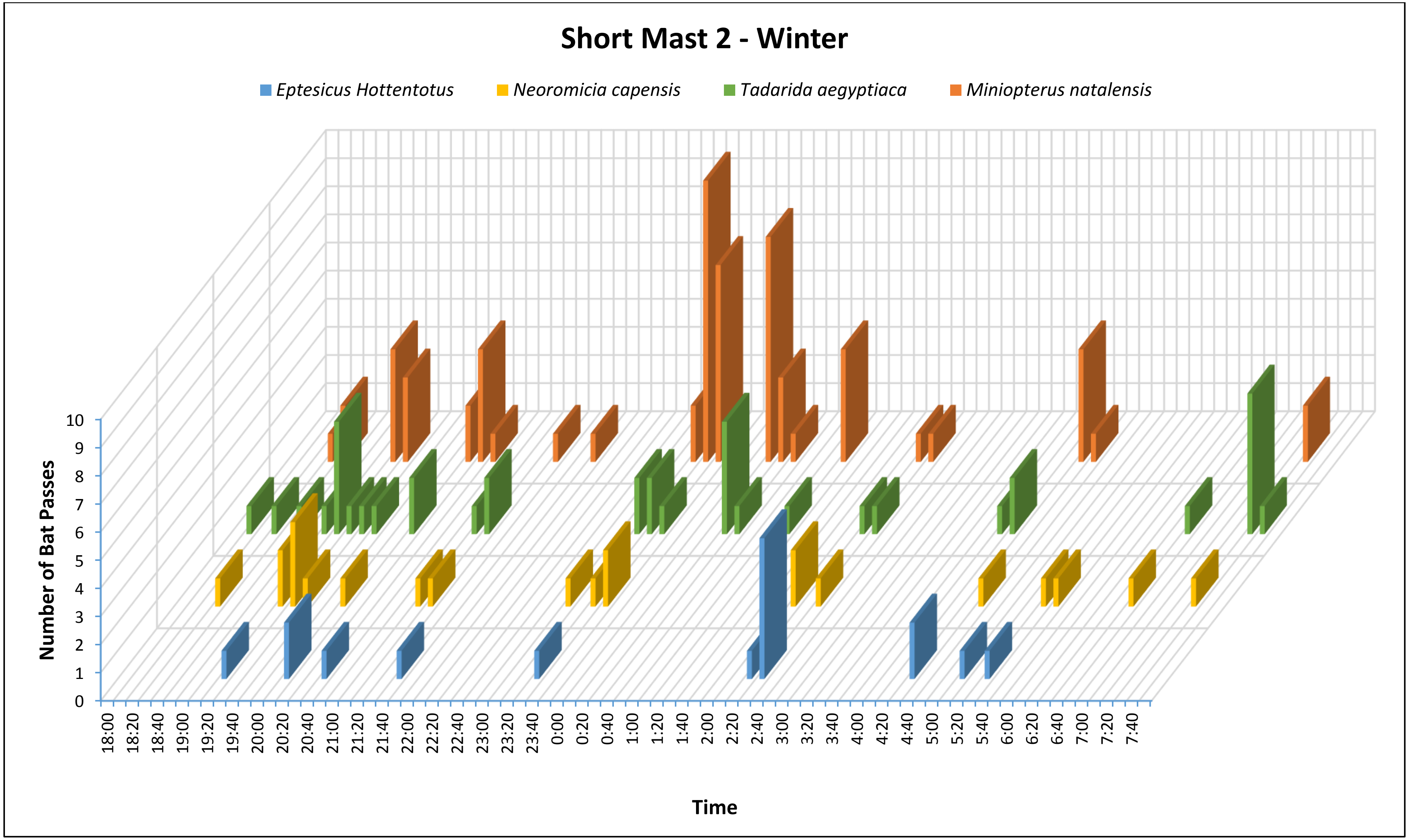


Figure 34: Temporal distribution of activity across the night as detected by Short Mast 2 in winter.

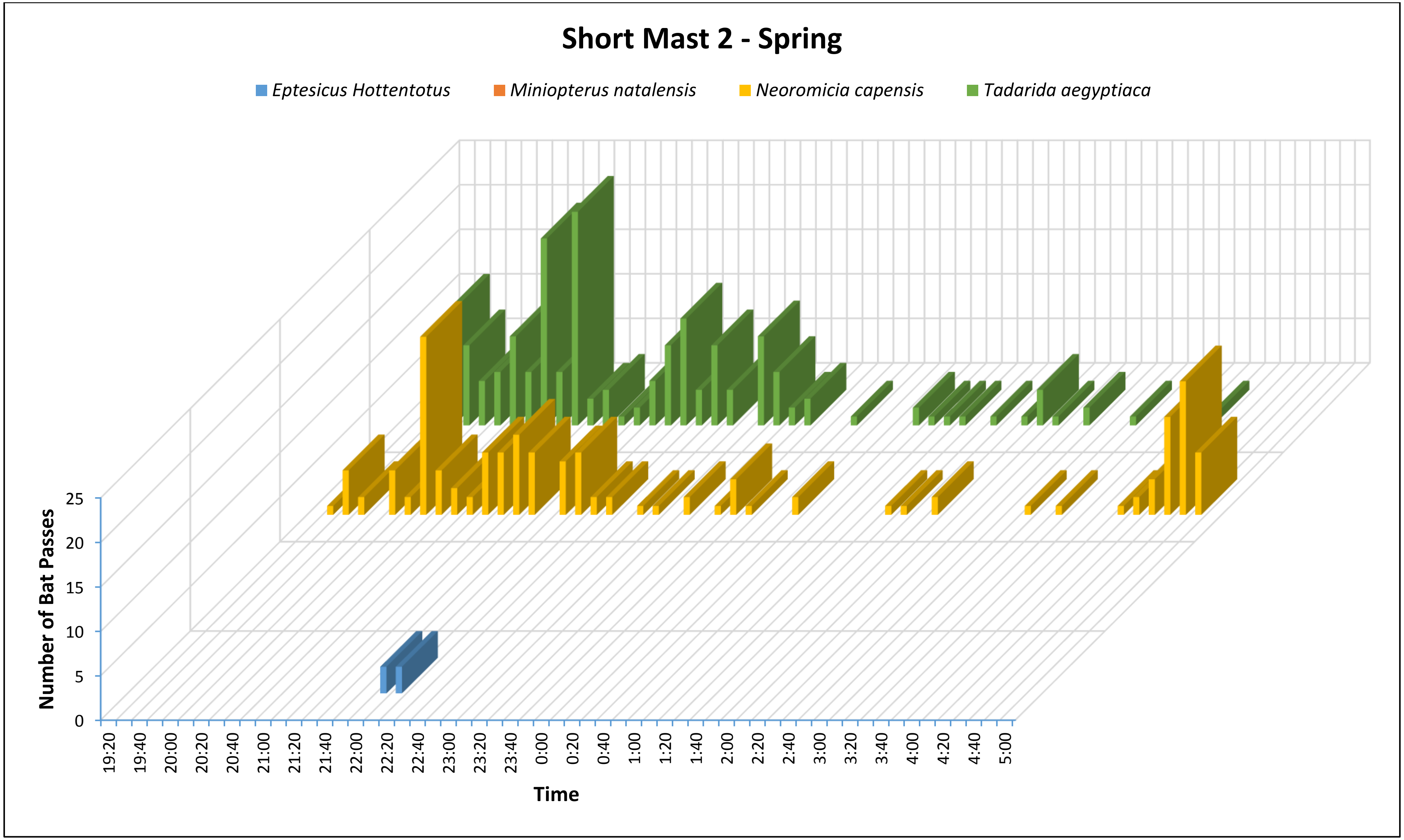


Figure 35: Temporal distribution of activity across the night as detected by Short Mast 2 in spring.

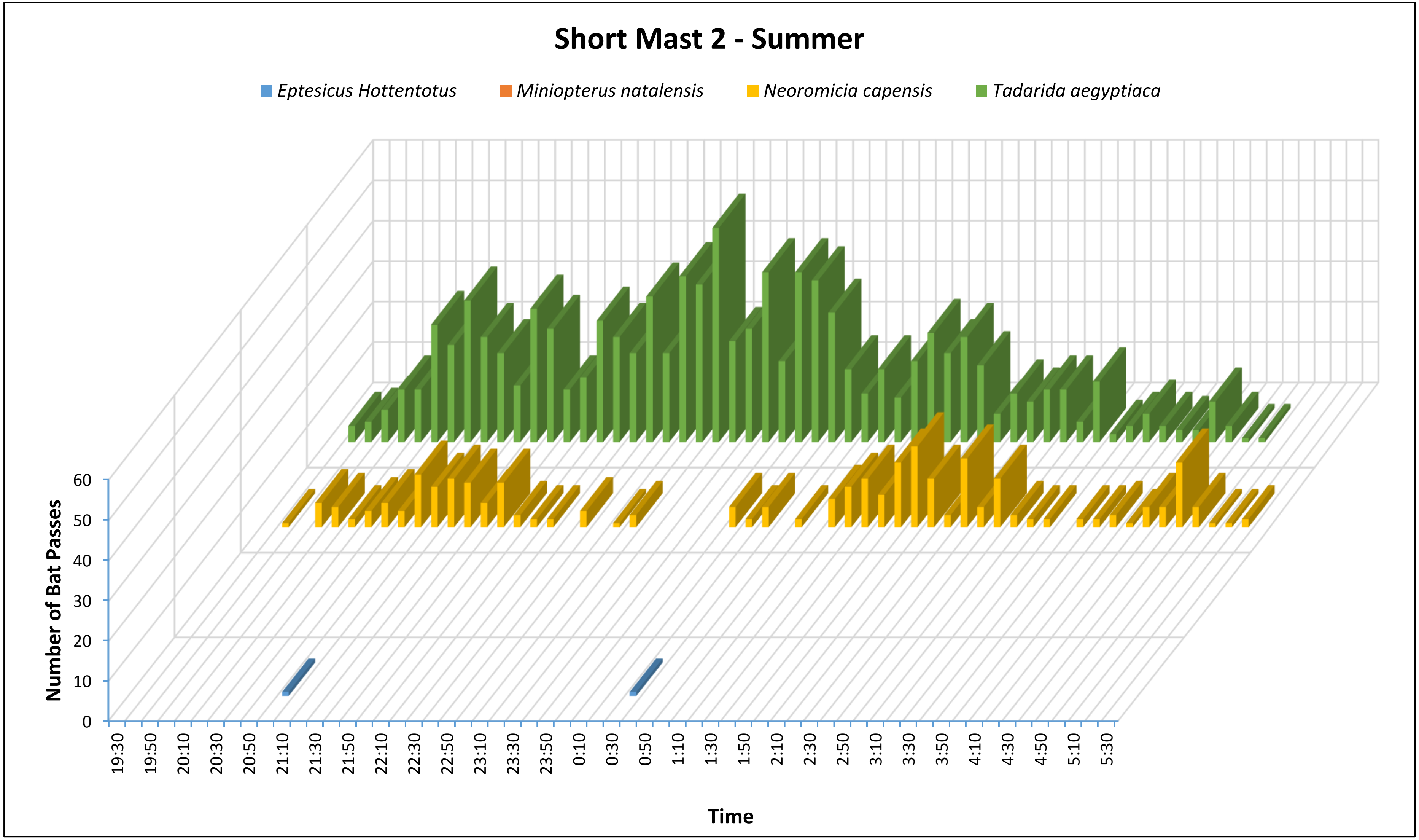


Figure 36: Temporal distribution of activity across the night as detected by Short Mast 2 in summer.

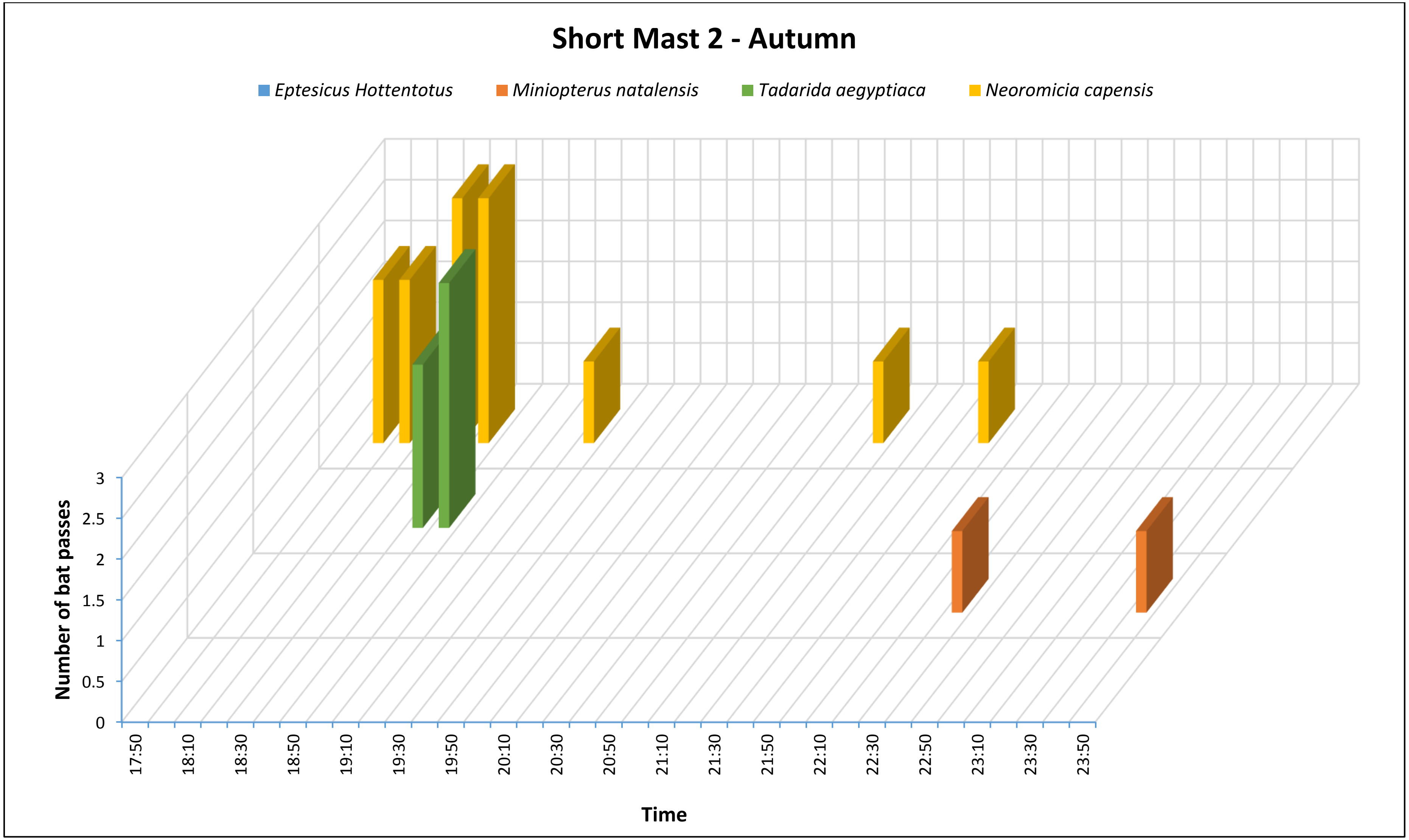


Figure 37: Temporal distribution of activity across the night as detected by Short Mast 2 in autumn.

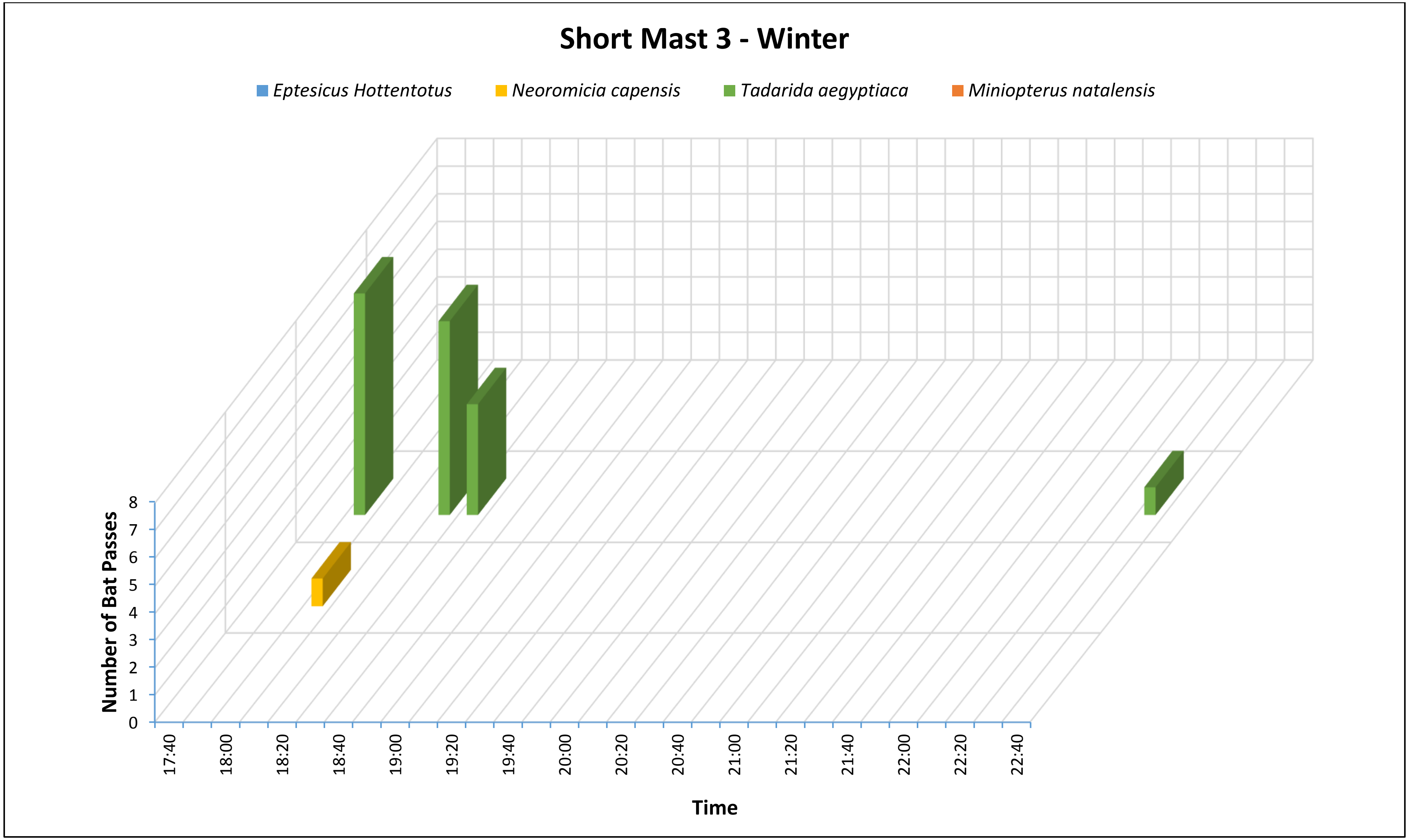


Figure 38: Temporal distribution of activity across the night as detected by Short Mast 3 in winter.

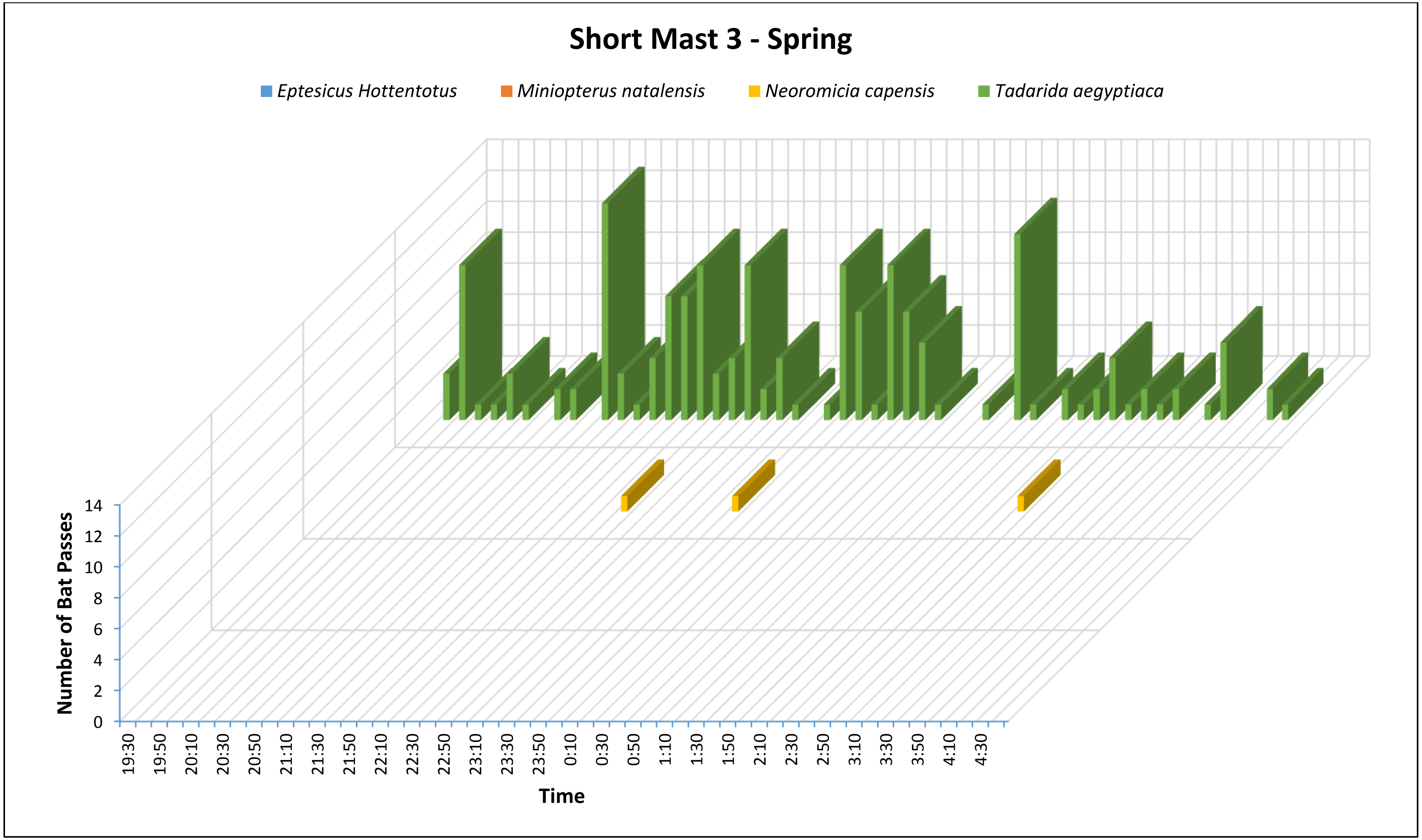


Figure 39: Temporal distribution of activity across the night as detected by Short Mast 3 in spring.

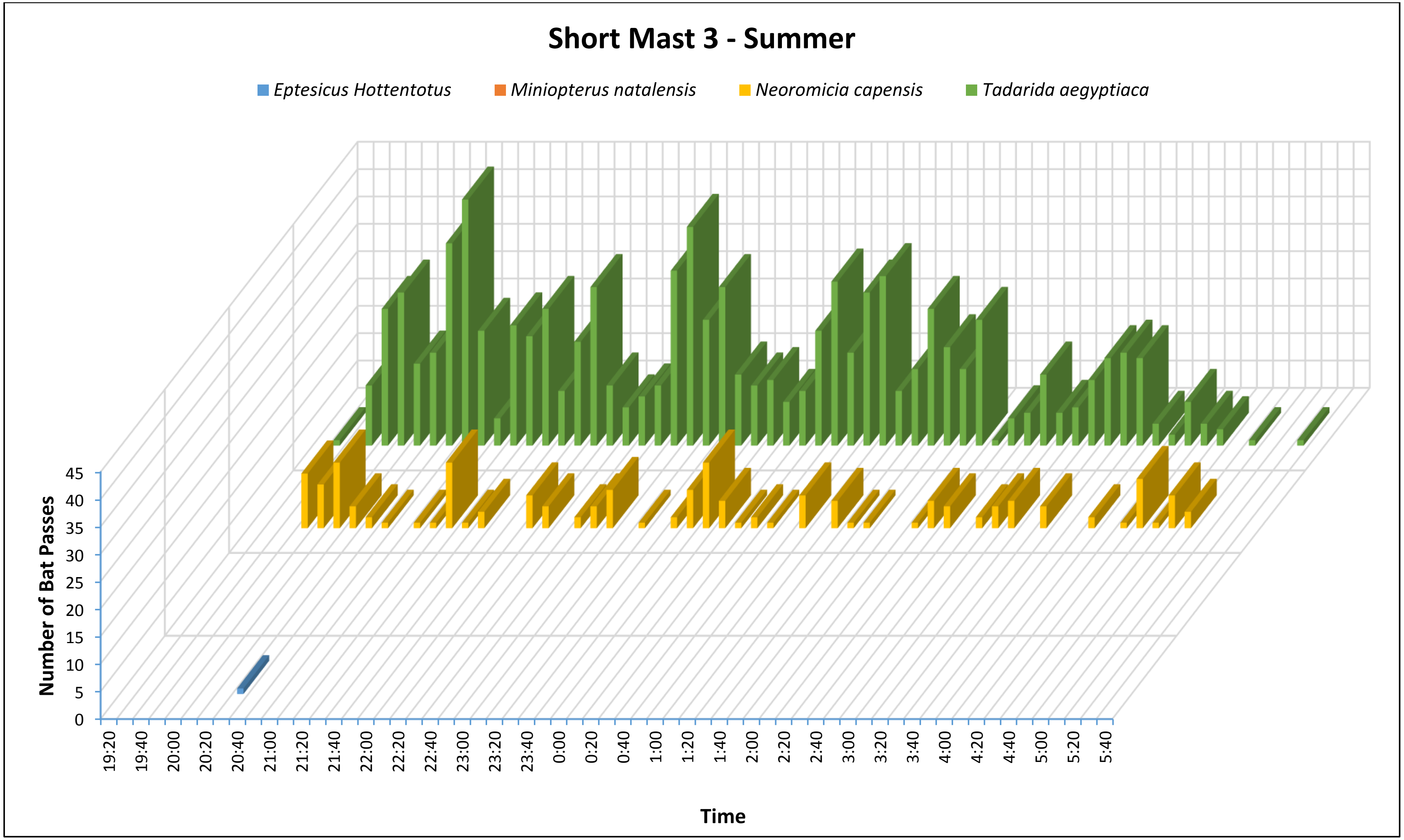


Figure 40: Temporal distribution of activity across the night as detected by Short Mast 3 in summer.

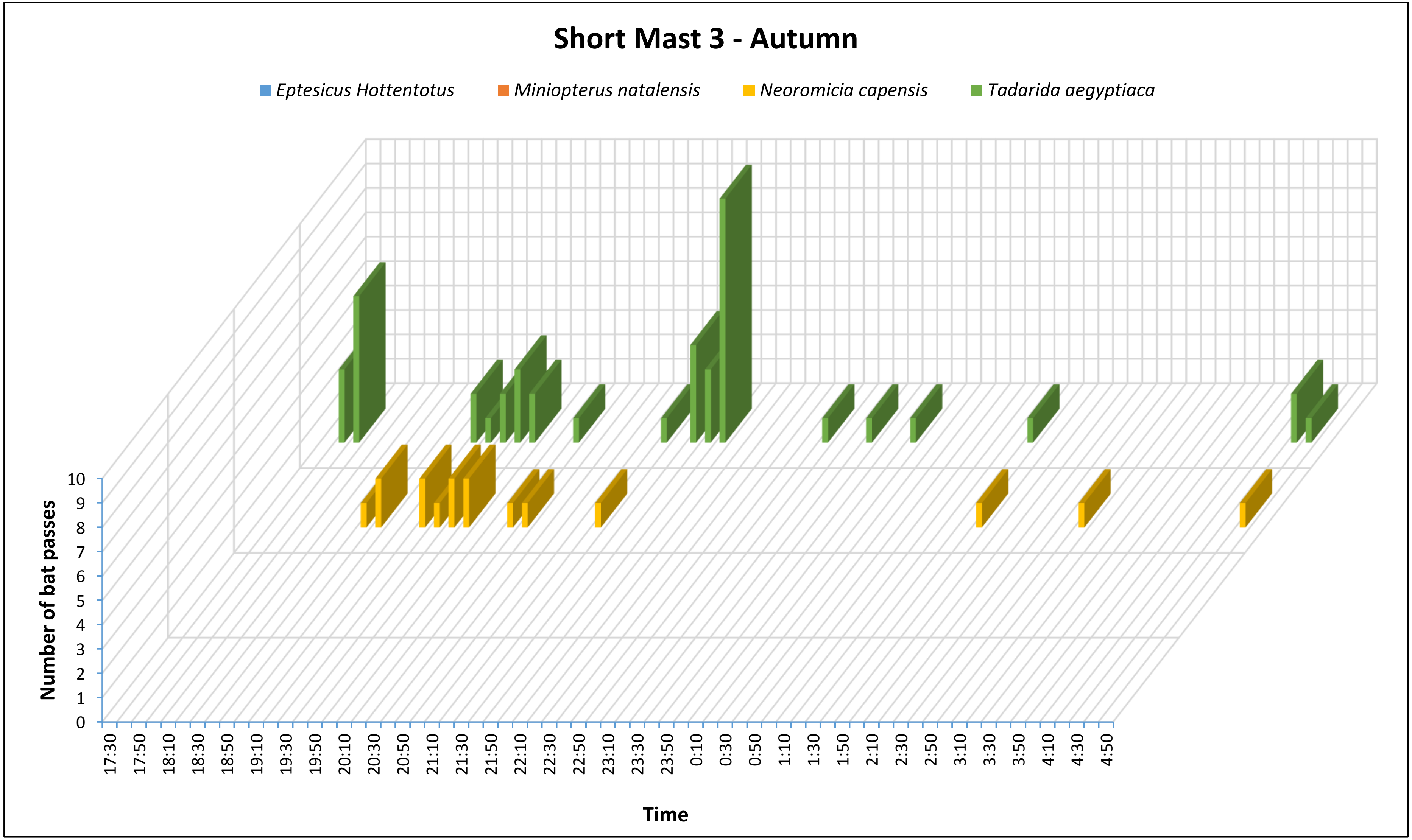


Figure 41: Temporal distribution of activity across the night as detected by Short Mast 3 in autumn.

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 considered. 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 5.6.2 and 5.6.3 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 used to inform mitigation in Section 7.

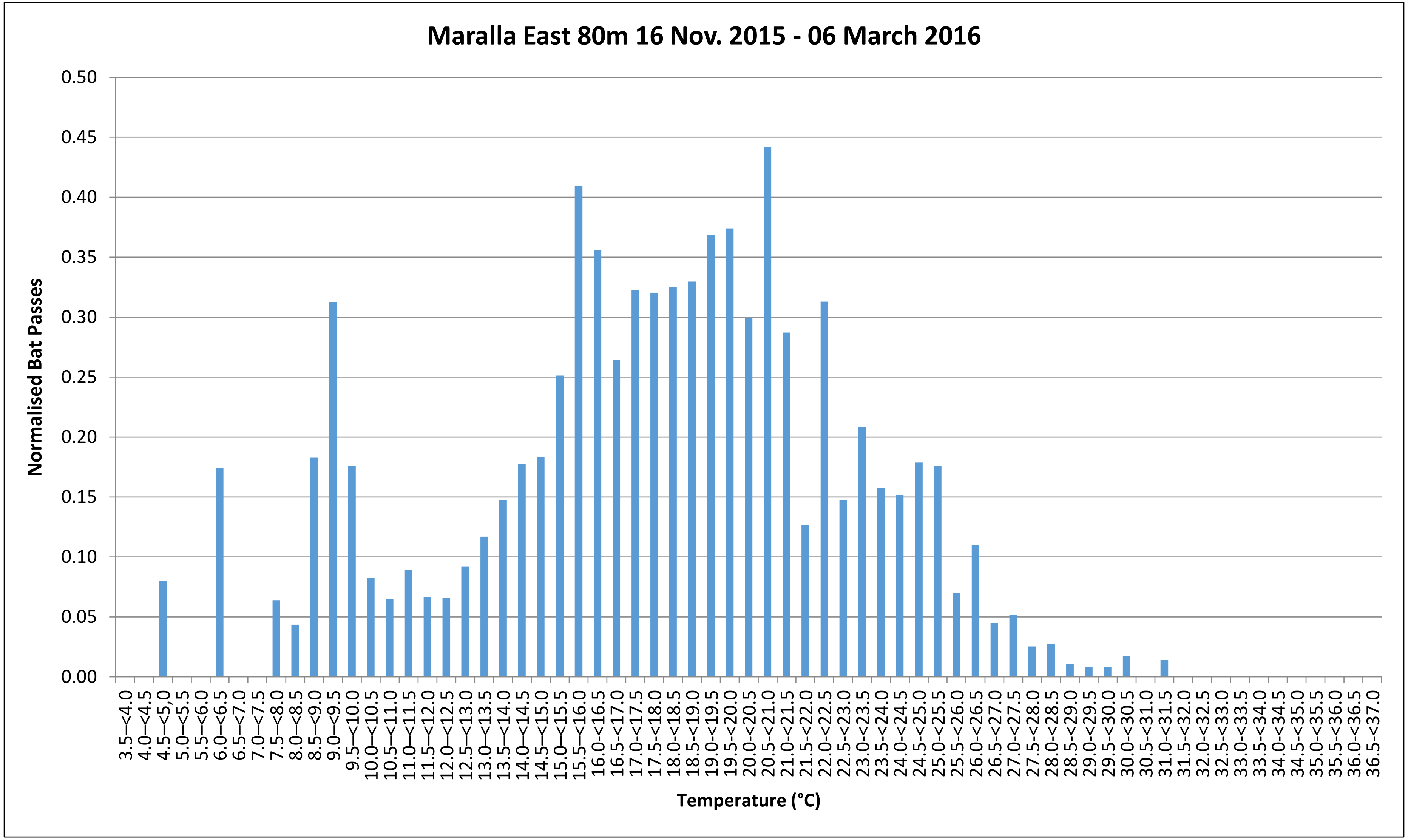


Figure 42: Sum of bat passes (Normalised) per Temperature category for Maralla East 80m (16 Nov. 2015 - 06 March 2016).

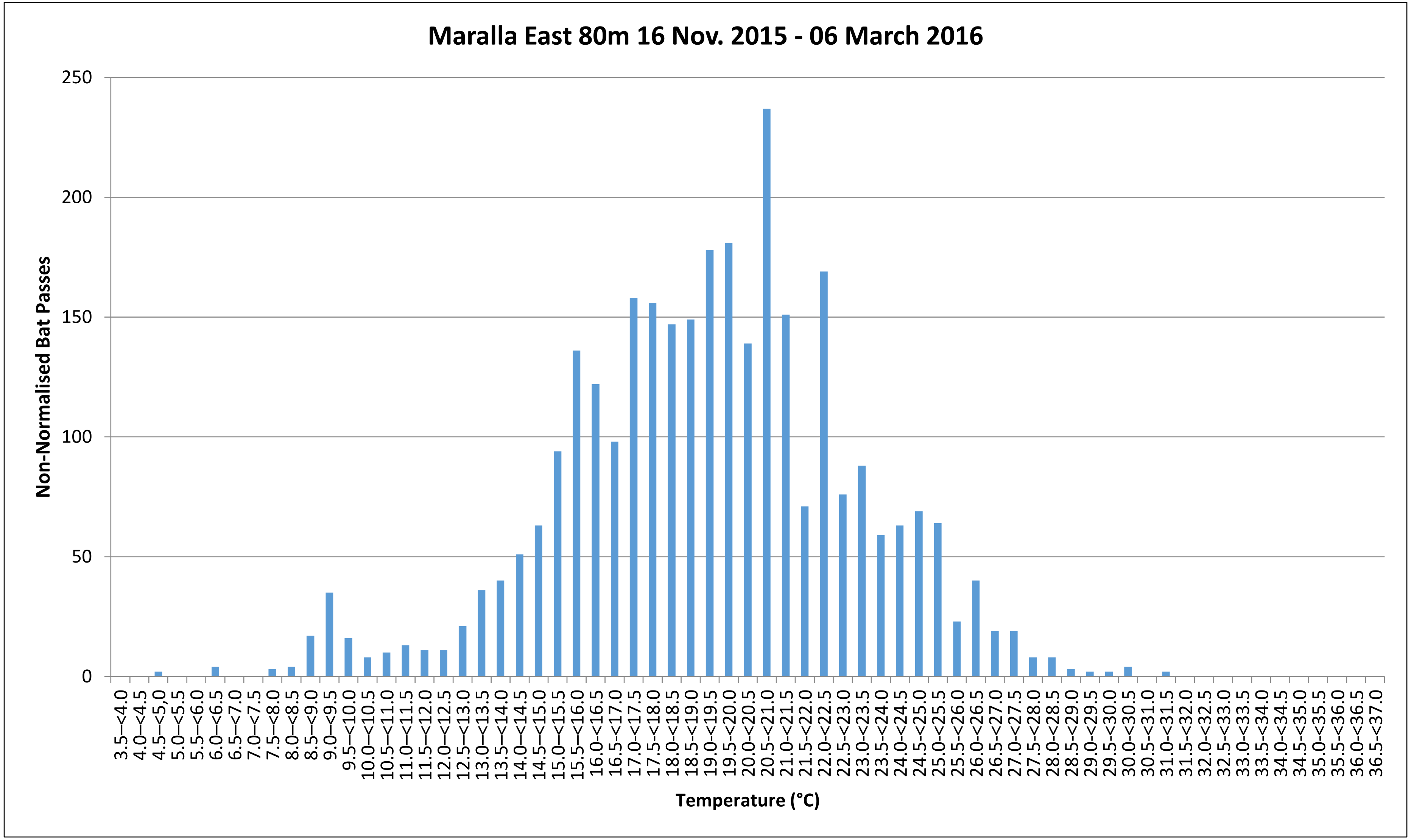


Figure 43: Sum of bat passes (Non-normalised) per Temperature category for Maralla East 80m (16 Nov. 2015 - 06 March 2016).

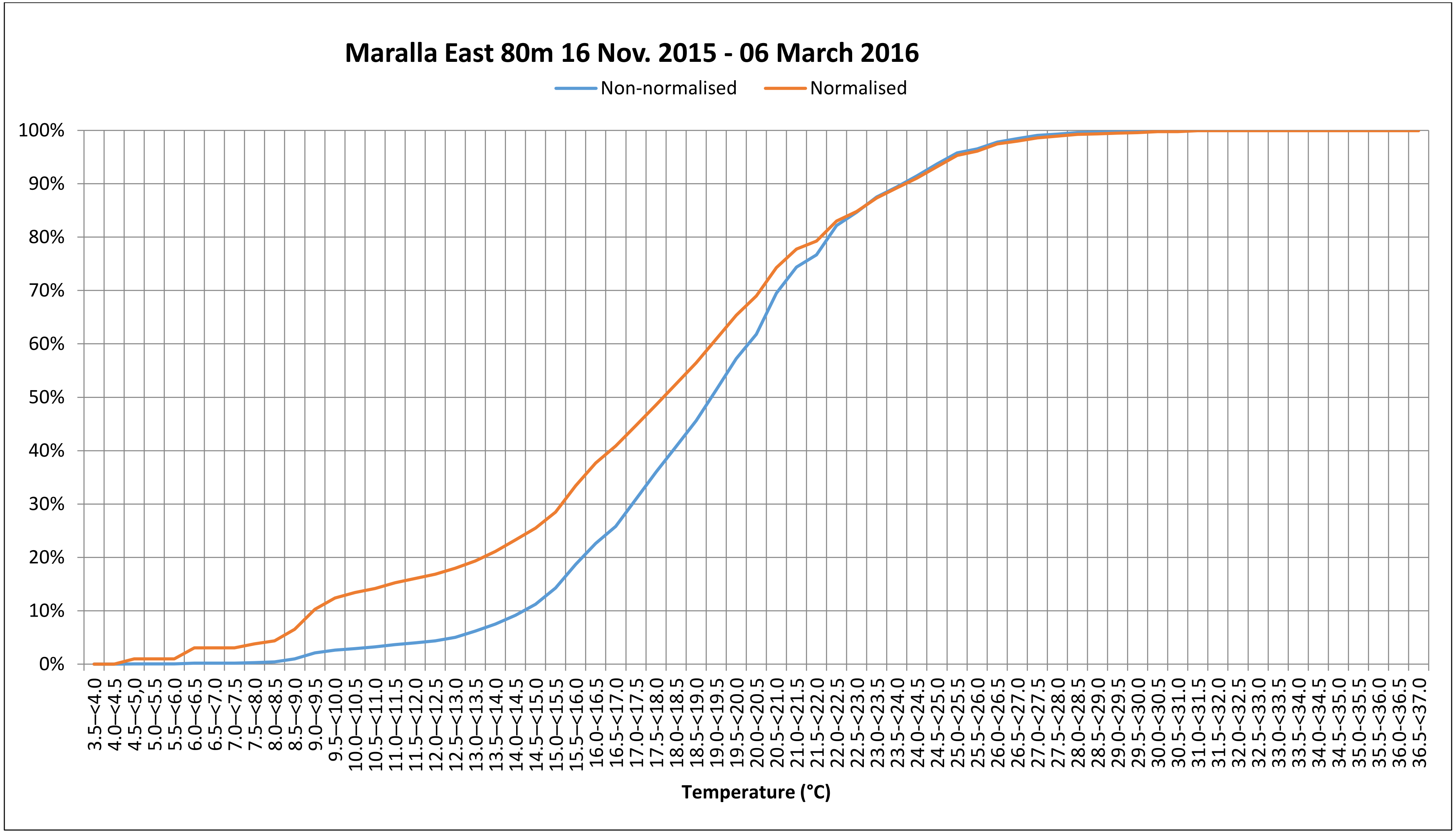


Figure 44: Cumulative percentage of normalised and non-normalised bat passes per temperature category for Maralla East 80m (16 Nov. 2015 - 06 March 2016).

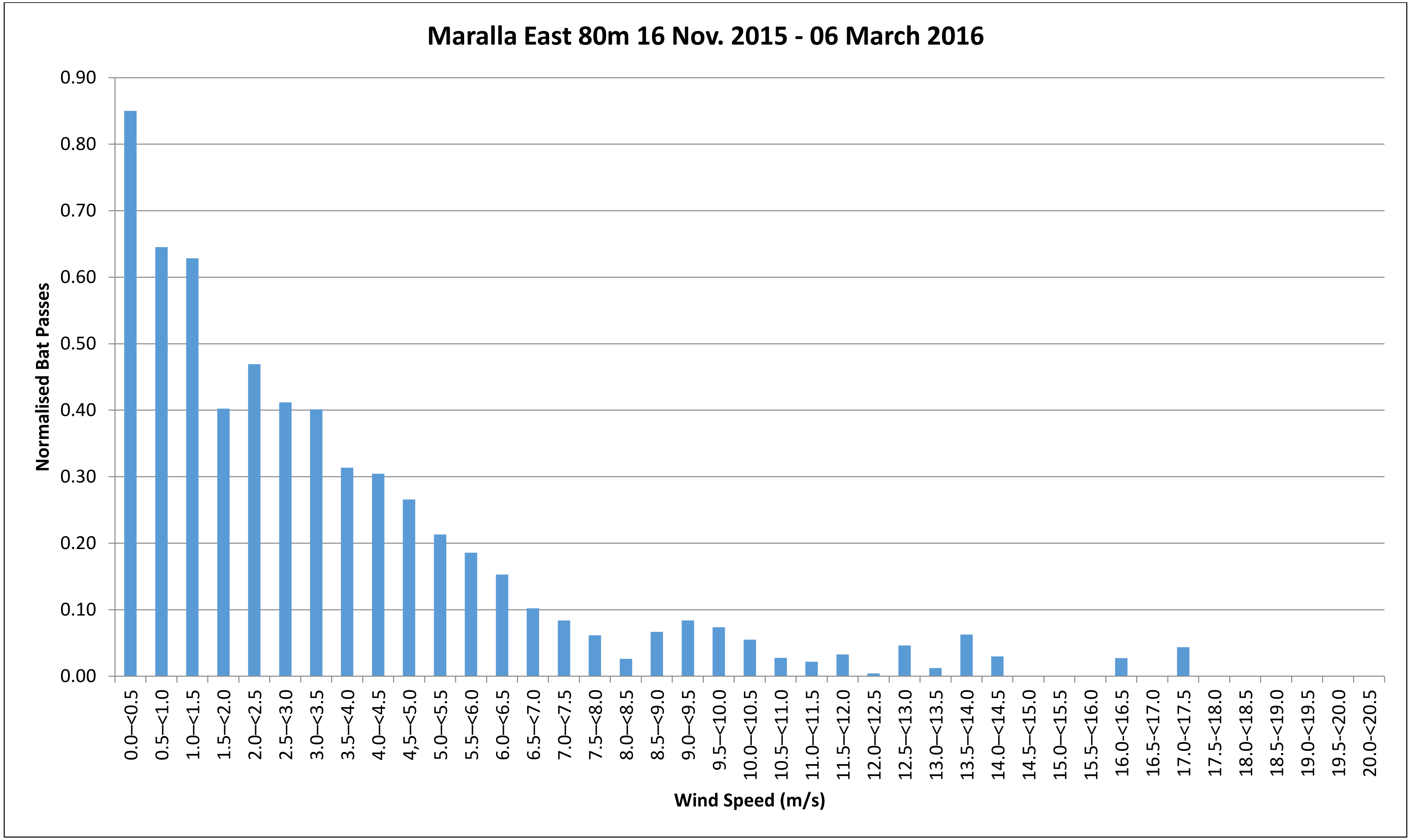


Figure 45: Sum of bat passes (Normalised) per Wind Speed category for Maralla East 80m (16 Nov. 2015 - 06 March 2016).

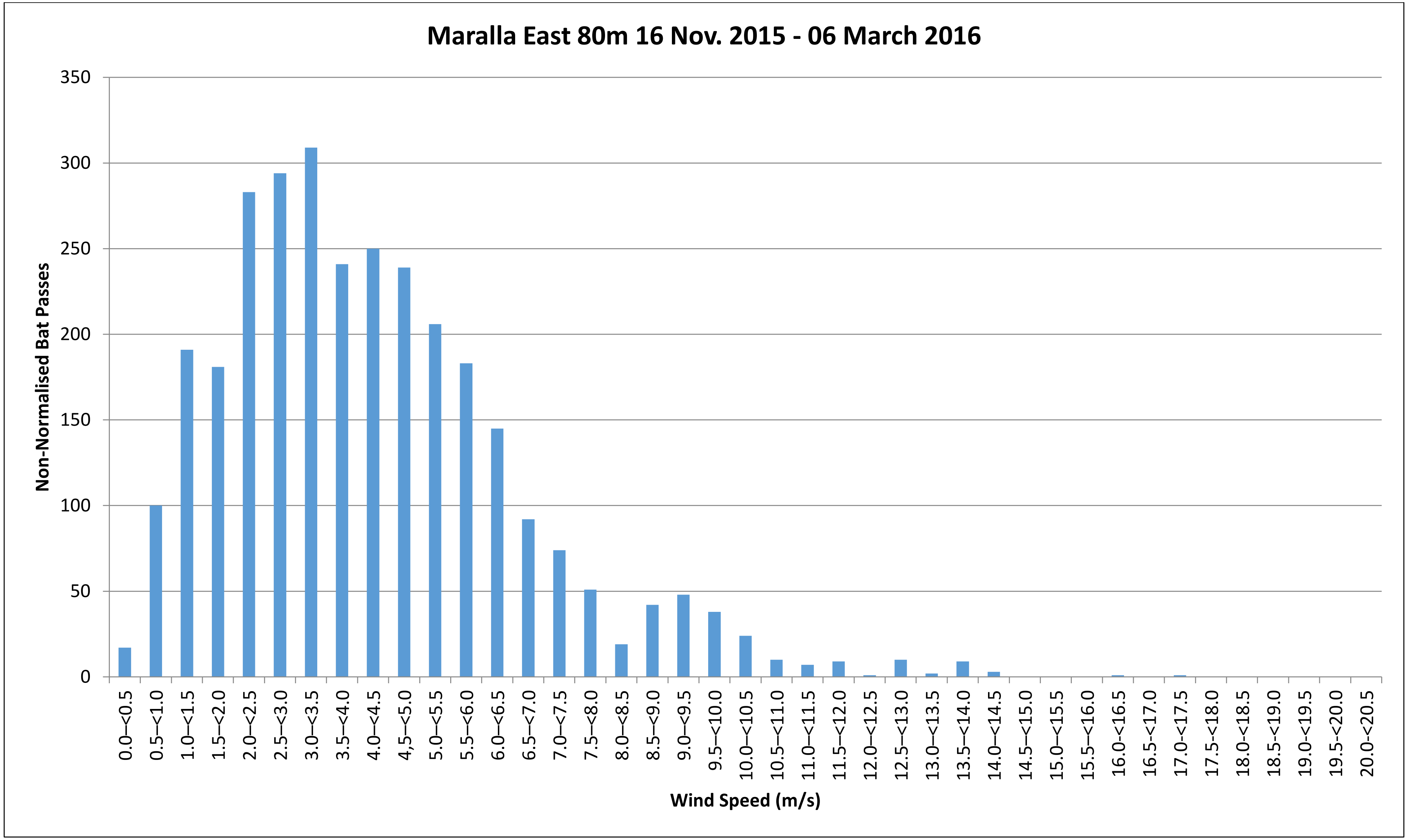


Figure 46: Sum of bat passes (Non-normalised) per Wind Speed category for Maralla East 80m (16 Nov. 2015 - 06 March 2016).

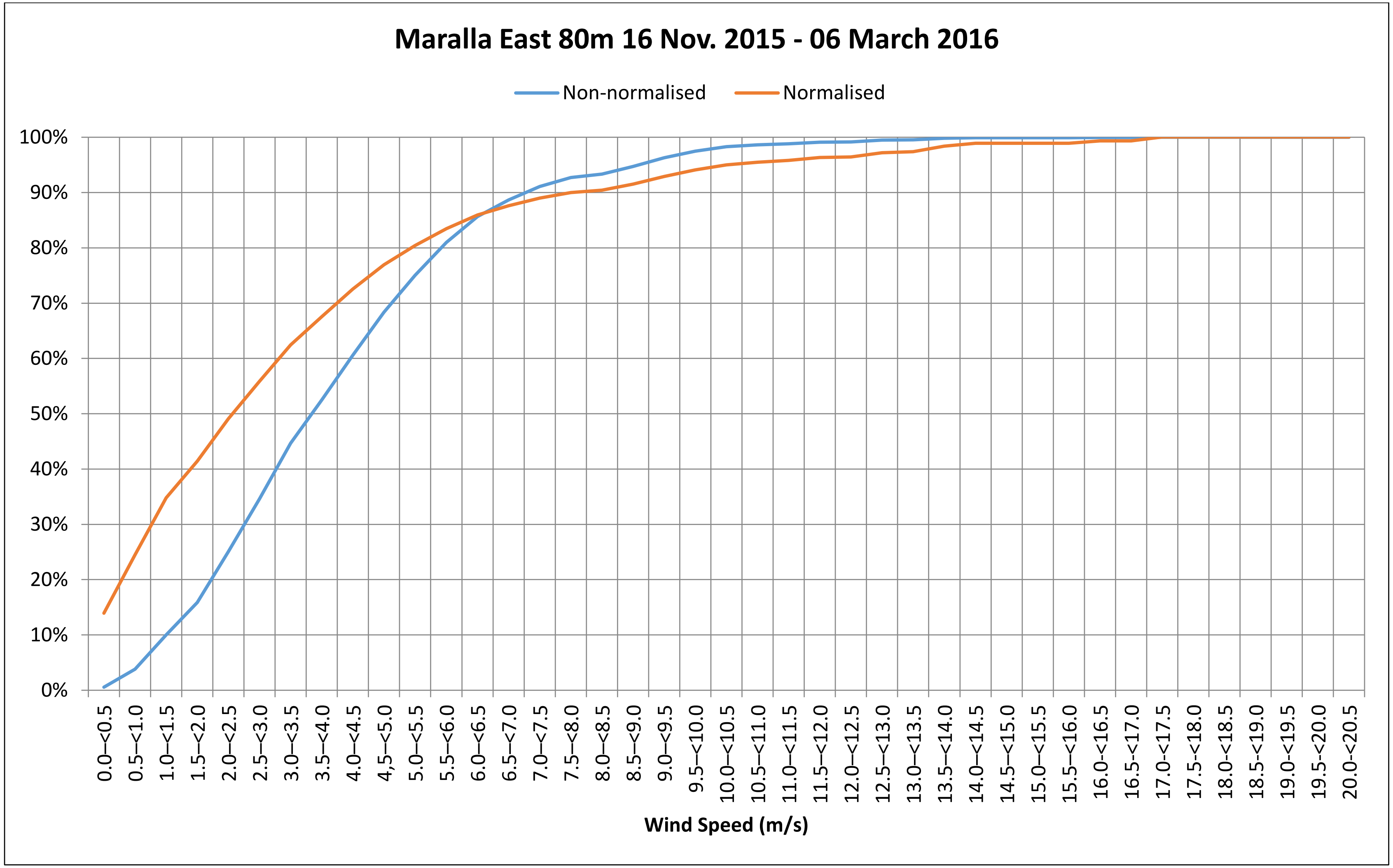


Figure 47: Cumulative percentage of normalised and non-normalised bat passes per Wind Speed category for Maralla East 80m (16 Nov. 2015 - 06 March 2016).

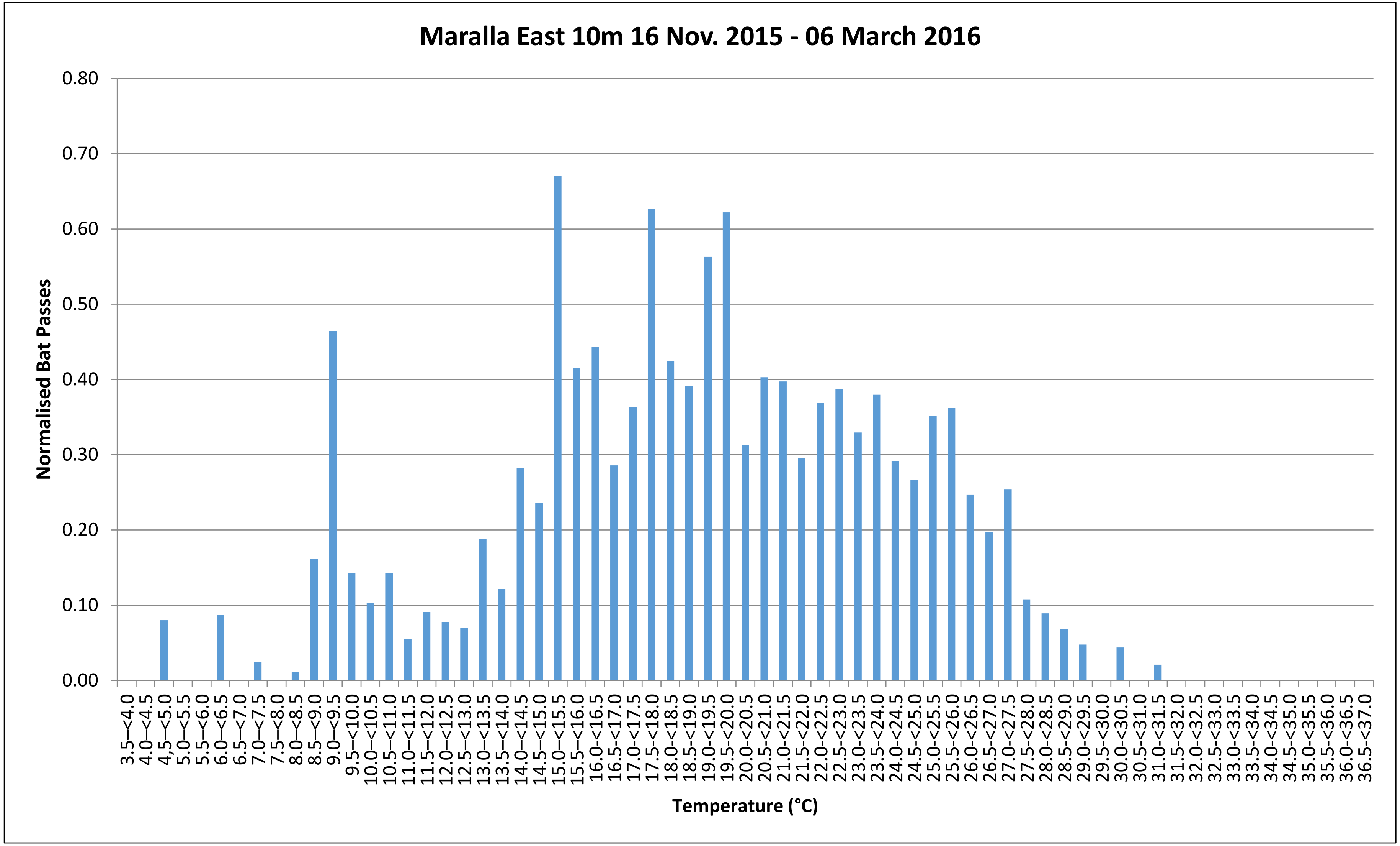


Figure 48: Sum of bat passes (Normalised) per Temperature category for Maralla East 10m (16 Nov. 2015 - 06 March 2016).

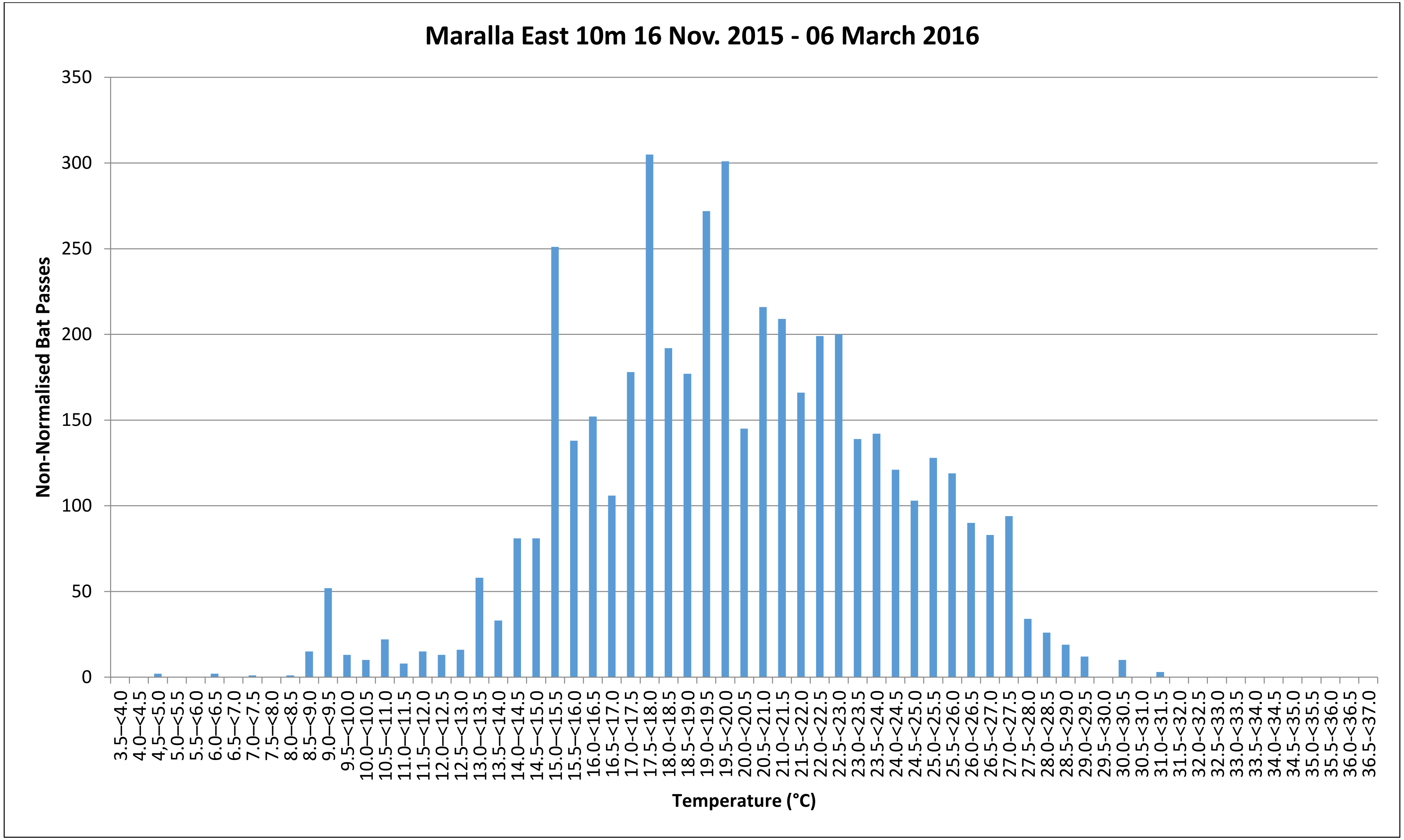


Figure 49: Sum of bat passes (Non-normalised) per Temperature category for Maralla East 10m (16 Nov. 2015 - 06 March 2016).

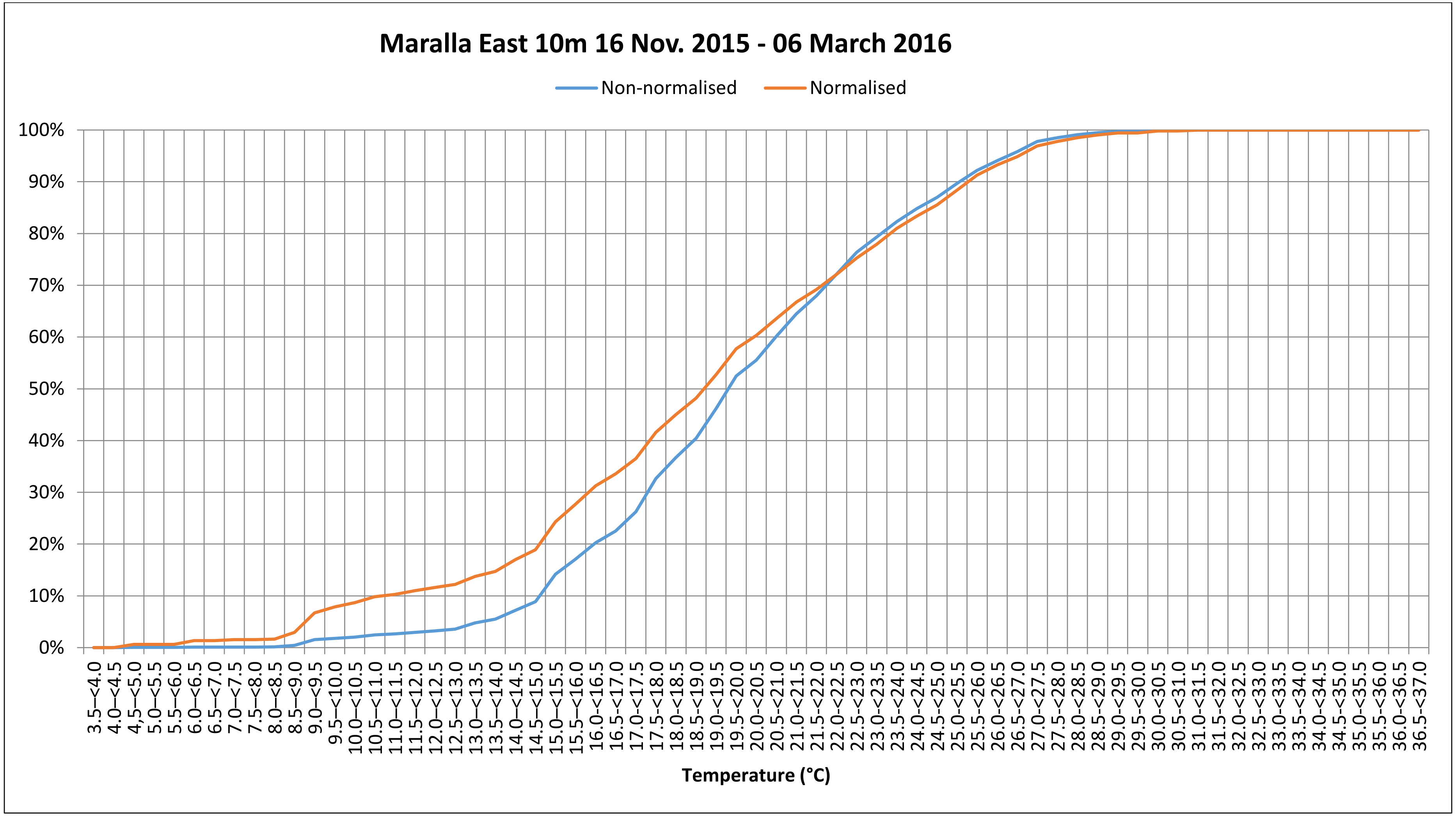


Figure 50: Cumulative percentage of normalised and non-normalised bat passes per Temperature category for Maralla East 10m (16 Nov. 2015 - 06 March 2016).

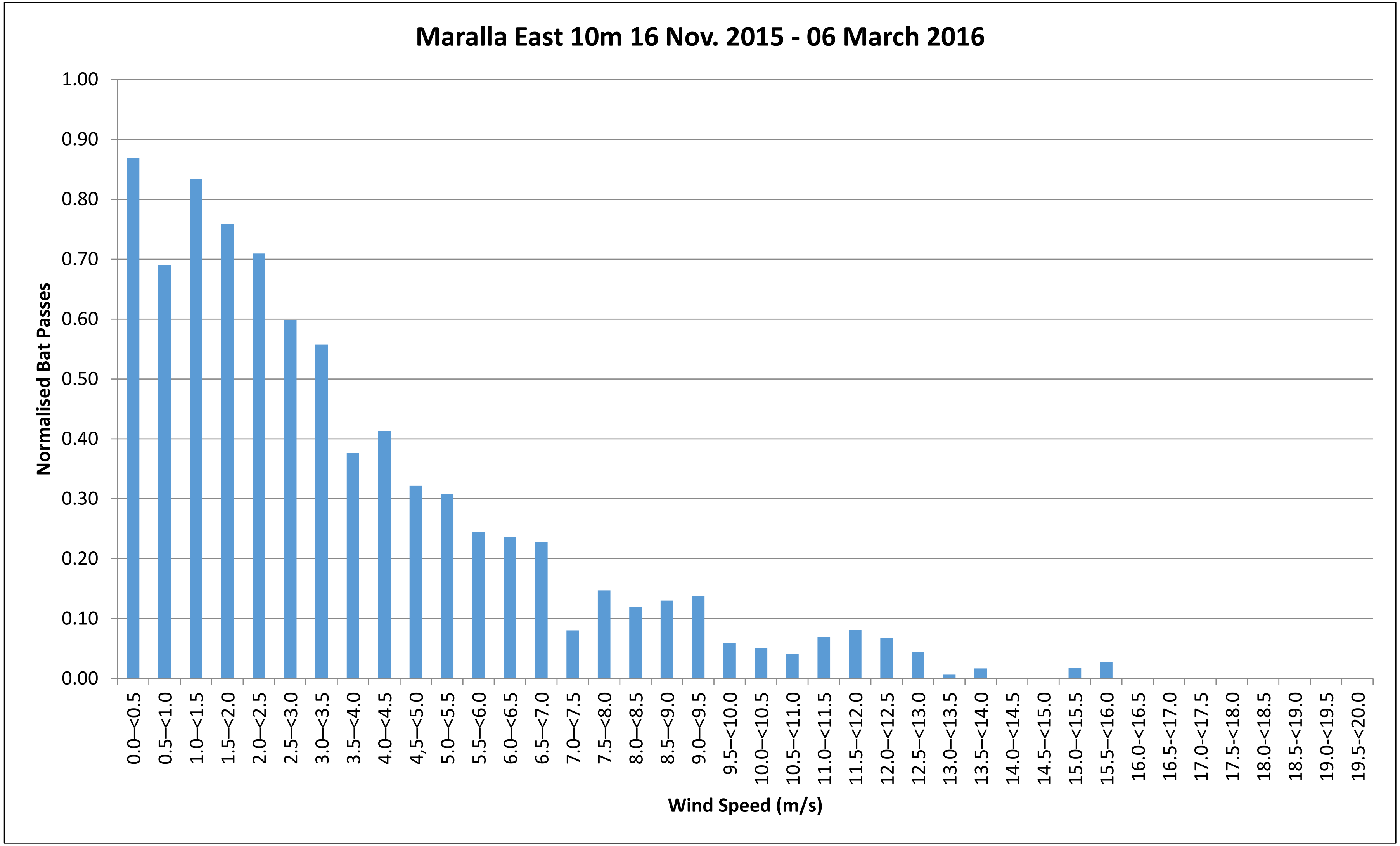


Figure 51: Sum of bat passes (Normalised) per Wind Speed category for Maralla East 10m (16 Nov. 2015 - 06 March 2016).

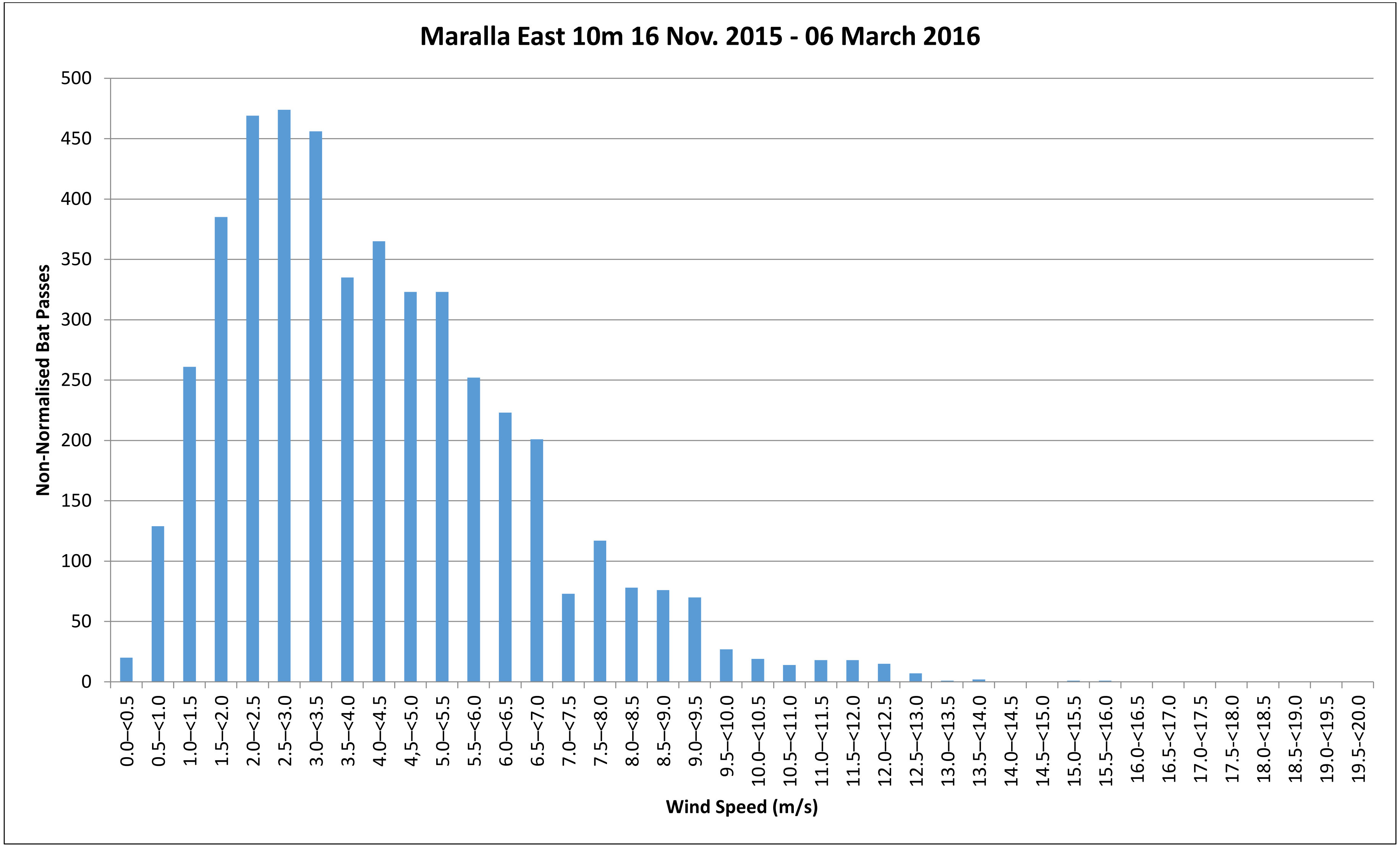


Figure 52: Sum of bat passes (Non-normalised) per Wind Speed category for Maralla East 10m (16 Nov. 2015 - 06 March 2016).

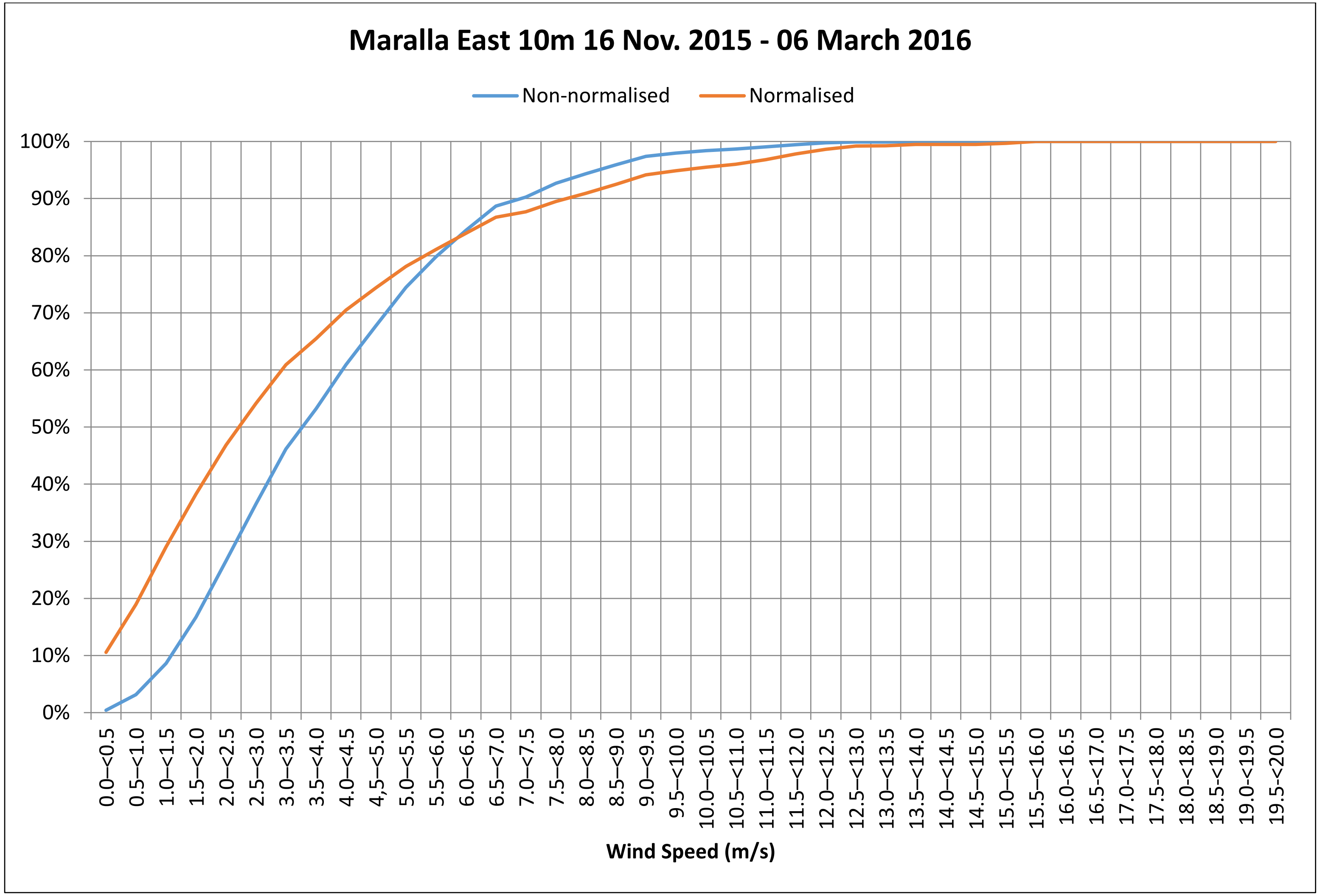


Figure 53: Cumulative percentage of normalised and non-normalised bat passes per Wind Speed category for Maralla East 10m (16 Nov. 2015 - 06 March 2016).

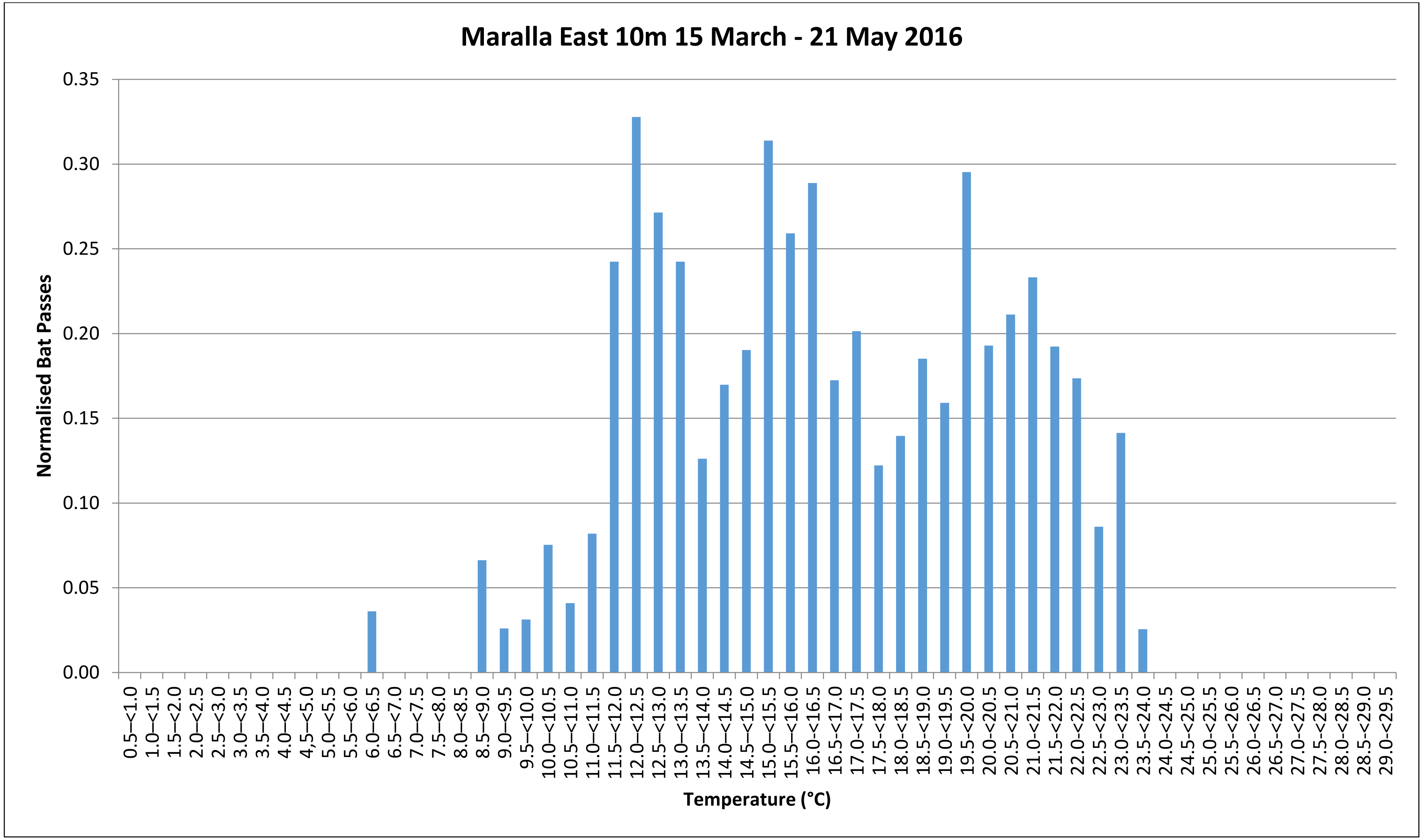


Figure 54: Sum of bat passes (Normalised) per Temperature category for Maralla East 10m (15 March – 21 May 2016).

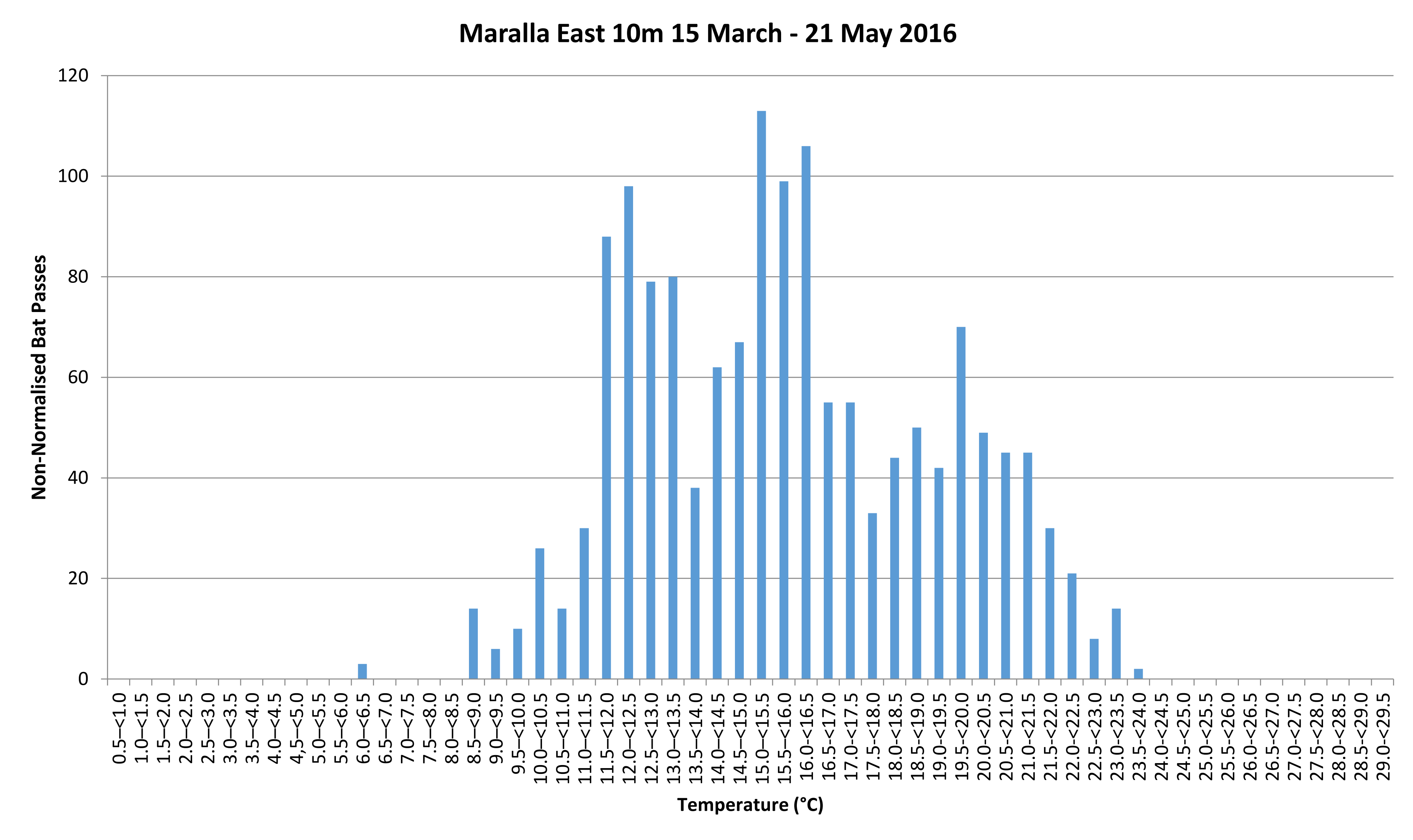


Figure 55: Sum of bat passes (Non-normalised) per Temperature category for Maralla East 10m (15 March – 21 May 2016).

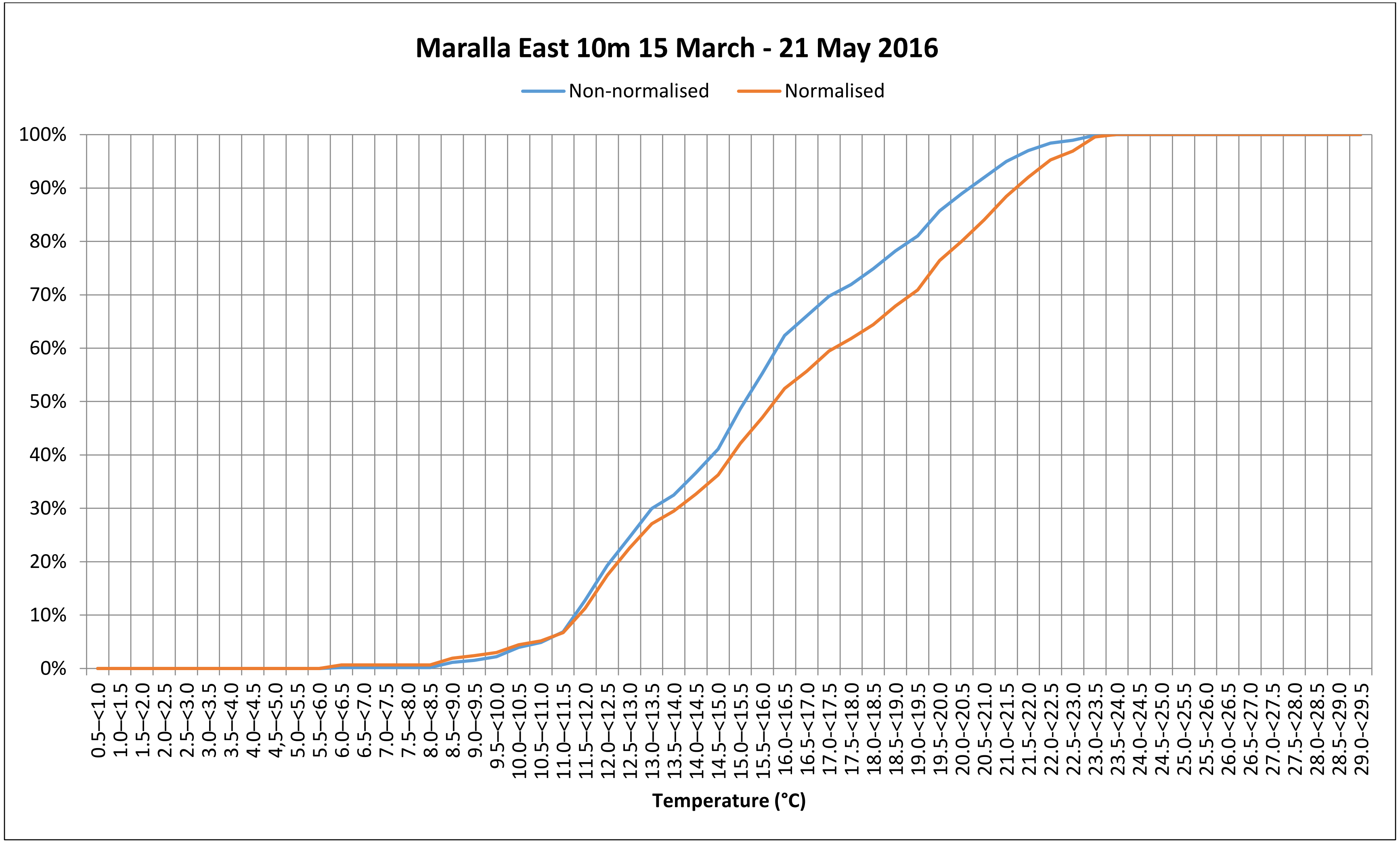


Figure 56: Cumulative percentage of normalised and non-normalised bat passes per Temperature category for Maralla East 10m (15 March – 21 May 2016).

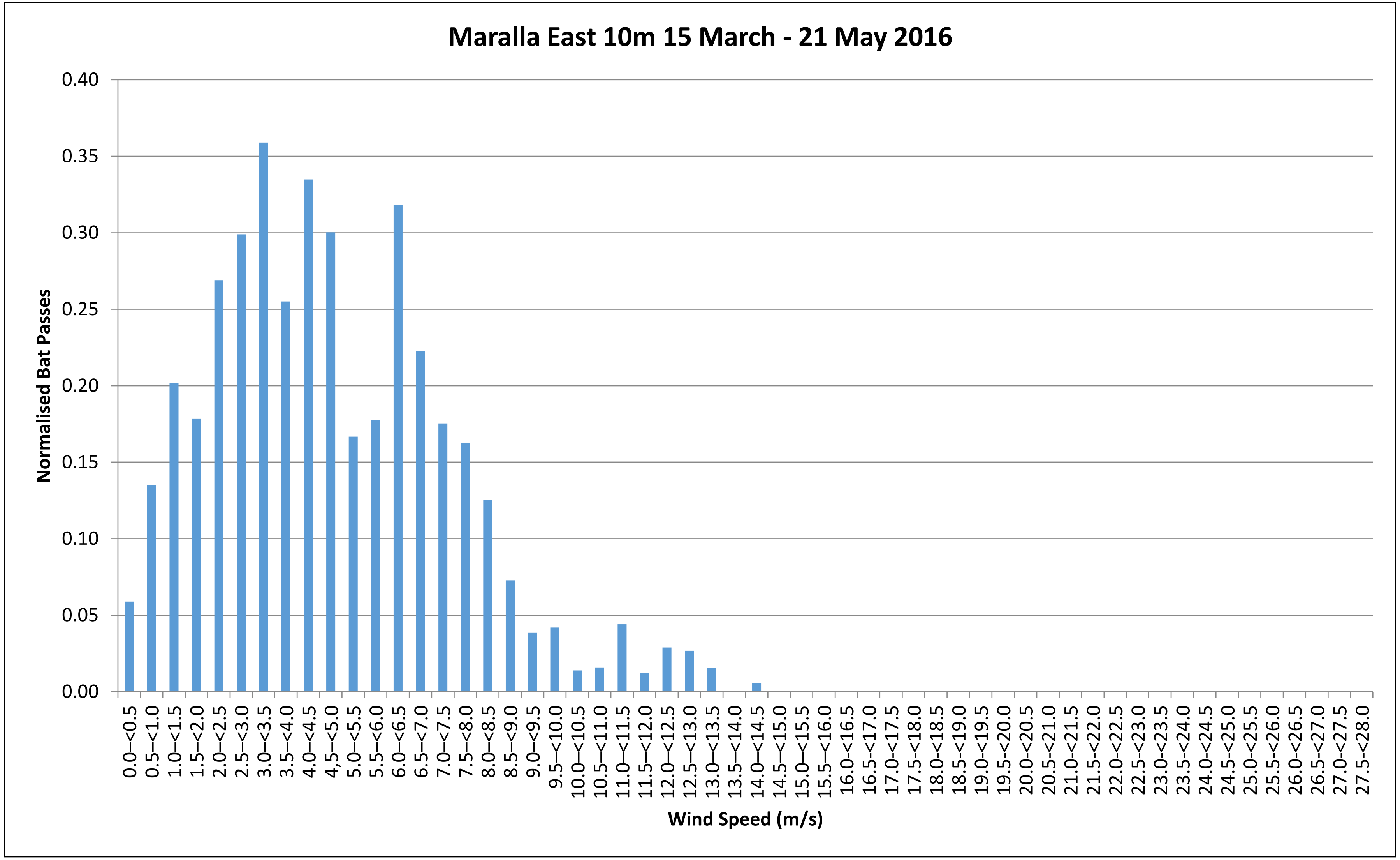


Figure 57: Sum of bat passes (Normalised) per Wind Speed category for Maralla East 10m (15 March – 21 May 2016).

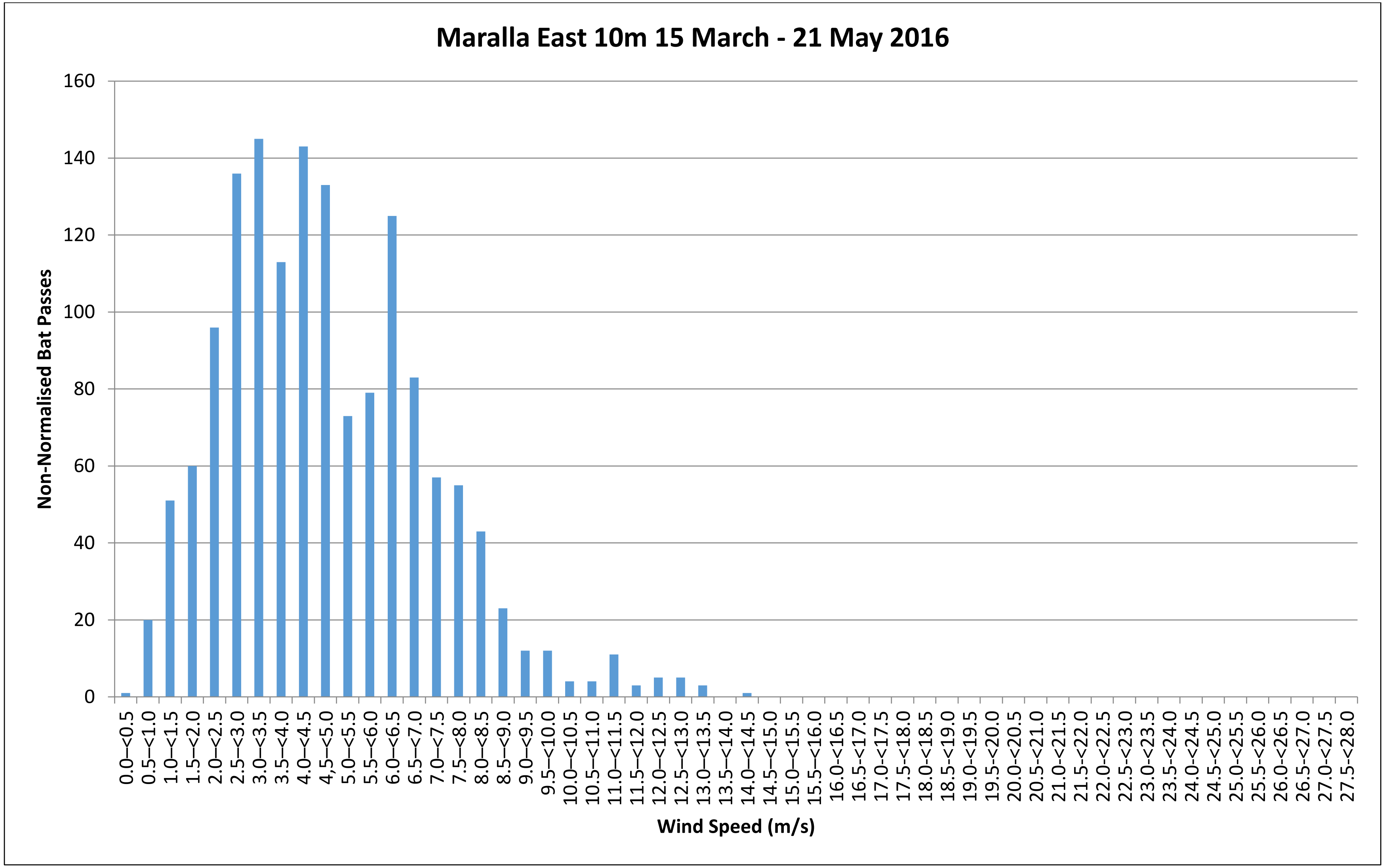


Figure 58: Sum of bat passes (Non-normalised) per Wind Speed category for Maralla East 10m (15 March – 21 May 2016).

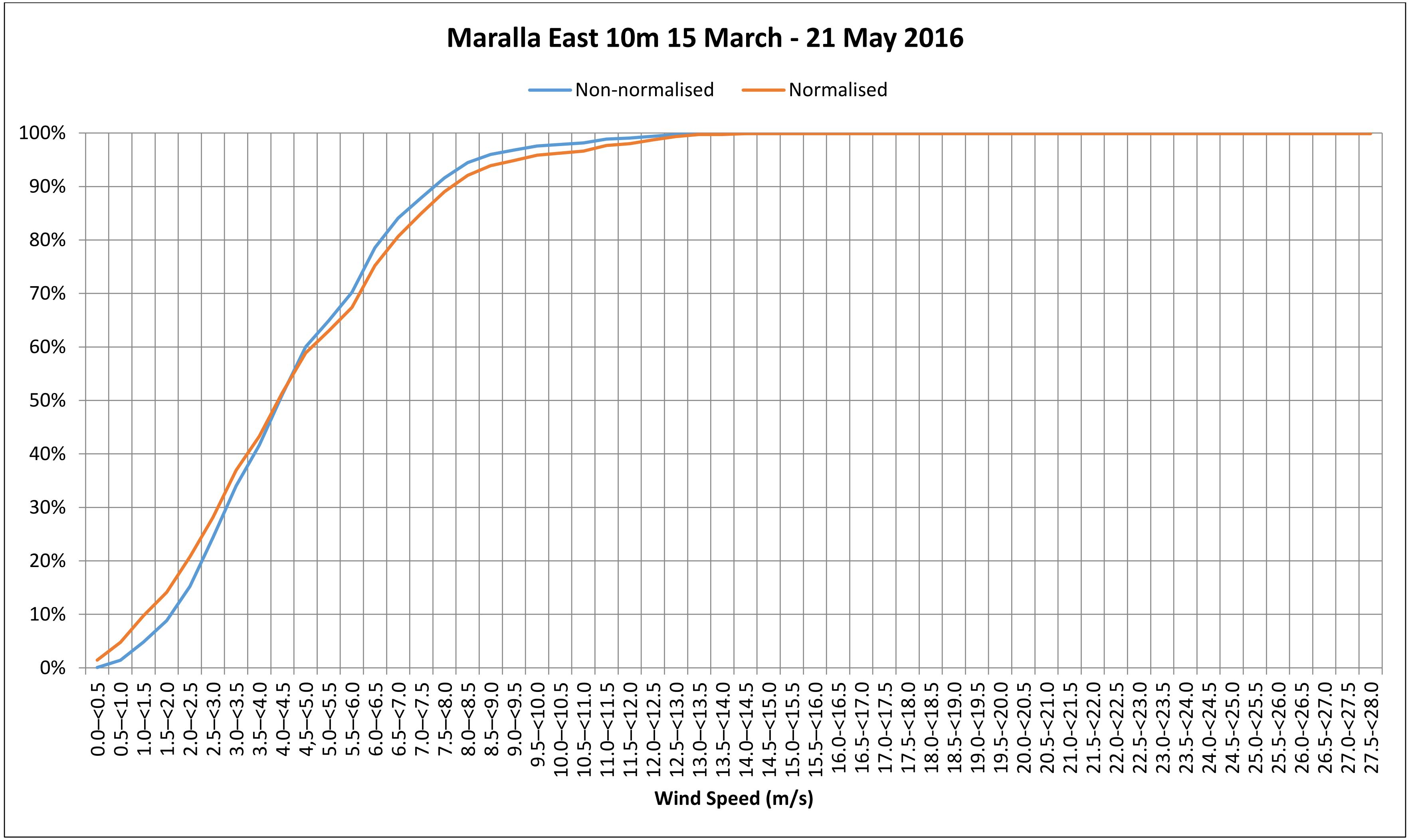


Figure 59: Cumulative percentage of normalised and non-normalised bat passes per Wind Speed category for Maralla East 10m (15 March – 21 May 2016).

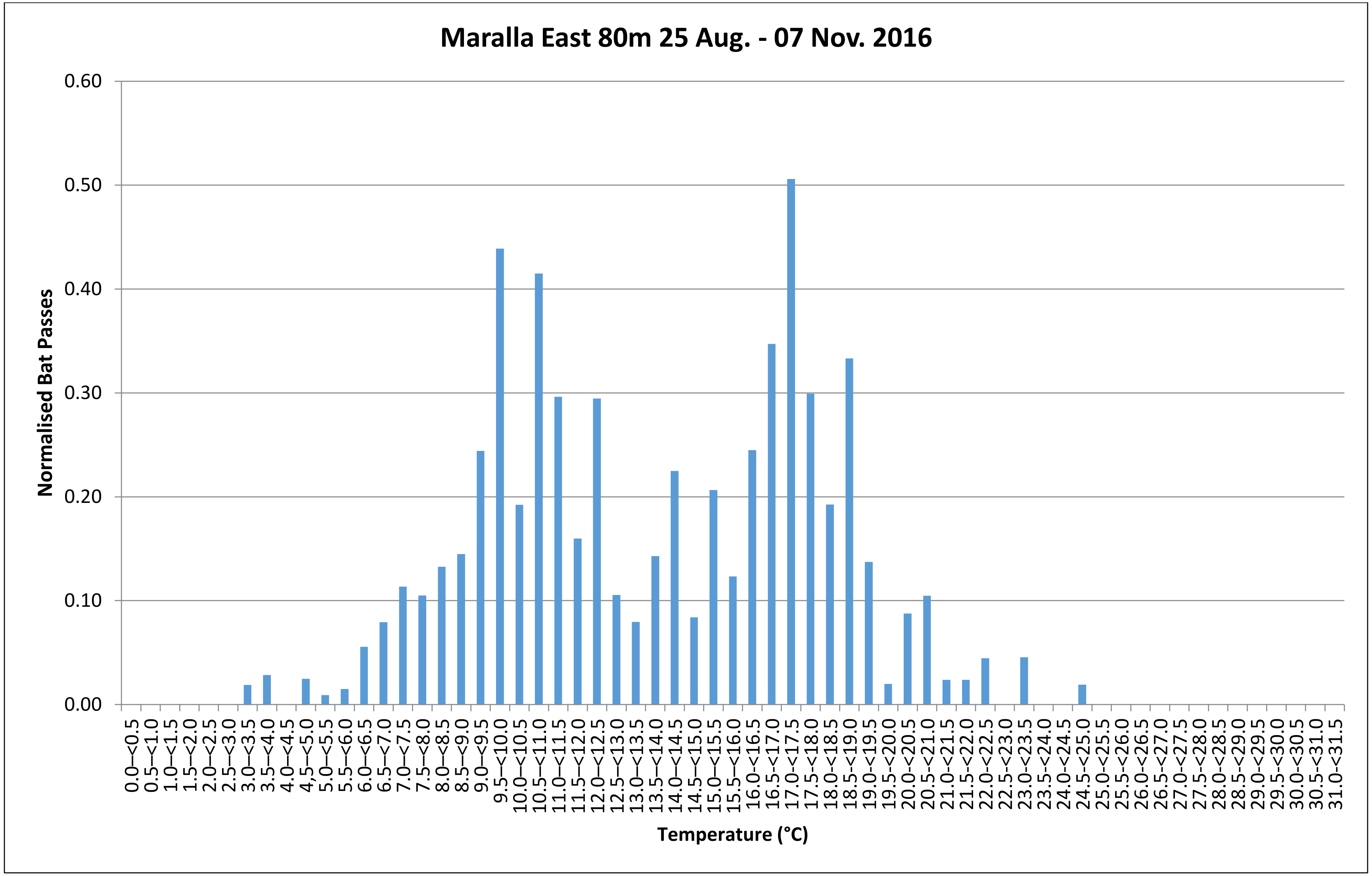


Figure 60: Sum of bat passes (Normalised) per Temperature category for Maralla East 80m (25 Aug. – 07 Nov. 2016).

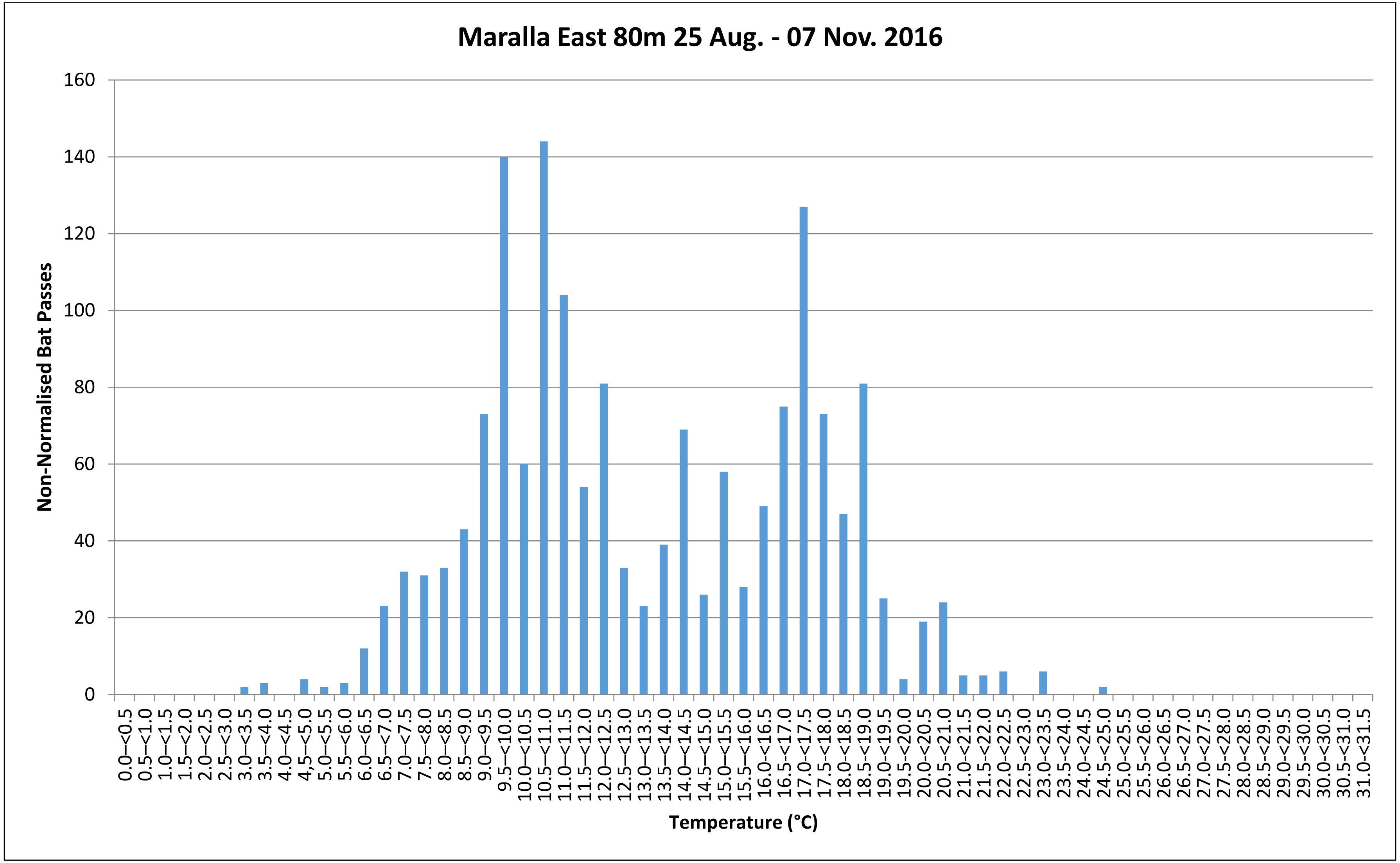


Figure 61: Sum of bat passes (Non-normalised) per Temperature category for Maralla East 80m (25 Aug. – 07 Nov. 2016).

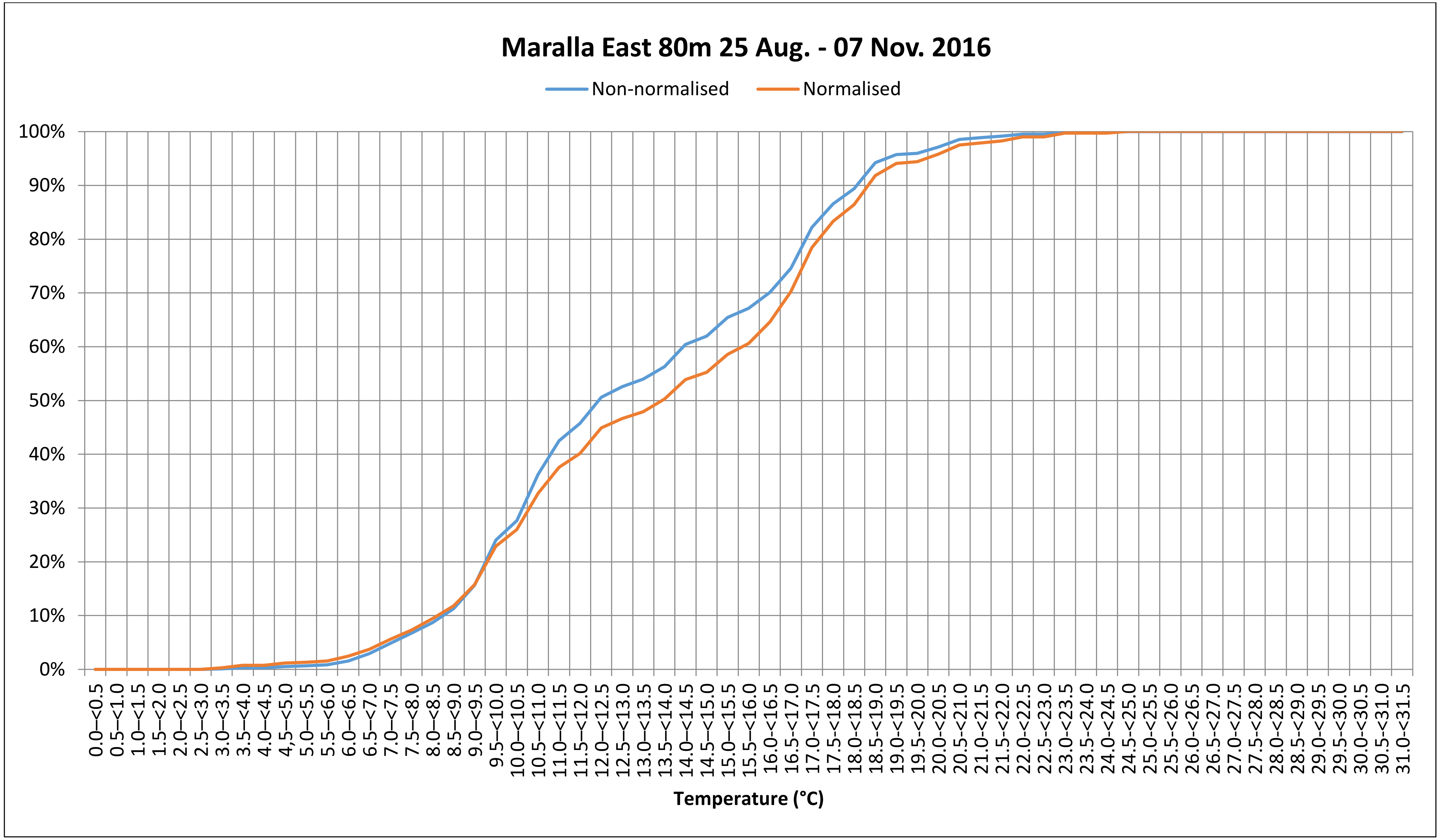


Figure 62: Cumulative percentage of normalised and non-normalised bat passes per Temperature category for Maralla East 80m (25 Aug. – 07 Nov. 2016).

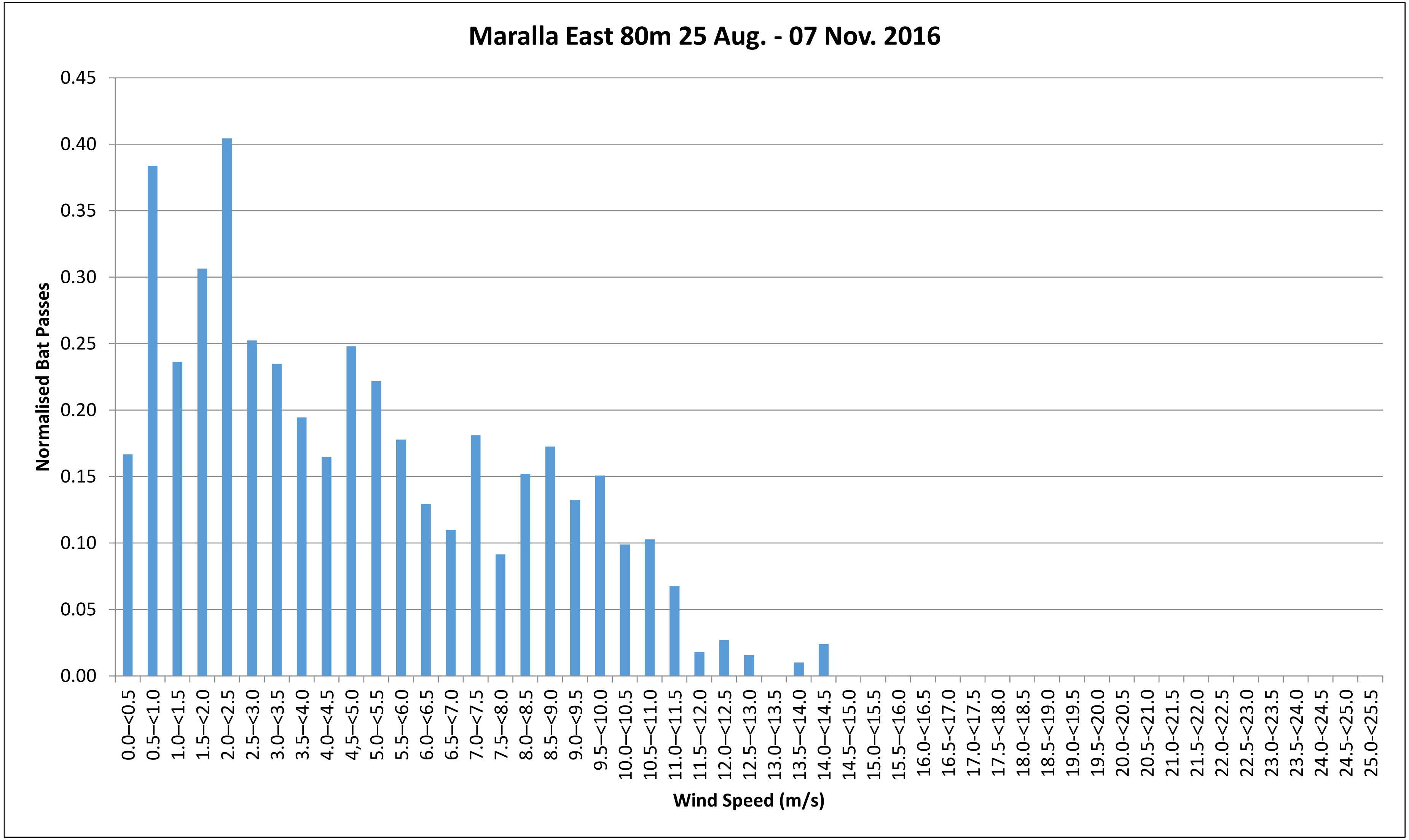


Figure 63: Sum of bat passes (Normalised) per Wind Speed category for Maralla East 80m (25 Aug. – 07 Nov. 2016).

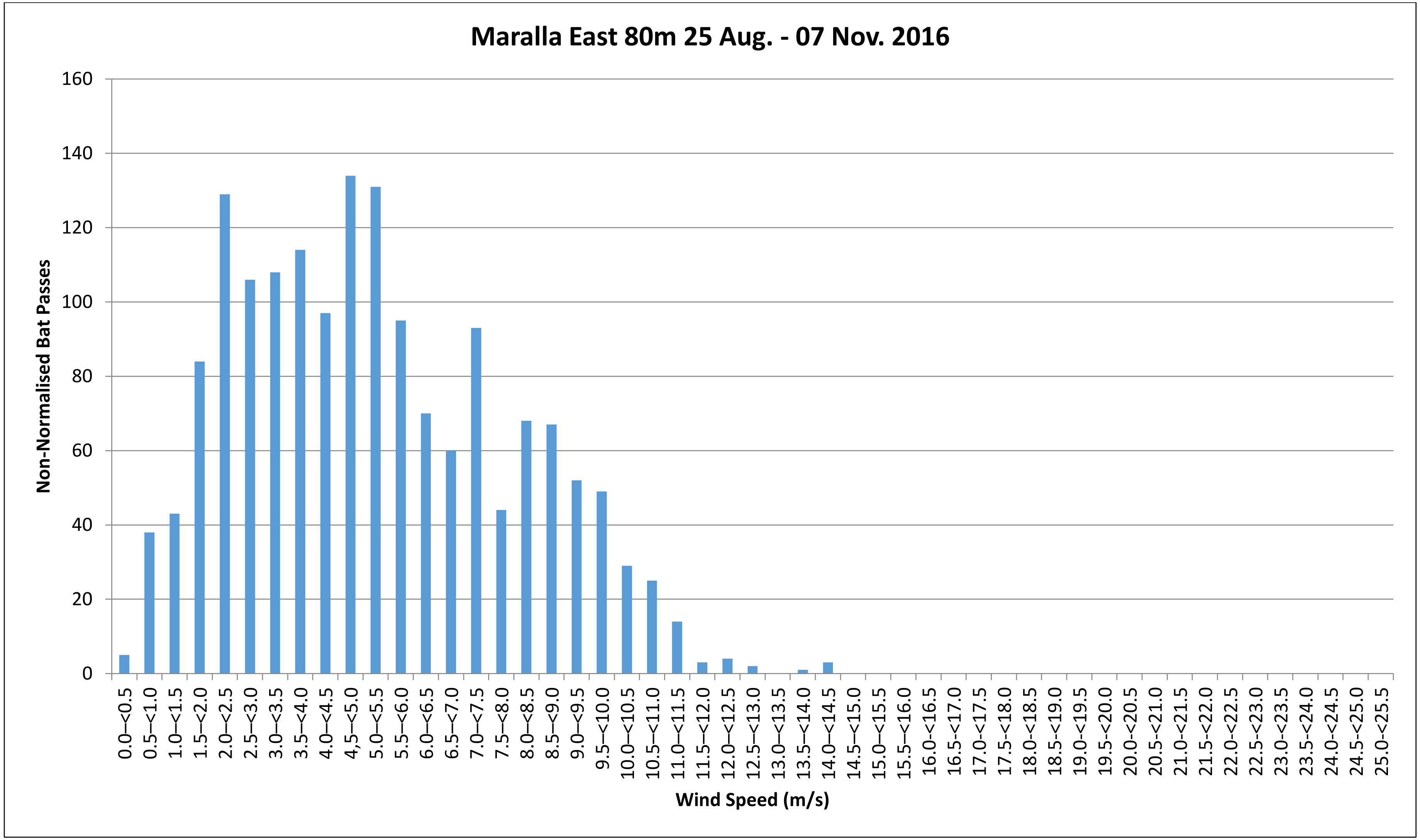


Figure 64: Sum of bat passes (Non-normalised) per Wind Speed category for Maralla East 80m (25 Aug. – 07 Nov. 2016).

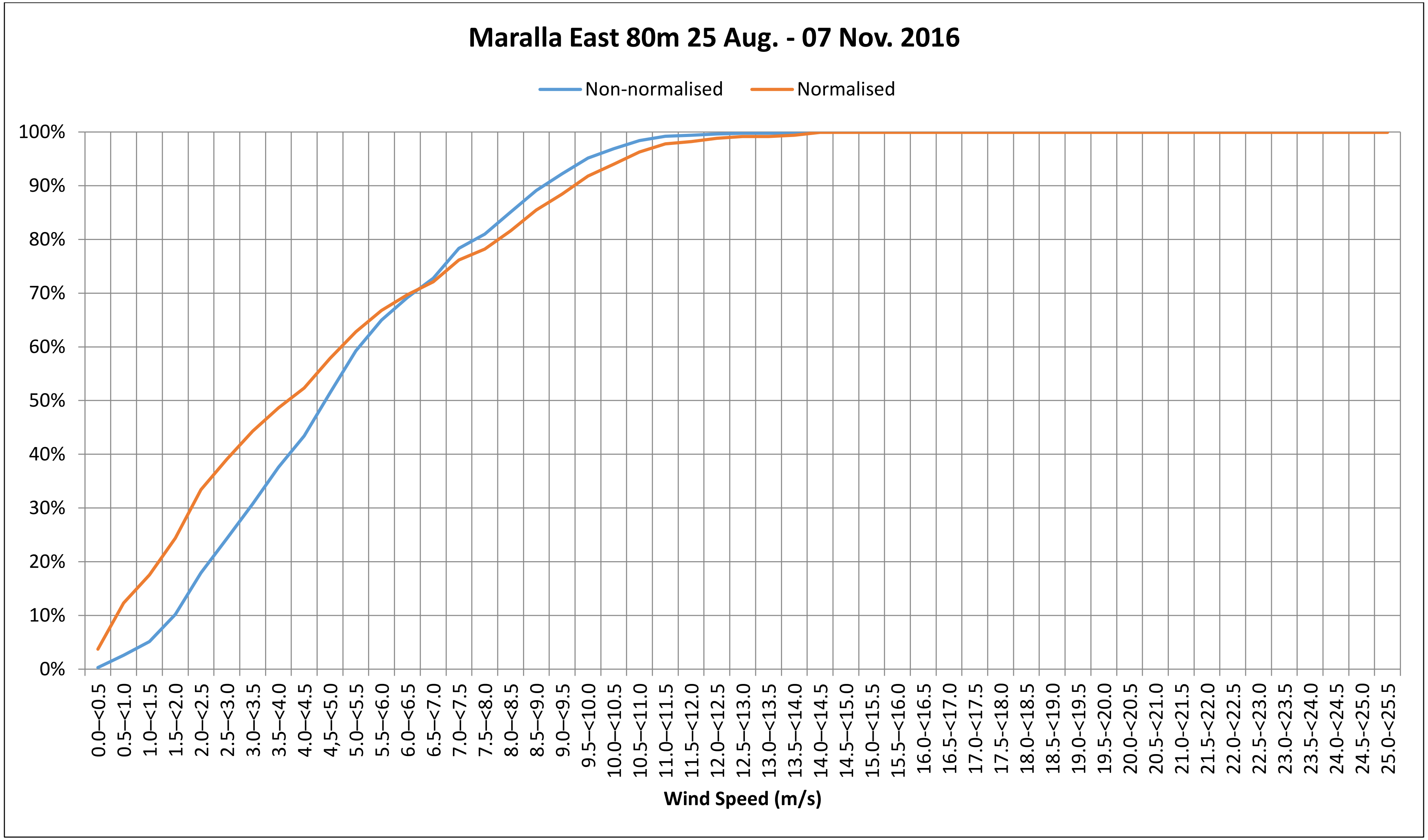


Figure 65: Cumulative percentage of normalised and non-normalised bat passes per Wind Speed category for Maralla East 80m (25 Aug. – 07 Nov. 2016).

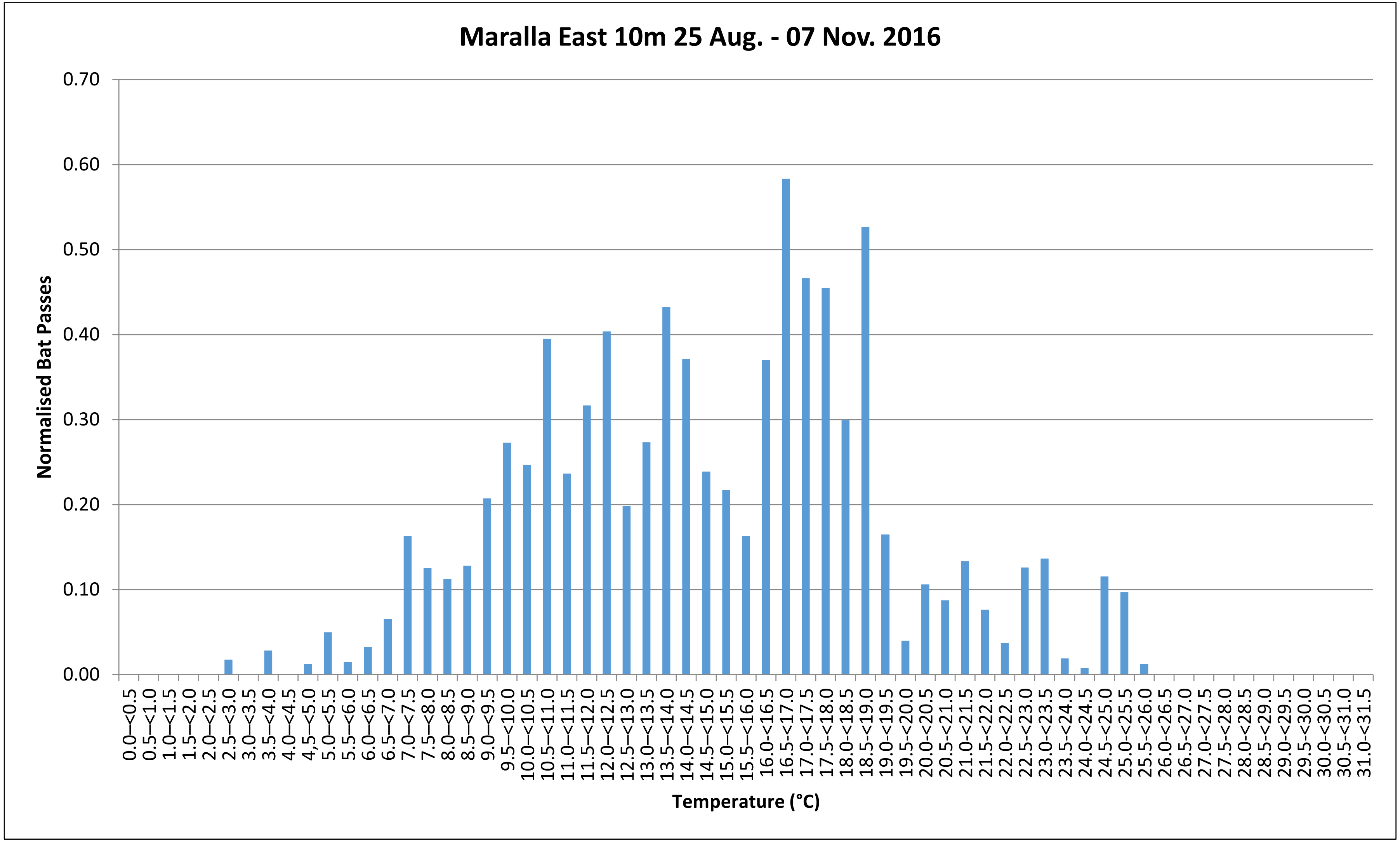


Figure 66: Sum of bat passes (Normalised) per Temperature category for Maralla East 10m (25 Aug. – 07 Nov. 2016).

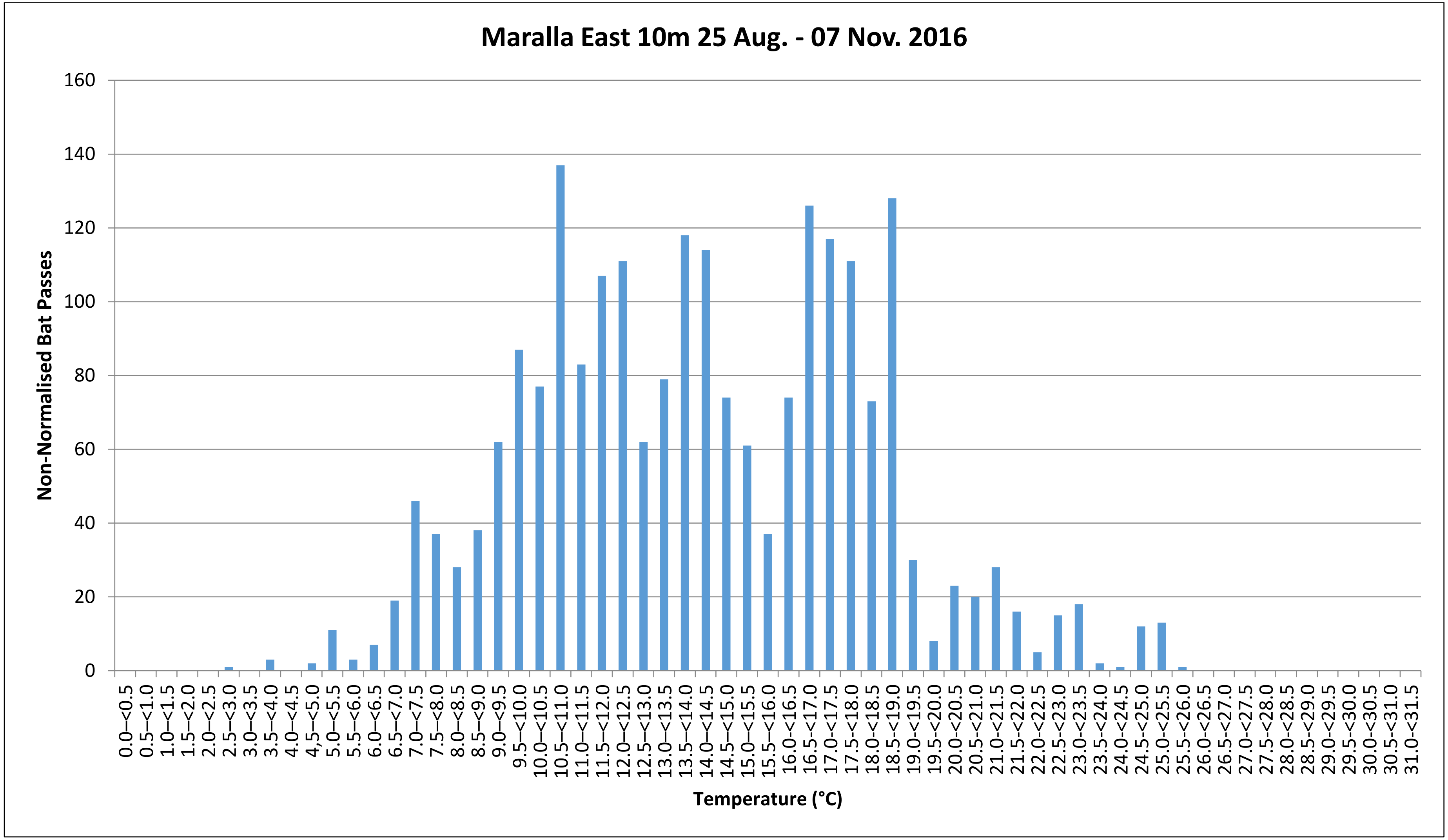


Figure 67: Sum of bat passes (Non-normalised) per Temperature category for Maralla East 10m (25 Aug. – 07 Nov. 2016).

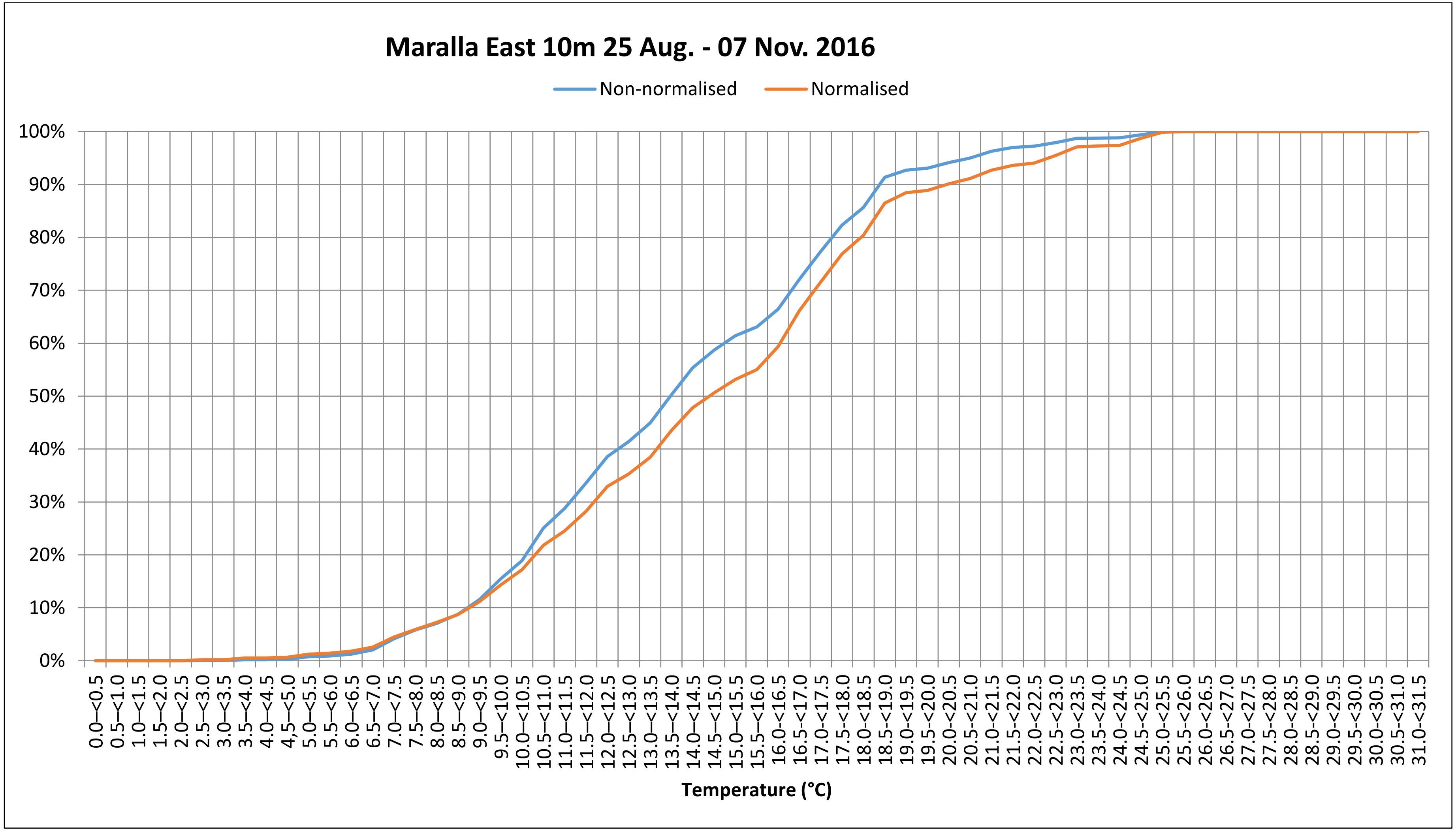


Figure 68: Cumulative percentage of normalised and non-normalised bat passes per Temperature category for Maralla East 10m (25 Aug. – 07 Nov. 2016).

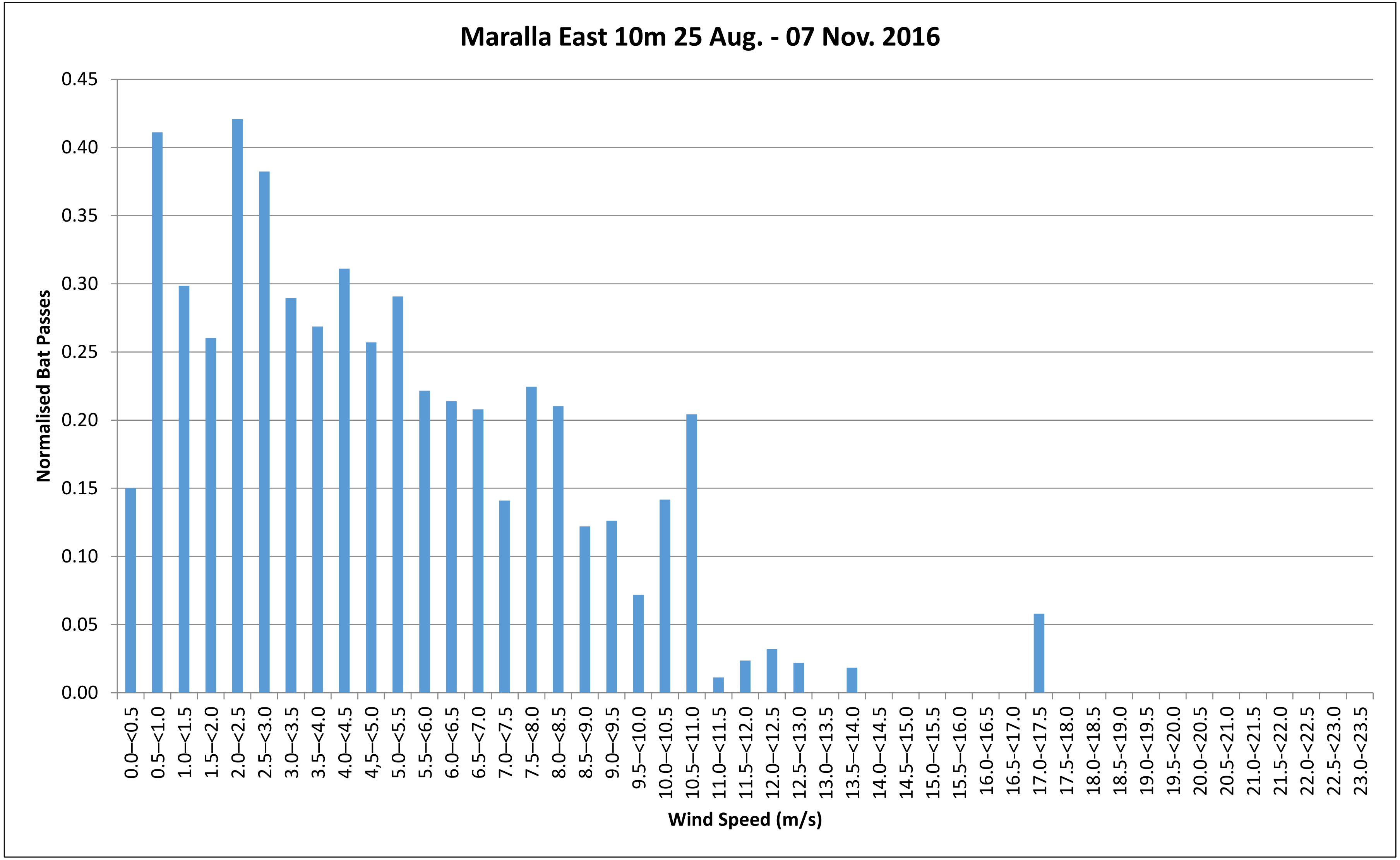


Figure 69: Sum of bat passes (Normalised) per Wind Speed category for Maralla East 10m (25 Aug. – 07 Nov. 2016).

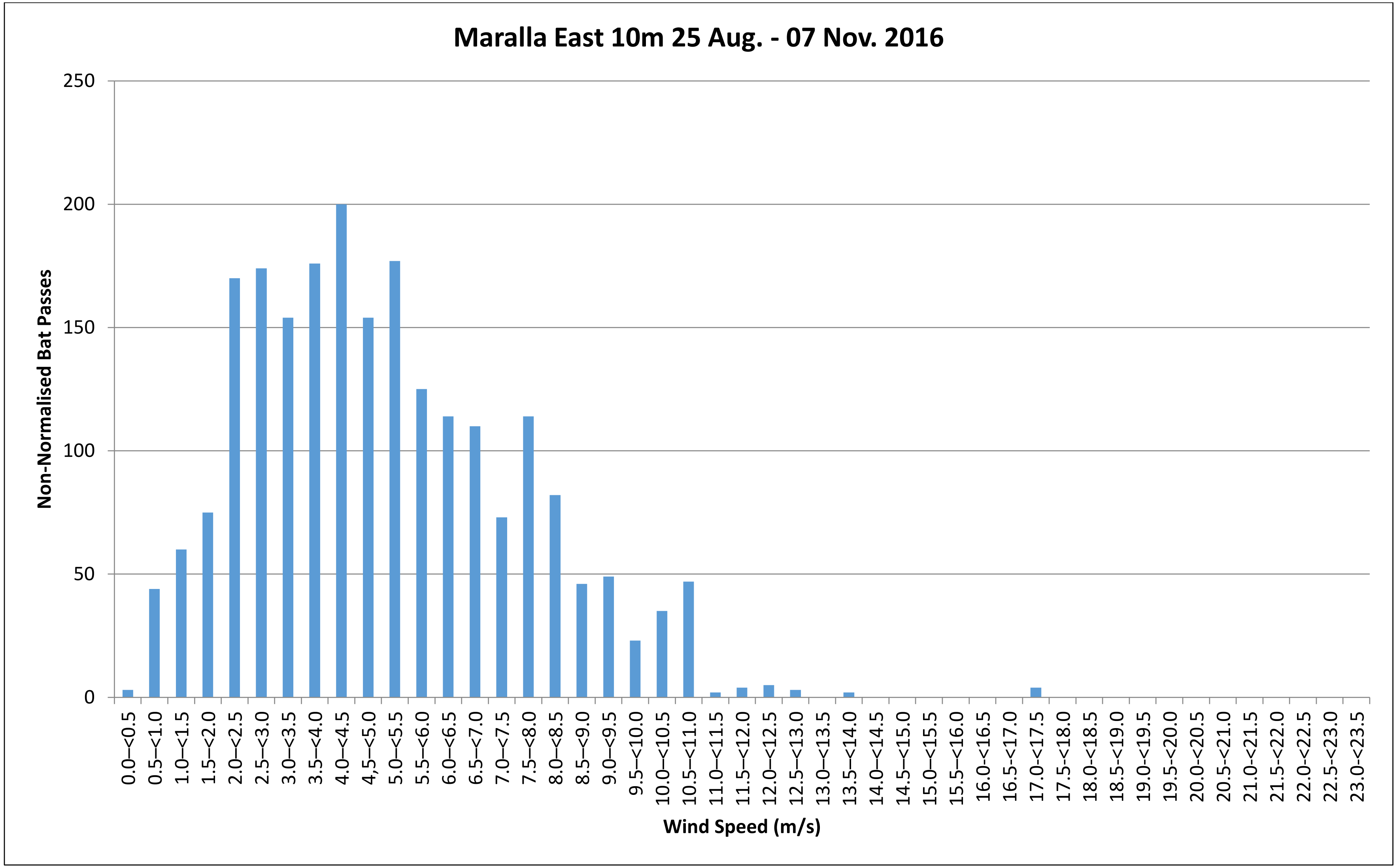


Figure 70: Sum of bat passes (Non-normalised) per Wind Speed category for Maralla East 10m (25 Aug. – 07 Nov. 2016).

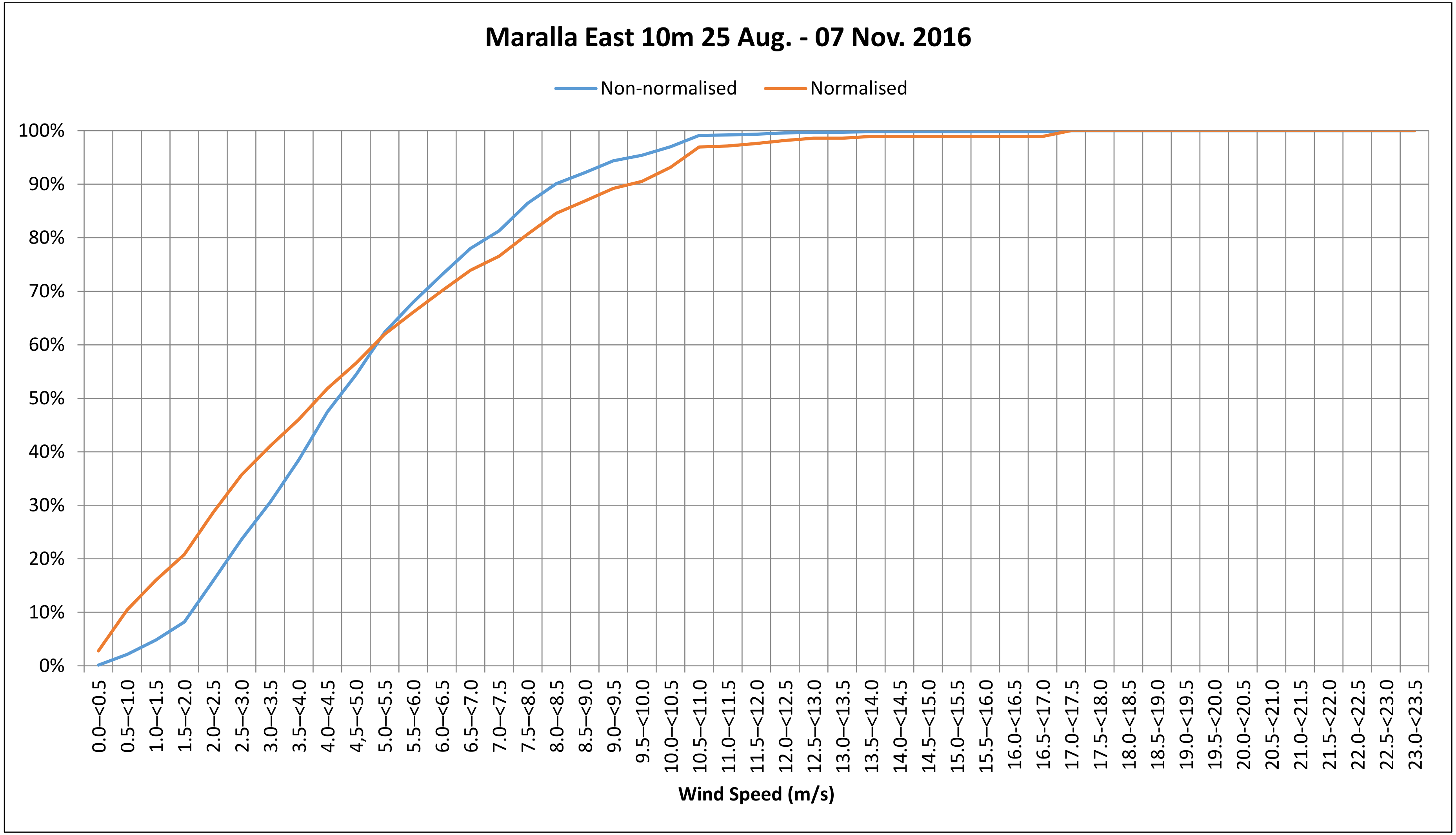


Figure 71: Cumulative percentage of normalised and non-normalised bat passes per Wind Speed category for Maralla East 10m (25 Aug. – 07 Nov. 2016).

6 IMPACT ASSESSMENT OF PROPOSED WEF ON BAT FAUNA

6.1 Construction phase

Construction Phase									
Maralla East WEF									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Destruction of bat roosts due to earthworks and blasting	Nature of impact:	Earthworks and blasting close to bat roosts will negatively affect bat populations through high mortality, which in effect will cause a decrease in bat population numbers. Direct impact.							
	Without Mitigation	1	3	10	3	42	Medium	-	High
	degree to which impact can be reversed:	Blasting occurring at bat roosts will cause damage to the bat population in the area. It is reversible over a longer time period.							
	degree of impact on irreplaceable resources:	If blasting and earthworks occurs close to a bat roost, it will be destroyed and lost.							
	Mitigation Measures	Adhere to the sensitivity map during turbine placement. Blasting should be minimised and used only when necessary. If blasting of a rocky area with crevices and cracks is necessary, a Bat Specialist must be consulted before blasting in order to determine whether a bat roost is present in the rocky area. The mitigation measures will reduce the impact blasting and earthworks will have on the environmental parameter, through avoiding sensitive areas.							
	With Mitigation	1	2	6	1	9	Low	-	High

Loss of foraging habitat	Nature of impact:	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.							
	Without Mitigation	1	4	4	4	36	Medium	-	High
	degree to which impact can be reversed:	Depending on the degree of habitat loss, it will be partly reversed with some mitigation measures, especially in more sensitive areas. Minimal foraging habitat will be permanently lost.							
	degree of impact on irreplaceable resources:	In areas where vegetation is removed for roads and turbines, there will be a loss of habitat resources, but the scale is relatively small.							
	Mitigation Measures	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. The mitigation measures will reduce the degree of habitat loss.							
	With Mitigation	1	3	2	2	12	Low	-	High

6.2 Operational phase

Operational Phase									
Maralla East WEF									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Bat mortalities due to direct blade impact or barotrauma during foraging activities (not migration)	Nature of impact:	Bat mortalities due to direct blade impact or barotrauma during foraging activities (not migration). The concerns of foraging bats in relation to wind turbines is discussed in Section 3.2. If the impact is too severe (e.g. in the case of no mitigation) local bat populations may not recover from mortalities.							
	Without Mitigation	2	4	10	5	80	High	-	High
	degree to which impact can be reversed:	The impact will occur throughout the lifespan of the wind facility. Population numbers may take very long to recover. Population and diversity genetics may be permanently altered.							
	degree of impact on irreplaceable resources:	Bat population numbers will decrease in the area.							
	Mitigation Measures	Adhere to the bat sensitivity map. Adhere to the operational mitigation measures outlined in Section 7 and 8. Apply mitigation measures outlined by the Bat Specialist during the operational bat monitoring study.							
	With Mitigation	2	4	6	3	36	Medium	-	High

Artificial lighting	Nature of impact:	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 to 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 is insect prey available, which can draw insect prey away from other natural areas and thereby artificially favor only certain species.							
	Without Mitigation	1	4	6	5	55	Medium	-	High
	degree to which impact can be reversed:	On completion of the operational phase, the artificial lighting will be removed, whereby certain bat species won't be favoured in the area.							
	degree of impact on irreplaceable resources:	No loss of resources.							
	Mitigation Measures	Utilise lights with wavelengths that attract less insects (low thermal/infrared signature). If not required for safety or security purposes, lights should be switched off when not in use or equipped with passive motion sensors. The mitigation measures will reduce the likelihood of certain bat species being favoured.							
	With Mitigation	1	2	2	1	5	Low	-	High

6.3 Decommissioning phase

Decommissioning Phase									
Esizayo									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Loss of foraging habitat	Nature of impact:	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.							
	Without Mitigation	1	4	4	4	36	Medium	-	High
	degree to which impact can be reversed:	Depending on the degree of habitat loss, it will be partly reversed with some mitigation measures, especially in more sensitive areas. Minimal foraging habitat will be permanently lost.							
	degree of impact on irreplaceable resources:	In areas where vegetation is removed for roads and turbines, there will be a loss of habitat resources, but the scale is insignificant.							
	Mitigation Measures	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. The mitigation measures will reduce the degree of habitat loss.							
	With Mitigation	1	3	2	2	12	Low	-	High

7 PROPOSED INITIAL MITIGATION MEASURES AND DETAILS

The mitigation schedule table below is based on the passive data collected. They infer mitigation be applied during the peak activity periods and times, and when the advised wind speed and temperature ranges are prevailing simultaneously (considering conditions in which 80% of bat activity occurred). Bat activity at 80m height of the Met Mast was used with wind speed data at 78.8m and temperature data at 4.5 meters. Bat activity at 10m height of the Met Mast were used, with wind speed data at 38m and temperature data at 4.5 meters.

The below is a preliminary mitigation schedule and may be adapted and applied to whichever turbine/s as identified as needed in the operational phase bat monitoring study.

Table 9: The possible wind turbine mitigation schedule for Maralla East WEF

Terms of mitigation implementation	
Peak activity Met Mast (times to implement curtailment/ mitigation)	Met Mast East (80m): 16 November – 06 March; sunset – 04:20
Environmental conditions in which to implement curtailment/ mitigation	Met Mast East (80m): Wind speed below 5.0m/s and Temperature above 13.0°C
Peak activity (times to implement curtailment/ mitigation)	Met Mast East (10m): 16 November – 06 March; sunset – 22:00
Environmental conditions in which to implement curtailment/ mitigation	Met Mast East (10m): Wind speed below 5.5m/s and Temperature above 15.0°C
Peak activity (times to implement curtailment/ mitigation)	Met Mast East (10m): 15 March – 21 May; sunset – 01:10
Environmental conditions in which to implement curtailment/ mitigation -	Met Mast East (10m): Wind speed below 6m/s and Temperature above 13.0°C
Peak activity (times to implement curtailment/ mitigation)	Met Mast East (80m): 25 August – 07 November; sunset – 01:30

Environmental conditions in which to implement curtailment/ mitigation	Met Mast East (80m): Wind speed below 7.5m/s and Temperature above 10.0°C
Peak activity (times to implement curtailment/ mitigation)	Met Mast East (10m): 25 August – 07 November; sunset – 01:30
Environmental conditions in which to implement curtailment/ mitigation	Met Mast East (10m): Wind speed below 7.0m/s and Temperature above 10.0°C

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

Curtailment:

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

Cut-in speed:

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

Feathering or Feathered:

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

Free-wheeling:

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

Increasing cut-in speed:

The turbine's computer system (referred to as the Supervisory Control and Data Acquisitions or SCADA system) is programmed to a cut-in speed higher than the manufacturer's set speed, and turbines are programmed to 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.

All turbines of the Maralla East WEF must be curtailed below cut in speed and not allow for free-wheeling from the start of operation (Level 3 mitigation), for every night of the year from sunset to sunrise. However, actual impacts on bats will be monitored during the operational phase monitoring, and the recommended mitigation measures and levels of curtailment will be adjusted according to the results of the operational monitoring. This is an adaptive management approach, and it is crucial that any suggested changes to the initial proposed mitigation schedule be implemented within a maximum of 2 weeks from the date of the recommendation, unless the recommendation refers to a time period later in the future (e.g. the following similar season/climatic condition).

8 CUMULATIVE IMPACT ASSESSMENT

Several renewable energy development applications have been submitted and/or authorized within the immediate area of the proposed Maralla East WEF. **Figure 42** below displays these areas. The impact of the Maralla East wind energy facility was assessed in Section 6 above; this section assesses the cumulative impact of all renewable energy developments within the area.

The bat sensitivity assessment reports and bat sensitivity maps could not be obtained for all of the neighbouring wind energy developments. The final pre-construction bat sensitivity information for the below listed wind energy facilities were used where applicable:

- Great Karoo WEF
- Karusa WEF

- Esizayo WEFs
- Rietrug WEF
- Roggeveld WEF
- Soetwater WEF
- Sutherland WEF
- Suurplaat WEF

8.1 Bat Sensitivity Map

Figure 44 below displays bat sensitivity maps of several wind farms neighbouring the Maralla East WEF (namely the Suurplaat WEF, Sutherland WEFs, Esizayo WEFs, Soetwater WEF, Great Karoo WEF, Karusa WEF and Roggeveld WEF). **Figure 43** displays the sensitivity map of the Rietrug WEF (taken from the Amendment Report for the proposed Rietrug Wind Energy Facility compiled by CSIR). The bat sensitivity maps were inspected for congruency of sensitive areas and similarities in their buffer distances. Figure 38 displays how extensive the bat sensitivity mapping of the area is and how thorough the pre-construction bat monitoring studies have been to delineate sensitive areas and thus exclude turbines from these areas. The sensitivity map of the Maralla East WEF is sufficient when assessed with neighbouring site sensitivity maps.

The sensitivity maps were also used to assess whether the Maralla East WEF turbine layout intersects interlinking bat sensitivity habitats between the different sites i.e. valley areas, rivers and streams, mountain ridges. The Maralla East WEF turbine layout does not traverse large scale ecological corridors or ecological areas of connectivity. The existing bat sensitivity map is sufficient in this regard.

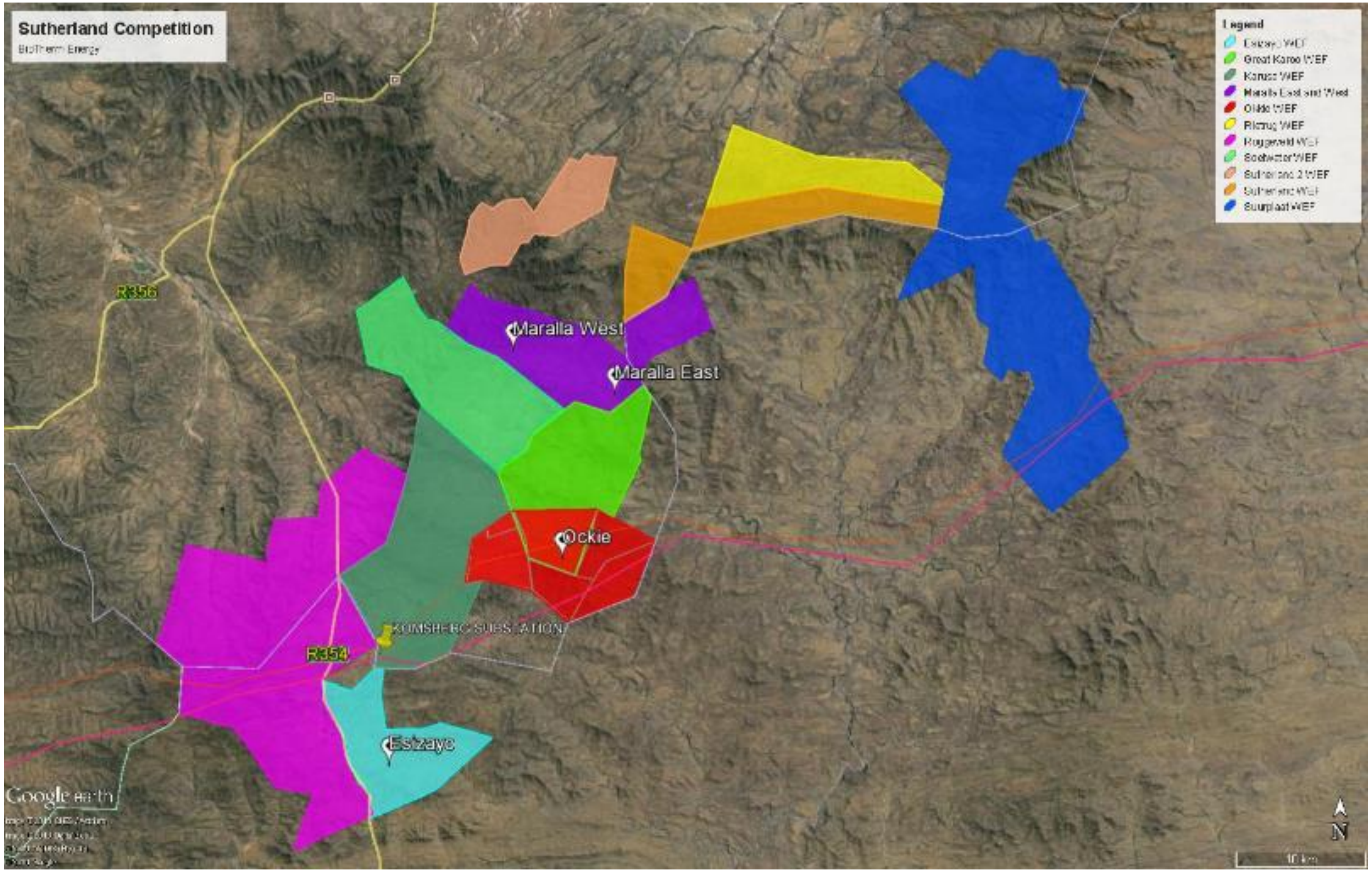


Figure 42: Wind energy facilities neighbouring the proposed Maralla East WEF

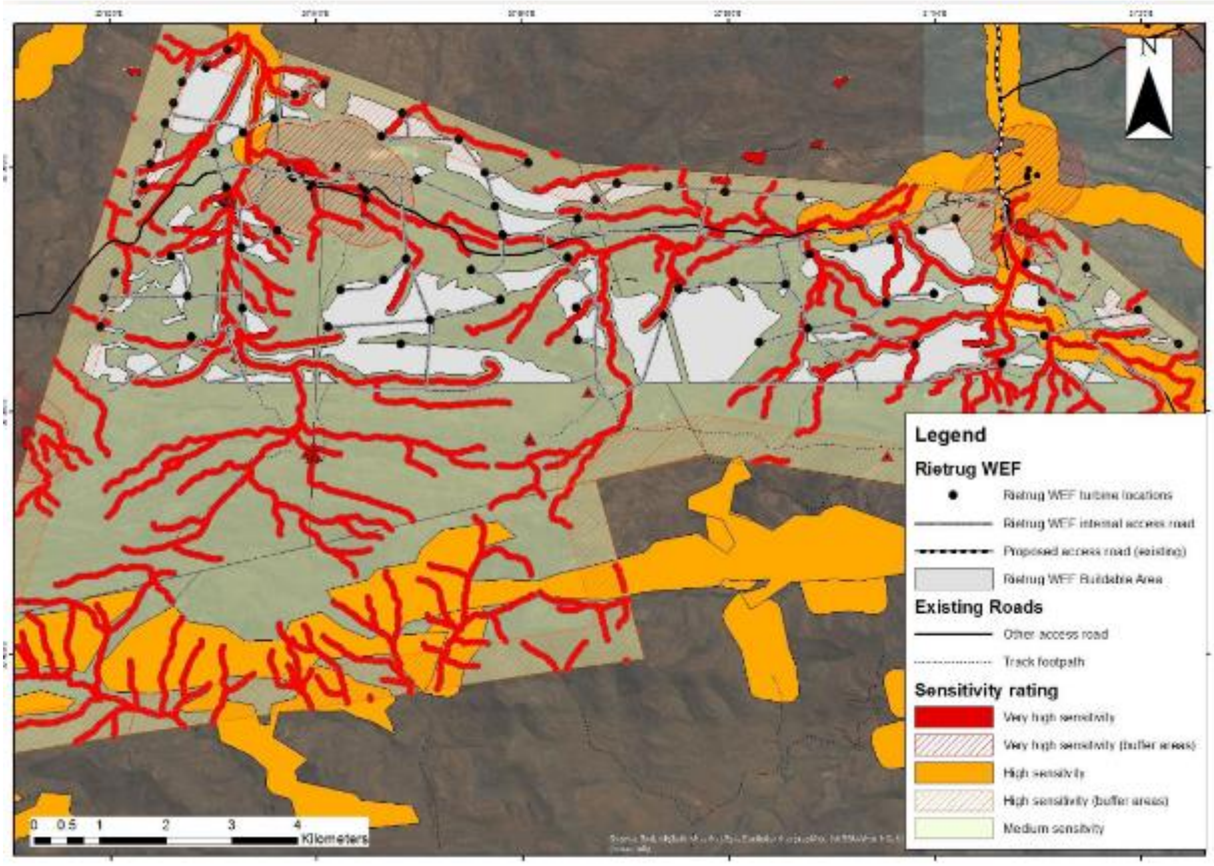
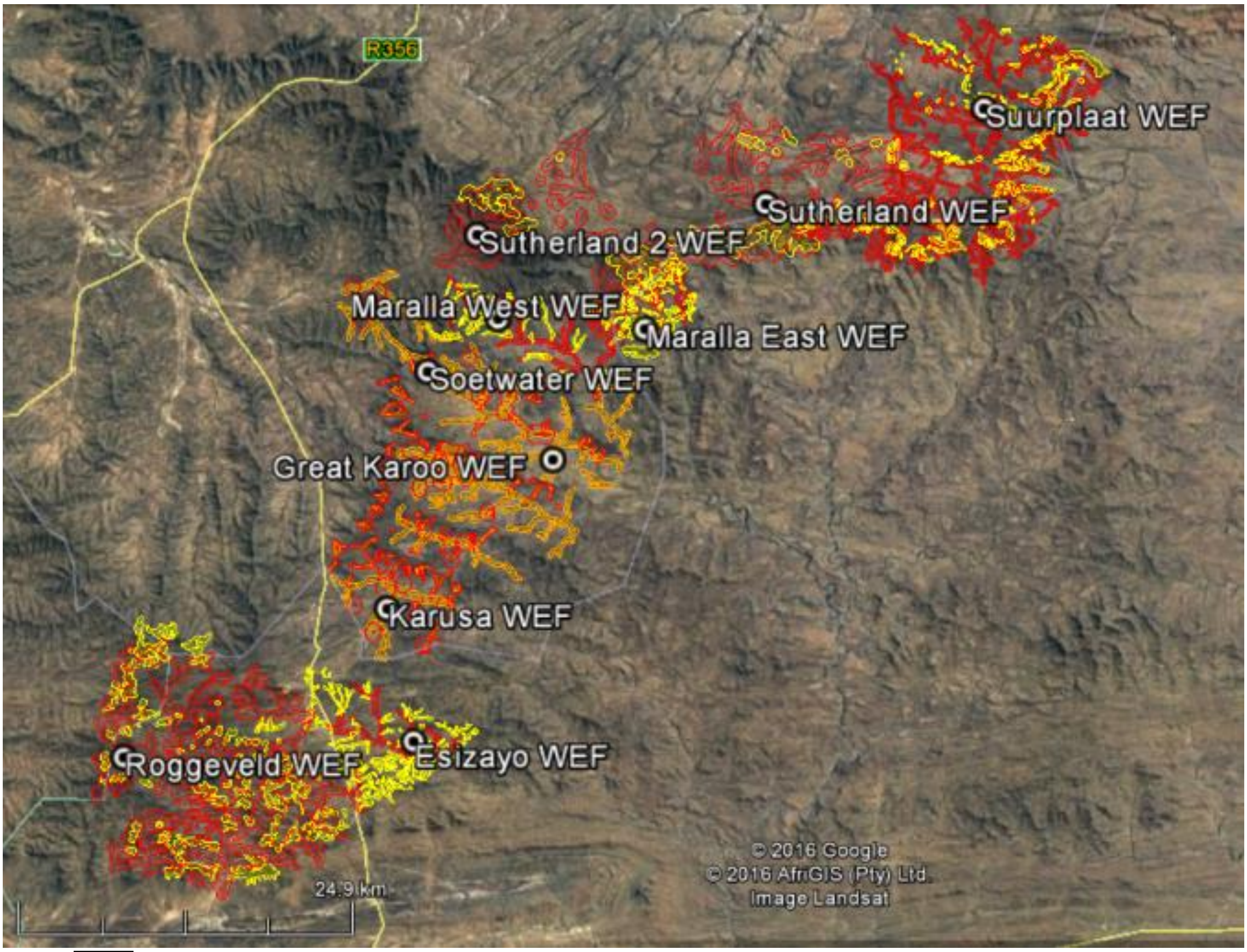


Figure 43: Sensitivity map of the Rietrug WEF (taken from the Amendment Report for the proposed Rietrug Wind Energy Facility compiled by CSIR)



High bat sensitivity area — High bat sensitivity buffer

Moderate bat sensitivity area — Moderate bat sensitivity buffer

Figure 44: Bat sensitivity maps of wind farm areas neighbouring Maralla East WEF .

8.2 Cumulative Impact Assessment Rating

Table 10 below lists and summarises the impact assessments from available Specialist reports of all neighbouring renewable energy projects.

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:

Cumulative Impacts									
Maralla East									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Cumulative bat mortalities due to direct blade impact or barotrauma during foraging (resident and migrating bats affected).	Nature of impact:	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. There is also the risk of complete loss of certain bat species from the area (namely *Tadarida aegyptiaca* and *Neoromicia capensis*).							
	Without Mitigation	4	4	10	4	72	High	-	High
	degree to which impact can be reversed:	Partly reversible. 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.							
	degree of impact on irreplaceable resources:	Significant loss of resources. Bat population numbers will decrease across the region; species may be lost regionally.							

	Mitigation Measures	Drainage 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 drainage 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.							
	With Mitigation	4	3	6	4	52	Medium	-	High

Table 10: Impact assessment of neighbouring renewable energy projects

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts													
							Construction				Operation					Decommissioning				
							Overall	Habitat loss	Foraging habitat loss		Overall	Habitat loss	Migration collisions	Barotrauma	Foraging collisions	Overall				
Proposed development of renewable energy facility at the Sutherland site, Western and Northern Cape.	12/12/20/1782/AM1	S&EIR	Mainstream Power Sutherland	28 600	811 MW			L				L	L	L						
Proposed Hidden Valley Wind Energy Facility, Northern Cape	12/12/20/2370/2	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd	9 530	150 MW			L					L	L	L					

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts												
							Construction				Operation					Decommissioning			
							Overall	Habitat loss	Foraging habitat loss		Overall	Habitat loss	Migration collisions	Barotrauma	Foraging collisions	Overall			
Proposed Hidden Valley wind energy facility, Northern cape	12/12/20/2370/3	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd	9 180	150 MW			L					L	L	L				
Proposed Hidden Valley wind energy facility, Northern cape	12/12/20/2370/1	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd	16 620	150MW			L					L	L	L				
Proposed Hidden Valley wind energy facility, Northern cape	12/12/20/2370	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd		650 MW			L					L	L	L				
Proposed Construction of the 140Mw Roggeveld Wind Farm Within the Karoo Hoogland Local Municipality of The Northern Cape Province and Within the Laingsburg Local Municipality of The Western Cape Province	12/12/20/1988/1/AM1	Amendment	G7 Renewable Energies (Pty) Ltd	26 529	140 MW			L	L				M		M				
				Total Ha	Total MW														
				128 276	2667 MW														

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts												
							Construction				Operation					Decommissioning			
							Overall	Habitat loss	Foraging habitat loss		Overall	Habitat loss	Migration collisions	Barotrauma	Foraging collisions	Overall			
Significance Totals per impact	Significance Rating							Total Hectares per impact											
	High Significance																		
	Medium Significance												26 529		26 529				
	Low Significance							90 459	26 529			28 600	63 390	63 390	34 790				
	Positive Impacts																		

The following EAs surrounding the Maralla East Wind Energy Facility have been either withdrawn or have lapsed and are therefore not been considered as part of the cumulative impact assessment:

Proposed Development Name	**DEA Reference**	**Current EA Status**	**Proponent**	**Proposed Capacity**
Proposed wind energy facility near Komsberg, Western Cape	12/12/20/2228	S&EIR	Inca Komsberg Wind (Pty) Ltd	300 MW
Proposed wind and solar project near Laingsburg, Western Cape	12/12/20/2328	S&EIR	Unknown	50 MW

No documentation was available, with regards to bat impacts, for following EAs surrounding the Maralla East Wind Energy Facility:

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity
Proposed 280 MW Gunstfontein Wind Energy Project	14/12/16/3/3/2/395	S&EIR	Networx Eolos Renewables (Pty) Ltd	12 000	280 MW
Proposed Photovoltaic (PV) Solar Energy Facility on A Site South of Sutherland, Within the Karoo Hoogland Municipality of The Namakwa District Municipality, Northern Cape Province	12/12/20/2235	BAR	Inca Komsberg Wind (Pty) Ltd	2	10 MW
Proposed establishment of the Suurplaat wind energy facility and associated infrastructure on a site near Sutherland, Western Cape and Northern Cape.	12/12/20/1583	S&EIR	Moyeng Energy (Pty) Ltd	28 600	120 MW
Proposed establishment of the Witberg Bay wind energy facility, Laingsburg Local Municipality, Central Karoo District, Western cape	12/12/20/1966/A2	Amendment	Witberg Wind Power (Pty) Ltd		Unknown
Proposed renewable energy facility at Konstabel	12/12/20/1787	S&EIR	South Africa Mainstream Renewable Power Development		170 MW
Proposed development of a renewable Energy facility at Perdekraal, Western Cape - Split 1	12/12/20/1783/2/AM1	Amendment	South Africa Mainstream Renewable Power Development		Unknown
Proposed Touwsrivier Solar energy facility	12/12/20/1956	S&EIR	Unknown	215	36 MW

8.3 Mitigation Measures

The pre-construction bat monitoring study reports of neighbouring projects were studied and the periods of high bat activity detected were as follows:

- Great Karoo, Soetwater and Karusa WEFs – late September to mid November 2016
- Rietrug WEF – no bat activity was detected over the study period in 2010 – 2011
- Sutherland WEF (preconstruction study is still ongoing and not yet complete) – mid November 2015 to early March 2016, and January to April 2016
- Suurplaat WEF – late September 2015 – early January 2016, and mid-January to late February 2016
- Esizayo WEF – late October 2015 to early February 2016, mid-March to early April 2016, and late August to late October 2016
- Rietkloof WEF (Roggeveld) – month of December 2015
- Brandvalley WEF (Roggeveld) – month of October 2015, early to mid-March 2016, and early December 2015 to mid-January 2016

The peak periods listed above from surrounding facilities are similar to one another and with those found from the Maralla East WEF preconstruction bat monitoring study, such that the need to mitigate the impacts on bat fauna by all of the facilities over these periods is crucial. Thus, the below listed mitigation parameters are essential to ensure their conservation and protection, and are to be applied at high risk turbines identified during the operational monitoring if needed (**Table 11**).

All turbines of the Maralla East WEF must be curtailed below cut in speed and not allow for free-wheeling from the start of operation, for every night of the year from sunset to sunrise. Bat activity is markedly higher over low wind speed periods. Preventing free-wheeling should not affect energy production significantly and will be a significant bat conservation mitigation measure.

To further minimise potential cumulative impacts from wind farms on bats, the preliminary mitigation schedule below (**Table 11**) may be adapted and adjusted to apply to whichever turbine/s identified by the results of the operational phase bat monitoring study, if required.

Table 11: The times of implementation of possible recommended mitigation measures for Maralla East WEF

Terms of mitigation implementation	
Peak activity Met Mast (times to implement curtailment/ mitigation)	Met Mast East (80m): 16 November – 06 March; sunset – 04:20
Environmental conditions in which to implement curtailment/ mitigation	Met Mast East (80m): Wind speed below 5.0m/s and Temperature above 13.0°C
Peak activity (times to implement curtailment/ mitigation)	Met Mast East (10m): 16 November – 06 March; sunset – 22:00
Environmental conditions in which to implement curtailment/ mitigation	Met Mast East (10m): Wind speed below 5.5m/s and Temperature above 15.0°C
Peak activity (times to implement curtailment/ mitigation)	Met Mast East (10m): 15 March – 21 May; sunset – 01:10
Environmental conditions in which to implement curtailment/ mitigation -	Met Mast East (10m): Wind speed below 6m/s and Temperature above 13.0°C
Peak activity (times to implement curtailment/ mitigation)	Met Mast East (80m): 25 August – 07 November; sunset – 01:30
Environmental conditions in which to implement curtailment/ mitigation	Met Mast East (80m): Wind speed below 7.5m/s and Temperature above 10.0°C
Peak activity (times to implement curtailment/ mitigation)	Met Mast East (10m): 25 August – 07 November; sunset – 01:30

Environmental conditions in which to implement curtailment/ mitigation	Met Mast East (10m): Wind speed below 7.0m/s and Temperature above 10.0°C

9 STAKEHOLDER COMMENTS

There were a number of comments from Stakeholders addressing issues identified in the Bat Sensitivity Scoping report. This section serves to address the relevant comments. The table below lists the comments, the Stakeholders that issued the comments, and the Bat Specialist response.

Table 12: Stakeholder comments and Specialists' response.

Stakeholder Comment	Stakeholder	Bat Specialist Response
The report refers to the 2014 good practice guidelines for monitoring bats at WEFS, however these guidelines were revised this year: http://www.sabaa.org.za/20160609_SAGoodPracticeGuidelinesforSurveyingBatsatWEFs_PreEIA_4th%20ed_FINAL.pdf. CapeNature recommends that the specialist update his report accordingly.	CapeNature	This has been identified as a typing error in the report and has been rectified. However, it must be noted that the study commenced in October 2015 and thus the study design was done per the 2014 good practice guidelines.
Bat data is only going to be collected using passive recorders, which are located at four sites, including one with paired microphones at Maralla East. What is the total area of the study sites? It is recommended that the number of passive recording stations should be increased if > 20,000 ha. In general, the geographical coverage of the area is therefore extremely limited. This could also be addressed by including nightly surveys along vehicle tracks and even on foot, using a portable EM3 recorder.	CapeNature	As mentioned above, the study commenced in October 2015 such that the study design was done per the 2014 good practice guidelines. The passive monitoring systems satisfy the requirements of the 2014 version of guidelines. The methodology of the study includes vehicle driven transects with the use of a Wildlife Acoustics SM2BAT+ bat detector. The transects have been carried out over every site visit for each season of the year.
There should also be intensive roost searches and surveys conducted by the specialist, with appropriate buffers around known roosts recommended. There are references to bat mortalities recorded at two pilot WEF sites, but not to those recorded during post-construction monitoring at operational	CapeNature	Roost searches on foot have been conducted during the site visits. No roosts were found. The bat monitoring study reports from operation wind energy facilities have not yet been made publicly available and thus no

WEFs. Is there any data available on this, perhaps via the SA Bat Assessment Association?		reference can be made to operational facilities at this time.
In the reports, the recommended buffers are changed from 200 m to 100 m for high sensitivity areas, and 100 m to 50 m for medium sensitivity areas. No explanation is given for this relaxing of the buffers and therefore can the specialist provide comment in this regarding especially considering the 2016 survey guidelines.	CapeNature	The Specialist reduced the sensitivity buffer zones on the basis that the bat sensitivity map was extensive and strict within itself such that the Specialist feels the sensitive areas across the entire site were well covered and protected. Additionally, the relative abundance of bat activity detected across the site had been identified as relatively low. The recommended mitigation measures listed within this final report are also extensive and strict. Thus, the combination of the meticulous sensitivity map (which the developer has respected when devising the turbine layout), relatively low bat activity and extensive mitigation measures ensure sufficient bat protection and conservation.
Curtailment (cut-in speeds) is rejected as being not effective enough to prevent bat mortalities. Can the specialist provide suitable evidence regarding this statement? There are several papers such as Arnett *et al*. (2011) and Baerwald *et al.* (2009) that describe significant reductions in bat mortalities after the introduction of cut-in speeds. Therefore, it is possible that cut-in speeds are likely to be at least as effective, possibly more so, than relocating turbines.	CapeNature	Curtailment was not rejected as being not effective enough. The below paragraph comes directly from the introduction section of the report: "Mitigation measures are being researched and experimented with globally, but are still only effective on a small scale. An exception is the implementation of curtailment processes, where the turbine cut-in speed is raised to a higher wind speed. This relies on the principle that the prey of bats will not be found in areas of strong winds and more energy is required for the bats to fly under these conditions. It is thought, that by the implementation of such a measure, that bats in the area are not likely to experience as great an impact as when the turbine blades move slowly in low wind speeds.

		However, this measure is currently not effective enough to translate the impact of wind turbines on bats to a category of low concern." The report also makes mention of the correct placement of wind farms and of individual turbines significantly decreasing the impacts on bat fauna, and that turbine relocation is the first step of impact mitigation.
Alternatives regarding turbine design should be considered to mitigate risk of direct mortality, for e.g. minimize rotor swept area (shorter blades are better), and maximize the ground-to-blade-tip distance. Can the specialist provide comment regarding how effective this could be as a mitigation measure?	CapeNature	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). The preconstruction bat monitoring study results for Maralla East WEF indicate a lower relative bat abundance detected by the 80m microphone of the met mast monitoring system than the 10m microphone of the met mast monitoring system. Thus, general bat activity (not specific to migratory species) and diversity is higher nearer to the ground (nearer to canopy level) such that the blade tip height from the ground should be as high as possible. Additionally, reducing the rotor swept area of the turbines by using shorter blades decreases the probability of bat mortalities based on smaller 'danger zones' from the rotating blades.
Given the extensive coverage of WEF projects across the region, can the specialist comment on how effective a provision for the	CapeNature	Broad scale temporary turbine shut downs are, to date, the most effective means of mitigating the mortality of

possibility of temporary turbine shutdowns could be in case of mass mortality events, e.g. related to migration?		bats by turbines, and it is imperative that they be implemented in the case of a migratory event being detected. The pre-construction bat monitoring study did not identify a migratory event however, there is provision in the mitigation section of the final report in the case of such an event. The WEF mitigation must take on an adaptive management approach, and it is crucial that any suggested changes to the initial proposed mitigation schedule be implemented within a maximum of 2 weeks from the date of the recommendation.
The competent authority must consider the broad-scale impact on the bat connectivity corridor, which extends beyond the parameters of the WEF development footprint.	DEA&DP	The cumulative impact on the bat connectivity corridors of the area have been considered and assessed in this report.
Cumulative high sensitivity areas that may be identified should be appropriately responded to in the development proposal, to lower the cumulative effects of several WEFs in the area.	DEA&DP	Mitigation has been devised in this report in response to the cumulative high sensitivity and impact of several wine energy facilities in the area.
This Directorate does not support the placement of turbines in high sensitivity and high sensitivity buffer areas.	DEA&DP	Turbines have been removed from all identified bat sensitive areas.

10 CONCLUSION

The 12-month preconstruction bat monitoring study for Maralla East WEF was carried out over November 2015 to November 2016, wherein data was collected from four long-term bat monitoring systems installed on one meteorological mast and three short masts**.** A few technical failures of the monitoring systems occurred over the course of the study. The failures should not compromise the quality of the study since an adequate amount of data was recorded during the 12 months. The data losses have not affected the confidence of the findings stated in this report.

The long-term data from the passive monitoring systems was analysed by means of identifying the bat species detected by the monitoring systems and the periods of high bat activity. Further site work included performing driven transects across the site with a mobile bat detector to understand the geospatial distribution of bat activity across the site. This information was used to inform the bat sensitivity map of Section 5.5. Roost searches were also performed in an effort to find temporary and permanent roosts on site. None were found.

A bat sensitivity map was drawn up (Section 5.5) which highlights habitats and site areas that are important for foraging and roosting purposes.

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.

The Met Mast monitoring system detected a significantly higher number of bat passes than any of the other monitoring systems, with 8949 at 10m **(Figure 14)**. Short Mast 1 followed it with 5515 bat passes at 10m **(Figure 15)**.

The Met Mast monitoring system had its highest bat activity during the summer months, with a peak in December 2015, after which a decrease in activity was shown as the seasons changed from summer to autumn to winter. As the seasons changed to spring, bat activity increased again. March 2016 saw an increase in the average number of *Neoromicia capensis* passes and subsequently increased during the months that followed until May 2016 **(Figure 18)**. Short Mast 1 monitoring system showed high bat activity during the summer months, with a peak in January 2016 for *Tadarida aegyptiaca,* whereafter *Neoromicia capensis* increased in February and March 2016. Short Mast 1 bat activity for April 2016 could not be indicated due to system failure, but as seasons changed from winter to spring bat activity increased again with the highest peak in activity during October 2016 by *Neoromicia capensis*

(**Figure 19**). Short Mast 2 and 3 had a peak in activity during December 2015, and due to system failures, some months show no data **(Figure 20 - 21)**.

Miniopterus Miniopterus natalensis is the only migratory species detected on site. It was detected by all the monitoring systems, except for Short Mast 3. The relative abundance of this species, as detected by the monitoring systems, was over the months of April – July 2016, with it being highest in June 2016 (Short Mast 2) (**Figures 18 – 21**). The data did not indicate a migratory event over the monitoring period. The operational phase bat monitoring study must implement further monitoring techniques for quick detection if a migratory event occurs in future.

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. This data will be used to inform the peak times that may inform mitigation, if needed.

Peak activity times across the night and monitoring period were identified, as well as wind speed and temperature parameters during which high bat activity was detected. Mitigations are outlined in Sections 7 and 8.3 are expected to be implemented once the turbines become operational. The proposed mitigation schedule follows the precautionary approach strongly and therefore the mitigations should be adjusted and refined during an operational phase bat monitoring study.

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