Final Impact Assessment Report on the 12-Month Preconstruction Bat Monitoring

- For the proposed Impofu West Wind Farm, Eastern Cape

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Appointment of Specialist

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Appointed by:	Red Cap Impofu West (Pty) Ltd
For:	Preconstruction bat monitoring study

Independence:

Animalia Consultants (Pty) Ltd has no connection with the developer. Animalia Consultants (Pty) Ltd is not a subsidiary, legally or financially of the developer; remuneration for services by the developer in relation to this 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.

NEMA Requirements

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

NEMA requirement	**Section/page in report**
Details of the specialist who prepared the report, and the expertise of that specialist to compile a specialist report including a curriculum vitae.	Separate Curriculum Vitae.
A declaration that the specialist is independent in a form as may be specified by the competent authority.	Page 3
An indication of the scope of, and the purpose for which, the report was prepared.	Section 1
An indication of the quality and age of the base data used for the specialist report.	Sections 3; 4
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	Sections 4; 5; 7
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Section 3
A description of the methodology adopted in preparing the report or carrying out the specialised process, inclusive of equipment and modelling used.	Section 3
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure.	Section 5
An identification of any areas to be avoided, including buffers.	Section 4.7
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 4.7
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section 3.2

A description of the findings and potential implications of such findings on the impact of the proposed activity, or activities.	Sections 4; 8
Any mitigation measures for inclusion in the EMPr.	Section 6
Any conditions for inclusion in the environmental authorisation.	Sections 5; 6
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 8
A reasoned opinion whether the proposed activity or portions thereof should be authorised, and regarding the acceptability of the proposed activity or activities. And if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr.	Sections 6; 8
A description of any consultation process that was undertaken during the course of preparing the specialist report.	Sections 3

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Figure 1.1: Map overview of the proposed Impofu West WEF turbine layout.

1 OBJECTIVES AND TERMS OF REFERENCE FOR IMPACT ASSESSMENT STUDY

- A description of the baseline characteristics and conditions of the receiving environment (e.g. site and/or surrounding land uses including urban and agricultural areas).
- An evaluation of the predicted impacts of the project on the receiving environment.
- An assessment of the probability of each impact occurring, the reversibility of each impact and the level of confidence in each potential impact.
- Consider and evaluate the cumulative impacts in terms of the current and proposed activities in the area.
- Recommendations to avoid negative impacts, as well as feasible and practical mitigation, management and/or monitoring options to reduce negative impacts that can be included in the Environmental Management Programme.
- A reasoned opinion as to whether the proposed activity, or portions of the activity should be authorised.
- 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 and temperature) influence bat activity.
- Determine the weather range in which bats are mostly active.
- Develop long-term baseline data for use during operational monitoring.
- Identify which turbines need to have special attention with regards to bat monitoring during the operational phase.
- 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 INTRODUCTION

This is the final impact assessment report including the 12 months preconstruction bat monitoring for the proposed Impofu West Wind Farm, located approximately 18km South west from Humansdorp in the Eastern Cape. The turbines are proposed to consist of the following technical specifications (**Figure 2.1**):

1. A maximum of 29 turbines.
2. Maximum rotor diameter of 150m (75m blade/radius).
3. Hub height from 90 to 120m.
4. The maximum tip height will be the 120m hub + 75m maximum blade length, thus 195m.
5. The minimum tip height (lowest rotor swept height) will be 30m.

6. This results in a rotor swept envelope range from 30m up to 195m, being 150m wide with a hub height from 90-120m high.

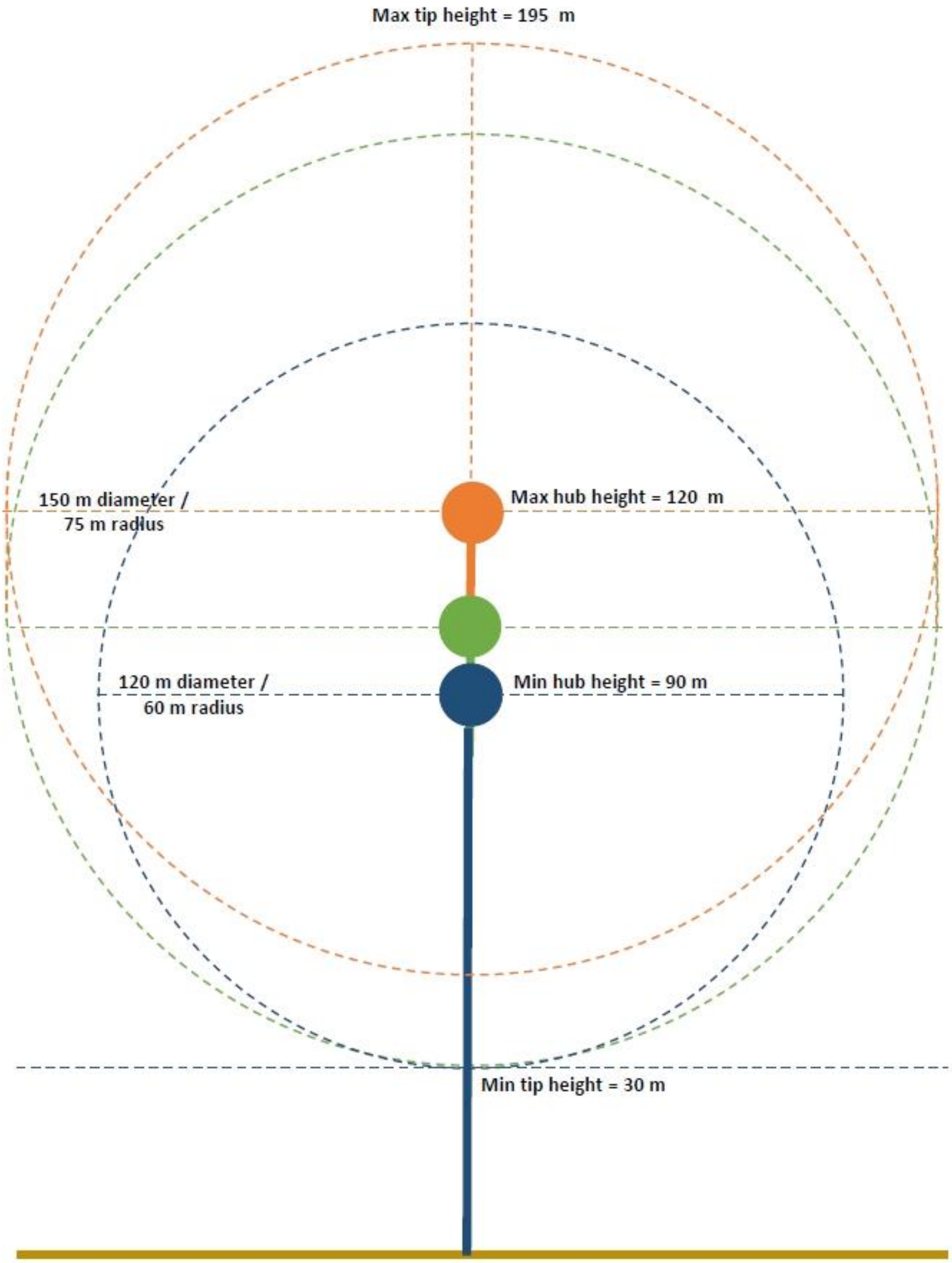

Figure 2.1: Diagram indicating the proposed turbine dimension ranges.

2.1 The Bats of South Africa

Bats form part of the Order Chiroptera and are the second largest group of mammals after rodents. They are the only mammals to have developed true powered flight and have undergone various skeletal changes to accommodate this. The forelimbs are elongated, whereas the hind limbs are compact and light, thereby reducing the total body weight. This unique wing profile allows for the manipulation 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. As a result, insectivorous bats are the predominant predators of nocturnal flying insects in South Africa and contribute greatly to the suppression of these numbers. Their prey also includes agricultural pests such as moths and vectors for diseases such as mosquitoes (Rautenbach 1982, Taylor 2000).

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

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

2.2 Bats and Wind Turbines

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

Although bats are predominately found roosting and foraging in areas near trees, rocky outcrops, human dwellings and water, in conditions where valleys are foggy, warmer air is drawn to hilltops through thermal inversion which may result in increased concentrations of insects and consequently bats at hilltops, where wind turbines are often placed (Kunz *et al*. 2007). Some studies (Horn *et al*. 2008) suggest that bats may be attracted to the large turbine structure as roosting spaces or that swarms of insects may get trapped in low pressure air pockets around the turbine, also encouraging the presence of bats. The presence of lights on wind turbines have also been identified as possible causes for increased bat fatalities for non-cave roosting species. This is thought to be due to increased insect densities that are attracted to the lights and subsequently encourage foraging activity of bats (Johnson *et al*. 2003). Clearings around wind turbines, in previously forested areas, may also improve conditions for insects, thereby attracting bats to the area and the swishing sound of the turbine blades has been proposed as possible sources for disorienting bats (Kunz *et al*. 2007). Electromagnetic fields generated by the turbine may also affect bats which are sensitive to magnetic fields (Kunz *et al*. 2007). It could also be hypothesized, from personal observations that the echolocation capabilities of bats are designed to locate smaller insect prey or avoid stationary objects, and may not be primarily focused on the detection of unnatural objects moving sideways across the flight path.

South African operational monitoring studies currently point to South African bats being just as vulnerable to mortality from turbines as international studies have previously indicated.

The main species of concern are *Neoromicia capensis*, *Tadarida aegyptiaca* and *Miniopterus natalensis,* on this site and in general.

Whatever the reason for bat fatalities in relation to wind turbines, it is clear to be a significant ecological problem which requires attention. 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). Various mitigation measures are being researched and experimented with globally. The implementation of curtailment processes, where the turbine cut-in speed is raised to a higher wind speed, have been proven to be the most effective mitigation measure currently. This relies on the principle that the prey of bats will not be found in areas of strong winds and more energy is required for the bats to fly under these conditions. 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.

3 METHODOLOGY

Three factors need to be present for most South African bats to be prevalent in an area: availability of roosting space, food (insects/arthropods or fruit), and accessible open water sources. However, the 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 was 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 were done mainly by briefly studying the geographic literature of each site, available satellite imagery and by groundtruthing with site visits. Species probability of occurrence based on the above-mentioned factors were estimated for the site and the surrounding larger area, but also considers species already confirmed on site as well as surrounding areas. Pre-construction and operational bat monitoring data from surrounding and nearby wind farms have also been consulted during this study. These include Banna Ba Pifhu, Oyster Bay Ubuntu, Impofu East and Impofu North as non-operational wind farms, and Jeffreys Bay wind farm, Kouga wind farm, Tsitsikamma Community wind farm and Gibson Bay wind farm as operational wind farms.

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

Passive detection was completed by means of bat monitoring systems on the 2 meteorological masts and 6 short masts on all three sites (**Figures 3.1 and 3.2**). The data of the passive systems from all three Impofu wind farm sites (North, East and West) are considered in the impact assessment report of each project, as they are located in terrain and habitat applicable to all three sites.

The Met masts each had a backup system also with microphones at 10m and 97m, to lessen the probability of data gaps. The microphones at 97m on the Met mast backup systems were set up in the 2nd site visit on March 2018, and all the other passive systems and microphones were set up during the first site visit in November 2017. The backup systems are referred to as Met A2 and Met B2 respectively.

After a slight boundary shift of the proposed wind farm due to the discovery of a Martial Eagle Nest, another short mast passive system, referred to as SM2A, was setup in March 2018 as an additional system to Short Mast (SM2).

The data was analysed by classifying (as near to species level as possible) and counting positive bat passes detected by the systems. A bat pass is defined as a sequence of ≥1 echolocation calls where the duration of each pulse is ≥2ms (one echolocation call can consist of numerous pulses). A new bat pass is identified by a >500ms period between pulses. These bat passes are summed into hourly intervals which are used to calculate nocturnal distribution patterns over time. Times of sunset and sunrise are automatically adjusted with the time of year. The **Table 3.1** below summarizes the equipment setup.

3.1 Site Visit and Equipment Setup Information

Table 3.1: Equipment setup and site visit information.

Site visit dates		**First Visit**	24 – 28 November 2017
		Second Visit	5 – 9 March 2018
		Third Visit	25 – 30 June 2018
		Fourth Visit	18 – 22 September 2018
		Fifth Visit	20 – 23 November 2018
Met mast passive bat detection systems	**Quantity on site**	2 (all three Impofu wind farm sites)	
	Microphone heights	10m; 97m	
	Coordinates	Met A: 34.093408°S 24.615461°E Met B: 34.057938°S 24.536612 °E Each met mast systems has a backup system on the same mast with microphones at 97m and 10m, to prevent data gaps. Referred to as Met A2 and Met B2 respectively.	
Short mast passive bat detection systems	**Quantity on site**	6 (all three Impofu wind farm sites)	
	Microphone height	10m	
	Coordinates	Short Mast 1 (SM1): 34.125598°S 24.498722°E Short Mast 2 (SM2): 34.083084°S 24.588759°E Short Mast 2A (SM2A): 34.086080°S 24.574528°E Short Mast 3 (SM3): 34.139070°S 24.655086°E Short Mast 4 (SM4): 34.140898°S 24.579343°E Short Mast 5 (SM5): 34.038204°S 24.517011°E	

Replacements/ Repairs/ Comments	
First Visit	The microphones were mounted such that they pointed approximately 30 degrees downward to avoid excessive water damage. Crows have been found to peck at microphones and subsequently destroying them. Hence, measures were taken for protection against birds, without noticeably compromising effectiveness. The bat detectors were installed within their weatherproof containers and all peripherals attached.
Second Visit	The 10m microphone on Met A recorded well until approximately 15 Feb 2018, and on Met B2 the 10m microphone failed on 23 Feb 2018. Fortunately, the backup 10m microphones could provide the data cover for these gaps. SM3 got trampled by cows on 25 Dec 2017 and was dysfunctional after that. All Short Masts were replaced with strong metal masts in March 2018 (**Figure 3.2**). The mic on SM4 failed on 15 Dec 2017. This was determined to be due to a factory fault of an internal short circuit and was replaced by the supplier. SM5 got physical wind damage due to a storm, but the mic was undamaged and continued to record bat activity. All damaged microphones were replaced to allow continuing recording of passive data.
Third Visit	The system on Met A had a firmware crash and did not record from 23 March 2018 until the problem was resolved in the June 2018 site visit. The backup system Met A2 recorded over this period. SM2 had a firmware crash from 6 - 25 May 2018, the nearby SM2B recorded over this period.
Fourth Visit	SM2 had a firmware crash from 2 July 2018 – 28 August 2018, the nearby SM2B recorded over this period.
Fifth Visit	The final passive data was retrieved.
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 in relation to latitude, longitude and season).

Trigger threshold	>16KHz, -18dB
Trigger window (time of recording after trigger ceased)	500ms
Microphone gain setting	12dB
Compression	WAC0
Single memory card size (each system uses 4 cards)	32GB
Battery size	17Ah; 12V
Solar panel output	20 Watts
Solar charge regulator	6 - 8 Amp with low voltage/deep discharge protection
Other methods	Terrain was investigated during the day for habitat observations.

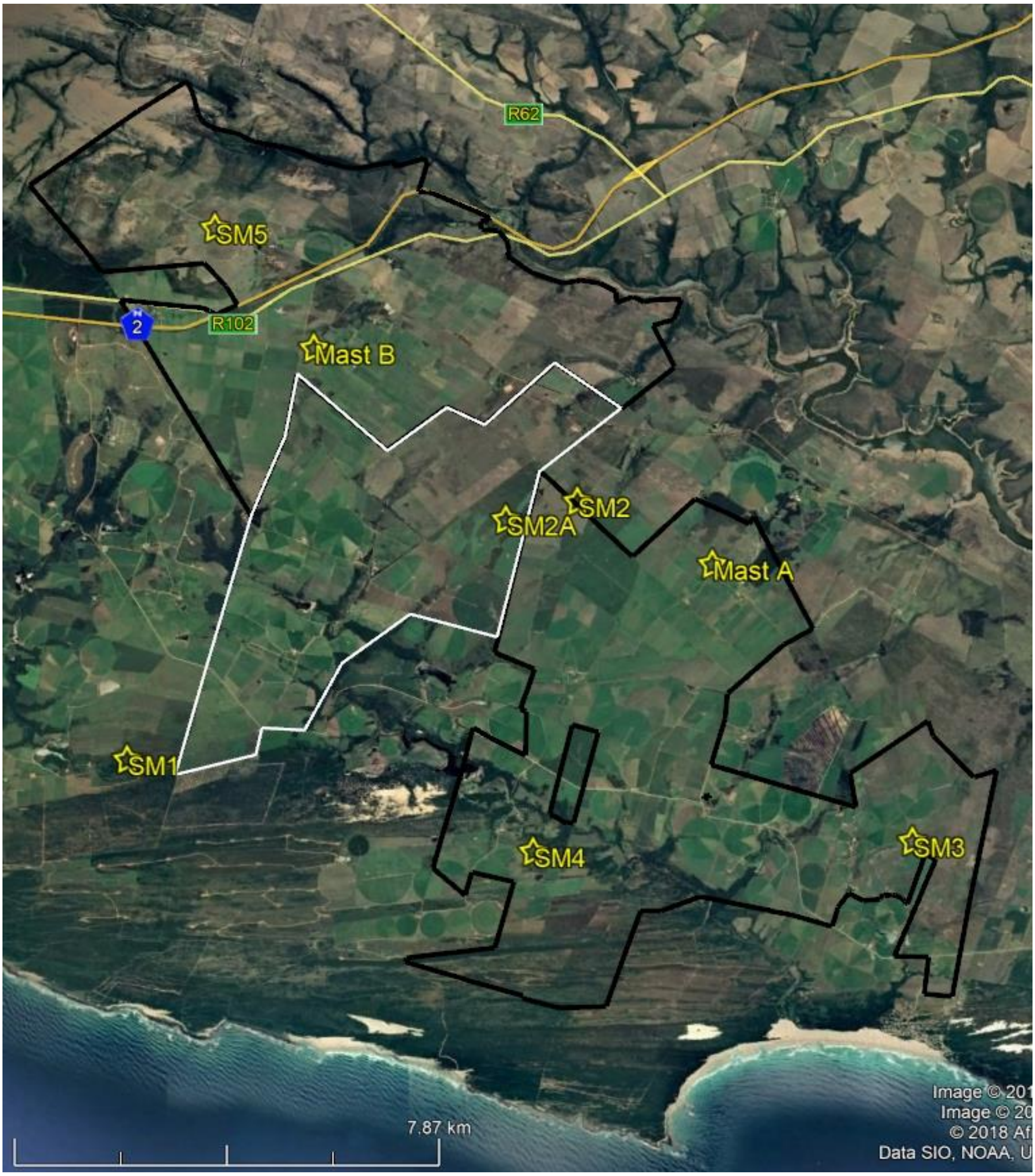

Figure 3.1: Positions of the passive bat detection systems on site. Impofu West is indicated with the white boundary and the other sites in a black boundary.

Figure 3.2: One of the Short Mast systems (SM1) set up on site.

3.2 Assumptions and Limitations

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

The migratory paths of bats are largely unknown, thus limiting the ability to determine if the wind farm will have a large-scale effect on migratory species. No indication of a migratory event is evident in the 12 months preconstruction data, however some uncertainty in this regard will remain until the end of operational monitoring of at least 2 years. Also, based on the currently available data from the 4 operational wind farms and other proposed wind farms in the area, there is nothing to date that indicates that the site is the location of a migratory path.

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

Species identification with the use of bat detection and echolocation is less accurate when compared to morphological identification, nevertheless it is a very certain and accurate indication of bat activity and their presence with no harmful effects on bats being surveyed.

Automated species identification by the Kaleidoscope software may produce a smaller portion of incorrect identifications or unknown identifications. In the last mentioned case, the dominant frequency of the unknown call was simply used to group the bat into a family or genus group, using dominant frequency only as the determining factor. However, the automated software is very effective at distinguishing bat calls from ultrasonic noise, therefore the number of bat passes are not significantly overestimated.

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

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

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

4 RESULTS AND DISCUSSION

4.1 Land Use, Vegetation, Climate and Topography

According to Mucina and Rutherford (2006), the Impofu West site is situated mostly on the Tsitsikamma Sandstone Fynbos and Southern Cape Dune Fynbos vegetation units, with narrow bands of Eastern Coastal Shale Bands and Garden Route Shale Fynbos transecting the site, and small patches of Southern Afrotemperate Forest dispersed nearby. The south of the site is predominantly occupied by the Southern Cape Dune Fynbos, and a far southern tip of the site touches the Algoa Dune Strandveld and Cape Seashore Vegetation. The Humansdorp Shale Renosterveld is nearby to the north (**Figure 4.1**). The general characteristics of the vegetation units are applicable from a bat habitat point of view (**Table 4.1**).

The **Tsitsikamma Sandstone Fynbos** unit consists of a relatively low mountain range with gentle to steep slopes with both northern and southern slopes over 140km. A few peaks and moderately undulating plains exist along the range. The vegetation consists of medium dense, tall proteoid, restioid and ericoid fynbos with fynbos thicket in wetter areas. Mean annual precipitation is 480 – 1230mm with a mean of 845mm. The mean daily maximum and minimum temperatures are 25.5°C (February) and 5.8°C (July) respectively.

The **Southern Cape Dune Fynbos** vegetation unit consists of coastal dune cordons often with steep slopes. The vegetation is fynbos heath that is dominated by sclerophyllous shrubs with a rich restio undergrowth. The alien *Acacia cyclops* thicket has replaced large areas of the fynbos and coastal dune areas. The mean annual precipitation is 600 – 900mm with a mean of 757mm. The mean daily maximum and minimum temperatures are 25.3°C (February) and 8°C (July) respectively.

The **Algoa Dune Strandveld** vegetation unit consists of tall dense thickets on dunes that are mainly outside of the influence of salt spray, dominated by stunted trees, shrubs, abundant lianas and sparse herbaceous and grassy undergrowth. The unit experiences a non-seasonal precipitation regime with a mean annual rainfall of 680mm. 300mm of rain falls in spring months while 350mm falls during the winter. The unit experiences mean daily maximum and minimum temperatures of 25°C (February) and 8.3°C (July) respectively.

Eastern Coastal Shale Bands form narrow 80 – 200m, linear, smooth and flat landscape features. The unit supports shrublands (often quite grassy) ranging from thicket to renosterveld and fynbos. The mean annual precipitation is 500 – 1140mm with a mean of 815mm. Rainfall peaks during the month of March and again from August to November.

The **Garden Route Shale Fynbos** consists of undulating hills and moderately undulating plains on the coastal forelands. The wetter areas have tall, dense proteoid and ericaceous fynbos while the drier areas have shrubby grassland. Fynbos is confined to flatter more extensive landscapes and most of the shales are covered in Afrotemperate Forest. The mean annual precipitation ranges between 310mm and 1 120mm. Annual precipitation is mostly evenly spread throughout the year. Mean daily maximum and minimum temperatures are 27.6˚C and 6.5˚C for January and July, respectively. This vegetation unit is classified as Endangered with only about 8% conserved. Much of the unit has been transformed for pasture and cultivation.

The **Cape Seashore Vegetation** unit consists of beaches, coastal dunes, dune slacks and coastal cliffs of open grassy, herbaceous and dwarf-shrubby vegetation. It is often dominated by a single pioneer species. This unit experiences a mostly uniform all year-round precipitation regime. The mean annual precipitation is 604mm.

The **Southern Afrotemperate Forest** vegetation unit is a tall, multilayered forest dominated by yellowwoods, *Ocotea bullata, Olea capensis* and *Pterocelastrus tricuspidatus*. In the scree habitats *Cunonia capensis, Heeria argentea* and *Metrosideros angustifolia* predominate. The shrub understory and herb layers are well developed.

The **Humansdorp Shale Renosterveld** unit consists of moderately undulating plains and undulating hills supporting vegetation composed of low, medium dense graminoid, dense cupressoid-leaved shrubland, dominated by renosterbos. The unit experiences a mean annual precipitation of 500 – 850mm with a mean of 630mm. Rainfall displays a slight peak in March. Mean daily maximum and minimum temperatures experienced in this unit are 25.1°C (February) and 7.5°C (July) respectively.

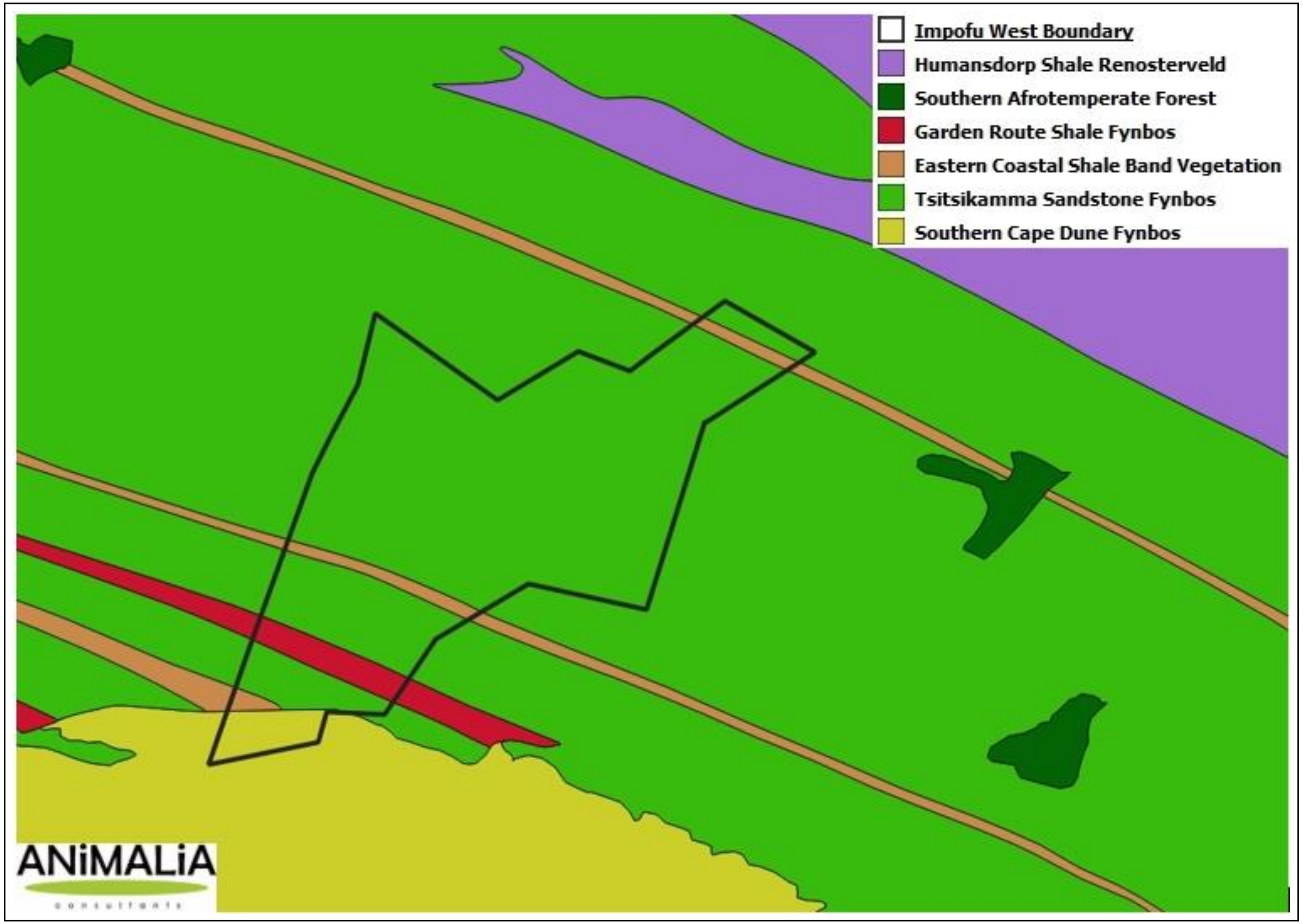

Figure 4.1: Vegetation units present on the proposed Impofu West WEF (Mucina and Rutherford 2006).

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 4.1**.

Table 4.1: Potential of the general vegetation units to serve as suitable roosting and foraging spaces for bats.

Vegetation Unit	Foraging Potential	Roosting Potential	Comments
Algoa Dune Strandveld	Moderate	Low - Moderate	Thickets and stunted trees may prove to be bat important vegetation features.
Eastern Coastal Shale Bands	Moderate - High	Low	Active bats were detected within the vicinity of this vegetation unit.
Tsitsikamma Sandstone Fynbos	Moderate - High	Low - Moderate	Active bats were found within the unit. The transformation of parts of this unit for pasture and agriculture attracts bats for foraging purposes.
Southern Cape Dune Fynbos	High	Moderate - High	Several species of active bats were detected within this vegetation unit.
Garden Route Shale Fynbos	Moderate - High	Moderate	Two common bat species were detected to be active within this area. The wet patches within the unit attract foraging bats.
Cape Seashore Vegetation	Unknown	Moderate	The small coastal cliffs may serve as roosting habitat for bats.
Southern Afrotemperate Forest	High	High	The vegetation provides suitable roosting and foraging space for bats.
Humansdorp Shale Renosterveld	Low	Moderate - High	Shrubland vegetation does not offer much suitable roosting space, however is suitable for open-air foragers.

The Klasies River coastal cave is situated approximately 7km south-west of the site, and this cave is used by roosting bats particularly *Miniopterus natalensis* and *Rhinolophus* species. The cave was visited during previous studies in the area in 2013 and 2014, and also during the September and November 2018 site visits of this study. It supported small roosts of approximately 200 – 300 Rhinolophid individuals and approximately 500 *Miniopterus natalensis* individuals during the visits in August 2013 and December 2013.

During a March 2014 site visit, the cave was found to be hosting approximately 500 *Rousettus aegyptiacus* (Egyptian Rousette fruit bat) individuals in a cavern. This species was not previously found in the cave, suggesting seasonal use.

During a May 2014 site visit, the number of *M. natalensis* individuals had increased since the last visit to approximately 1 000 individuals, although the cave is used year-round. The *Rhinolophid* population has remained constant over all cave visits, while the *R. aegyptiacus* population had decreased again since the March 2014 visit to approximately 300 individuals.

In September 2018 approximately 100 *R. aegyptiacus* and 500 *M. natalensis* were observed, and in November 2018 the *R. aegyptiacus* colony reduced again to roughly 100 individuals. The *M. natalensis* colony was almost the same size as in September 2018.

The cave is isolated from human interference and has a supply of drinking water for the bats, making it a suitable roost, and is buffered 10km in the bat sensitivity map.

4.2 Baseline Impact of Nearby Wind Farms Currently Operating in the area

There are 4 wind farms currently operating in the area (see **Figure 7.1** in Section 7). **Table 4.2** below indicates the current bat impact status of the nearby operational facilities, compared to the acceptable sustainable mortality thresholds as determined according to the calculations explained in the SABAAP Bat Threshold Document (MacEwan, *et al.*, October 2018). The sustainable acceptable mortality thresholds are determined in the Guidelines per ecoregion as an additional 2% per 10ha per year loss of bats due to anthropogenic pressure, which is for the Lowland Fynbos and Renosterveld ecoregion calculated as 0.45 bats/10ha/annum. The acceptable mortality of a wind farm is then simply calculated by considering the hectare size of the wind farm (area of turbine influence) and the value of 2% of bats/10ha/year for the ecoregion, to give an annual number of sustainable bat mortalities that is acceptable for that wind farm. The recorded and estimated fatalities per year is from the bat species or family that dominated the carcass records. This is in line with the SABAAP Bat Threshold Document (MacEwan, *et al.*, October 2018). Estimator fatality results extracted from the specialist reports are used to compare to acceptable sustainability thresholds. Estimator fatalities are adjusted numbers of the recorded fatalities, by considering field bias factors such as scavenger removal of carcasses, effeciency of the carcass searchers and time interval for rotating searches between all turbines on site.

For Wind Farms 1 – 3 the Erickson & Johnson' s Equation was used to calculate the estimator bat fatalities (Warren-Hicks et al., 2013). The estimator results were retrieved from the relevant specialist reports where calculations were done by the specialists. Note that all studies did not use similar bat fatality estimators, and the area of a wind farm was considered as the area of turbine influence. **Table 4.2** is intended to merely serve as a comparative indication for this current status assessment, and should not be used to determine which wind farms must apply mitigation. For that the applicable specialist report and detailed results of an operational monitoring study must be consulted for decision making purposes. It is important to note that the wind farms that have high estimator fatalities in the table below have recently implemeting varied mitigation stratergies and thus it is likely that the bat fatalaties at these two wind farms will be reduced and this table thus represents a worst case senario without mitigation.

Table 4.2: Current status of impact at operational nearby wind farms.

Wind Farm	**Duration of data set**	**Recorded fatalities/ year**	**Estimator fatalities/ year**	**Acceptable annual mortality of bats (based on 2% calculation)**	**Status**
Wind farm 1 **(2715 ha)**	3 Years	35	198	0.45 x (2715/10) = 0.45 x 271.5 = **122 bats**	**Above threshold**
Wind farm 2 **(2640 ha)**	2 Years	34	78	0.45 x (2640/10) = 0.45 x 264.0	Below threshold

				= **118 bats**	
Wind farm 3 **(851 ha)**	24 Months	17	34	0.45 x (851/10) = 0.45 x 85.1 = **38 bats**	Below threshold
Wind farm 4 **(2146 ha)**	12 Months	72	244	0.45 x (2146/10) = 0.45 x 214.6 = **97 bats**	**Above threshold**

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

“Probability of Occurrence” is assigned based on consideration of the presence of roosting sites and foraging habitats on the site, compared to literature described preferences, species records from nearby and adjacent wind farms, and species currently confirmed on site. The probability of occurrence is also influenced by the likelihood of encountering the bat species on site (e.g. it’s scarcity in general, or if the distribution is marginal to the site location).

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. (2017) based on species distributions, altitudes at which they fly and distances they traverse; and assumes a 100% probability of occurrence.

Table 4.3: Table of species that are currently confirmed on site, and/or have been previously recorded in the area and may be occurring based on literature. Roosting or foraging in the study area, the possible site-specific roosts, and their probability of occurrence based on literature as well as recordings and observations in the surrounding area, is also briefly described (Monadjem *et al.* 2010).

Species	**Common name**	**Probability of occurrence (%)**	**Conservation status (2016 Regional Listing)**	**Possible roosting habitat on site**	**Possible foraging habitat utilised on site**	**Likelihood of risk of fatality (Sowler, *et al.*, 2017)**
Tadarida aegyptiaca	Egyptian free-tailed bat	Confirmed on site	Least Concern	Roosts in rock crevices, hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings, which is more the case on site.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of natural and urbanised habitats.	High
Neoromicia capensis	Cape serotine	Confirmed on site	Least Concern	Roosts in the roofs of houses and buildings, and also under the bark of trees.	It appears to tolerate a wide range of environmental conditions from arid semi-desert areas to montane grasslands, forests, and savannahs. But is predominantly a medium height clutter edge forager.	Medium - High
Miniopterus natalensis	Natal long-fingered bat	Confirmed on site	Near Threatened (2004 National Listing)	Cave and hollow dependent, closest cave approximately 7km from site. Will also roost in small groups or individually in culverts and other hollows.	Clutter-edge forager. May forage in more open terrain during suitable weather.	Medium - High
Miniopterus fraterculus	Lesser long-fingered bat	Confirmed in area	Near Threatened (2004 National Listing)	Cave and hollow dependent, closest cave approximately 7km from site.	Clutter-edge forager	Medium - High
Eptesicus hottentotus	Long-tailed serotine	Confirmed on site	Least Concern	It is a crevice dweller roosting in rock crevices, as well as other crevices in buildings. Rock crevices in valleys near site.	It generally seems to prefer woodland habitats, and forages on the clutter edge. But may still forage over open terrain occasionally.	Medium

Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	Confirmed in area	Least Concern	Roosts in dense foliage of large, leafy trees and may travel several kilometres each night to reach fruiting trees.	Feeds on fruit, nectar, pollen and flowers. If and where available on site.	Medium - High
Rousettus aegyptiacus	Egyptian rousette fruit bat	Confirmed in area	Least Concern	Roosts gregariously in caves, closest cave approximately 7km from site.	Feeds on fruit, if and where available on site.	Medium - High
Rhinolophus capensis	Cape horseshoe bat	20 - 30	Near Threatened (2004 National Listing)	Roosts in caves and mine adits, closest cave approximately 7km from site. May utilise man-made hollows.	Forages predominantly in the canopy of trees which may be found in man-made gardens.	Low
Rhinolophus clivosus	Geoffroy's horseshoe bat	Confirmed on site	Near Threatened (2004 National Listing)	Roosts in caves and mine adits, closest cave approximately 7km from site. May utilise man-made hollows.	It is associated with a variety of habitats including thickets that may be found in man-made gardens.	Low
Rhinolophus swinnyi	Swinny's horseshoe bat	10 - 20	Vulnerable	Roosts in caves and old mines, closest cave approximately 7km from site.	Clutter forager	Low
Nycteris thebaica	Egyptian slit-faced bat	30 - 40	Least Concern	Roosts in hollows, aardvark burrows, culverts under roads and the trunks of dead trees.	It appears to occur throughout the savannah and karoo biomes but avoids open grasslands. May possibly occur in the thickets of man-made gardens, forest patches and riverine vegetation.	Low
Taphozous mauritianus	Mauritian tomb bat	70 - 80	Least Concern	Roosts on rock faces, tree trunks, and walls, where it rests its belly on the surface of the roost with its head facing down.	Open-air forager	High
Kerivoula argentata	Damara woolly bat	30 - 40	Near Threatened	Roosting preferences are mostly unknown but have been found to roost in weavers' nests	Clutter forager	Low
Kerivoula lanosa	Lesser woolly bat	50 - 60	Near Threatened (2004 National Listing)	Roosting preferences are mostly unknown but have been found to roost in sunbird and weavers' nests	Clutter forager	Low

Myotis tricolor	Temmink's myotis	Confirmed on site	Near Threatened (2004 National Listing)	Roosts gregariously in caves, or singly in culverts. Closest cave approximately 7km from site.	Clutter-edge forager	Medium - High
Pipistrellus hesperidus	Dusky pipistrelle	Confirmed on site	Least Concern	Roosts in narrow cracks and under the loose bark of trees. Rock crevices in riverine valleys.	Medium	Medium - High
Scotophilus dinganii	Yellow-bellied house bat	Confirmed on site	Least Concern	Roosts in holes in trees and roofs of houses.	Clutter-edge forager	Medium - High

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

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

Tadarida aegyptiaca

The Egyptian Free-tailed Bat, *Tadarida aegyptiaca*, is a Least Concern species (IUCN Red List 2016) as it has a wide distribution and high abundance throughout South Africa, and is part of the Free-tailed bat family (Molossidae). It occurs from the Western Cape of South Africa, north through to Namibia and southern Angola; and through Zimbabwe to central and northern Mozambique (Monadjem *et al*. 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, savannah, grassland and agricultural lands. Its presence is strongly associated with permanent water bodies due to concentrated densities of insect prey (Monadjem *et al*. 2010).

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.

The Egyptian Free-tailed bat is considered to have a High likelihood of risk of fatality due to wind turbines (Sowler *et al.* 2016) and they are displaying moderate to high numbers of mortalities at nearby operating wind farms. 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.

Neoromicia capensis

Neoromicia capensis is commonly called the Cape serotine and has a conservation status of Least Concern (IUCN Red List 2016) as it is found in high numbers and is widespread over much of Sub-Saharan Africa.

High mortality rates of this species due to wind turbines would be a cause of concern as *N. capensis* is abundant and widespread and as such has a more significant role to play within the local ecosystem than the rarer bat species. They do not undertake migrations and thus are considered residents of the site.

It roosts individually or in small groups of two to three bats in a variety of shelters, such as under the bark of trees, at the base of aloe leaves, and under the roofs of houses. They will use most man-made structures as day roosts which can be found throughout the site and surrounding areas (Monadjem *et al*. 2010).

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).

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 *et al.* 2016). And are displaying moderate to high numbers of mortalities at nearby operating wind farms.

Miniopterus natalensis

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

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

The Natal long-fingered bat undertakes short migratory journeys between hibernaculum and maternity roosts. Due to this migratory behaviour, they are considered to be at high risk of fatality from wind turbines if a wind farm is placed within a migratory path (Sowler *et al.* 2016). The mass movement of bats during migratory periods could result in mass casualties if wind turbines are positioned over a mass migratory route and such turbines are not effectively mitigated. Very little is known about the migratory behaviour and paths of *M. natalensis* in South Africa with migration distances exceeding 150 kilometres. No indication of a migratory event is evident in the 12 months preconstruction data, however some uncertainty in this regard will remain until the end of operational monitoring of at least 2 years. Also, based on the currently available data from the 4 operational wind farms and other proposed wind farms in the area, there is nothing to date that indicates that the site is the location of a migratory path.

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

Sowler *et al.* (2016) advise that *M. natalensis* faces a medium to high risk of fatality due to wind turbines. This evaluation was based on broad ecological features and excluded migratory information. And are displaying low to moderate numbers of mortalities at nearby operating wind farms.

4.5 Transects

4.5.1 First Site Visit

No transects were conducted during the first site visit of 24 – 28 November 2017, due to installations of the passive bat detection systems.

4.5.2 Second Site Visit

Figure 4.2 below indicates the transect routes during the second site visit in March 2018. Transect routes were not calculated and were carried out based on available access to the farms and condition of the farm roads. The SM2BAT+ Real time expansion type detector was used. **Table 4.4** displays the sampling effort and weather conditions prevalent during the transect survey. Basic weather for Oyster Bay sourced from www.worldweatheronline.com.

Table 4.4: Transect distance, duration and average weather conditions experienced during the second site visit.

Date	Time started	Distance (km)	Duration (hours and minutes)	Temperature (˚C)	Rain (mm)	Wind speed (km/h)
6 March 2018	19:33	93km	4h 10 min	19	0.4	12
7 March 2018	19:38	74km	4h 17 min	19.5	0.0	14

4.5.3 Third Site Visit

Figure 4.3 below indicates the transect routes during the third site visit in June 2018. Transect routes were not calculated and were carried out based on available access to the farms and condition of the farm roads. The SM2BAT+ Real time expansion type detector was used. **Table 4.5** displays the sampling effort and weather conditions prevalent during the transect survey. Basic weather for Oyster Bay sourced from www.worldweatheronline.com.

Table 4.5: Transect distance, duration and average weather conditions experienced during the second site visit.

Date	Time started	Distance (km)	Duration (hours and minutes)	Temperature (˚C)	Rain (mm)	Wind speed (km/h)
28 June 2018	19:16	100km	3h 13 min	9	0.0	10.5
29 June 2018	18:22	48.1km	1h 49 min	12.5	0.0	6.5

4.5.4 Fourth Site Visit

Figure 4.4 below indicates the transect routes during the fourth site visit in September 2018. Transect routes were not calculated and were carried out based on available access to the farms and condition of the farm roads. The SM2BAT+ Real time expansion type detector was used. **Table 4.6** displays the sampling effort and weather conditions prevalent during the transect survey. Basic weather for Oyster Bay sourced from www.worldweatheronline.com.

Table 4.6: Transect distance, duration and average weather conditions experienced during the second site visit.

Date	Time started	Distance (km)	Duration (hours and minutes)	Temperature (˚C)	Rain (mm)	Wind speed (km/h)
20 September 2018	20:05	81.3km	2h 24 min	10.5	0.0	7

4.5.5 Fifth Site Visit

Figure 4.5 below indicates the transect routes during the fifth site visit in November 2018. Transect routes were not calculated and were carried out based on available access to the farms and condition of the farm roads. The SM2BAT+ Real time expansion type detector was used. **Table 4.7** displays the sampling effort and weather conditions prevalent during the transect survey. Basic weather for Oyster Bay sourced from www.worldweatheronline.com.

Table 4.7: Transect distance, duration and average weather conditions experienced during the second site visit.

Date	Time started	Distance (km)	Duration (hours and minutes)	Temperature (˚C)	Rain (mm)	Wind speed (km/h)
21 November 2018	19:49	58km	1h 13 min	14.5	0.1	19.5
22 November 2018	20:55	58km	1h 18 min	14.5	0.0	9.5

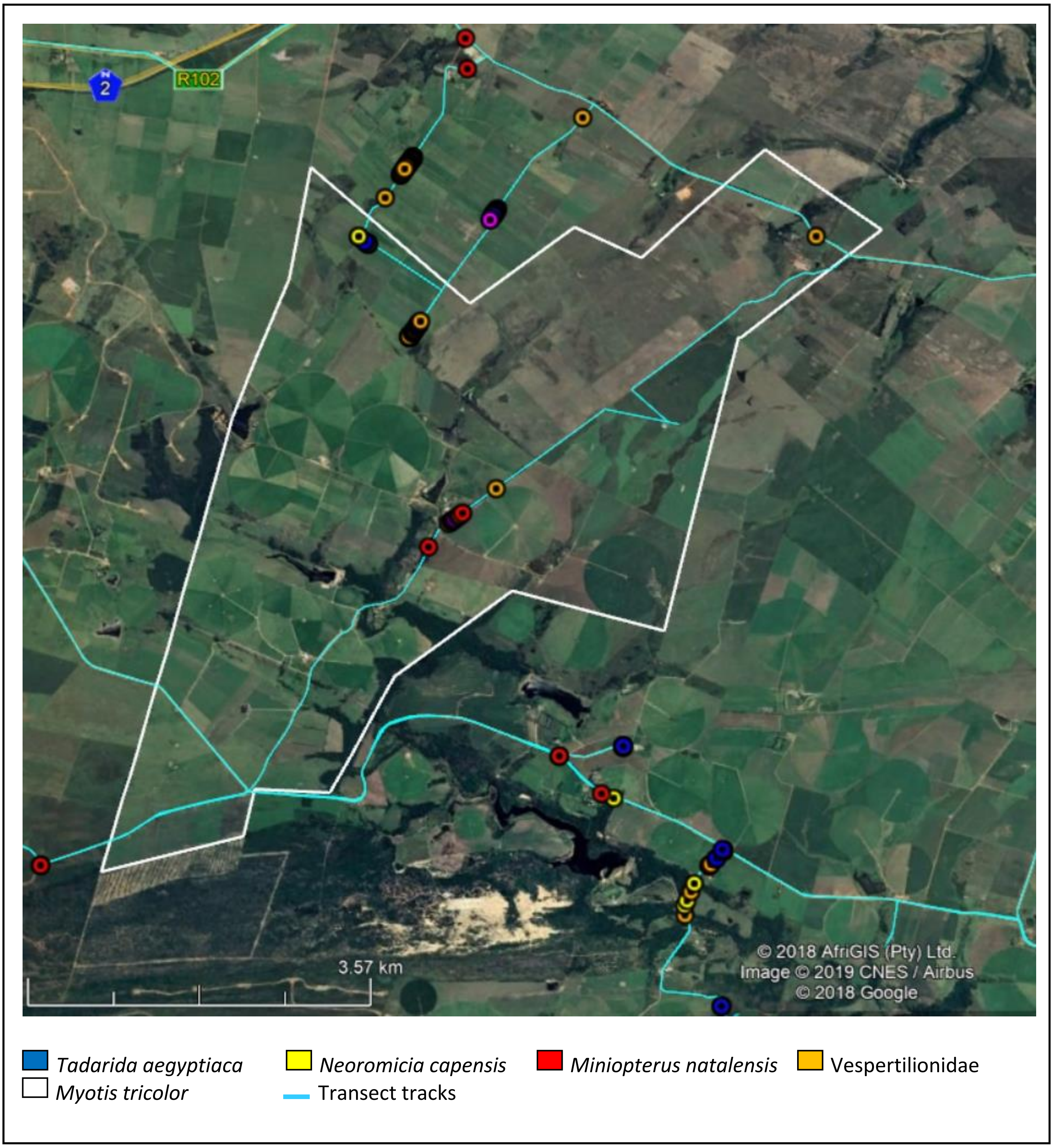

Figure 4.2: Transect routes and bat passes recorded over the second site visit.

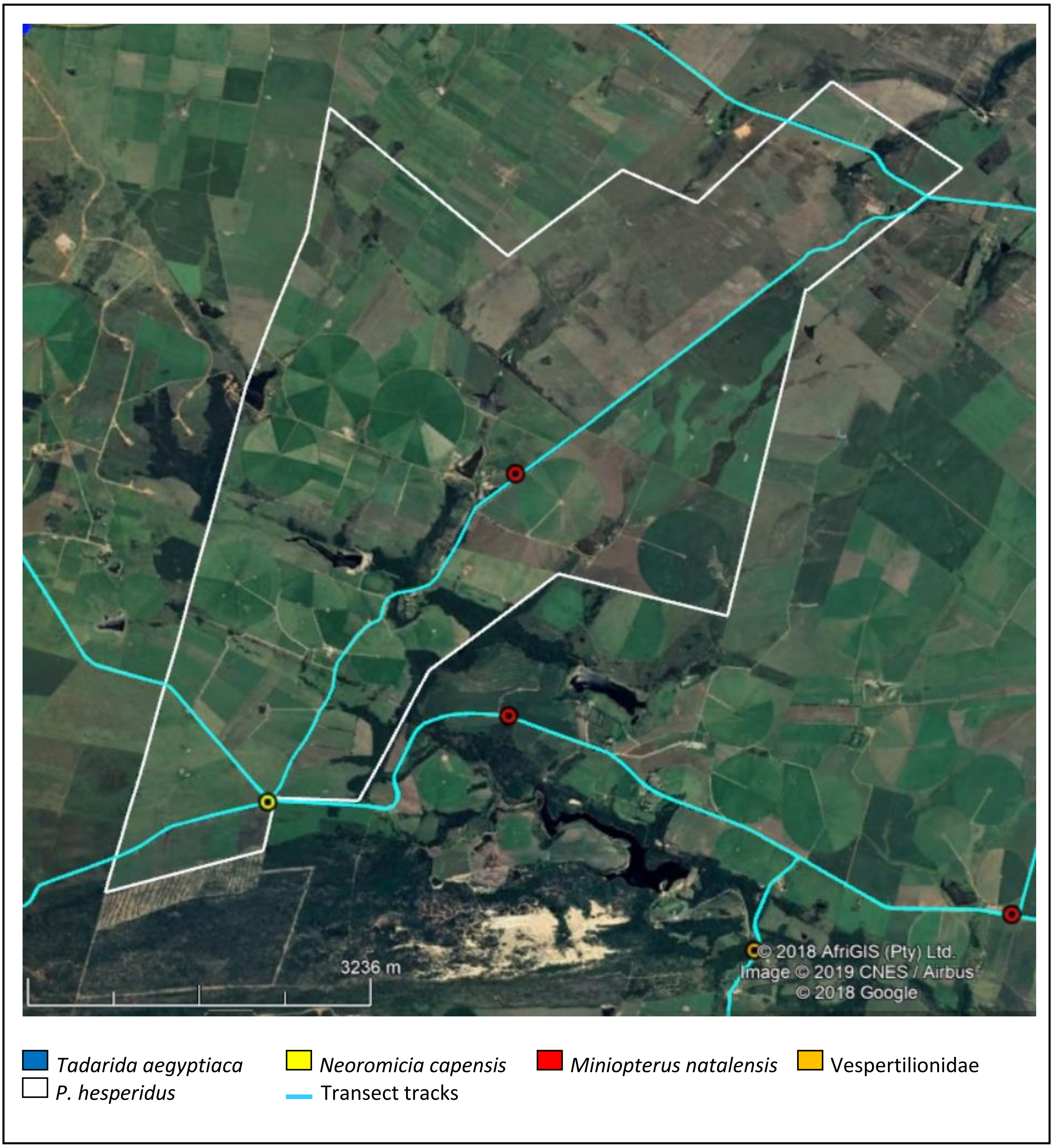

Figure 4.3: Transect routes and bat passes recorded over the third site visit.

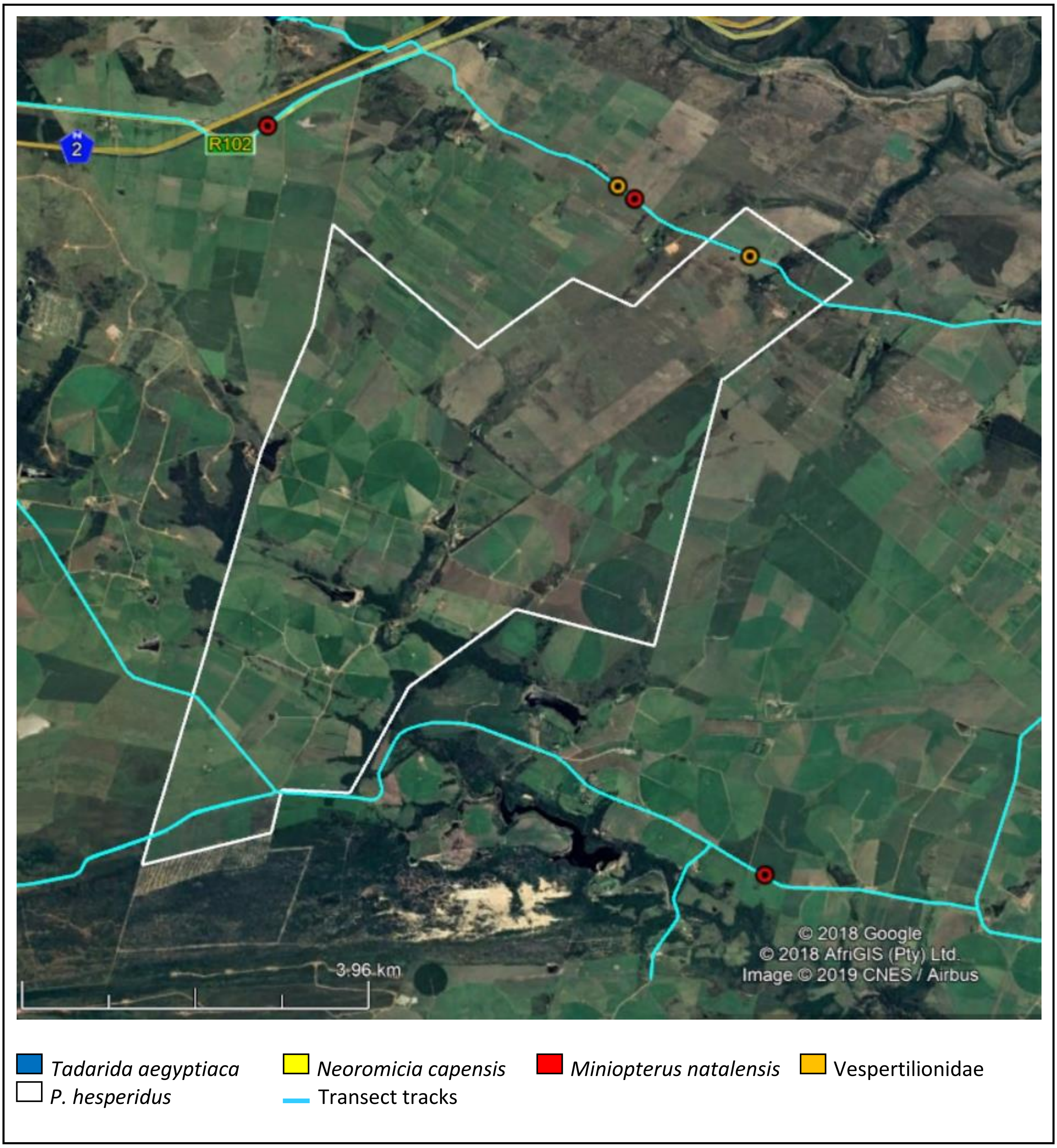

Figure 4.4: Transect routes and bat passes recorded over the fourth site visit.

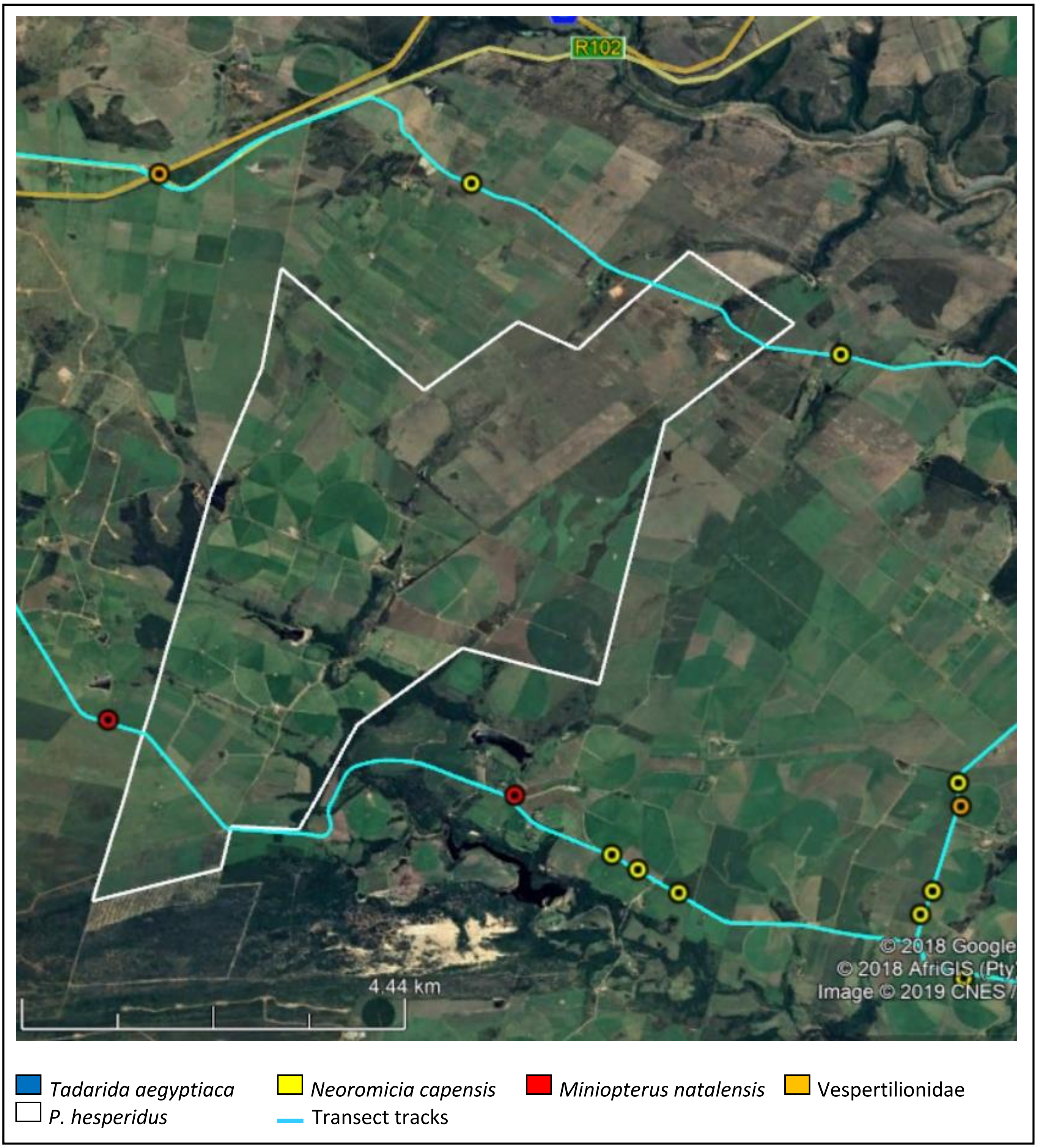

Figure 4.5: Transect routes and bat passes recorded over the fifth site visit.

4.6 Passive Data

4.6.1 Abundances and Composition of Bat Assemblages

Average hourly bat passes detected per night and total number of bat passes detected over the monitoring period (November 2017 to November 2018) by the systems are displayed in **Figures 4.6 – 4.25**. Seven bat species were detected namely *Eptesicus hottentotus*, *Tadarida aegyptiaca, Pipistrellus hesperidus, Neoromicia capensis, Miniopterus natalensis and Myotis tricolor*. Additionally, bat passes were recorded that are classified up to family level and includes Vespertilionidae, Miniopteridae, Molossidae/Emballonuridae and Rhinolophidae. All of these families, except Emballonuridae and Rhinolophidae, includes the species identified and were simply used to group bat passes that were harder to identify. The values of hourly bat passes per night for the month of November 2017 is not shown as it will be skewed due to the small sample size available (the systems were installed between 24 and 28 Nov 2017).

In general *Tadarida aegyptiaca* were most commonly detected on 97m, and *Neoromicia capensis* dominated at 10m except for SM2, SM2B, Met A2 and Met B. Such abundant species are of a large value to the local ecosystems as they provide a greater contribution to most ecological services than the rarer species, due to their higher numbers. SM3 had the highest bat activity levels, probably due to it being located in a high bat sensitivity area and high activity of cattle near a milkery combined with an open water source. Met B had the second highest overall activity levels. In all cases the 97m microphones recorded significantly less bats than the 10m microphones.

The monitoring systems detected the migratory species, *Miniopterus natalensis.* The temporal distribution of this species did not indicate any events that are clearly indicating evidence of migratory events. And overall the activity of this species was very low at 97m.

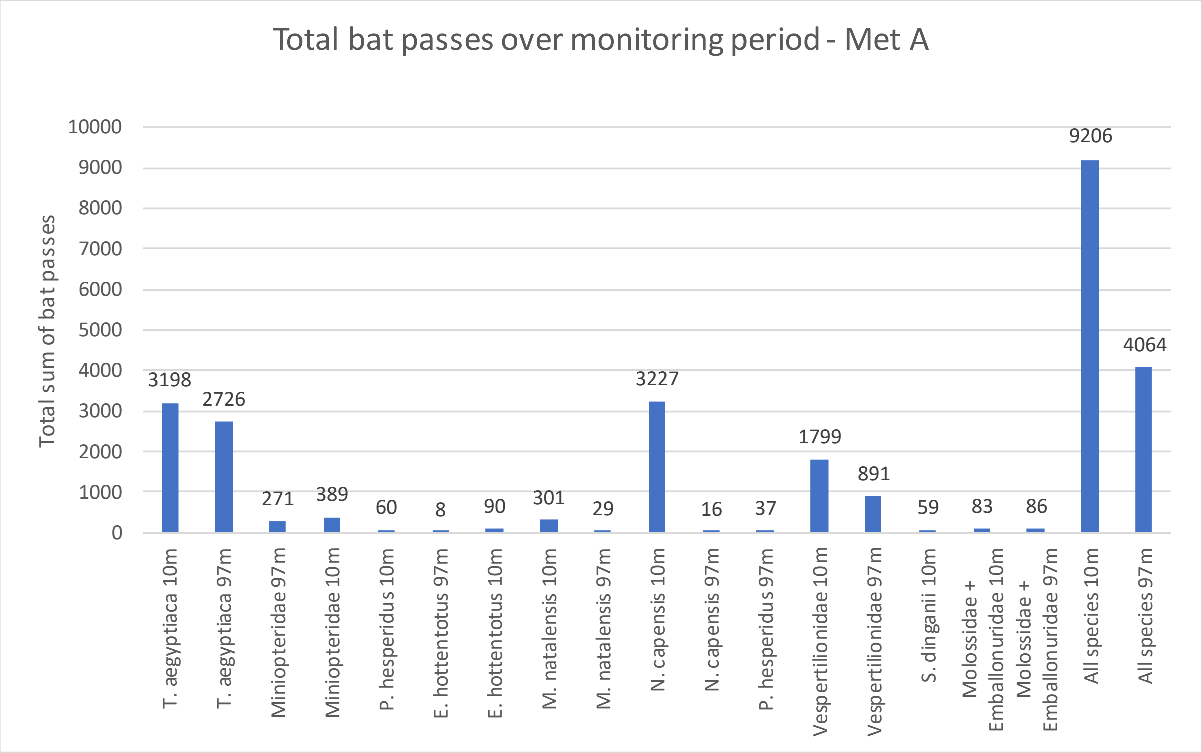

Figure 4.6: Total bat passes recorded over the monitoring period by Met A.

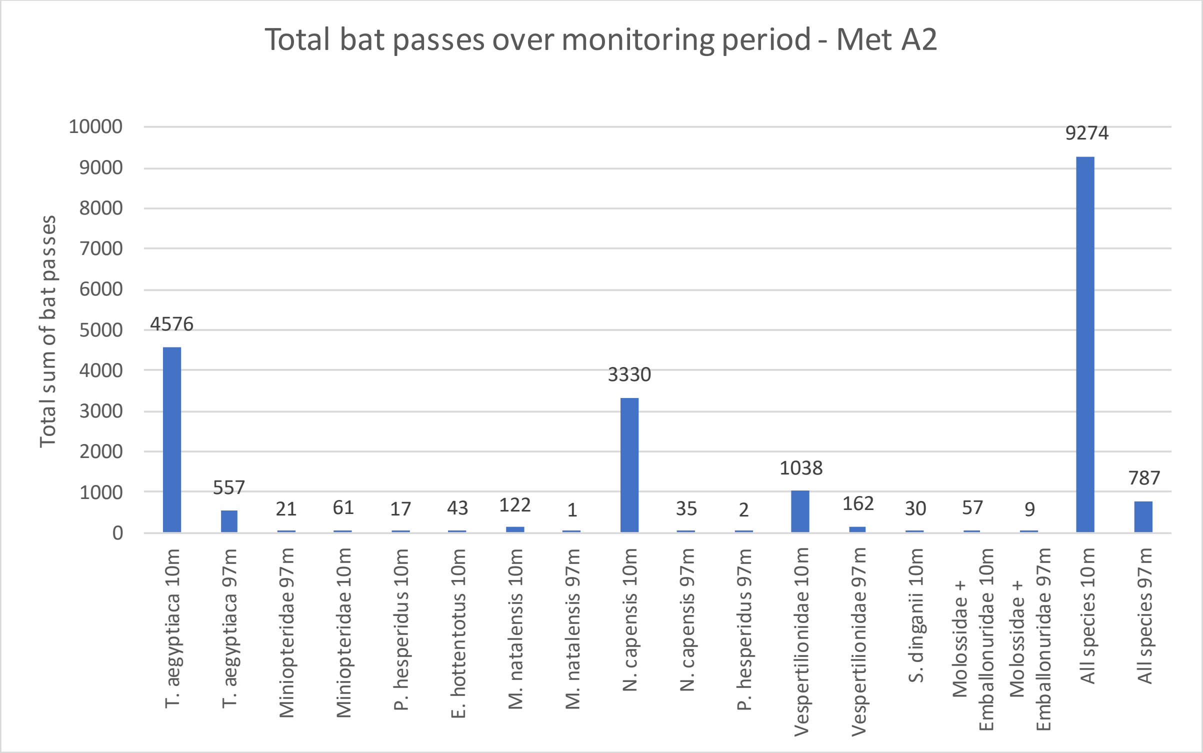

Figure 4.7: Total bat passes recorded over the monitoring period by Met A2.

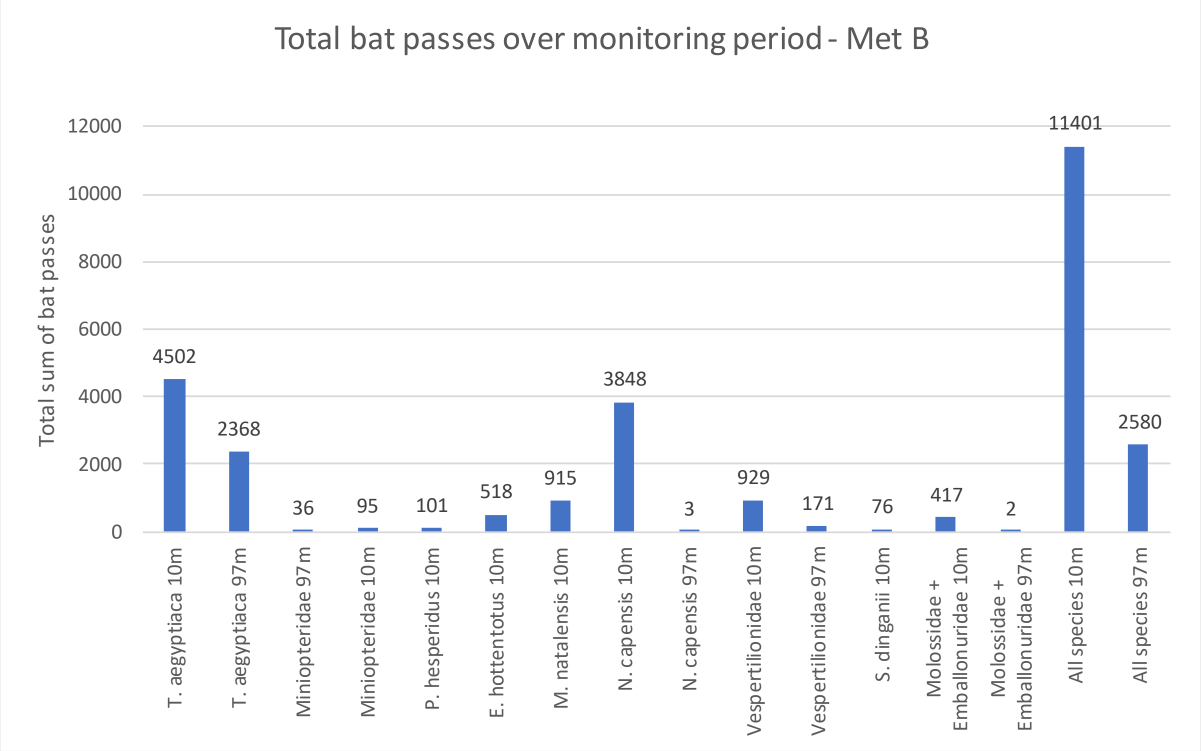

Figure 4.8: Total bat passes recorded over the monitoring period by Met B.

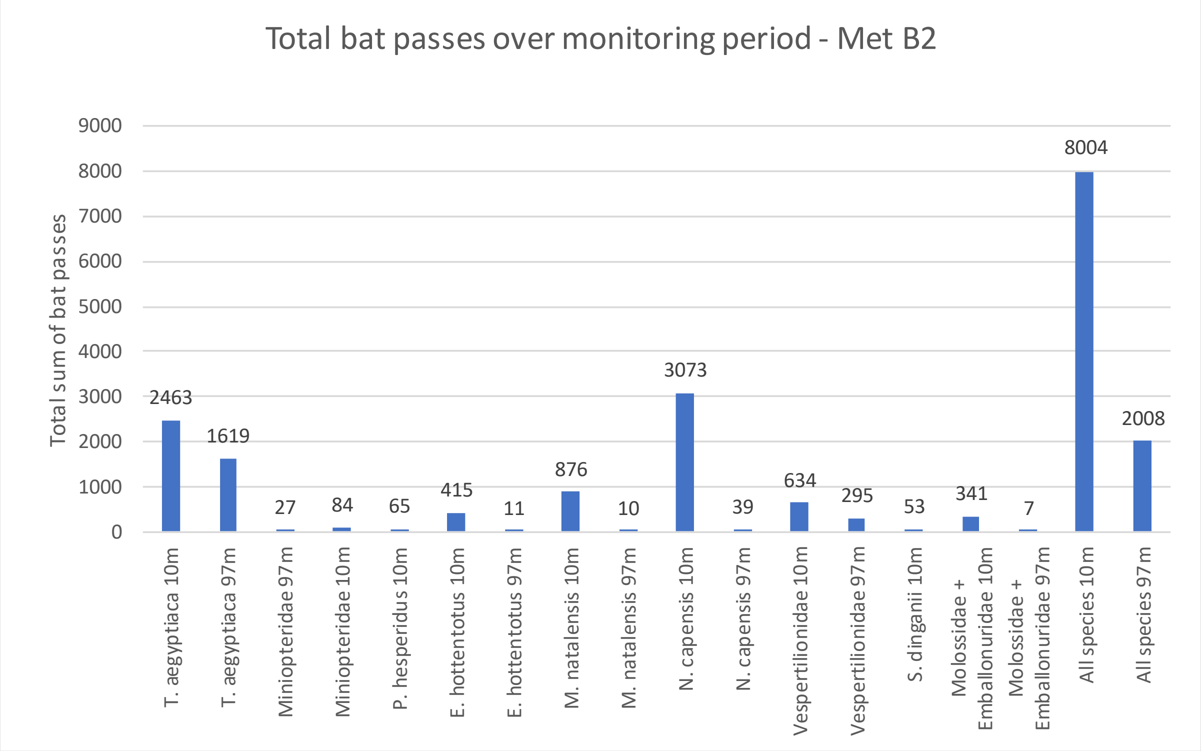

Figure 4.9: Total bat passes recorded over the monitoring period by Met B2.

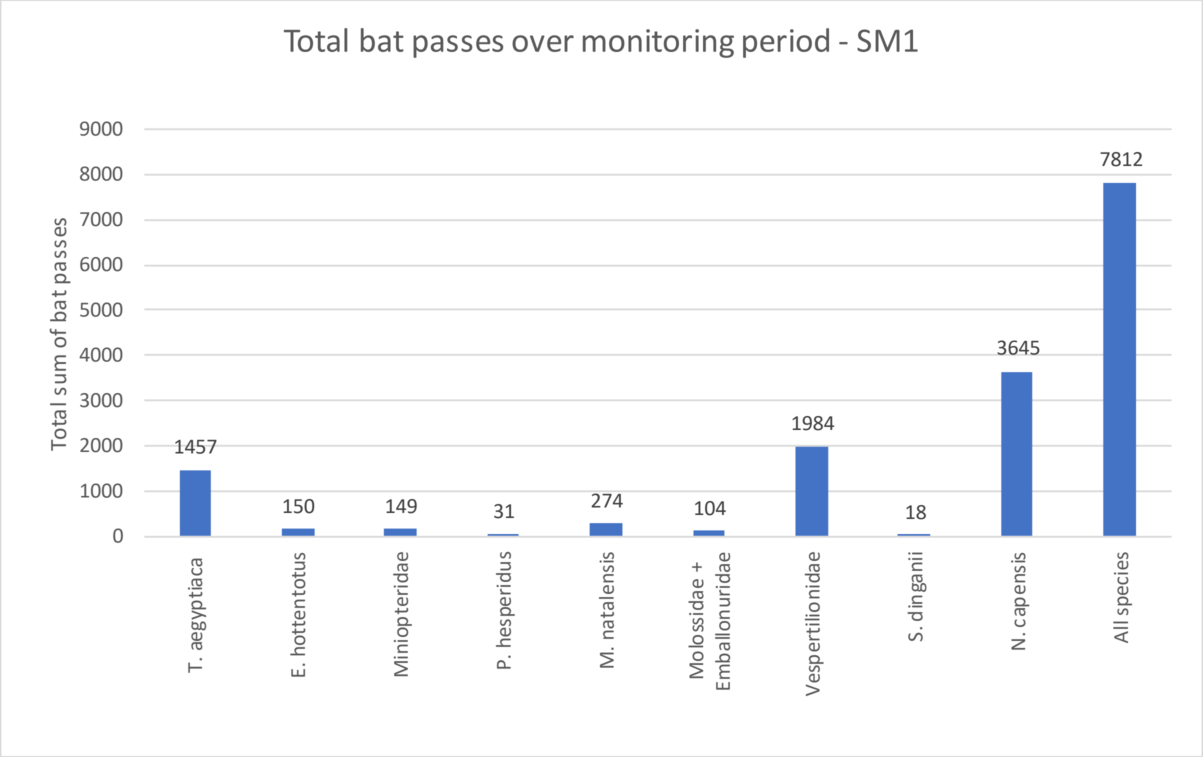

Figure 4.10: Total bat passes recorded over the monitoring period by SM1.

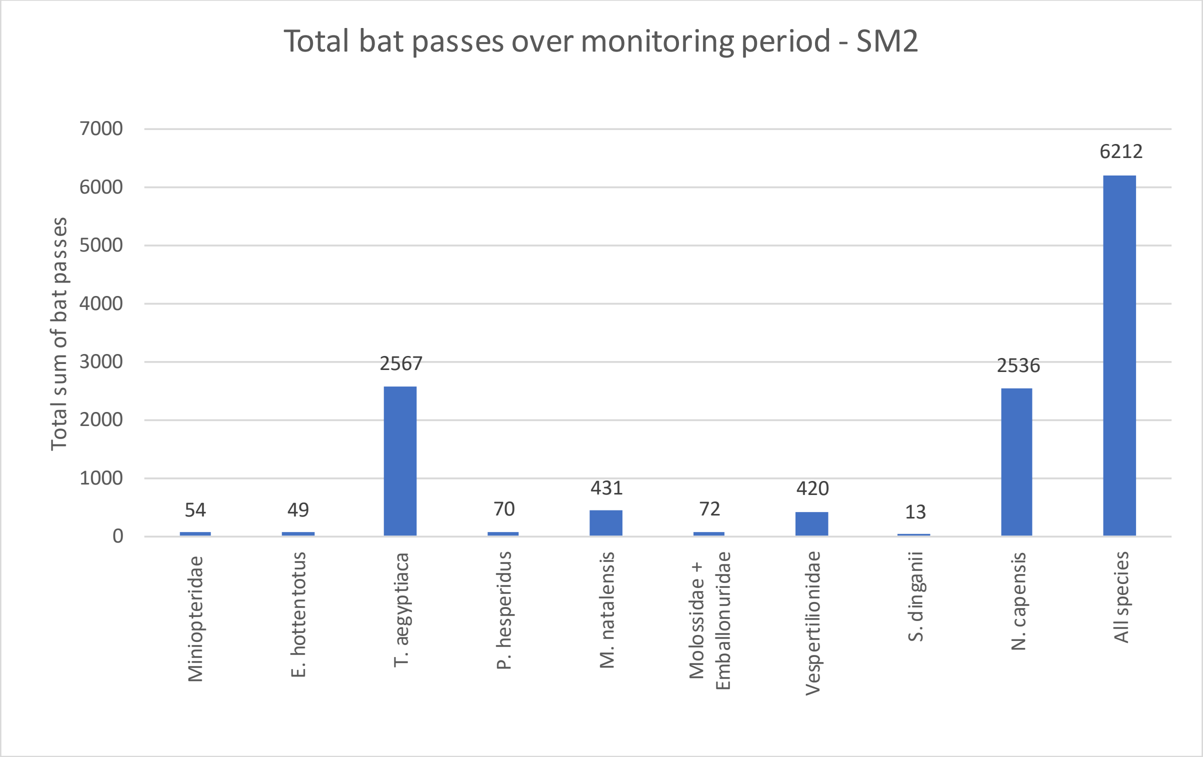

Figure 4.11: Total bat passes recorded over the monitoring period by SM2.

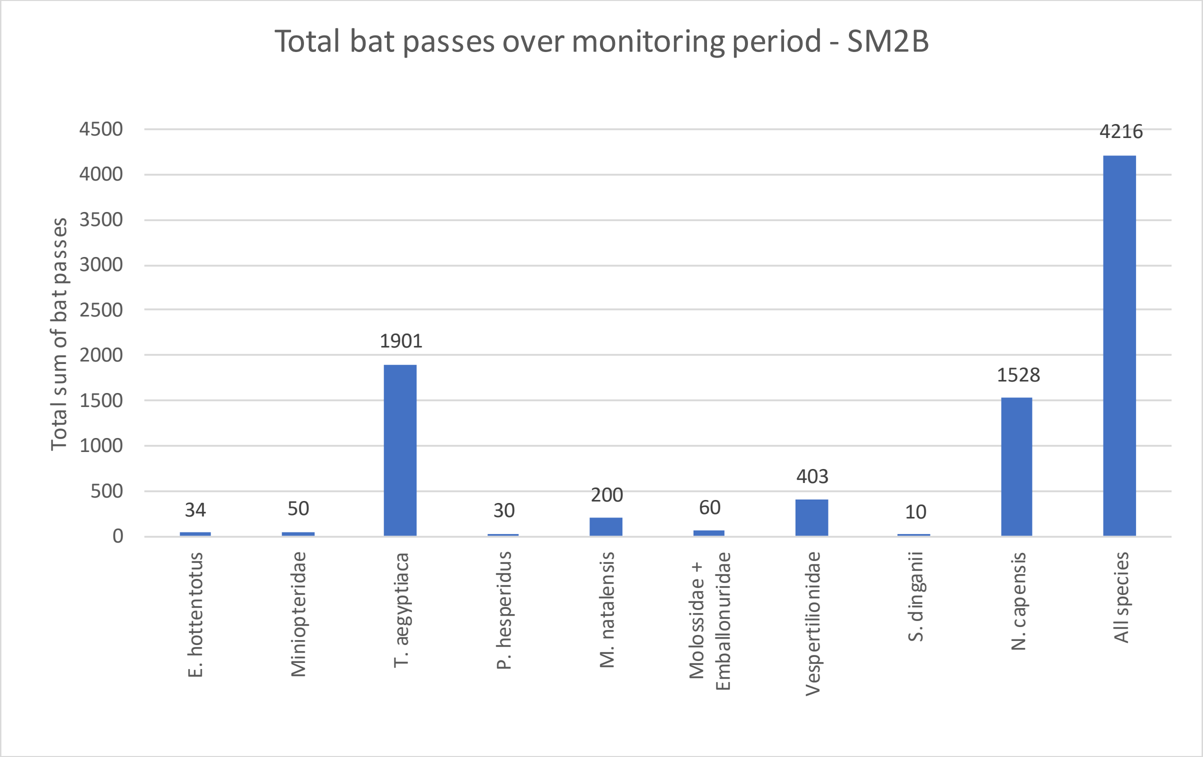

Figure 4.12: Total bat passes recorded over the monitoring period by SM2B.

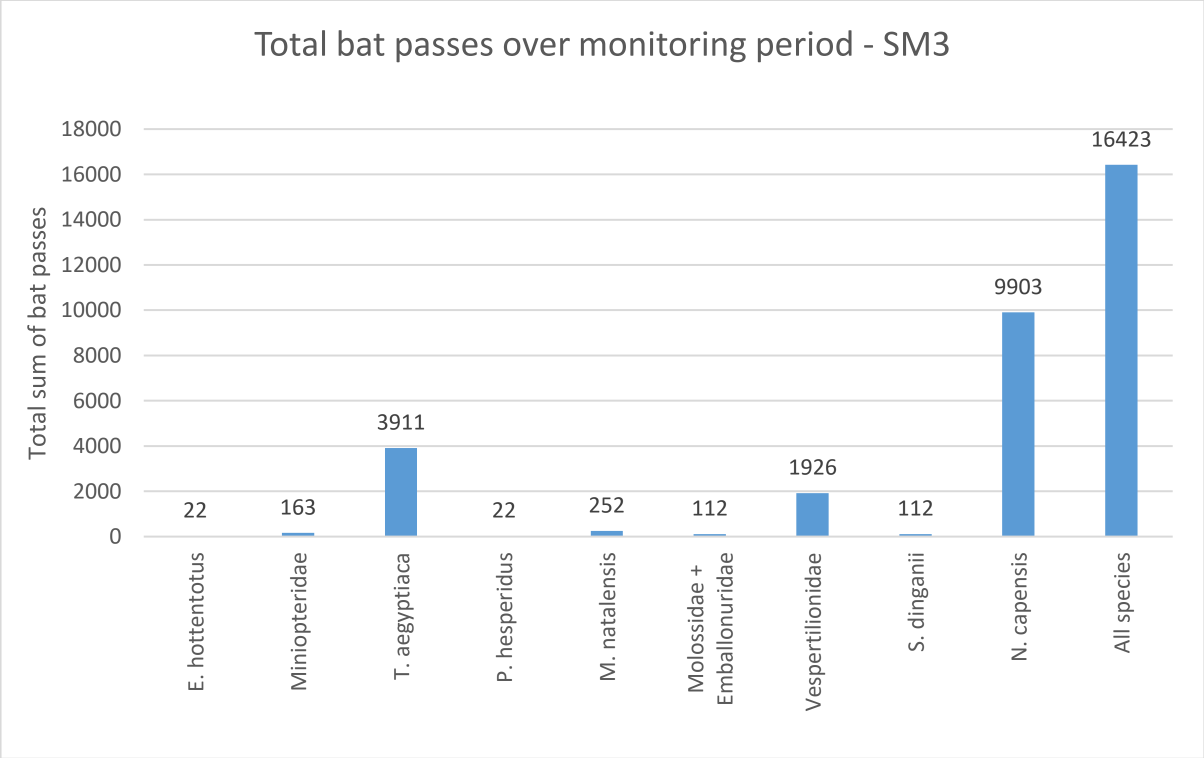

Figure 4.13: Total bat passes recorded over the monitoring period by SM3.

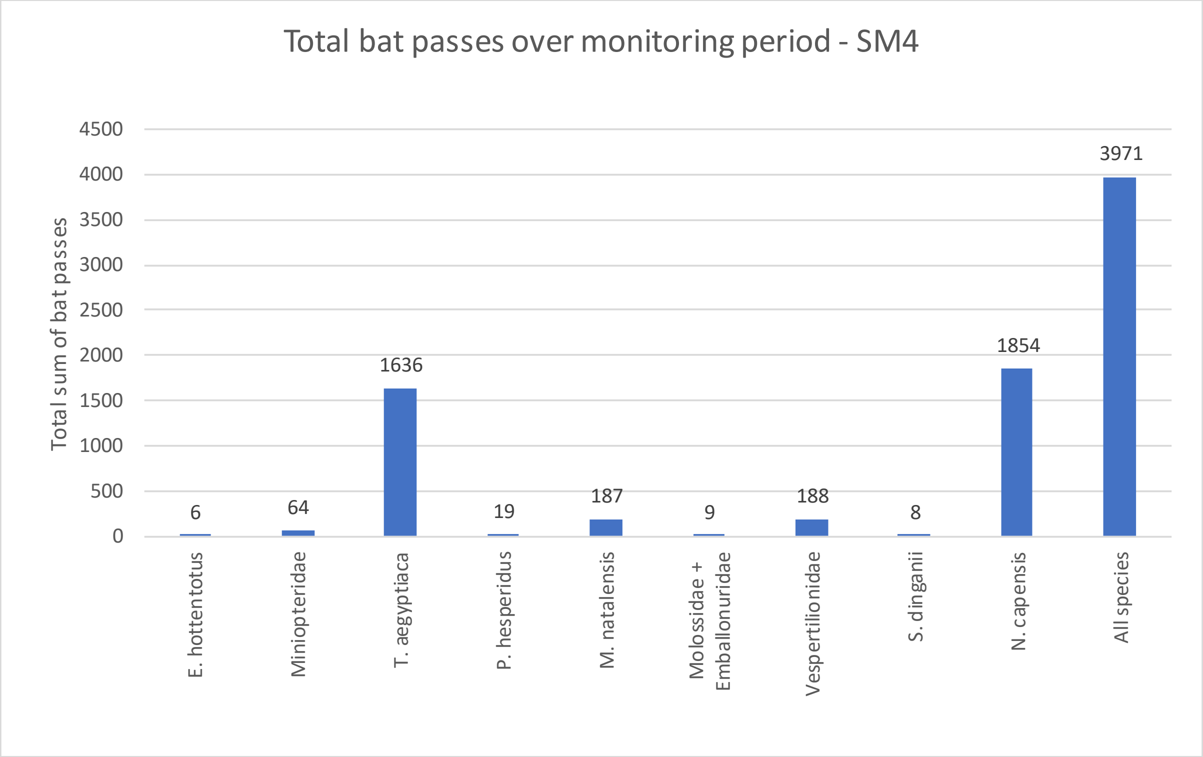

Figure 4.14: Total bat passes recorded over the monitoring period by SM4.

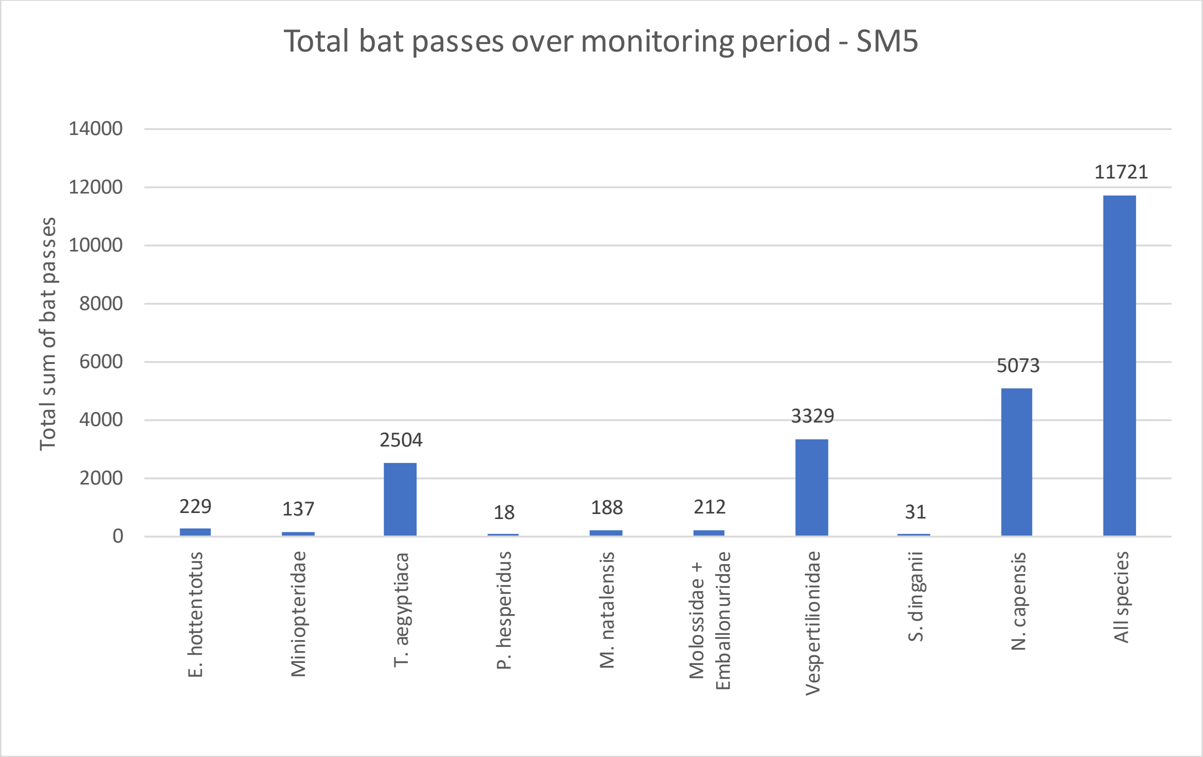

Figure 4.15: Total bat passes recorded over the monitoring period by SM5.

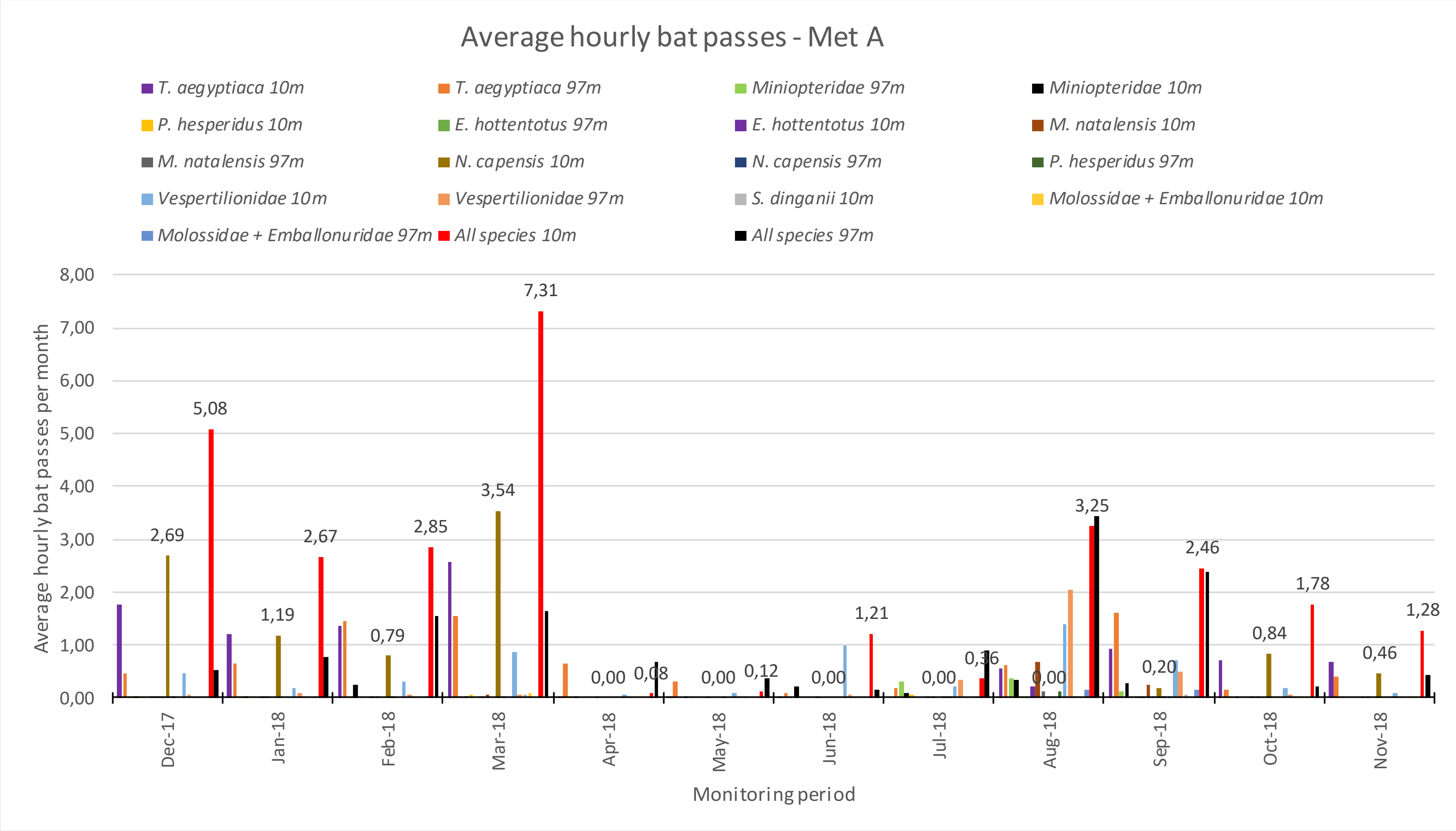

Figure 4.16: Average hourly bat passes recorded per month by Met A.

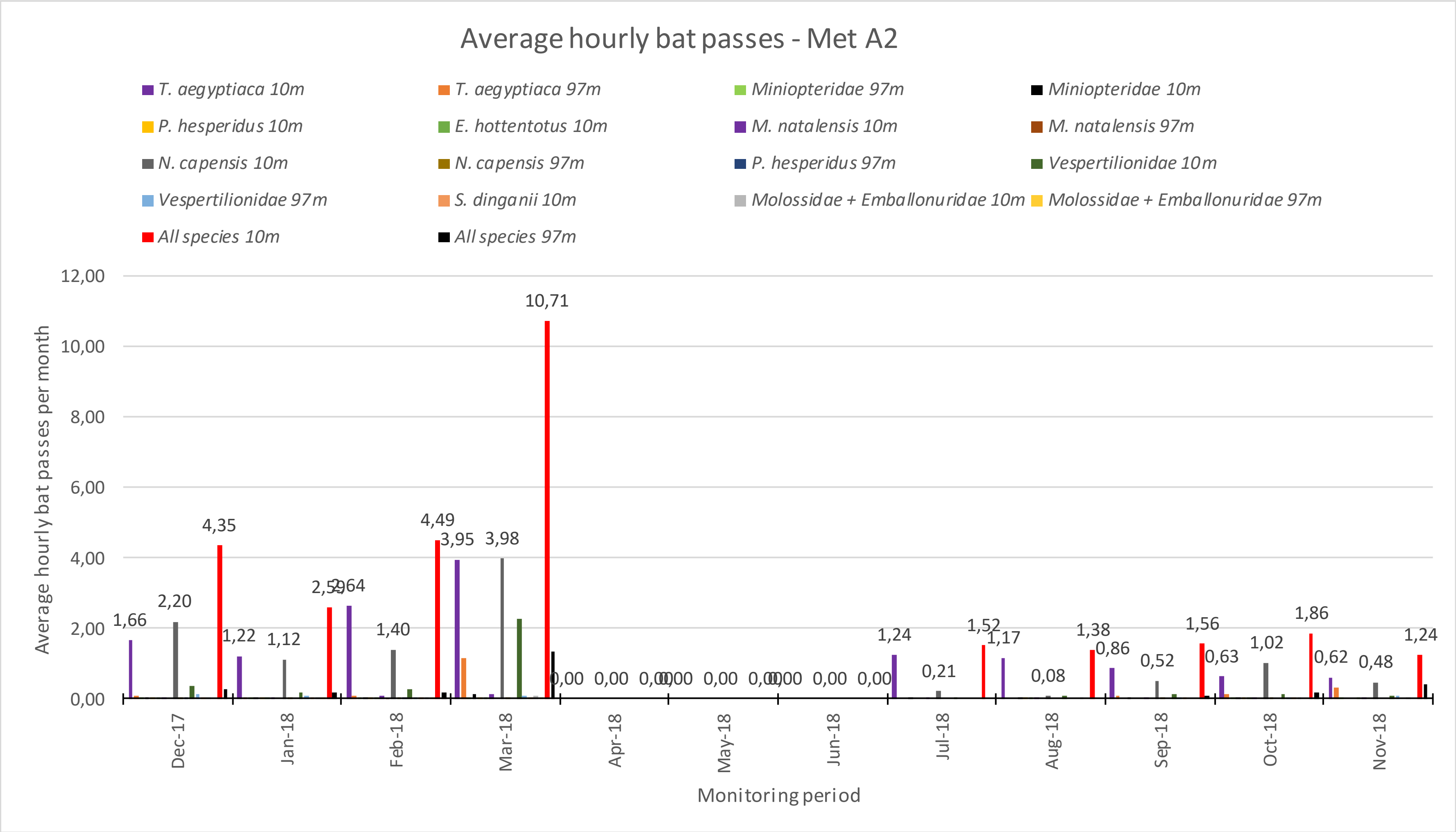

Figure 4.17: Average hourly bat passes recorded per month by Met A2.

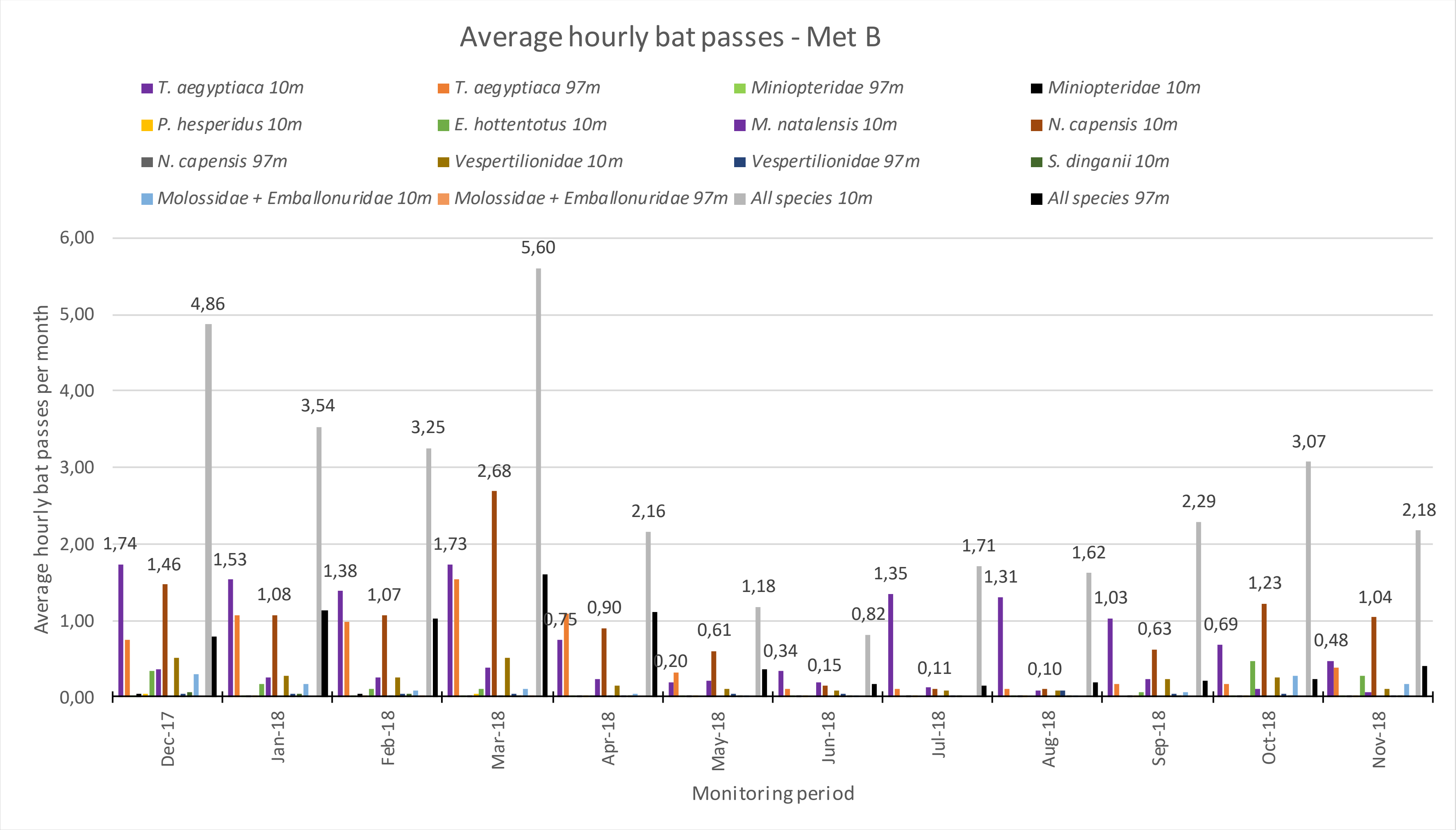

Figure 4.18: Average hourly bat passes recorded per month by Met B.

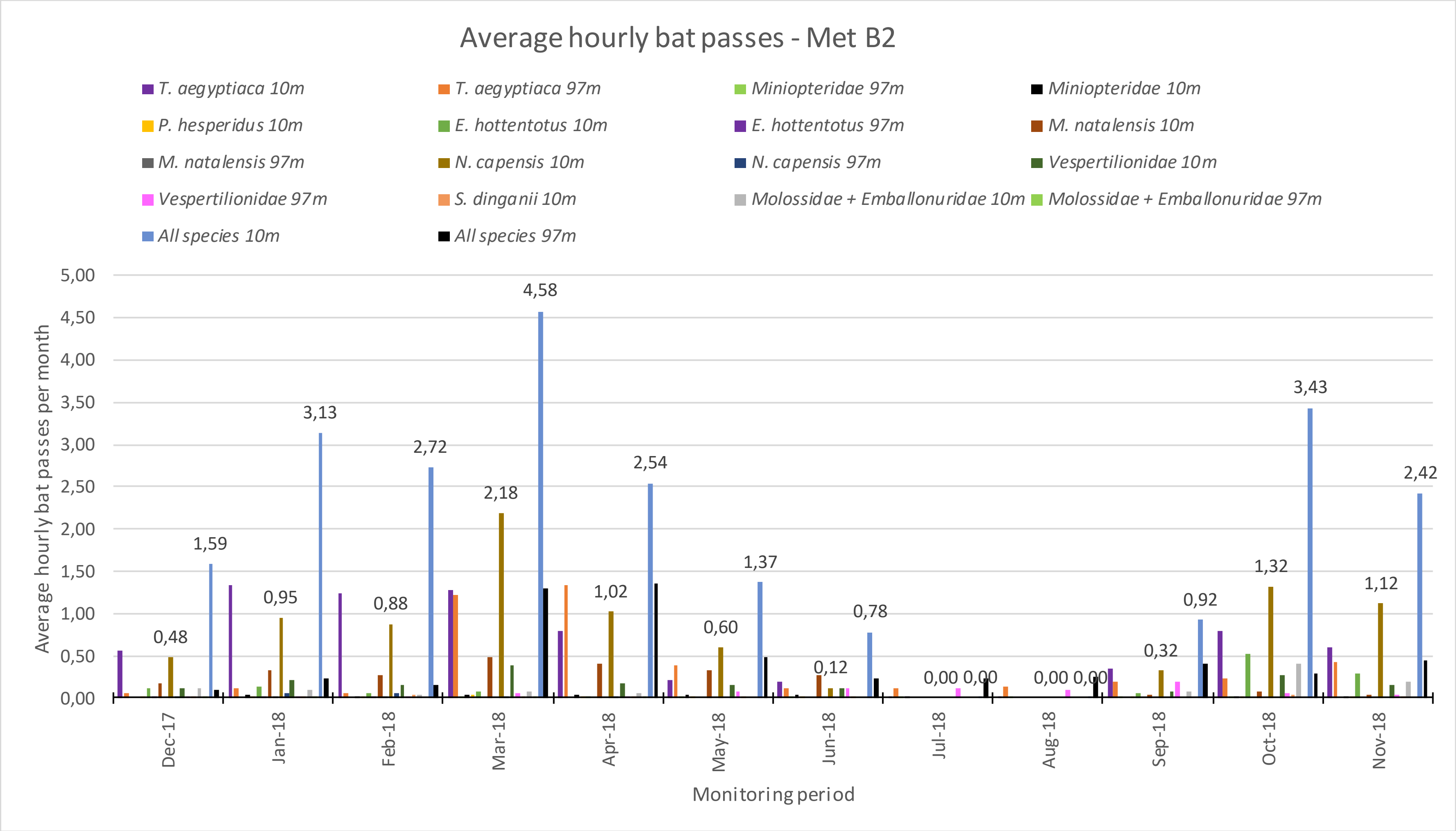

Figure 4.19: Average hourly bat passes recorded per month by Met B2.

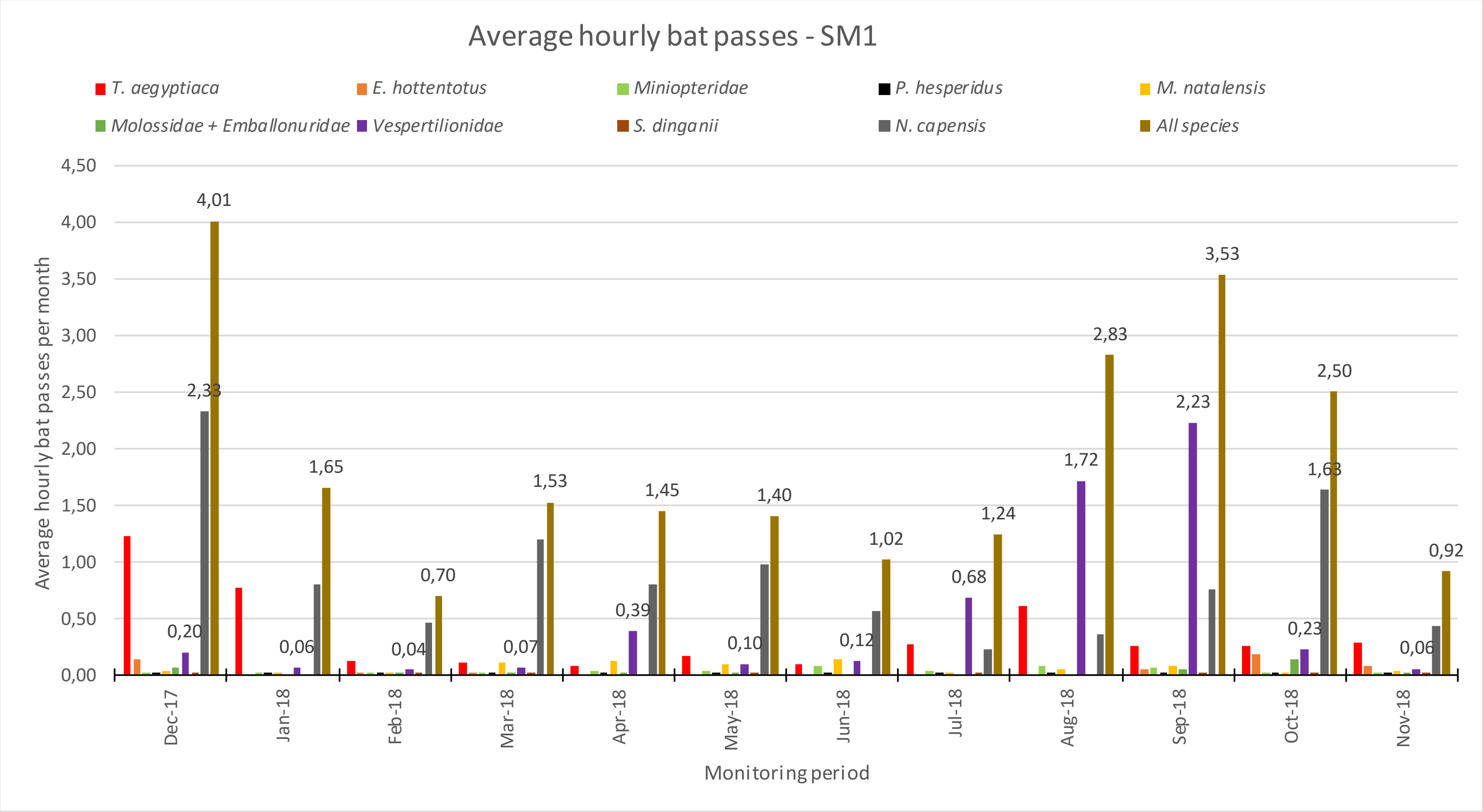

Figure 4.20: Average hourly bat passes recorded per month by SM1.

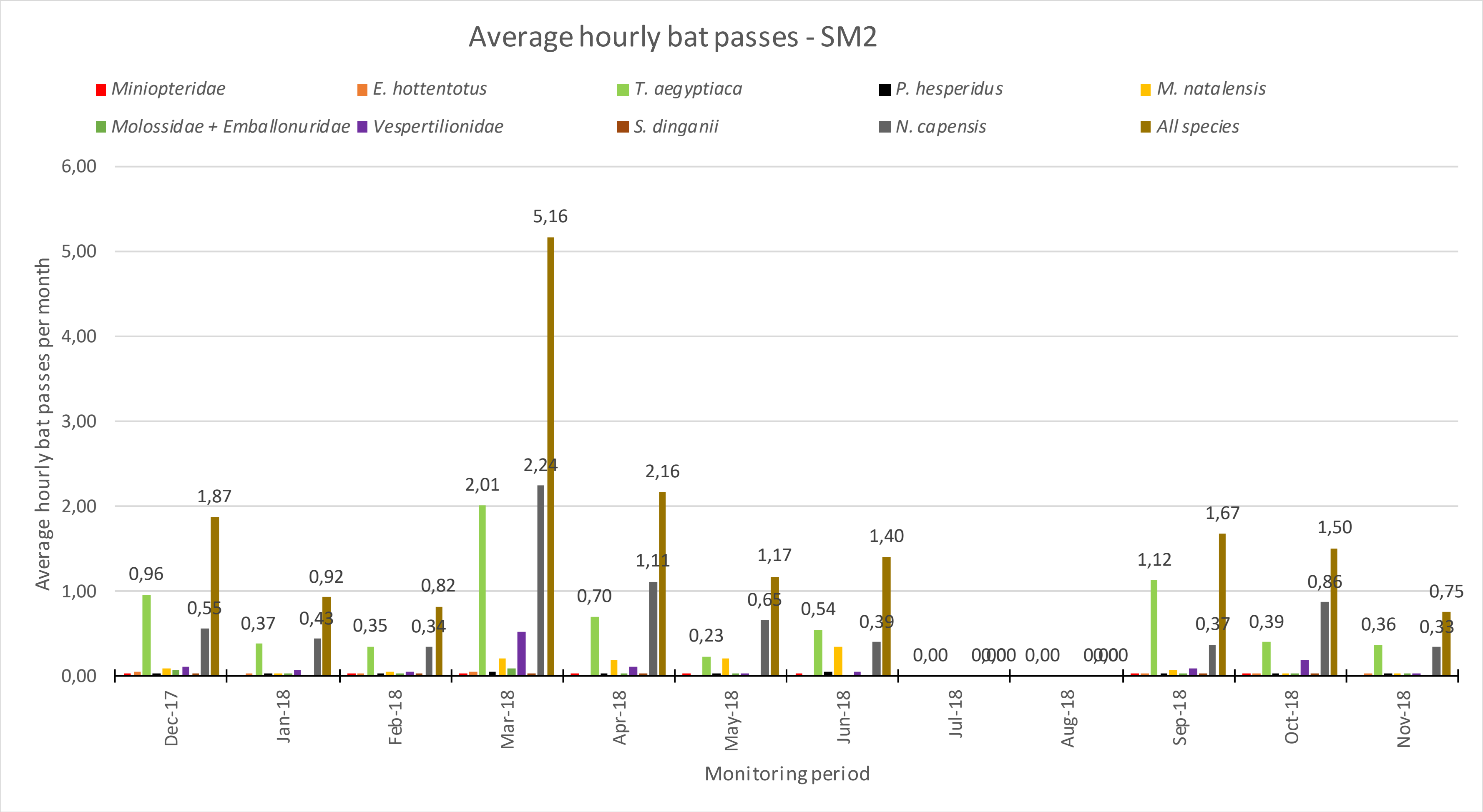

Figure 4.21: Average hourly bat passes recorded per month by SM2.

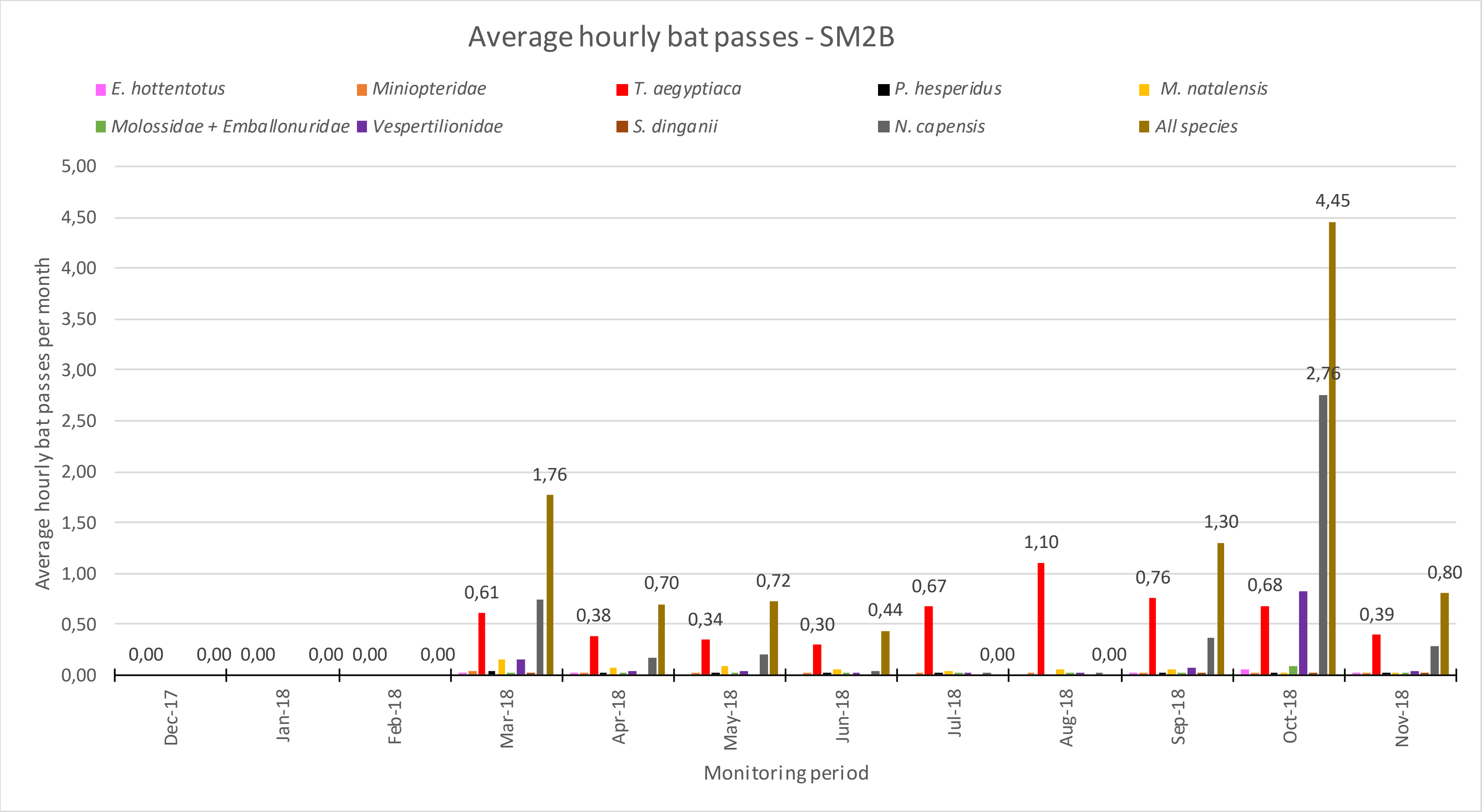

Figure 4.22: Average hourly bat passes recorded per month by SM2B.

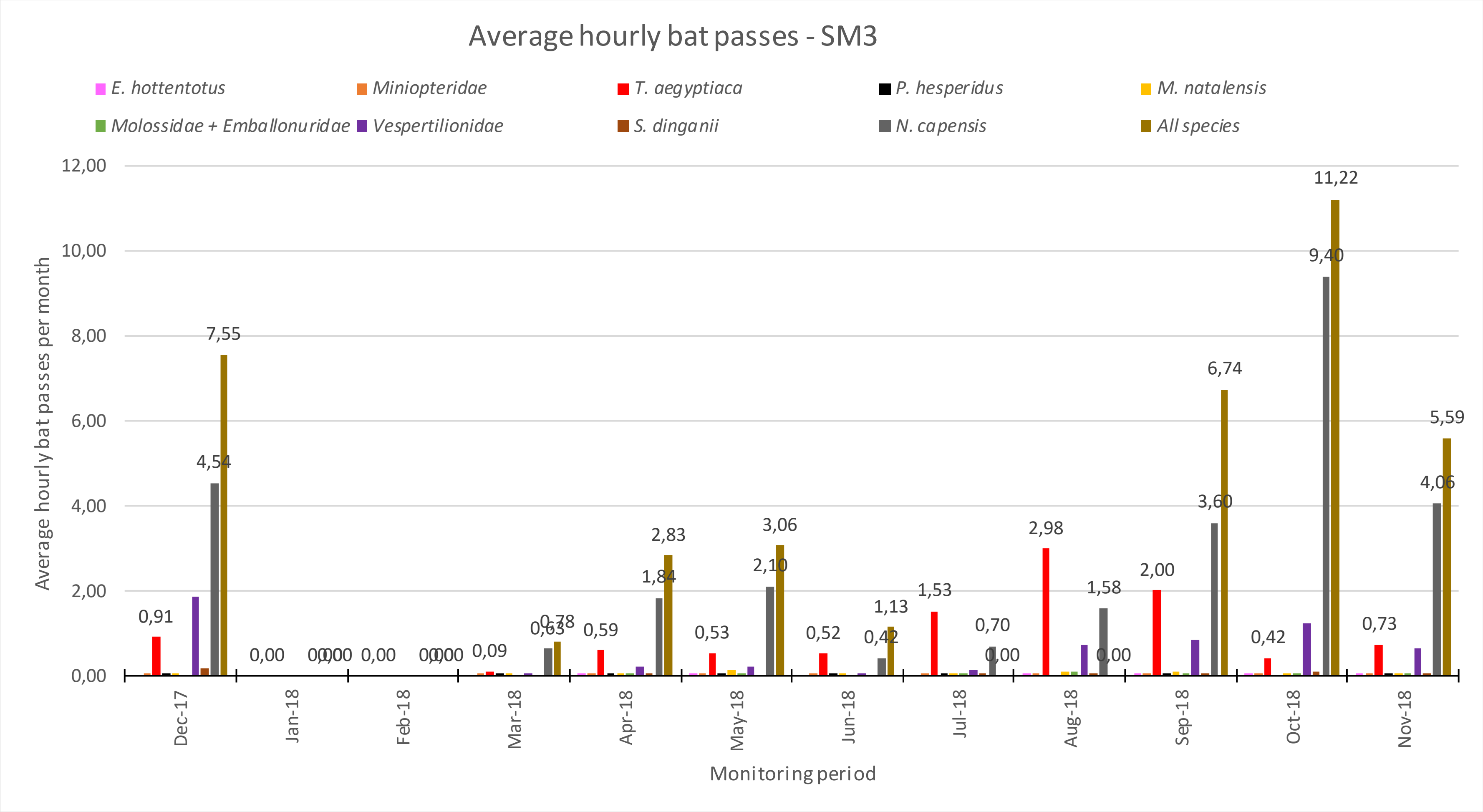

Figure 4.23: Average hourly bat passes recorded per month by SM3.

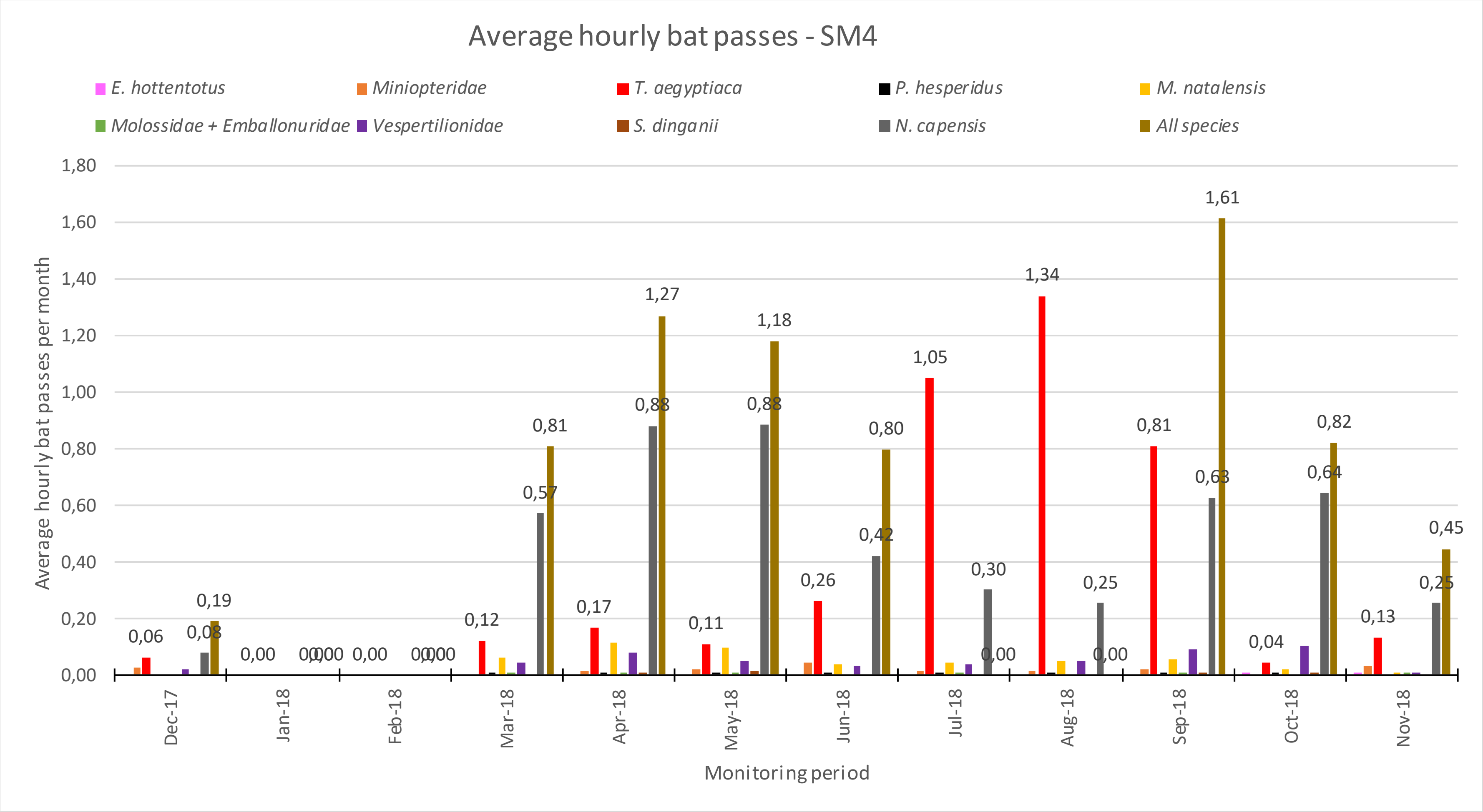

Figure 4.24: Average hourly bat passes recorded per month by SM4.

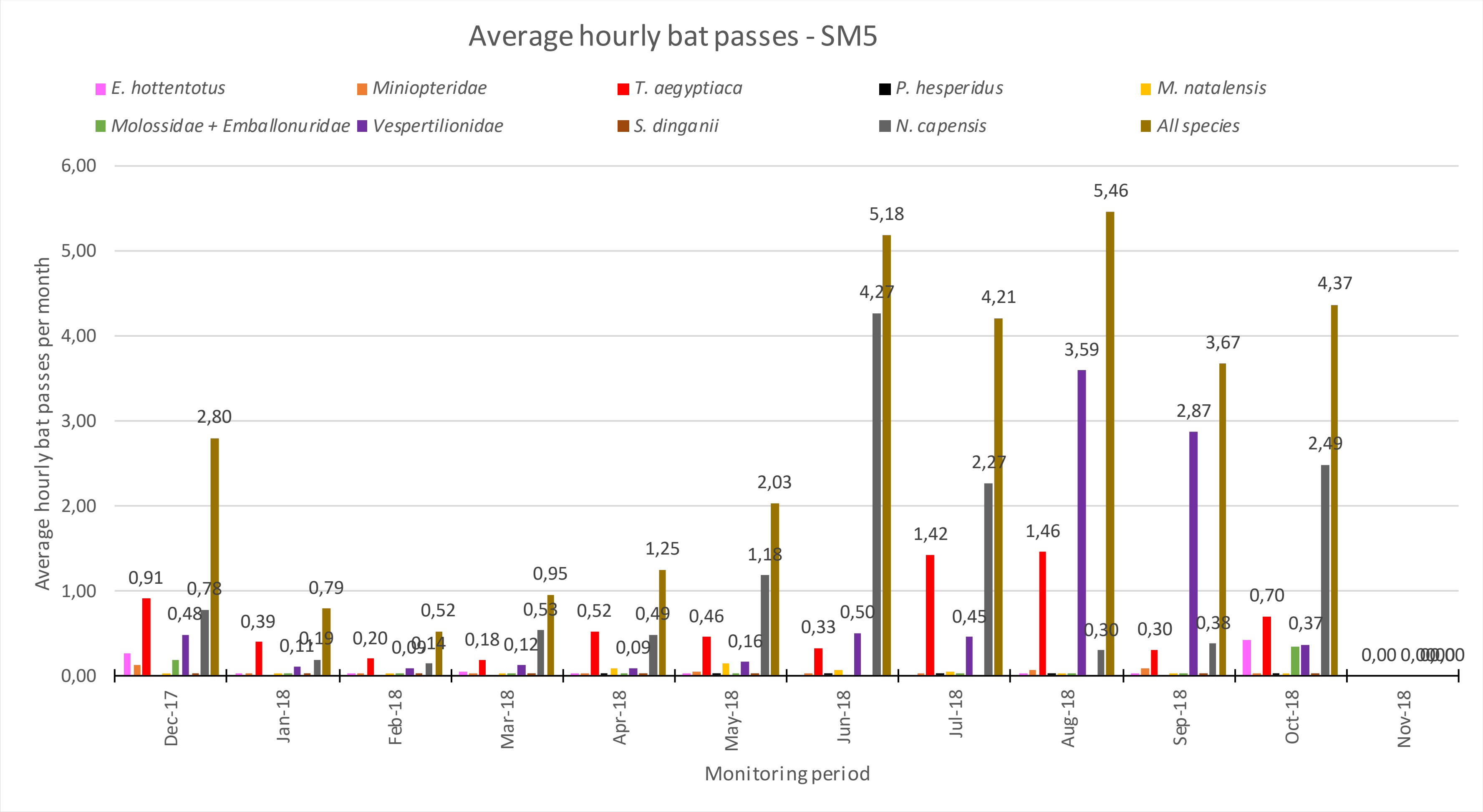

Figure 4.25: Average hourly bat passes recorded per month by SM5.

4.6.2 Temporal Distribution

The sum of all bat passes recorded by the monitoring systems of the particular species are displayed per night over the monitoring period so far (**Figures 4.26 – 4.35**). This information is useful to graphically compare seasonal differences and indicate peak activity periods that may have occurred in short time spans. It can also be used to inform a schedule for mitigation measures, if mitigation measures are found to be required during the operational phase.

It’s not unusual for bat activity to show various prominent peaks over a period of several months, as can be observed in these figures. In general the autumn and spring seasons had the highest bat activity levels, except for SM4 and SM5 where mid and late winter had high activity levels.

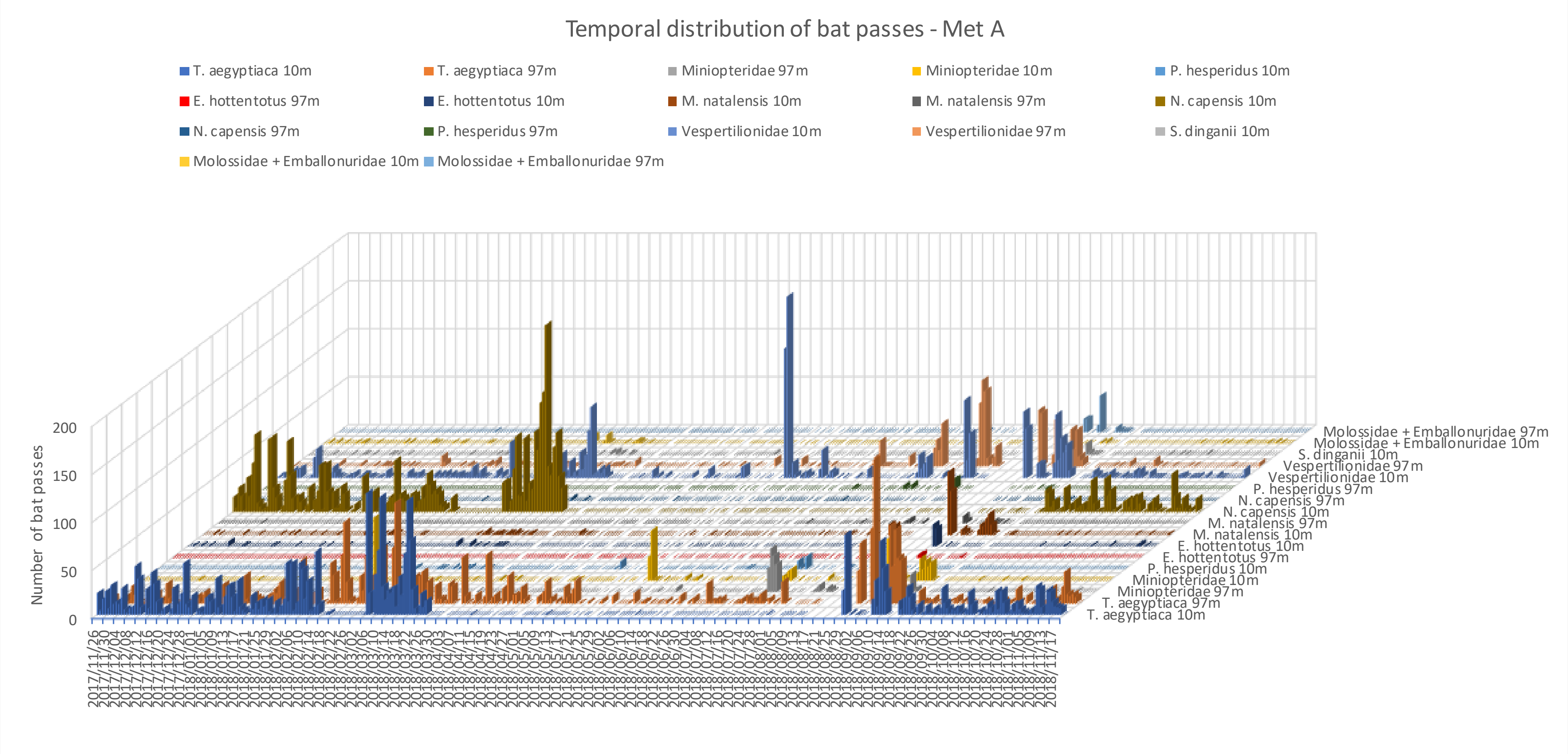

Figure 4.26: Temporal distribution of bat passes detected by Met A.

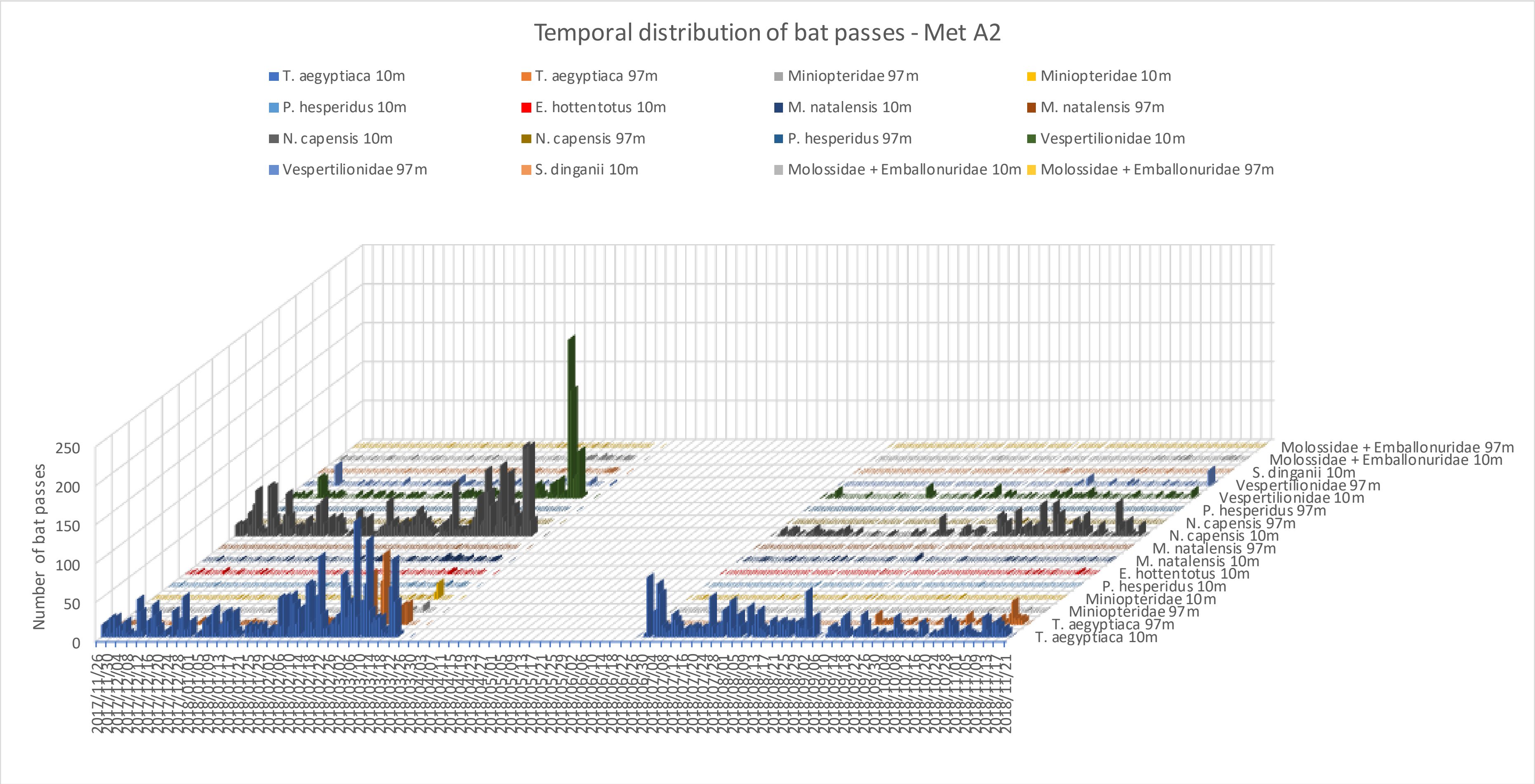

Figure 4.27: Temporal distribution of bat passes detected by Met A2.

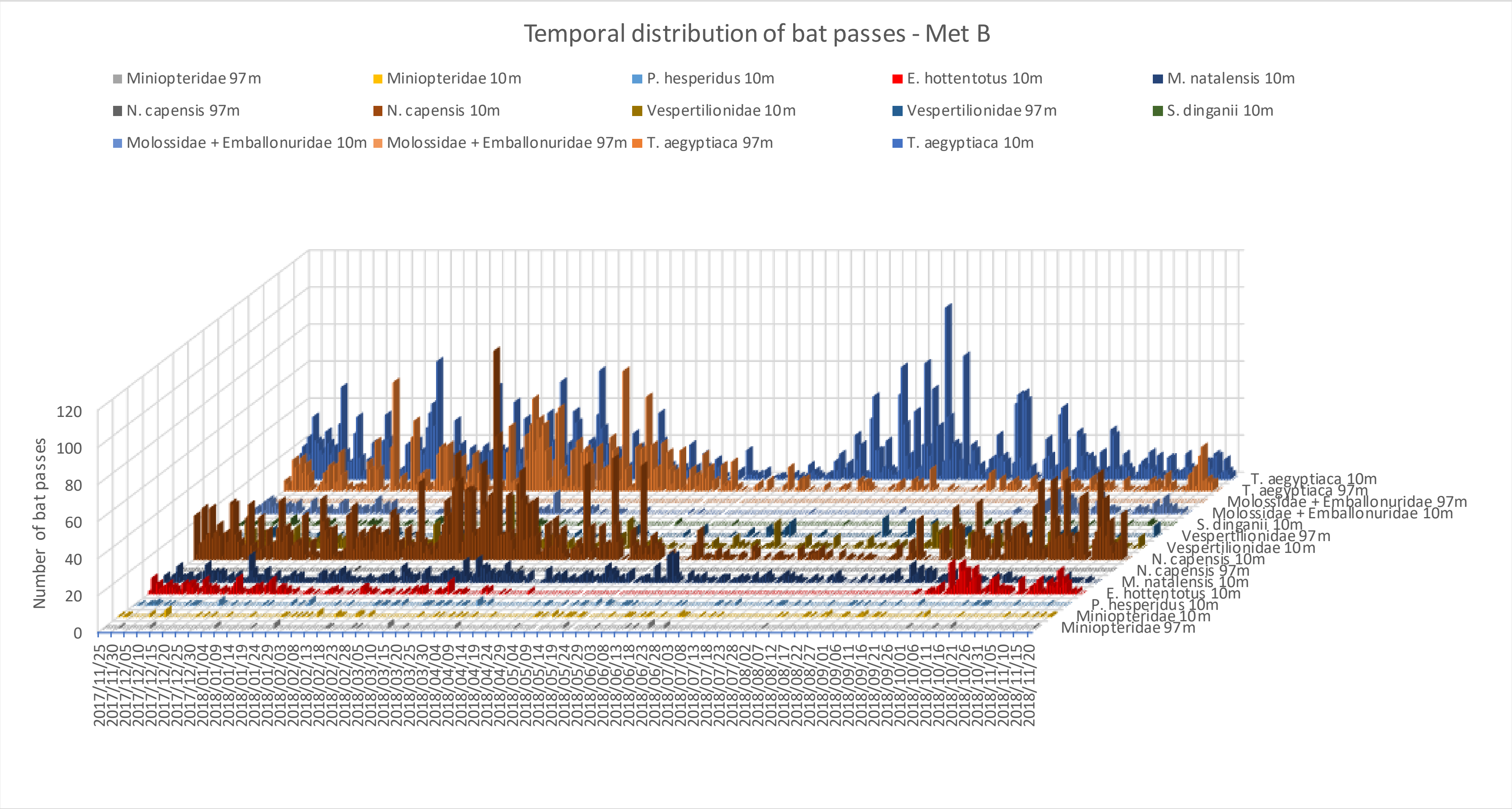

Figure 4.28: Temporal distribution of bat passes detected by Met B.

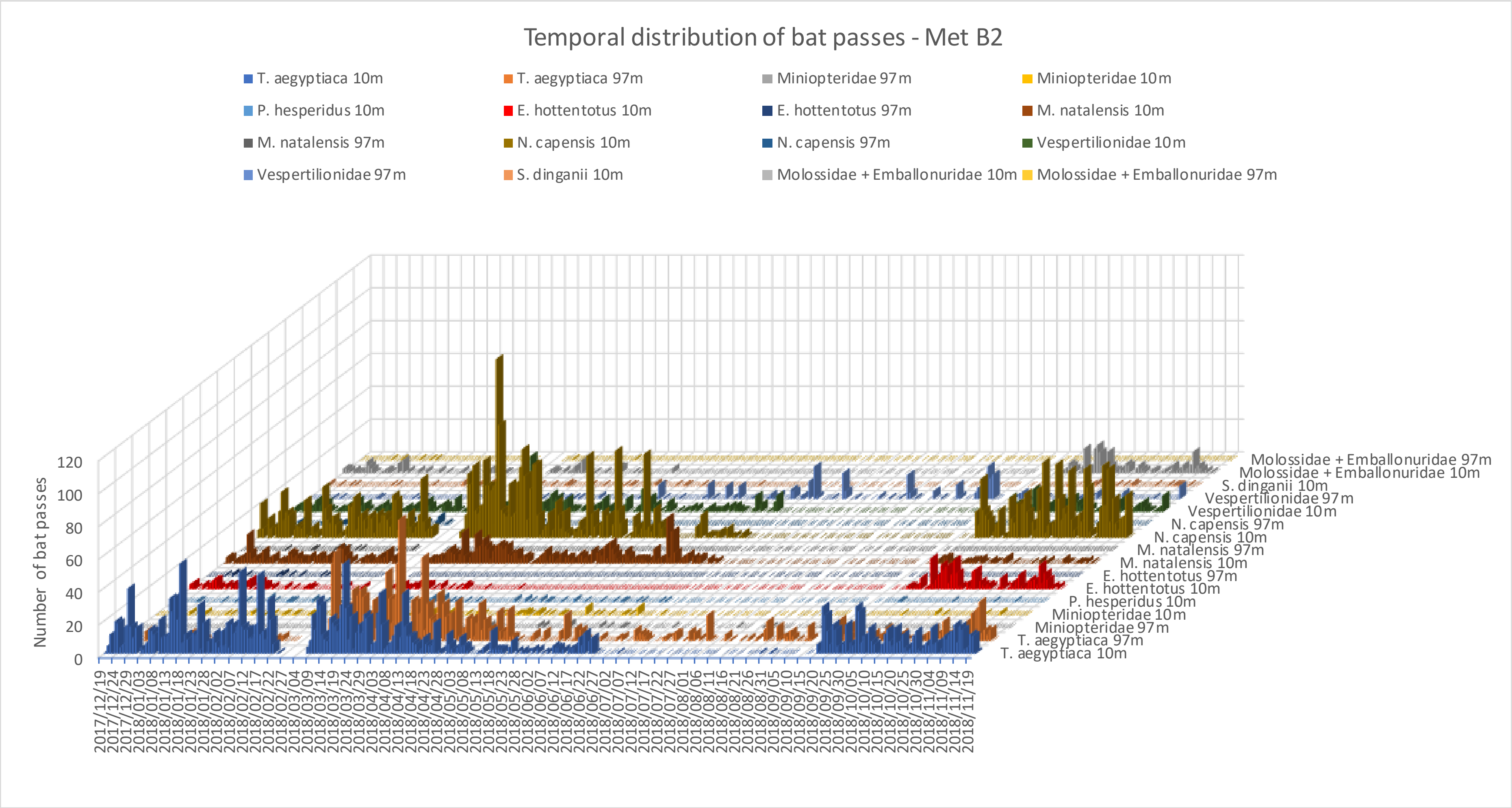

Figure 4.29: Temporal distribution of bat passes detected by Met B2.

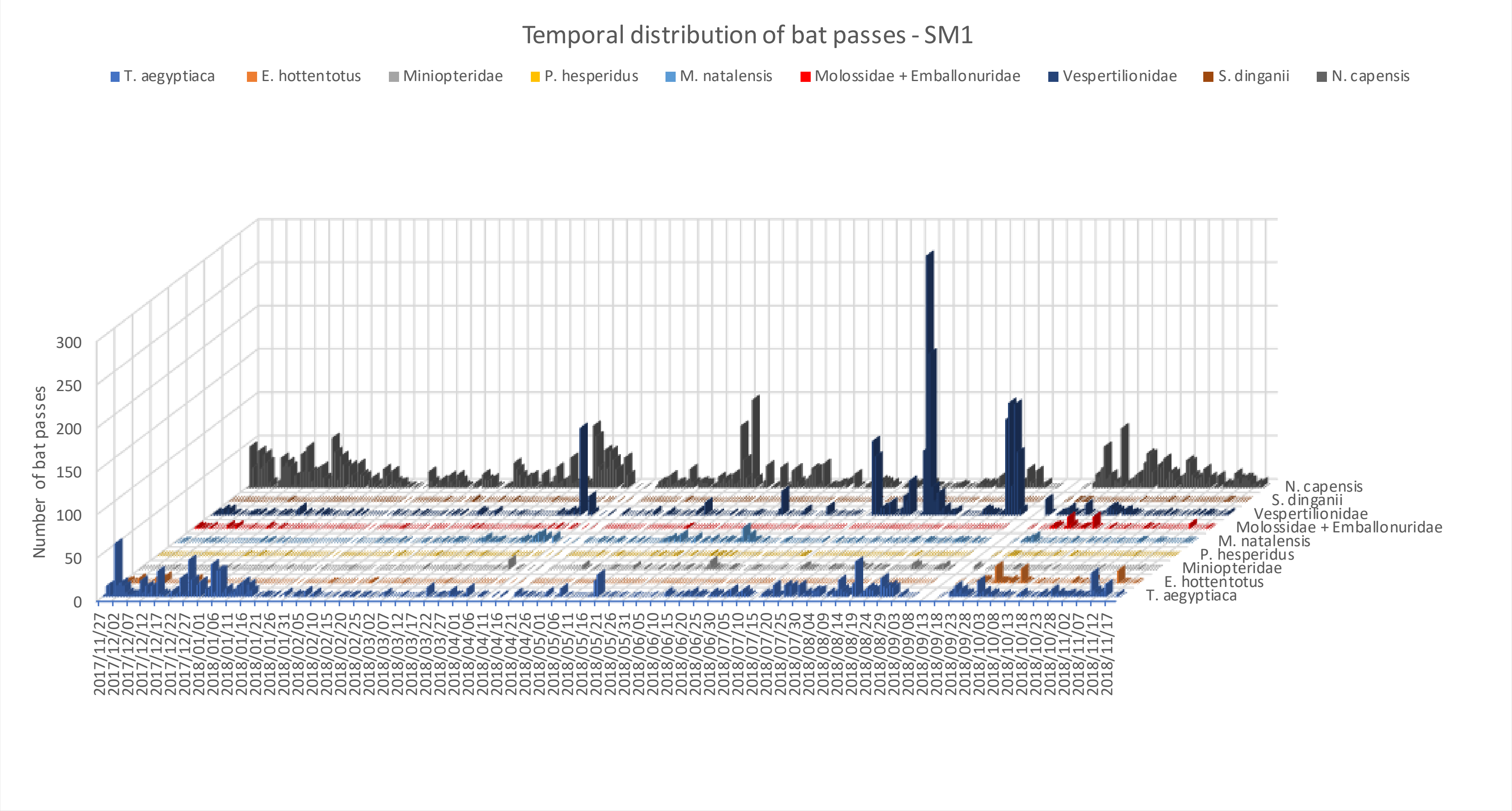

Figure 4.30: Temporal distribution of bat passes detected by SM1.

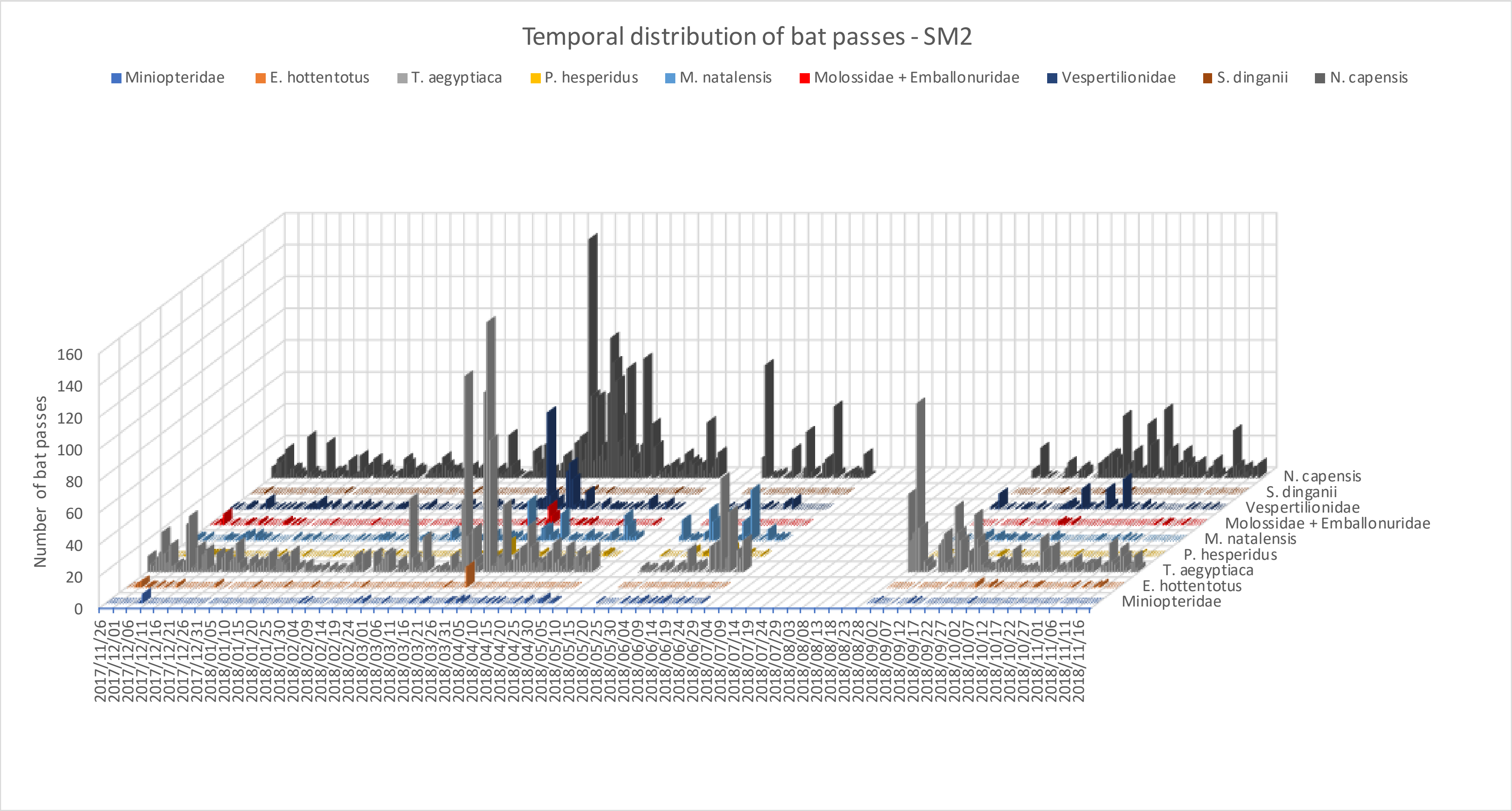

Figure 4.31: Temporal distribution of bat passes detected by SM2.

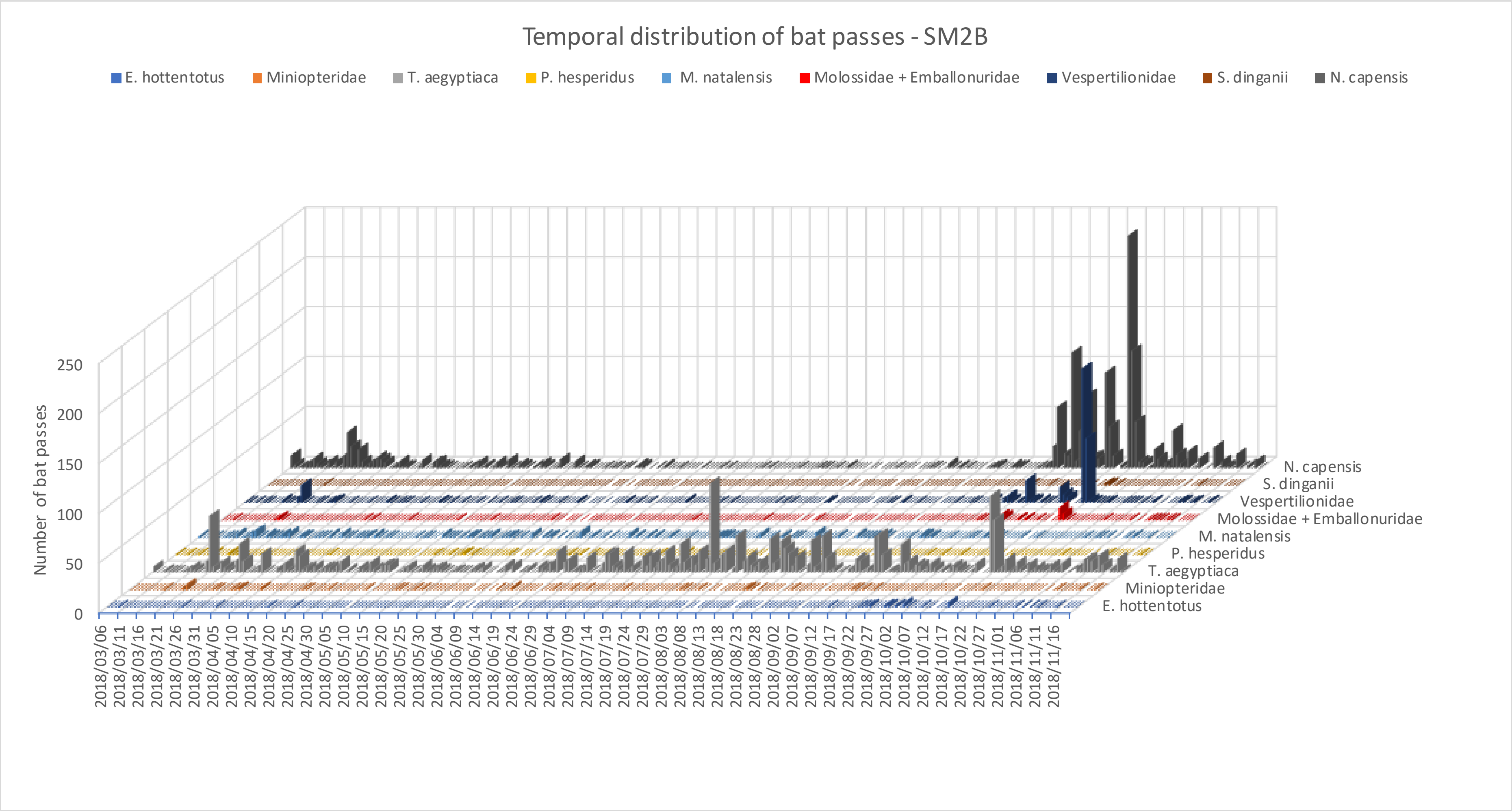

Figure 4.32: Temporal distribution of bat passes detected by SM2B.

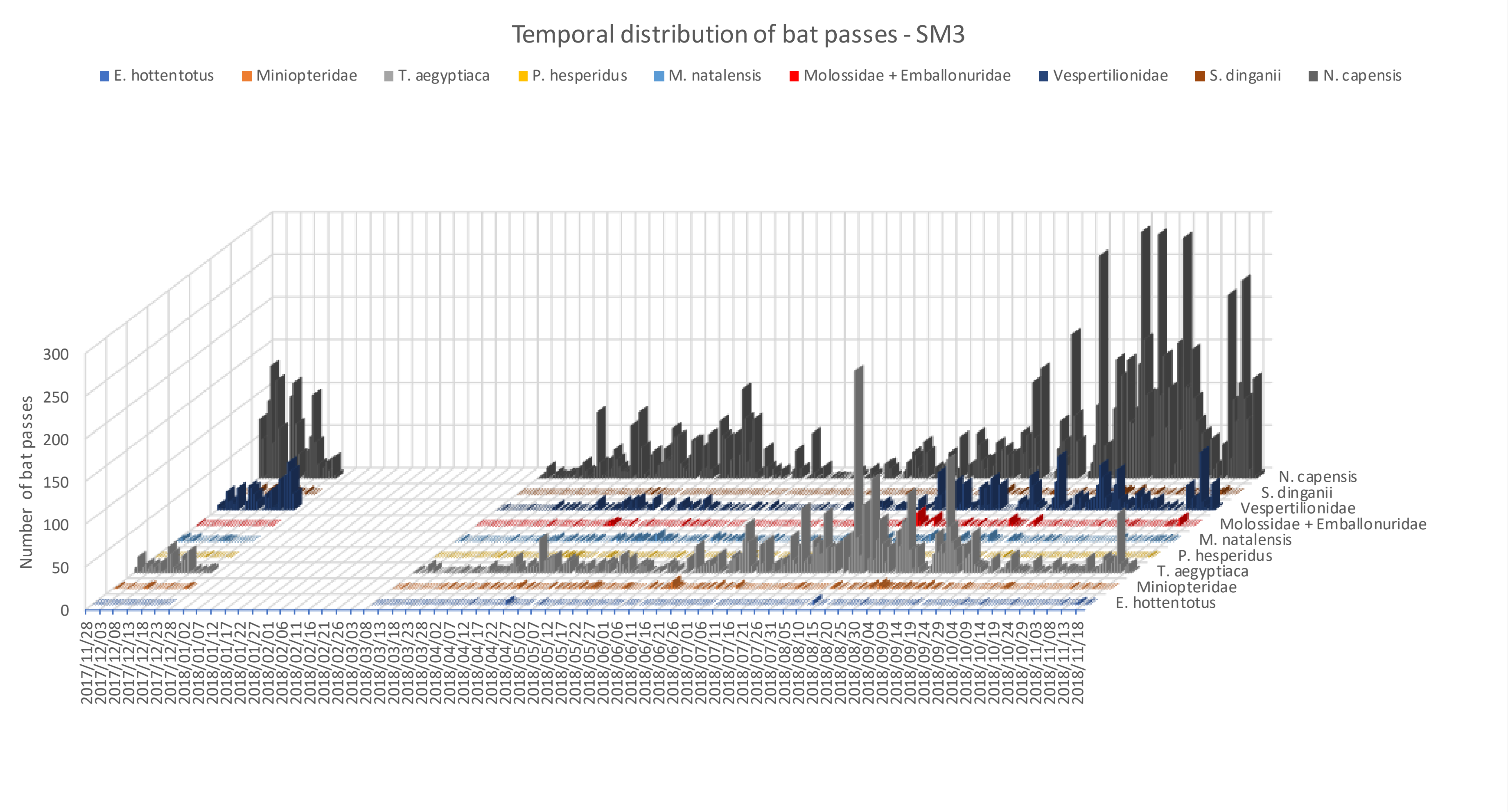

Figure 4.33: Temporal distribution of bat passes detected by SM3.

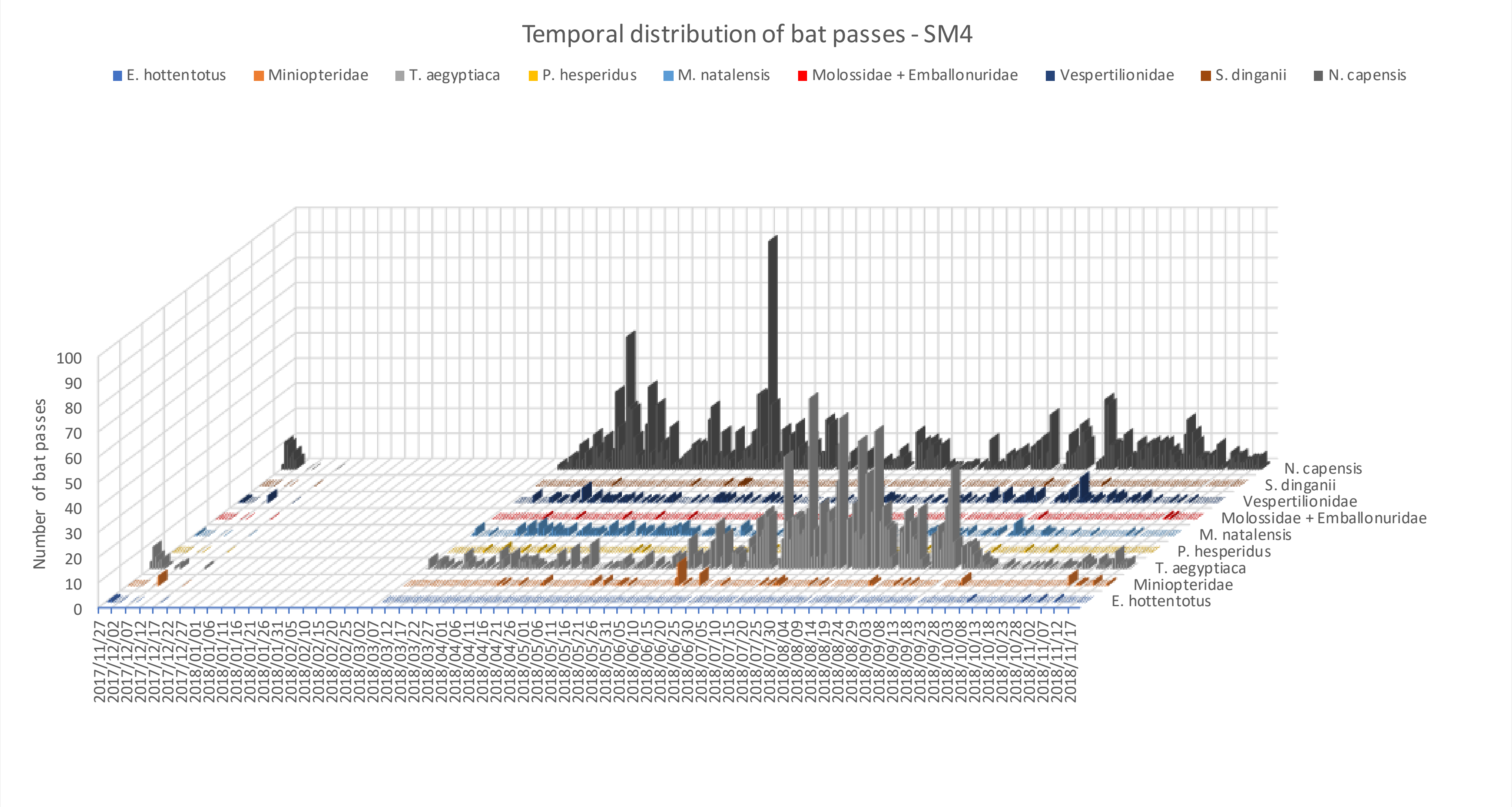

Figure 4.34: Temporal distribution of bat passes detected by SM4.

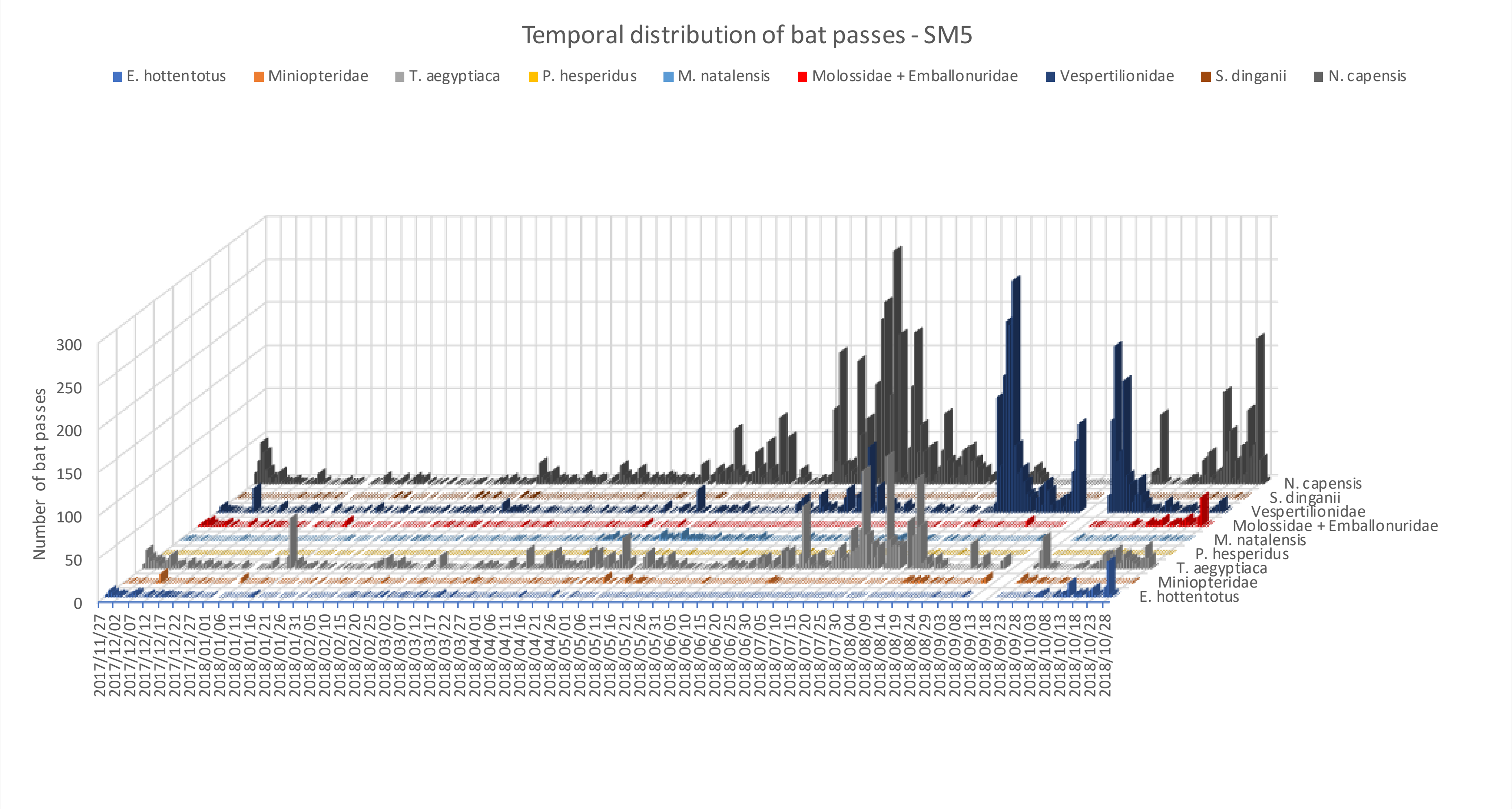

Figure 4.35: Temporal distribution of bat passes detected by SM5.

4.6.3 Relation between Bat Activity and Weather Conditions

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

Wind speed

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

Wind speed and direction also 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). 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.

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.

Analysis

The results below present figures of the sum of bat passes that were detected within specific wind speed and temperature categories. However, the distribution of bat activity within each wind speed and temperature range may be biased due to the frequency of occurrence of each wind speed and temperature range. Thus, the number of bat passes were 'normalised' wherein the frequency with which each wind speed and temperature range were recorded was taken into account. The 'normalised' sum of bat passes per wind speed and temperature range are also presented below. Cumulative percentages of the normalised sum of bat passes per wind speed and temperature ranges are also presented.

The aim of this analysis (**Figures 4.38 – 4.48**) is to determine the wind speed and temperature range within which 80% of bat passes were detected (of the normalised sum of bat passes). These values of wind speed and temperature may be used, if necessary, to inform mitigation measures for turbines based on conserving 80% of detected bat passes. This is keeping in mind the synergistic or otherwise contradictory effects that the combination of wind speeds and temperatures can have on bat activity. This analysis is only be done on the most critical bat activity periods of the year.

Time periods used in the analysis below were identified in Sections 4.6.1 and 4.6.2 as periods of elevated activity , which were 1 Feb – 30 April 2018, and 1 – 30 September 2018. The analysis was only performed for time frames where bat activity was generally the highest at 97m, this includes data from Met A, Met B and Met B2. Wind speed measured at a height of 62m and temperature measured at a height of 60m were used for the analysis.

Figures 4.36 – 4.37 below indicates the hourly bat activity for the focus periods where bat activity were generally the highest at 97m, this includes summed data from Met A, Met B and Met B2.

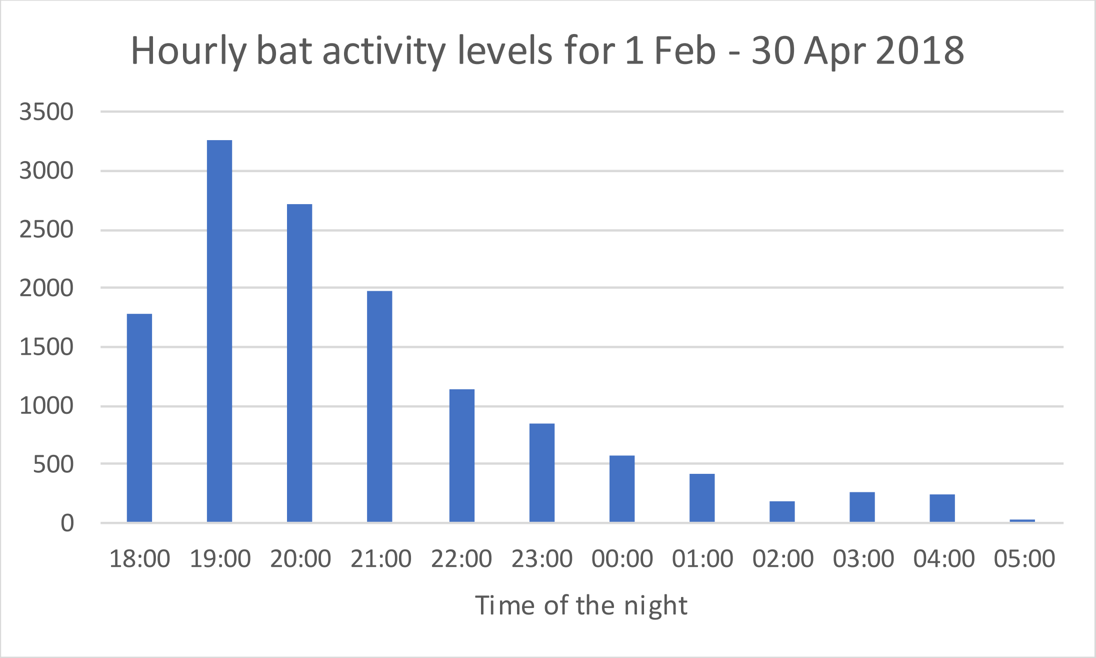

Figure 4.36: Hourly bat activity levels for the period of 1 Feb to 30 Apr 2018.

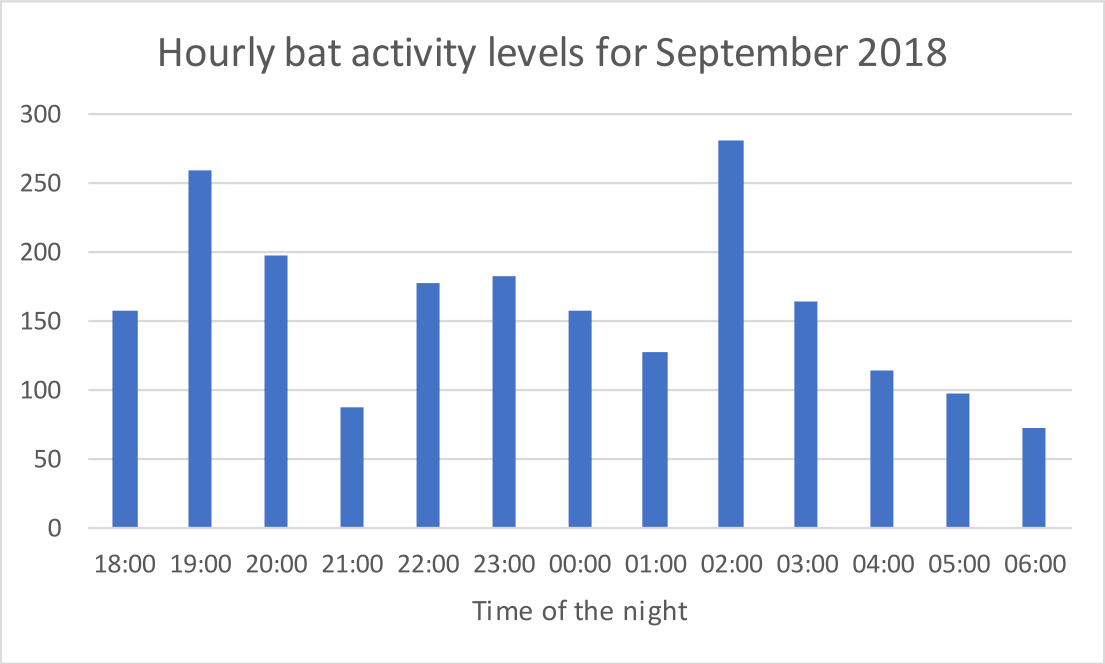

Figure 4.37: Hourly bat activity levels for the period of September 2018.

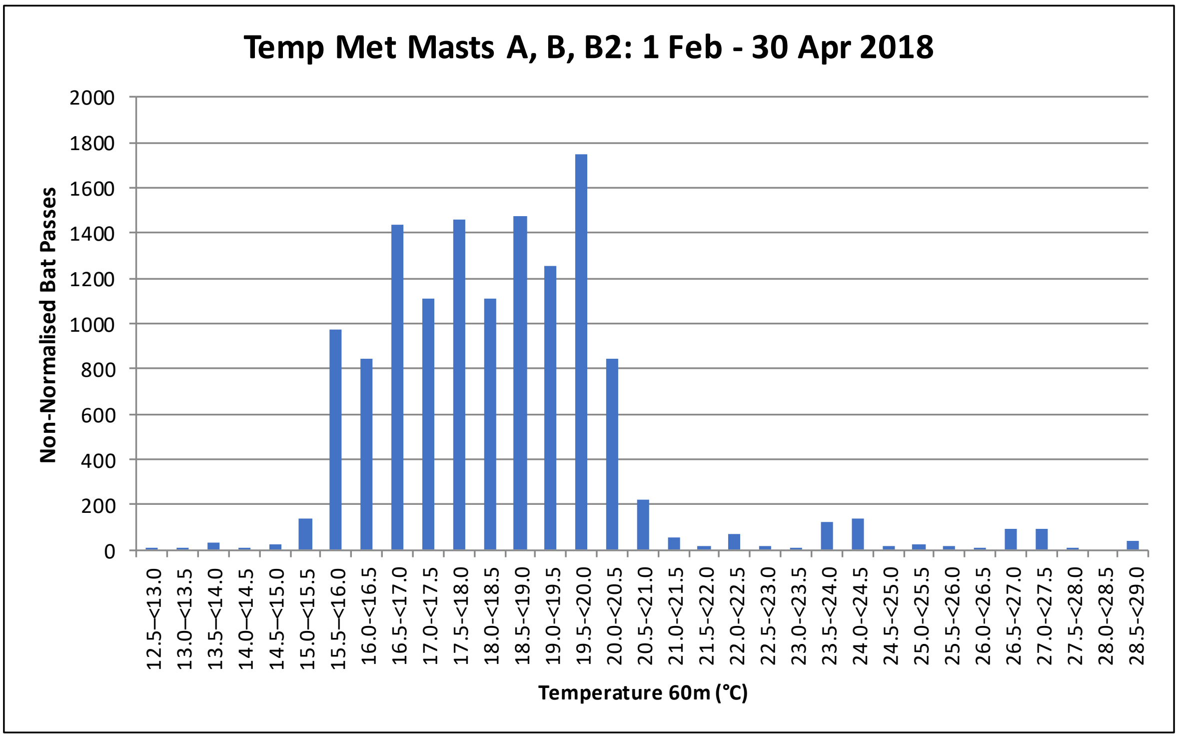

Figure 4.38: Sum of bat passes (non-normalised) per temperature category for Met A, Met B and Met B2 (1 Feb – 30 Apr 2018).

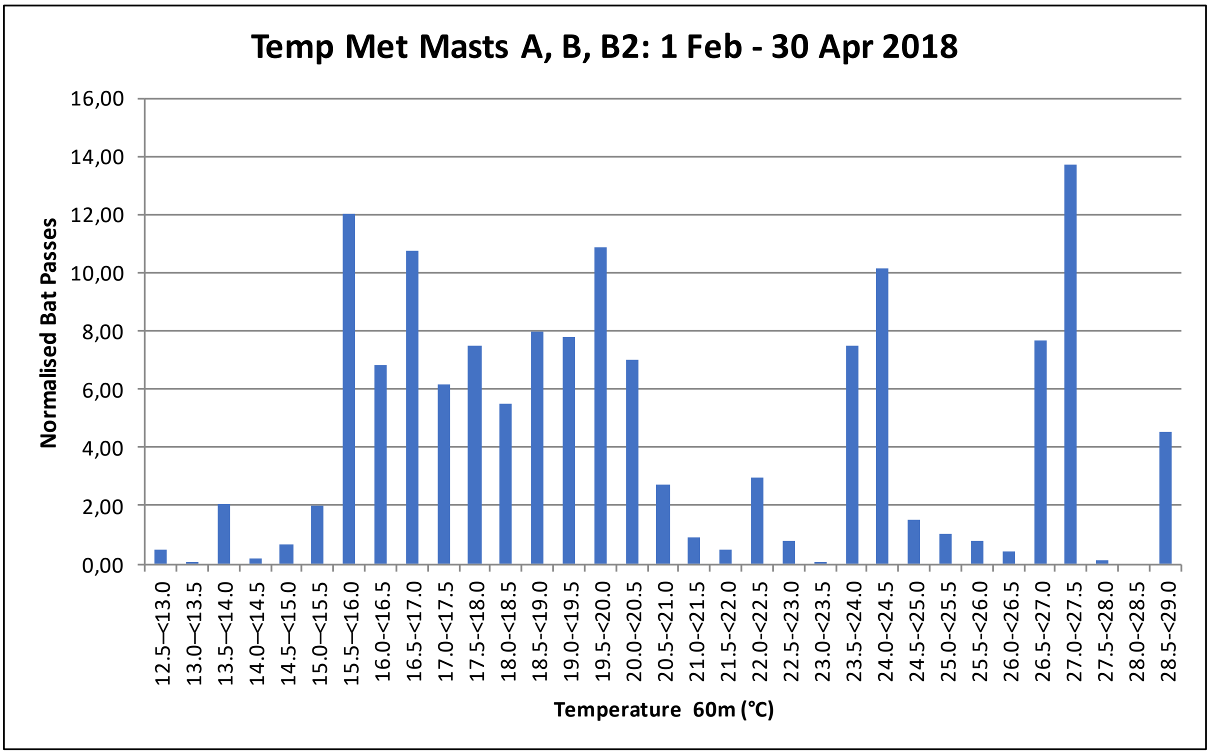

Figure 4.39: Sum of bat passes (normalised) per temperature category for Met A, Met B and Met B2 (1 Feb – 30 Apr 2018).

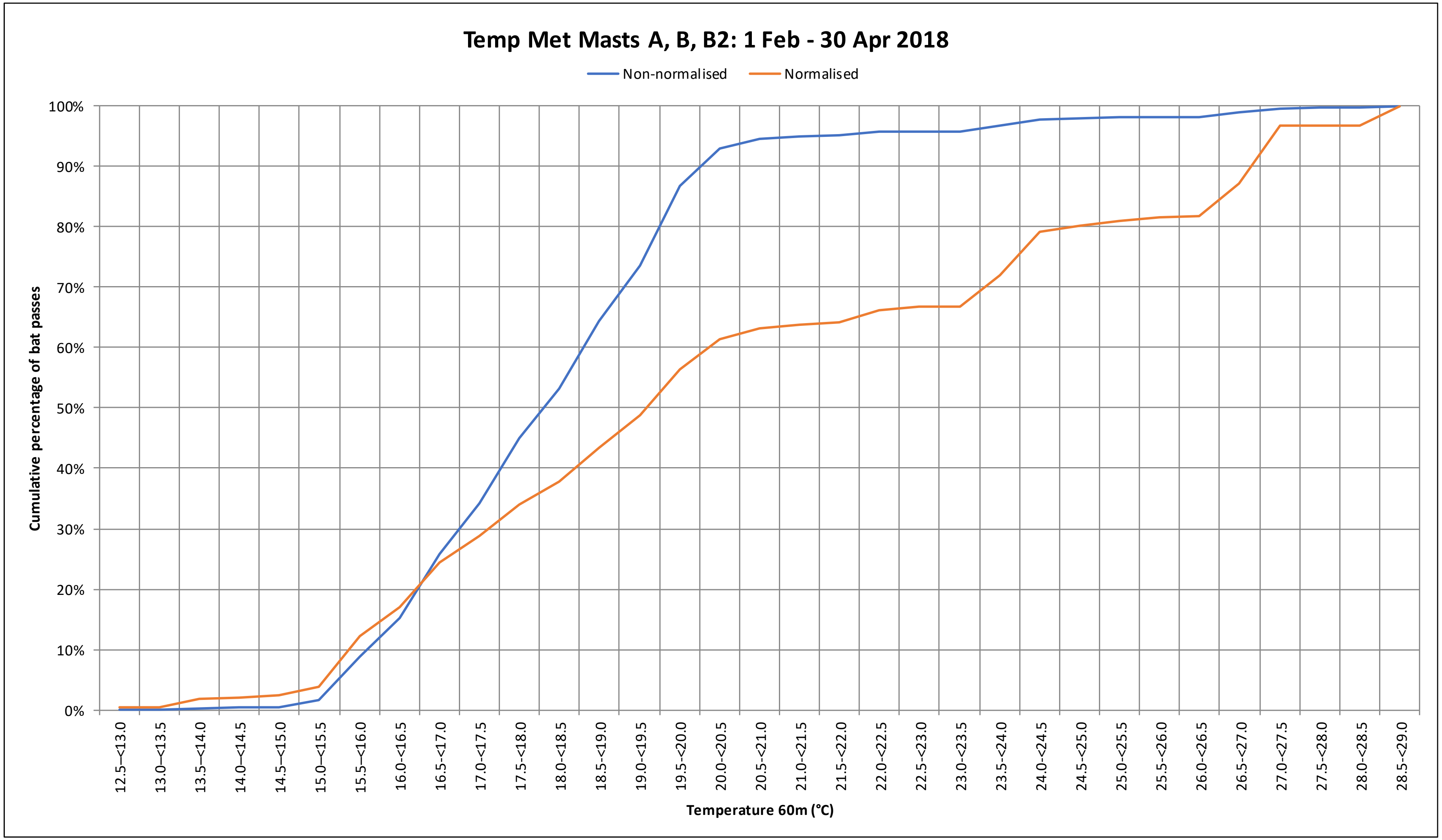

Figure 4.40: Cumulative percentage of normalised and non-normalised bat passes per temperature category for Met A, Met B and Met B2 (1 Feb – 30 Apr 2018).

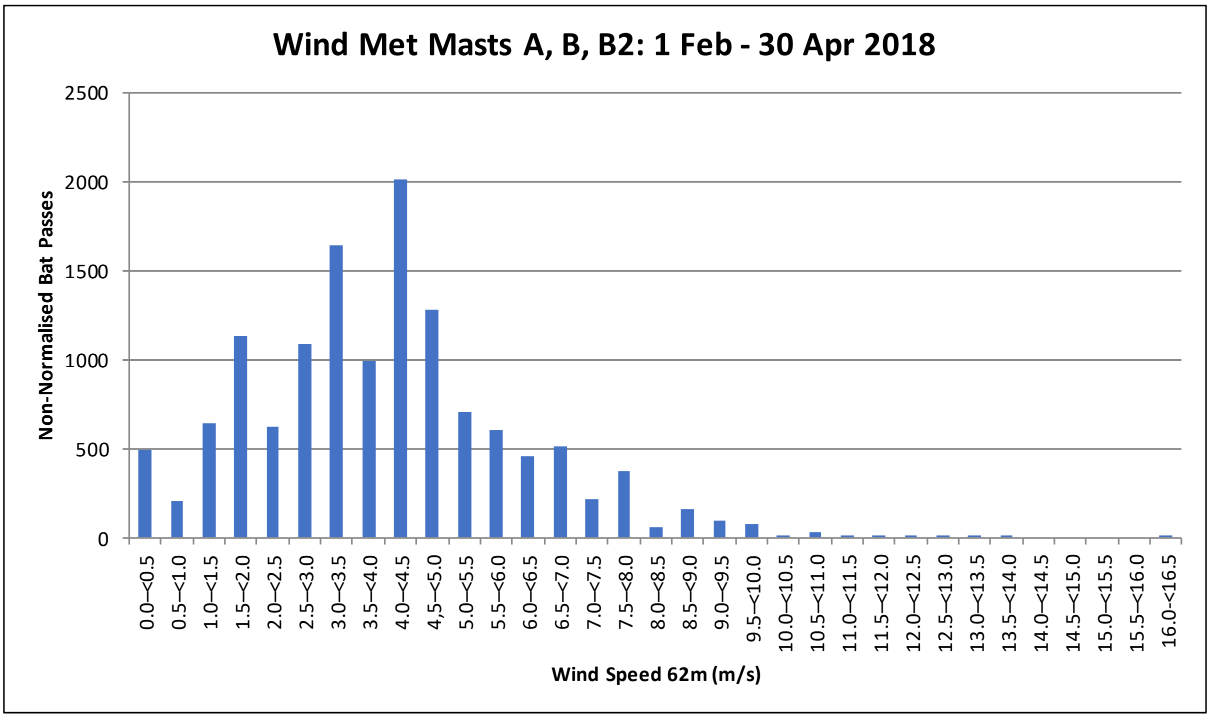

Figure 4.41: Sum of bat passes (non-normalised) per wind speed category for Met A, Met B and Met B2 (1 Feb – 30 Apr 2018).

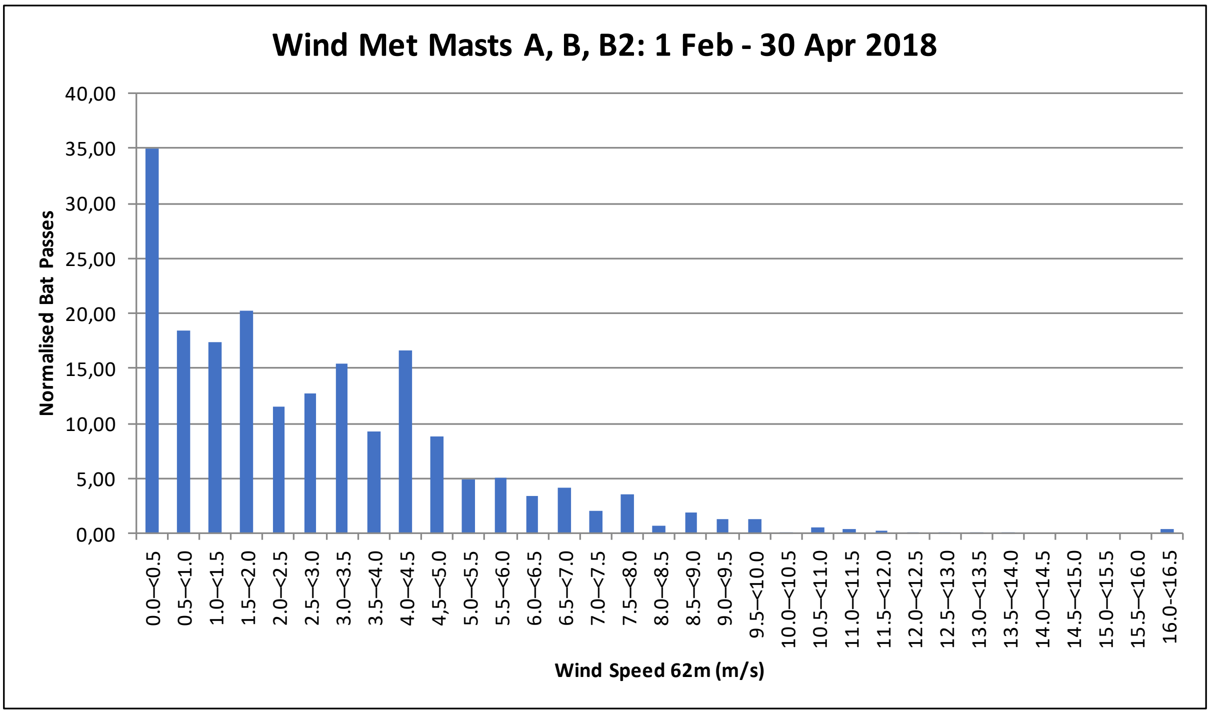

Figure 4.42: Sum of bat passes (normalised) per wind speed category for Met A, Met B and Met B2 (1 Feb – 30 Apr 2018).

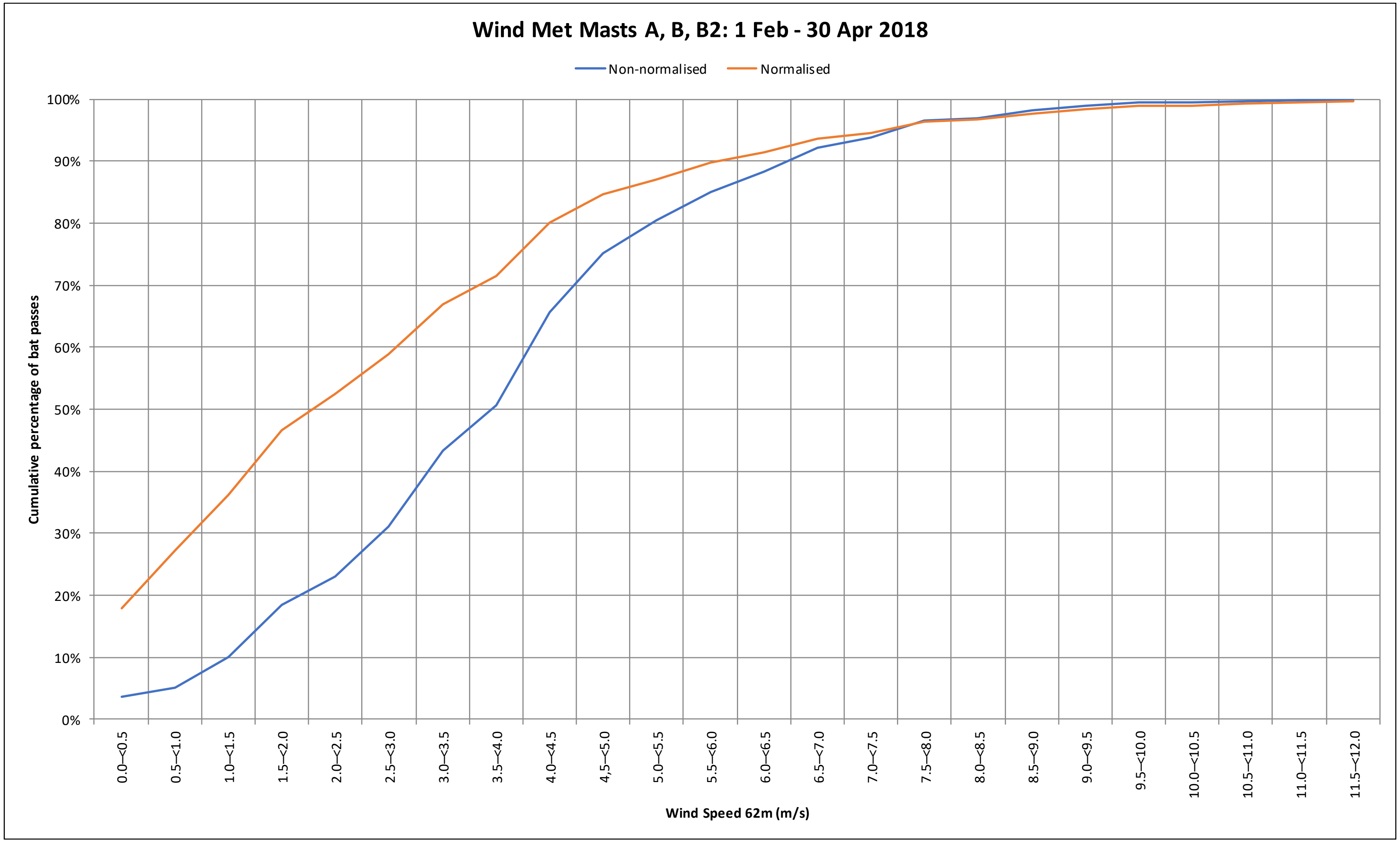

Figure 4.43: Cumulative percentage of normalised and non-normalised bat passes per wind speed category for Met A, Met B and Met B2 (1 Feb – 30 Apr 2018).

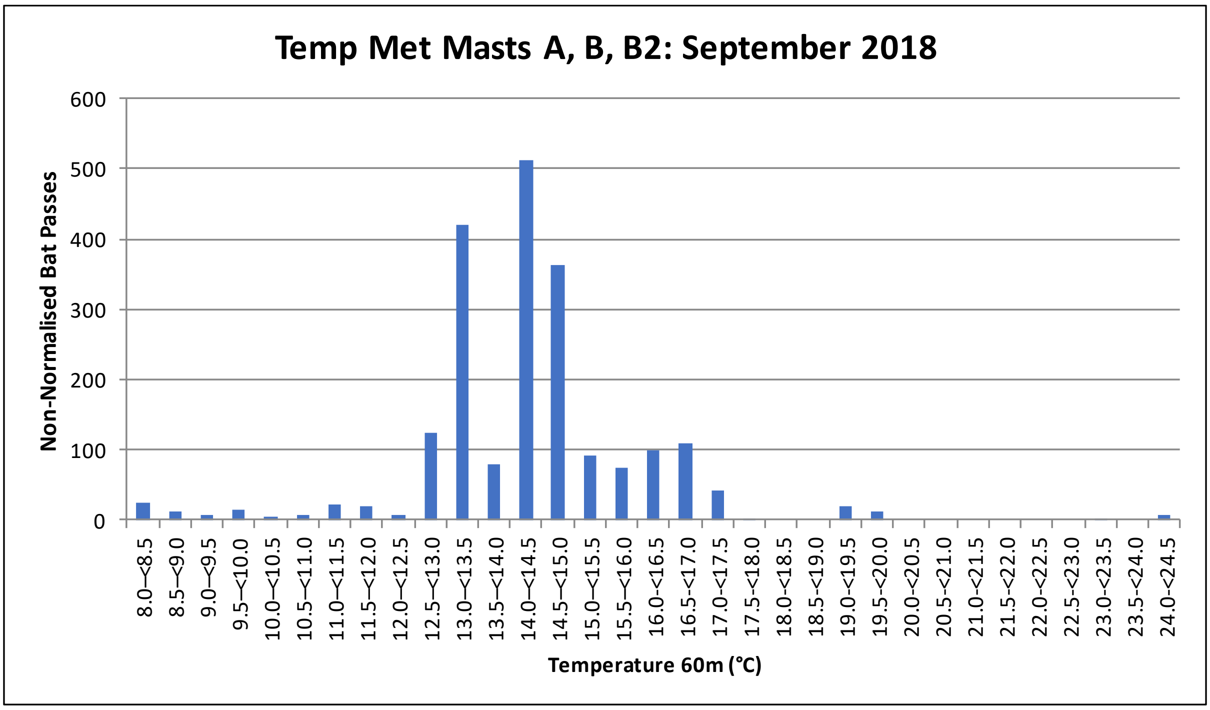

Figure 4.44: Sum of bat passes (non-normalised) per temperature category for Met A, Met B and Met B2 (September 2018).

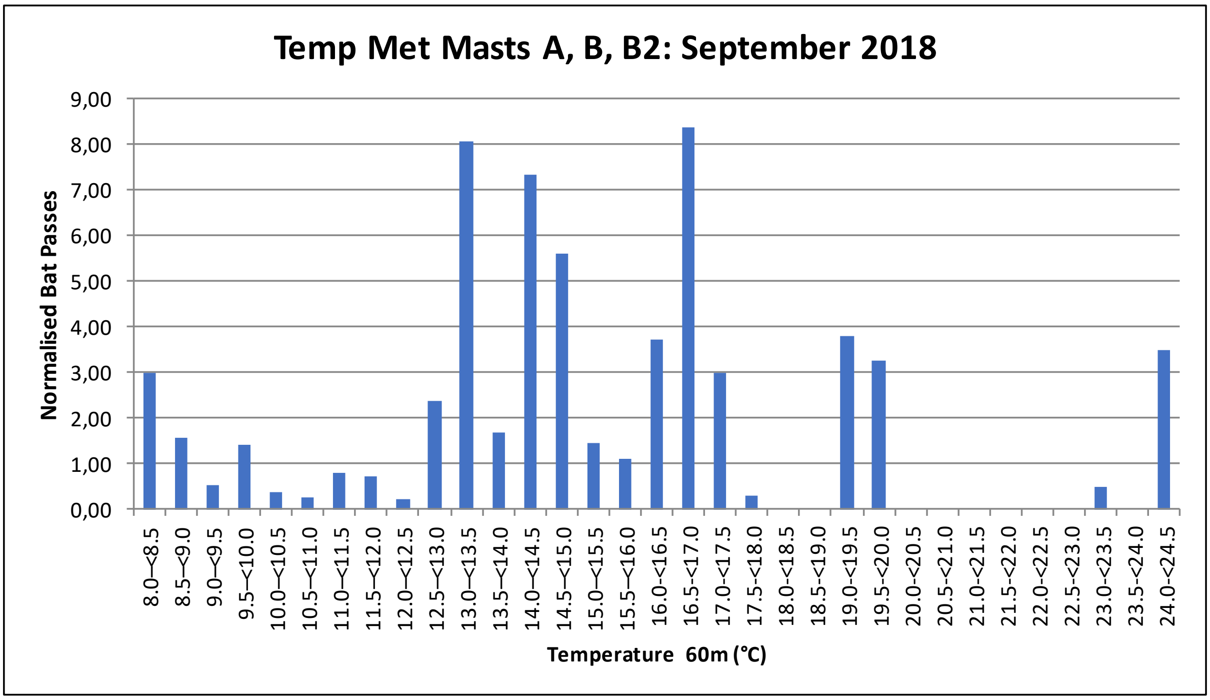

Figure 4.45: Sum of bat passes (normalised) per temperature category for Met A, Met B and Met B2 (September 2018).

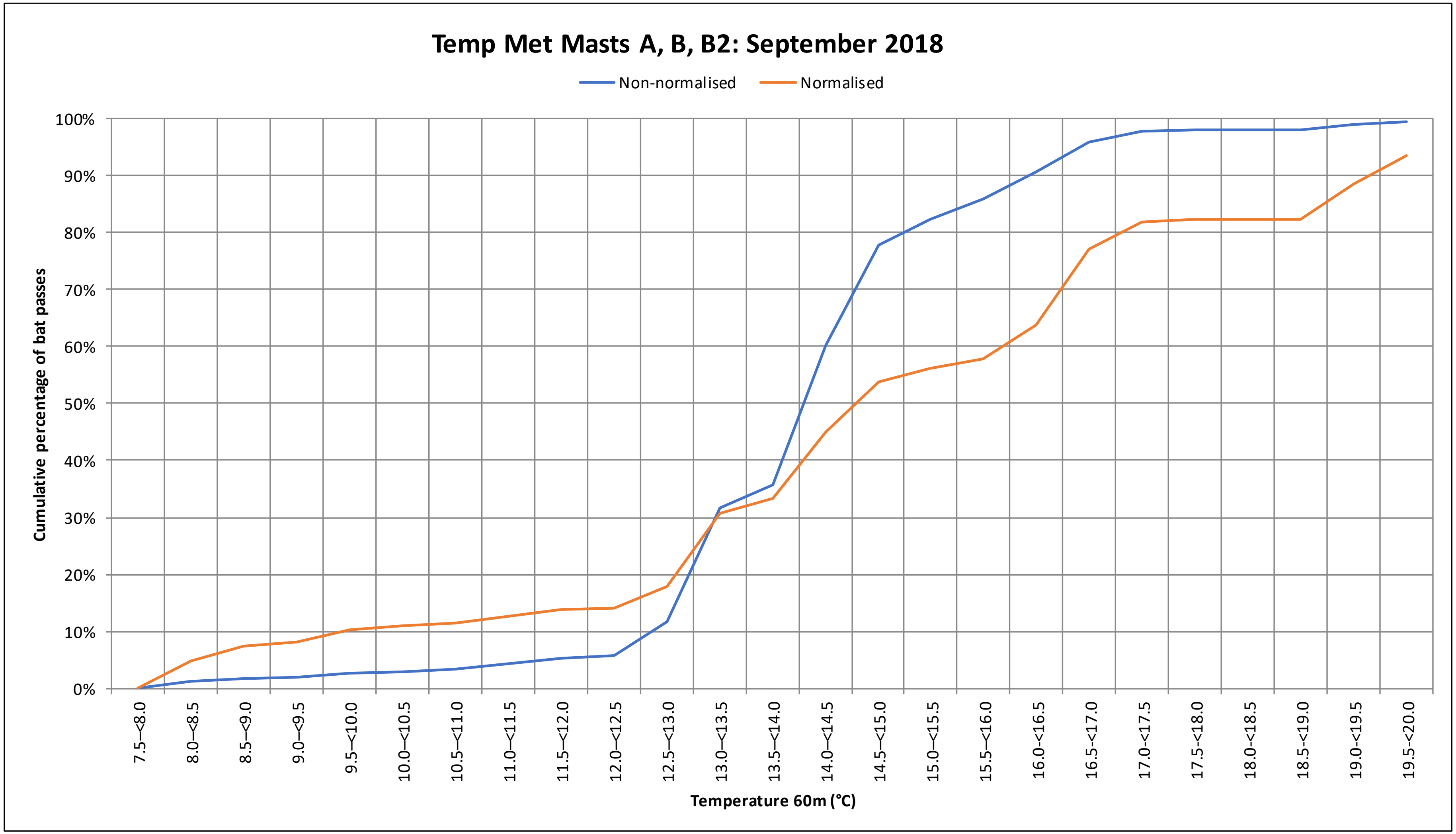

Figure 4.46: Cumulative percentage of normalised and non-normalised bat passes per temperature category for Met A, Met B and Met B2 (September 2018).

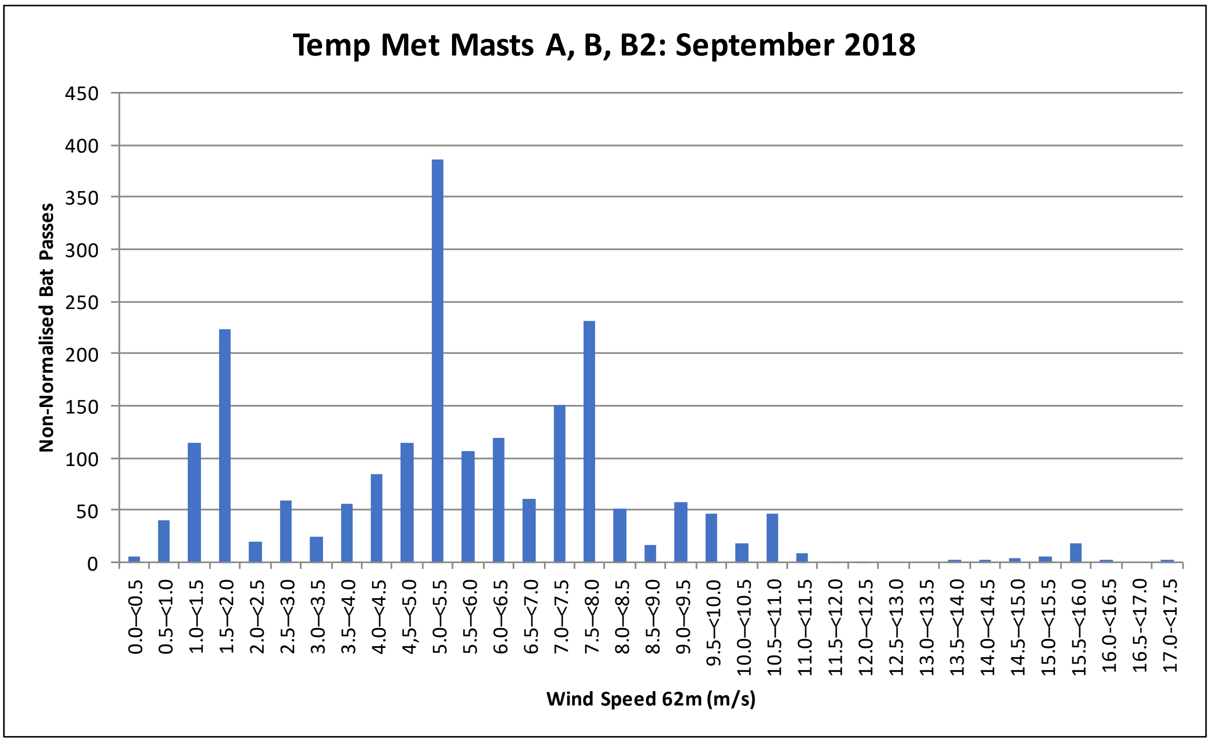

Figure 4.46: Sum of bat passes (non-normalised) per wind speed category for Met A, Met B and Met B2 (September 2018).

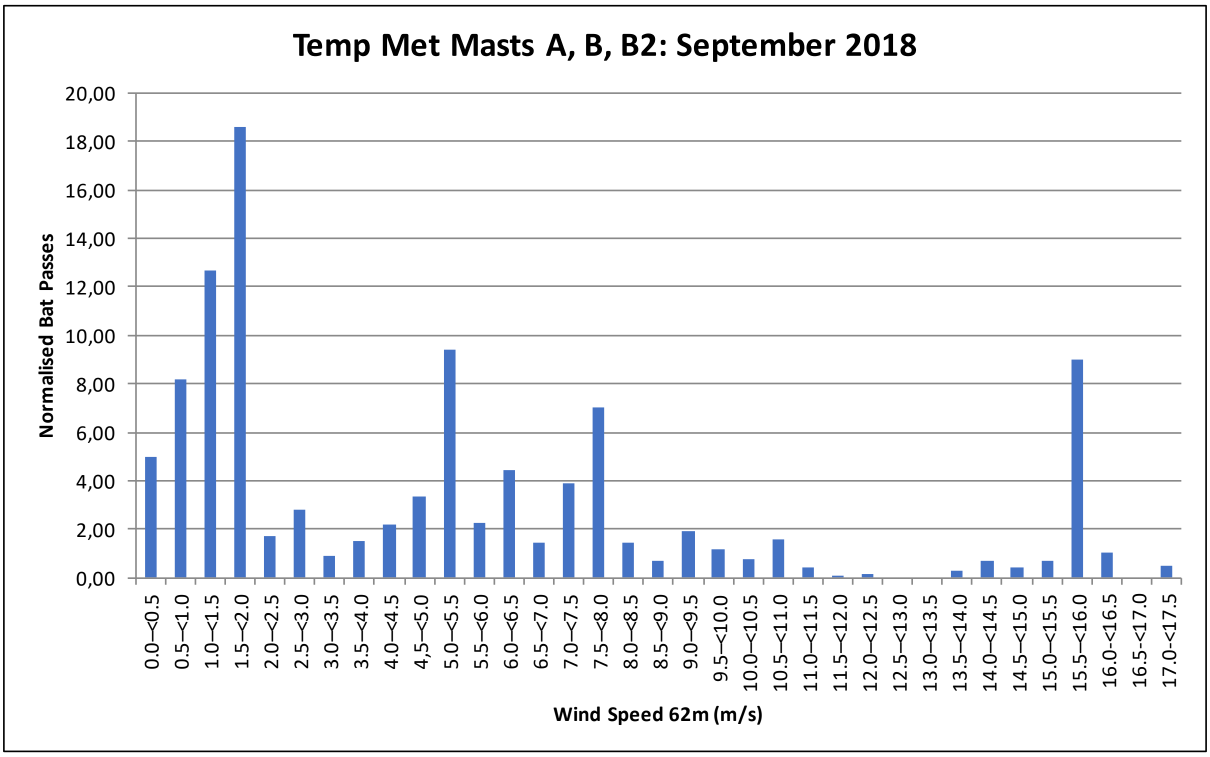

Figure 4.47: Sum of bat passes (normalised) per wind speed category for Met A, Met B and Met B2 (September 2018).

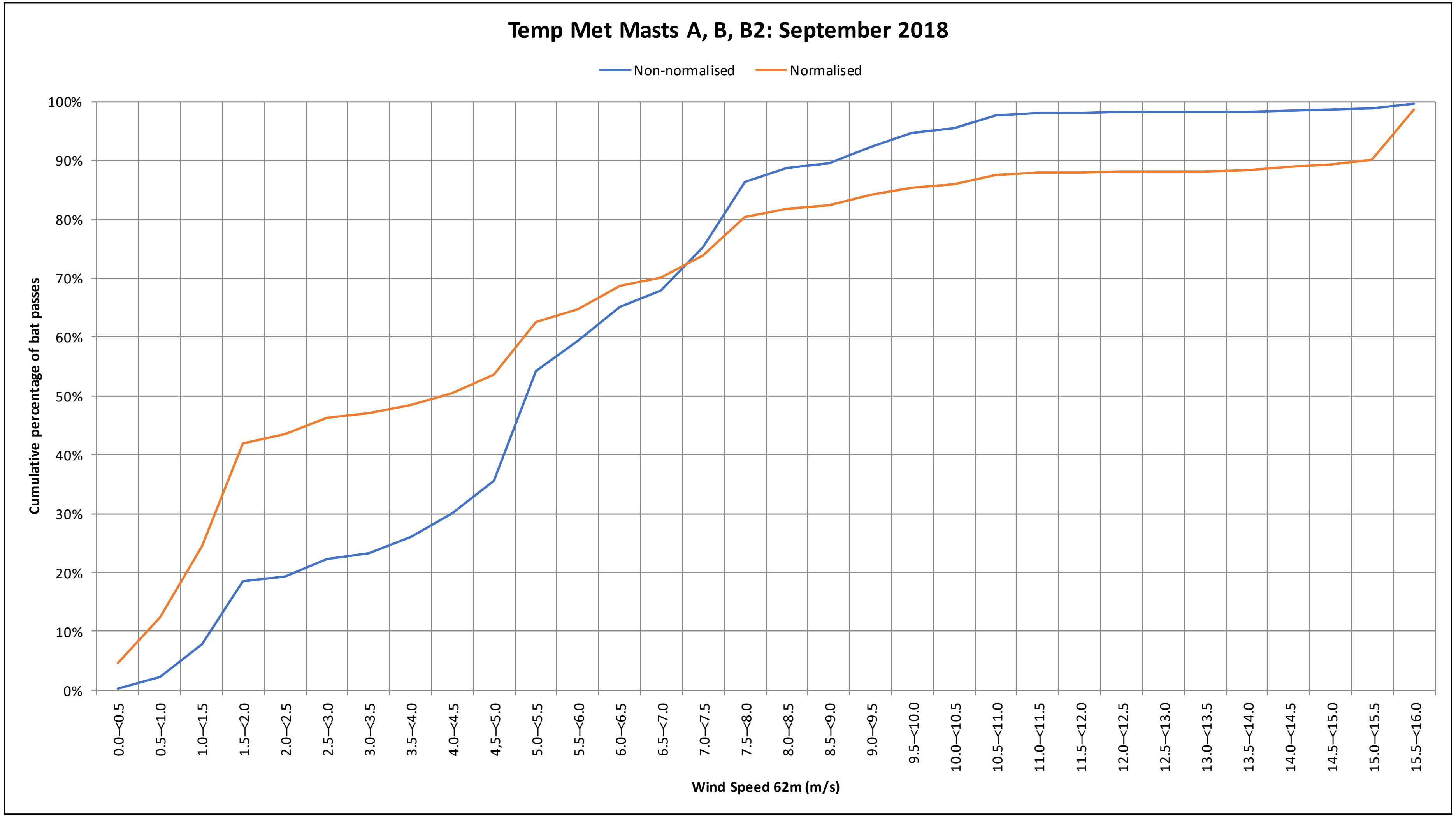

Figure 4.48: Cumulative percentage of normalised and non-normalised bat passes per wind speed category for Met A, Met B and Met B2 (September 2018).

4.7 Sensitivity Map

Figures 4.49 – 4.51 depicts the preliminary sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that most commonly occur on site. Thus, the sensitivity map is based on species ecology and habitat preferences. This map has already been used as a pre-construction mitigation in terms of improving turbine placement with regards to the avoidance of bat preferred habitats on site. The turbine layout has been further refined (January 2019) based on updates to the sensitivity map.

Table 4.8: Description of parameters used in the construction of the sensitivity map.

Last revision	November 2018
High sensitivity buffer	Impofu dam: 600m radial buffer
	Klipdrift dam: 500m radial buffer
	Tsitsikamma River: 5km radial buffer
	Klasies River cave: 10km radial buffer
	Northern valley: 450m radial buffer
	Coastal edge: 500m radial buffer
	Agricultural pivots: 200m radial buffer
	Drainage lines, other water bodies and other sensitivities: 200m radial buffer
Moderate sensitivity buffer	150m radial buffer on all Moderate sensitivities (drainage lines and vegetation)
Features used to develop the sensitivity map	Manmade structures, such as buildings, houses, barns and sheds. These structures provide easily accessible roosting sites.
	Agricultural pivots are regularly irrigated and visited by livestock, this attracts insects and therefore insectivorous bats.
	The different vegetation types and landform. Valleys and slopes can offer airspace sheltered from wind for insect prey and subsequently attract insectivorous bats. Larger woody shrubs or small trees can offer similar sheltered airspace or offer some roosting spaces.
	Open water sources, be it man-made farm dams or seasonal natural areas. They are important sources of drinking water and provide habitat that host insect prey.

Table 4.9: Description of sensitivity categories and their significance in the sensitivity map.

Sensitivity	**Description**
Moderate Sensitivity and its buffers	Areas of foraging habitat or roosting sites considered to have significant roles for bat ecology. Turbines within these areas and their buffers may acquire priority (not excluding all other turbines) during post-construction studies, and in some instances, there is a higher likelihood that mitigation measures may need to be applied to them.
High Sensitivity and its buffers	Areas that are deemed critical for resident bat populations, capable of elevated levels of bat activity and support greater bat diversity/activity than the rest of the site. These areas are 'no-go' zones and turbines, as well as turbine bkades, may not intrude into these areas and their buffers.

Table 4.10: Turbines located within bat sensitive areas and buffers. Considering the maximum rotor diameter of 150m which makes the effective range of the turbine footprint 75m from the centre of the base point.

Bat sensitive area	**Proposed turbine layout**
High bat sensitivity area	None
High bat sensitivity buffer	None
Moderate bat sensitivity area	Turbines 2, 16, 29
Moderate bat sensitivity buffer	Turbines 1, 5, 6, 17, 21, 22

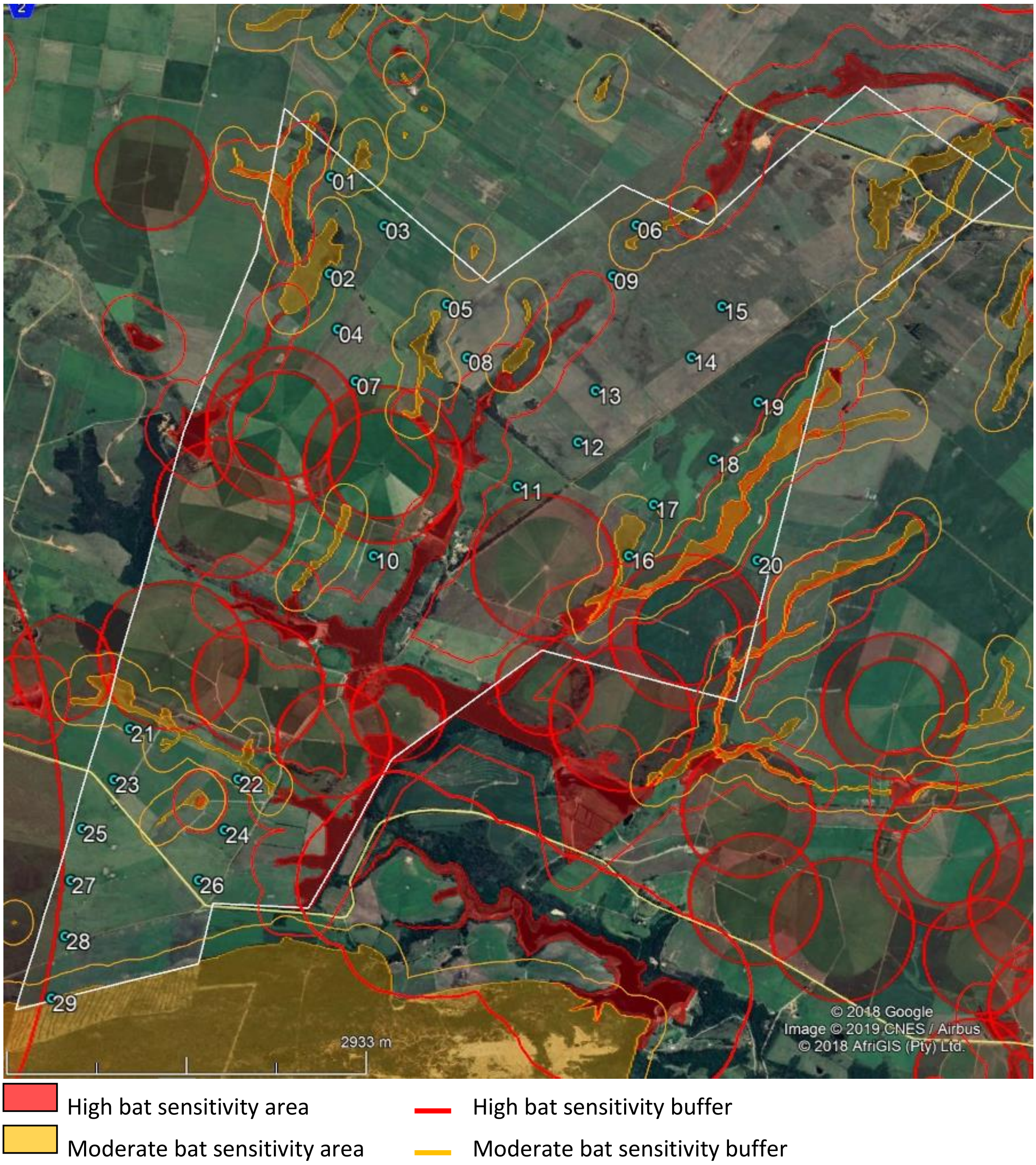

Figure 4.49: Bat sensitivity map of the proposed Impofu West wind farm site, showing moderate and high sensitivity zones and their buffers.

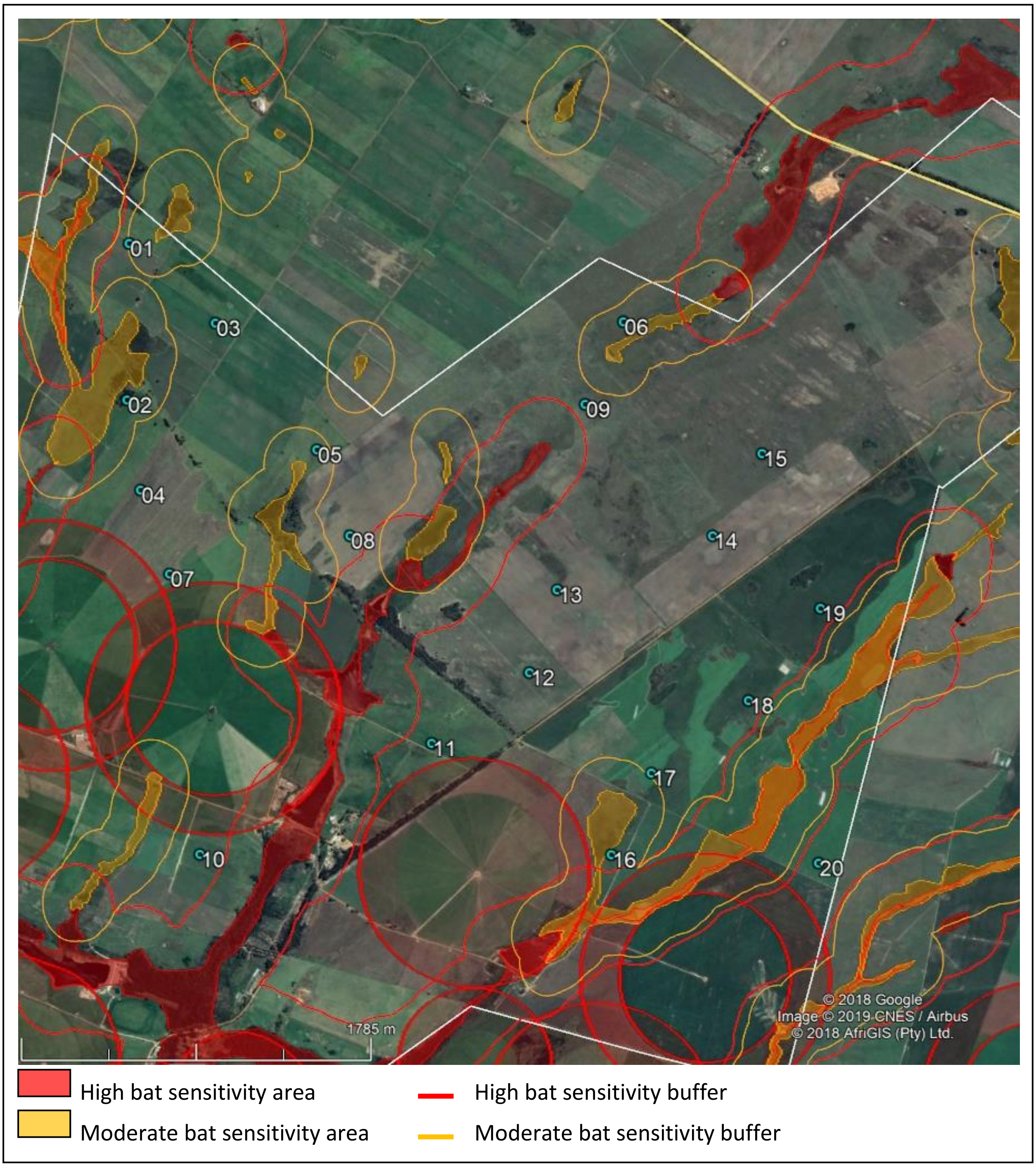

Figure 4.50: Northern section of the bat sensitivity map of the Impofu West wind farm site, showing moderate and high sensitivity zones and their buffers.

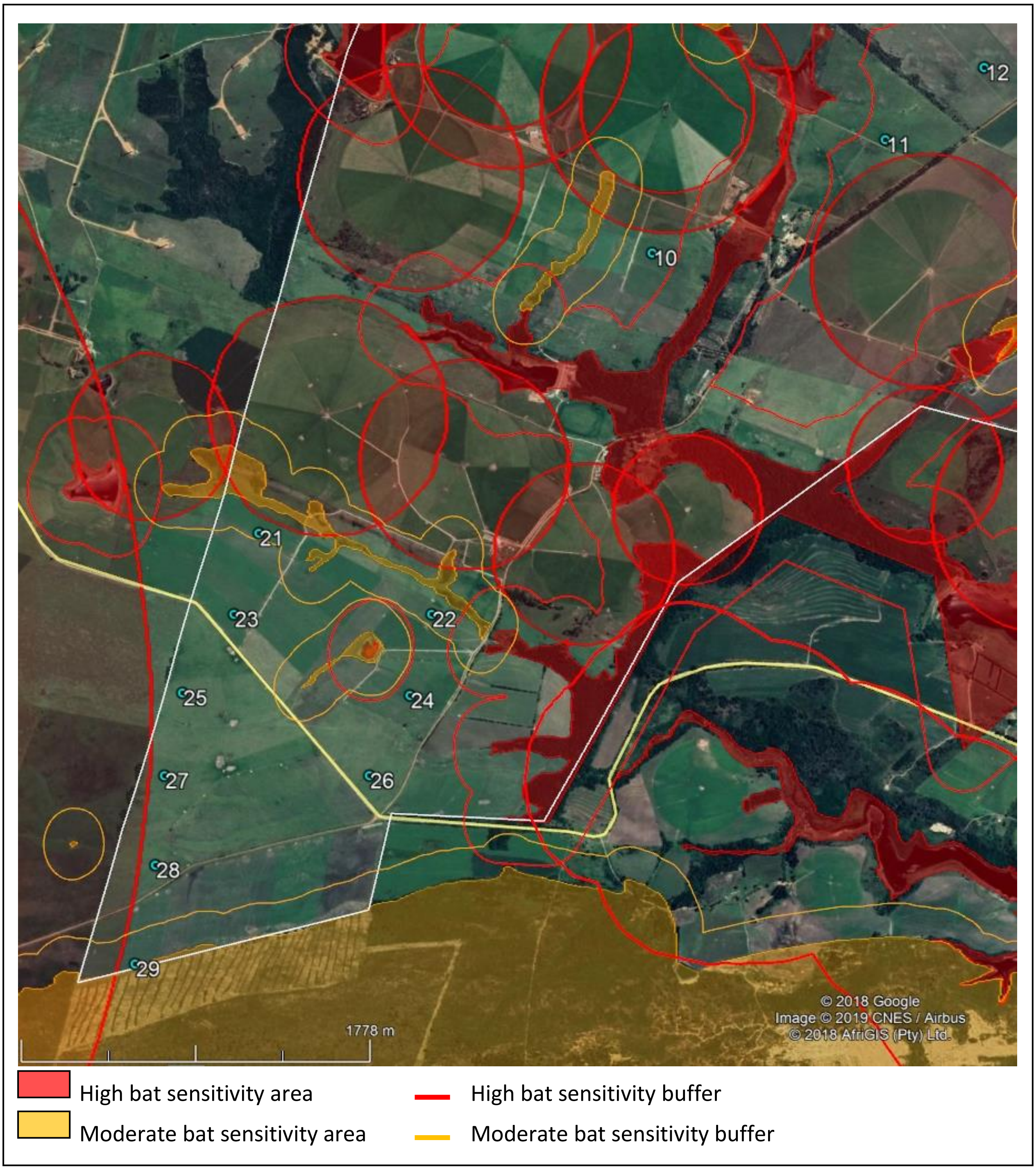

Figure 4.51: Southern section of the bat sensitivity map of the Impofu West wind farm site, showing moderate and high sensitivity zones and their buffers.

5 IMPACT ASSESSMENT EVALUATION

Tables 5.1 – 5.3 below indicates the evaluated impacts associated with the proposed Impofu West Wind Farm during the construction and operational phases. No significant impacts are identified for the decommissioning phase.

Table 5.1: Evaluation of the impact of foraging habitat loss during the construction phase.

Project phase	**Construction**			
Impact	**Destruction of foraging habitat by clearing vegetation**			
Description of impact	**During construction some very limited foraging habitat will inevitably be destroyed to clear ground for the Wind Farm. Apart from the hardstands this includes roads, substations, laydown areas, etc. However, this impact is not considered to have a significant effect on bat populations.**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**Rehabilitate cleared vegetation where possible at areas such as laydown yards.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	impact will last between 1 and 5 years	Short term	impact will last between 1 and 5 years
Extent	Very limited	Limited to specific isolated parts of the site	Very limited	Limited to specific isolated parts of the site
Intensity	Negligible	Natural and/ or social functions and/ or processes are negligibly altered	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Negligible - negative**		**Negligible - negative**	
Comment on significance	Due to the small percentage of the site being transformed for turbines and associated infrastructure construction, the impact on bat foraging habitat is deemed as negligible. The *Tadarida. aegyptiaca* species found to be occurring most on site have a very wide habitat tolerance and will utilise the open spaces on site for foraging, while the layout respects the high bat sensitivity areas which constitutes the majority of the foraging habitat for *Neoromicia capensis* and *Miniopterus natalensis.*			
Cumulative impacts	Cumulatively, more turbines will result in a larger area being transformed. However, the habitat transformations remain significantly dispersed even when several wind farms are considered. And due to the layout considering the sensitivity map, the critical bat habitat remains untransformed and provide continuous habitat with neighbouring wind farms. The significance of the impact is therefore rated as Minor (negative) without mitigation and Negligible (negative) with mitigation.			

Table 5.2: Evaluation of the impact of bat mortalities due to moving turbine blades during the operational phase.

Ref:	2			
Project phase	**Operation**			
Impact	**Bat mortalities due to moving turbine blades**			
Description of impact	**Foraging and/or migrating bats can be killed by moving turbine blades, this happens either by direct impact or due to barotrauma.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**Turbine layout adjustments (already implemented) and where needed reducing blade movement at selected turbines and high-risk bat activity times/weather conditions. Also refer to Section 6 of this report.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Local	Extending across the site and to nearby settlements
Intensity	Very high	Natural and/ or social functions and/ or processes are majorly altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Likely	The impact may occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Moderate - negative**		**Minor - Negative**	
Comment on significance	The Impofu West Wind Farm area indicates relatively high bat activity levels. Especially of *Tadarida aegyptiaca* which dominated at 97m and utilises higher airspaces and have the capability of foraging in higher wind speeds than *Neoromicia capensis.* Last mentioned which had the highest occurrence on site at 10m during the passive data period. *N. capensis* is a clutter edge forager meaning that turbines closer to high sensitivities have a higher probability of impacting this species. As the layout is well designed and avoids bat sensitivity this should result in it significantly reducing the probability and impacts on bat populations as well as the significance of the impact. However, *T. aegyptiaca* is an open-air forager and therefore a probability still exists of it being impacted on even with a well-designed layout, therefore operational monitoring is essential in identifying the level of impacts and whether additional mitigation measures (additional to layout adjustments), should be used as necessary.			
Cumulative impacts	It is logical to deduce that additional turbines in an area will increase the cumulative bat mortalities for that area, but it should also be noted that cumulative wind farms occupy a larger area space which also means the applicable bat populations will be larger. Therefore, the model of considering the cumulative total area of turbine influence and an acceptable sustainability threshold of fatalities per year is used. The layout of the proposed Impofu West Wind Farm is not particularly compact, increasing the area of turbine influence considerably during the cumulative assessment and thereby allowing more unmodified foraging space for			

	bats. No migration routes have been identified in the preconstruction and operational studies in the area, additionally the species composition is dominated by resident non-migrating bats. *T. aegyptiaca* has a wider foraging range and may therefore be more prone to cumulative impacts than *N. capensis.* The significance of the impact is rated as High Moderate (negative) without mitigation and Low Moderate (negative) with mitigation.

Table 5.3: Evaluation of the impact of increased likelihood of bat mortalities due to bat attractions by security and/or operational light sources.

Ref:	3			
Project phase	**Operation**			
Impact	**Increased bat mortalities due to light attraction**			
Description of impact	**Security and/or operational lights used close to or on turbines will attract high insect numbers and thereby attract additional insectivorous bat activity. This will highly increase the likelihood of impacts by turbine blades. This is not applicable to red aviation lights.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**Only use lights with low sensitivity motion sensors that switch off automatically when no persons are nearby, to prevent the creation of regular insect gathering pools. Ensure all lights are down hooded.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Local	Extending across the site and to nearby settlements
Intensity	Very high	Natural and/ or social functions and/ or processes are majorly altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Moderate - negative**		**Negligible - negative**	
Comment on significance	If not mitigated, all species found to be dominant on site will be significantly impacted on since they will all be attracted to the increased insect numbers at outside lights, as opposed to cave dwelling bat species which may be repelled by light sources. Cave dwelling bat species did not dominate occurrence on site. This impact can have detrimental effects if not mitigated, but fortunately it is extremely simple and cost effective to mitigate.			

Cumulative impacts	Increasing the likelihood and therefore annual bat fatalities of a wind farm will naturally increase the cumulative effect in a larger area, especially if several wind farms are causing this same impact. However, simple and cost- effective mitigations will lower this impact cumulatively. The significance of the impact is rated as Moderate (negative) without mitigation and Minor (negative) with mitigation.

No-go alternative

The ‘no-go’ alternative will naturally have no positive or negative effects on bat populations, as the environment will remain unchanged. Therefore, no impact assessment criteria can be assessed for this alternative as it remains neutral.

6 PROPOSED MITIGATION MEASURES

The correct placement of wind farms and of individual turbines can significantly lessen the impacts on bat fauna in an area and have already been applied as the preferred and initial layer for mitigation, since the applicant significantly adjusted the turbine layout to accommodate the intensified bat sensitivity map. The no go areas and buffers used have become larger and more numerous since the earlier studies done on operational wind farms in this area, thus the Impofu wind farms have in general been better mitigated through avoidance compared to the older facilities in the area.

Additional to mitigation by location of turbines to avoid known highly sensitive areas, other options that may be utilised when necessary include curtailment, blade feathering, blade lock or acoustic deterrents. 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, with the aim to raise the cut-in speed without free-wheeling.

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 Revolutions per Minute (RPMs) below cut-in speed when no electricity is being produced.

Feathering or Feathered:

Feathering refers to 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.

Acoustic deterrents:

This is a developing technology that is being experimented with on a nearby wind farm and thus far yielded positive results that may indicate potential effectiveness of the devices. However, data on the trials are currently available for only 4.5 months, which is a small sample set and many other factors may influence effectiveness of the devices. It is encouraged for the applicant to run experimental trials to test such similar devices during the operation of this facility.

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 doesn'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. Currently the most effective method of mitigation, after correct turbine placement, is alteration of blade speeds under environmental conditions favourable to bats.

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

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

It is recommended that curtailment be applied initially to all turbines at the start of operation at **Level 3** of the mitigation scale as long as this is technically feasible with the turbines that are used for this wind farm. The impacts of the facility on bats will be monitored during the operational phase monitoring, and if necessary additional mitigation (**Table 6.1**) may need to be applied to any turbines or group of turbines identified as causing mortalities that are above the sustainable threshold levels. The levels and specifics of mitigation may need to be adjusted according to the results of the operational monitoring, based on robust scientific data. This is an adaptive management approach, and it is crucial that any changes suggested by the appointed Bat Specialist to the initial proposed mitigation schedule, be implemented as soon as practically possible.

In order to guide and preliminarily inform future operational monitoring and adaptive management/mitigation measures, **Table 6.1** below highlights the recommended dates, times and climatic conditions in which mitigation measures may need to be applied. This is useful when high mortalities are detected, and insufficient bat activity data is gathered during the operational monitoring (e.g. at the start of the operational monitoring study). However, it's preferable that bat activity gathered at actual problematic turbines during the operational phase be used to inform a mitigation schedule, when needed.

The table below infers that mitigation be applied when the advised wind speed and temperature ranges are prevailing simultaneously (considering conditions in which 80% of bat activity at 97m occurred, normalised data). Wind speed measured at a height of 62m and temperature measured at a height of 60m were used for the analysis.

Table 6.1: Preliminary mitigation schedule to be implemented during above threshold mortalities.

Preliminary mitigation schedule	
Peak activity (times to implement curtailment/ mitigation)	1 February – 30 April from the time of sunset to 23:00
Environmental conditions in which to implement curtailment/ mitigation	Wind speed below 4m/s *and* Temperature above 17°C
Peak activity (times to implement curtailment/ mitigation)	1 – 30 September from the time of sunset – 02:00
Environmental conditions in which to implement curtailment/ mitigation	Wind speed below 7.5m/s *and* Temperature above 13°C

7 CUMULATIVE IMPACTS FROM NEARBY WIND FARMS

Other operating wind farms or proposed wind farms with valid environmental authorisations within an ‘ecologically applicable area’ (black polygon) around the site are depicted in **Figure 7.1** below. The Ubuntu, Banna ba Phifu and Oyster Bay facilitities have received environmental authorisation but are not constructed yet. All facilities indicated in **Figure 7.1** fall within the Lowland Fynbos and Renosterveld ecoregion. Since watercourses and riparian habitats have been treated as bat sensitivities in the Impofu as well as surrounding wind farms, they allow for continous natural bat foraging habitat and movement corridors through the facilities. The ecologically important area was determined by topography, land use and to some degree the extent of the Lowland Fynbos and Renosterveld ecoregion. This ecologically applicable area was only used to decide which nearby wind farms should form part of the cumulative assessment, this area as a whole is not the area of influence, therefore no thresholds are calculated for this area.

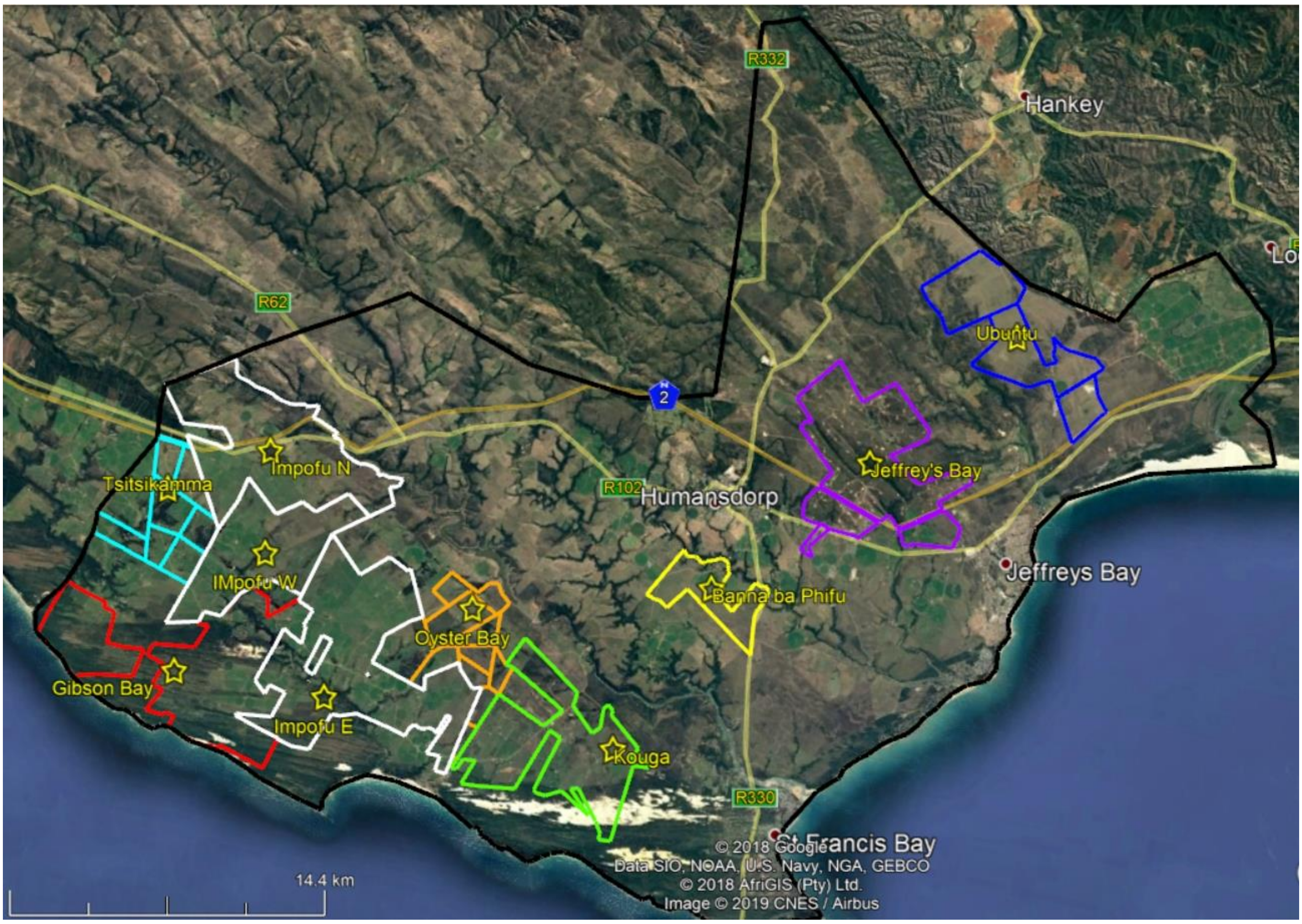

Figure 7.1: Neighbouring and nearby existing and proposed wind farms in relation to the proposed three Impofu wind farm sites (white boundary). The black polygon is an ‘ecologically applicable area’ to aid in deciding which wind farms form part of the cumulative assessment.

Table 7.1 below indicates the current bat impact status of the nearby operational facilities, compared to the acceptable sustainable mortality thresholds as determined according to the calculations explained in the SABAAP Bat Threshold Document (MacEwan, *et al.*, October 2018). The sustainable acceptable mortality thresholds are determined in the Guidelines per ecoregion as an additional 2% per 10ha per year loss of bats due to anthropogenic pressure, which is for the Lowland Fynbos and Renosterveld ecoregion calculated as 0.45 bats/10ha/annum.

The acceptable mortality of a wind farm is then simply calculated by considering the hectare size of the wind farm (area of turbine influence) and the value of 2% of bats/10ha/year for the ecoregion, to give an annual number of sustainable bat mortalities that is acceptable for that wind farm. The recorded and estimated fatalities per year is from the bat species or family that dominated the carcass records. This is in line with the SABAAP Bat Threshold Document (MacEwan, *et al.*, October 2018). Estimator fatality results extracted from the specialist reports are used to compare to acceptable sustainability thresholds. Estimator fatalities are adjusted numbers of the recorded fatalities, by considering field bias factors such as scavenger removal of carcasses, effeciency of the carcass searchers and time interval for rotating searches between all turbines on site.

For Wind Farms 1 – 3 the Erickson & Johnson' s Equation was used to calculate the estimator bat fatalities (Warren-Hicks et al., 2013). The estimator results were retrieved from the relevant specialist reports where calculations were done by the specialists. Note that all studies did not use similar bat fatality estimators, and the area of a wind farm was considered as the area of turbine influence. **Table 7.1** is intended to merely serve as a comparative indication for this cumulative assessment, and should not be used to determine which wind farms must apply mitigation. For that the applicable specialist report and detailed results of an operational monitoring study must be consulted for decision making purposes. It is important to note that the wind farms that have high estimator fatalities in the table below have recently implemented varied mitigation strategies and thus it is likely that the bat fatalities at these two wind farms will be reduced and this table thus represents a worst case senario without mitigation.

Table 7.1: Current status of impact at operational nearby wind farms.

Wind Farm	Duration of data set	Recorded fatalities/ year	Estimator fatalities/ year	Acceptable annual mortality of bats (based on 2% calculation)	Status
Wind farm 1 **(2715 ha)**	3 Years	35	198	0.45 x (2715/10) = 0.45 x 271.5 = **122 bats**	**Above threshold**
Wind farm 2 **(2640 ha)**	2 Years	34	78	0.45 x (2640/10) = 0.45 x 264.0 = **118 bats**	Below threshold
Wind farm 3 **(851 ha)**	24 Months	17	34	0.45 x (851/10) = 0.45 x 85.1 = **38 bats**	Below threshold
Wind farm 4 **(2146 ha)**	12 Months	72	244	0.45 x (2146/10) = 0.45 x 214.6 = **97 bats**	**Above threshold**

Table 7.2: The sustainable acceptable mortality thresholds of the proposed Impofu wind farms.

	Area of influence of wind turbines (hectares) Refer to Figure 7.2	Acceptable annual mortality of bats (based on 2% calculation)
Impofu East	3 633	0.45 x (3633/10) = 0.45 x 363.3 = **164 bats**
Impofu West	2 156	0.45 x (2156/10) = 0.45 x 215.6 = **97 bats**
Impofu North	2 224	0.45 x (2224/10) = 0.45 x 222.4 = **100 bats**

The sustainable acceptable mortality thresholds for the proposed Impofu wind farms are indicated in **Table 7.2**. The area of the wind farm was considered to be the area of influence (**Figure 7.2**), which is dictated by the turbine layout as per the Threshold Guidelines.

Figures 7.3 – 7.5 below indicates the areas considered during each cumulative impact scenario as described in **Table 7.3**, they are tight fitting polygons that surround the applicable wind farms of a specific cumulative scenario. As suggested in the SABAAP Bat Threshold Document (MacEwan, *et al.*, October 2018). This approach was chosen because it considers how close facilties are to each other by taking into account the area space in between wind farms where bat populations are not impacted on.

Table 7.3: Cumulative impact scenarios involving the Impofu West Wind Farm site and other nearby wind farms.

Cumulative scenario	Area (hectares) of cumulative scenario polygon	Acceptable annual mortality of bats (based on 2% calculation)

Impofu West Scenario (Existing Wind Farms 1 to 4 + Impofu West)	35 959	0.45 x (35959/10) = 0.45 x 3595.9 = **1618 bats**
Cumulative Scenario 1 (Existing Wind Farms 1 to 4 + Impofu East, West and North)	44 181	0.45 x (44181/10) = 0.45 x 4418.1 = **1988 bats**
Cumulative Scenario 2 (Existing Wind Farms 1 to 4 + Impofu East, West and North + Ubuntu, Banna ba Pifhu and Oyster bay)	54 635	0.45 x (54635/10) = 0.45 x 5463.5 = **2459 bats**

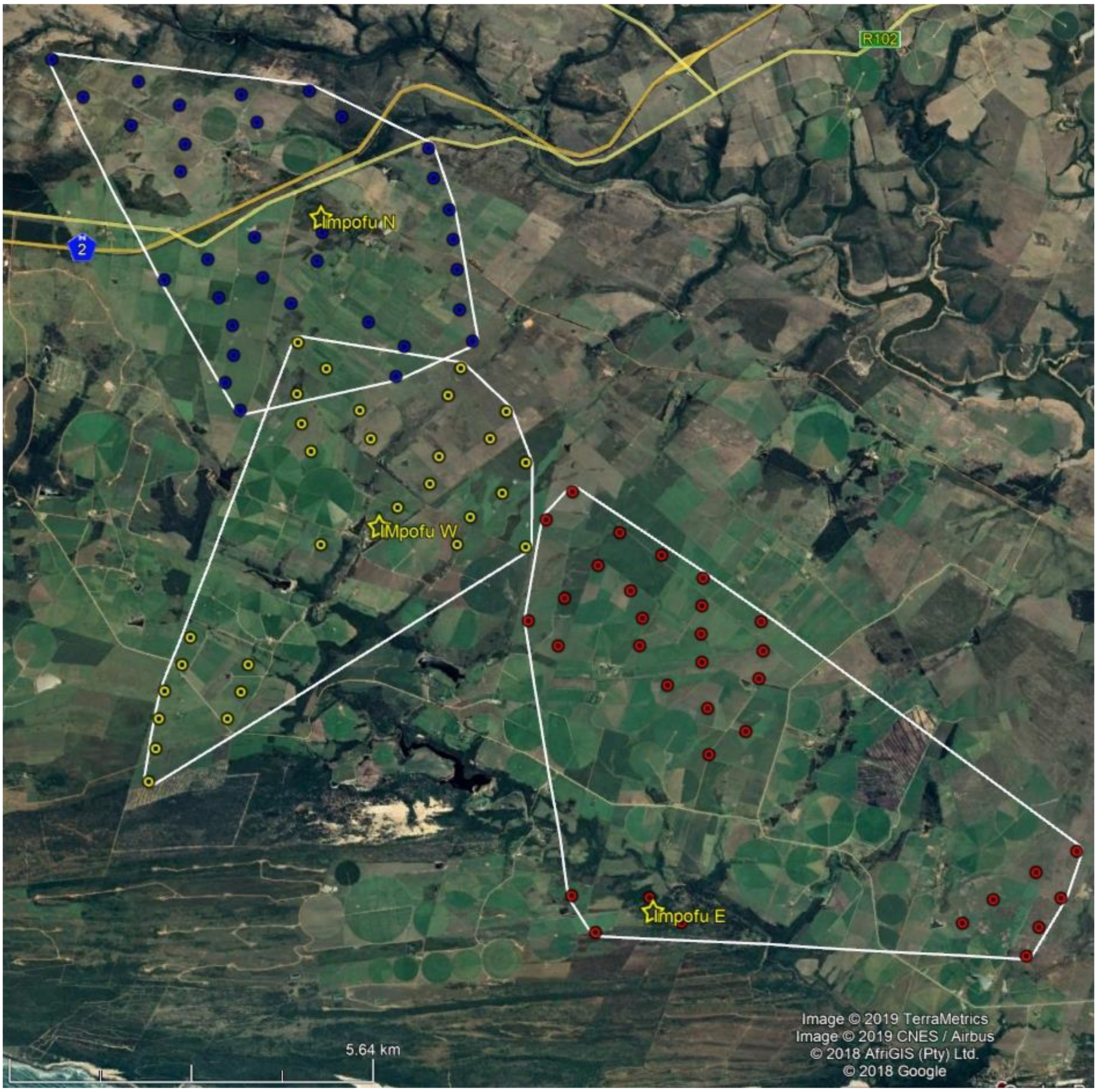

Figure 7.2: The area of influence used for each proposed Impofu wind farm to calculate the sustainable mortality thresholds in **Table 7.2**.

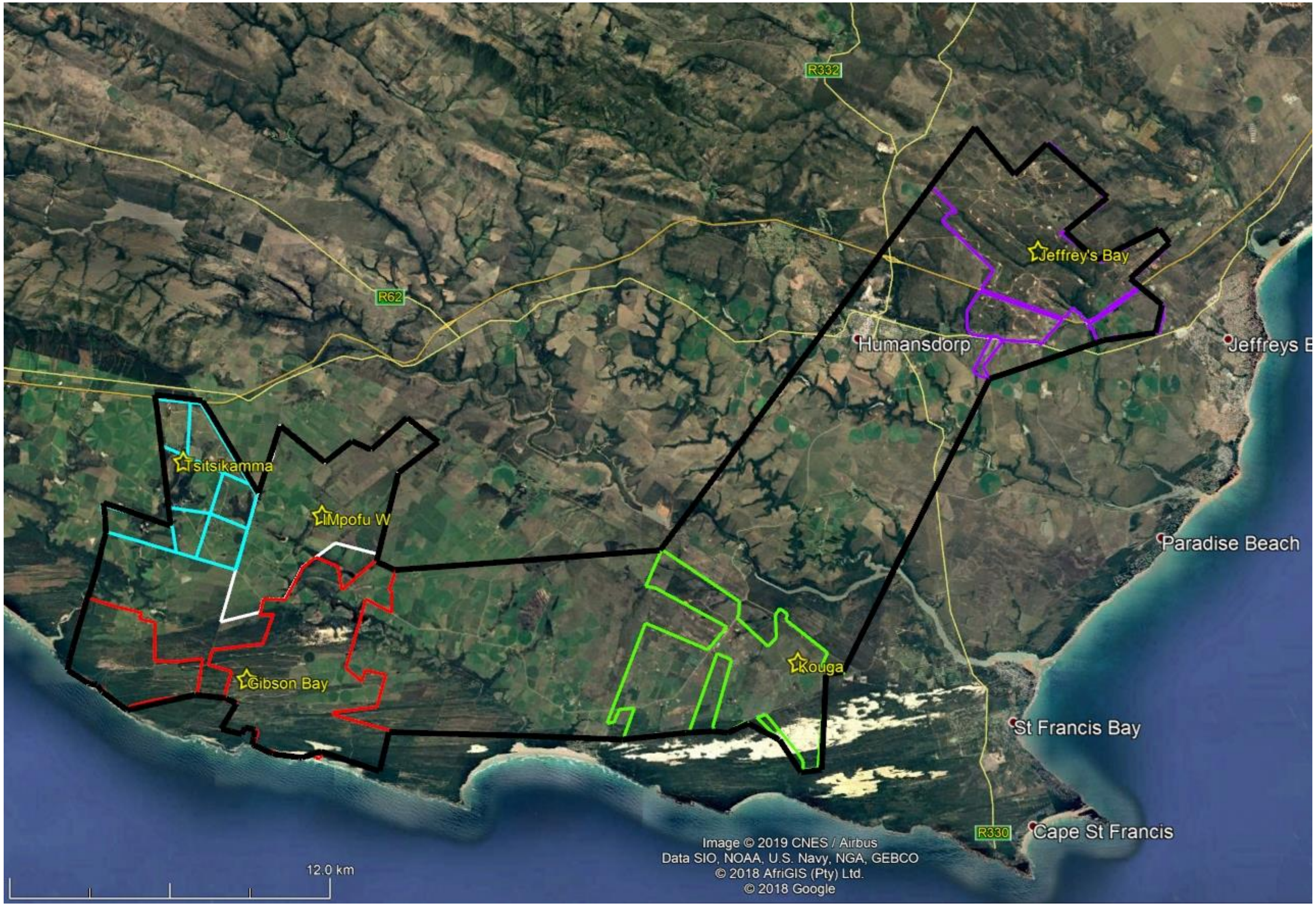

Figure 7.3: Area (black polygon) considered during the Impofu West cumulative scenario described in **Table 7.3**.

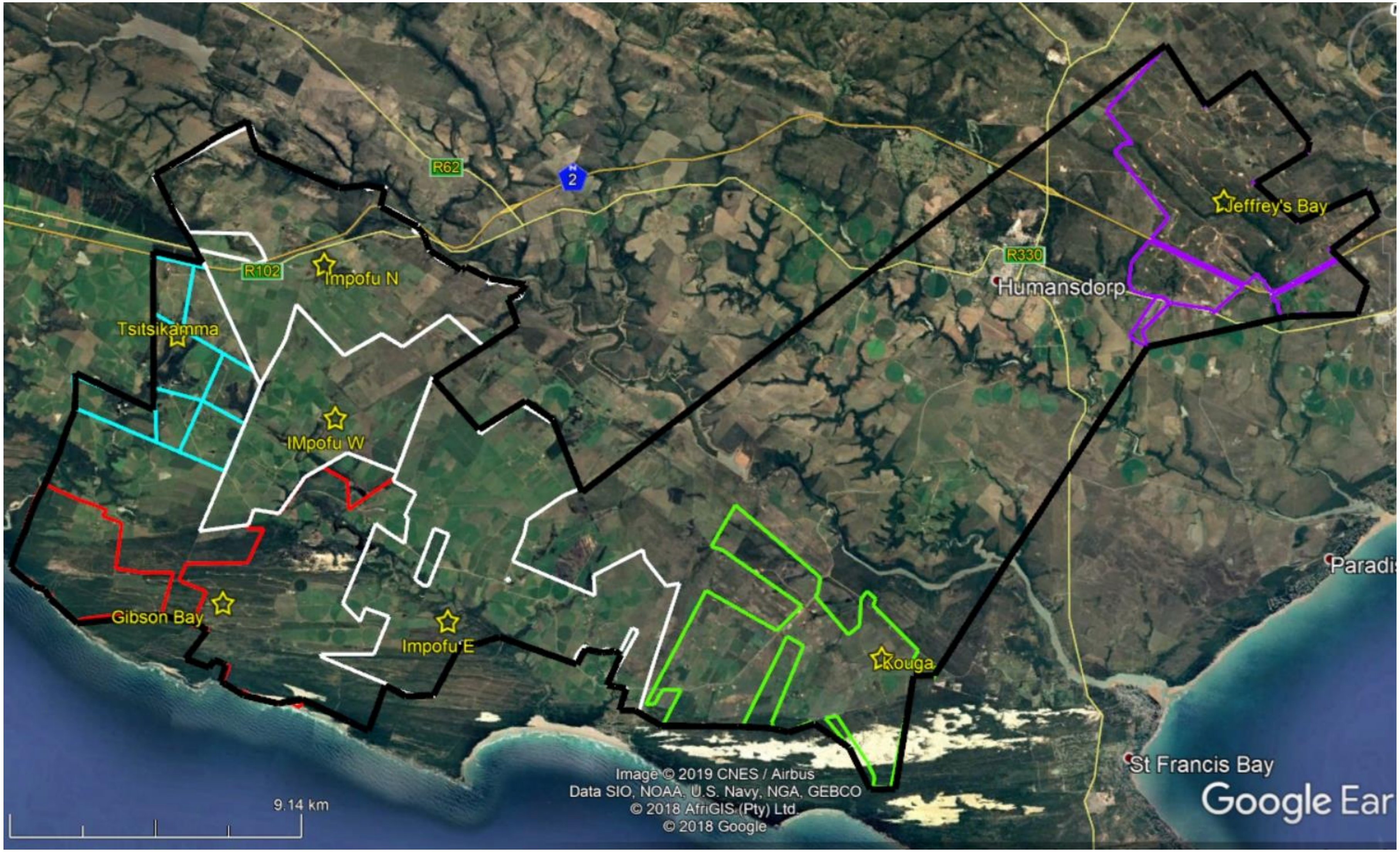

Figure 7.4: Area (black polygon) considered during the Cumulative Scenario 1 described in **Table 7.3**.

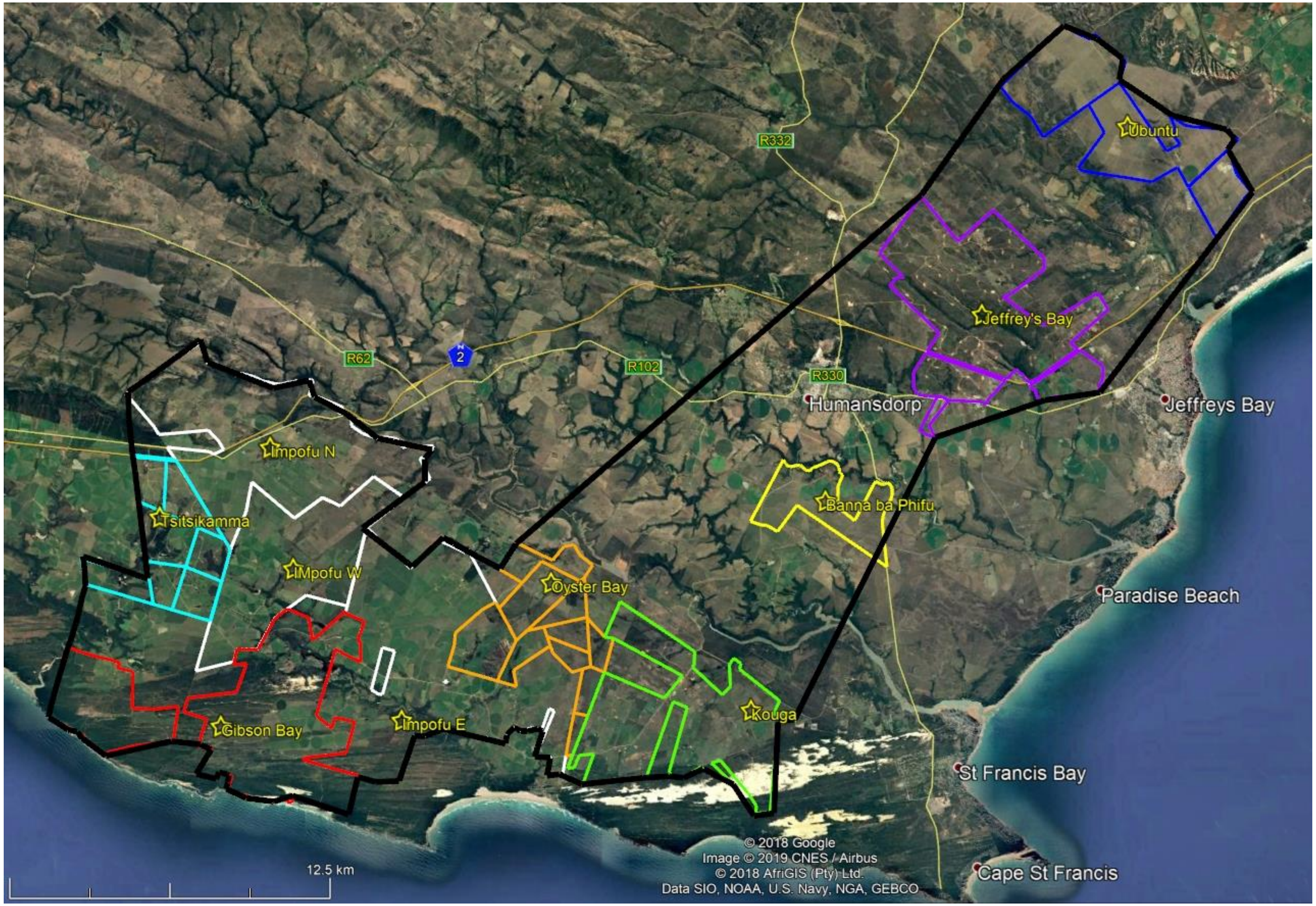

Figure 7.5: Area (black polygon) considered during the Cumulative Scenario 2 described in **Table 7.3**.

Considering the total current estimated annual bat fatalities of Wind Farms 1 – 4 (**Table 7.1**- total is 554), summed with the threshold for Impofu West of 97 bats (**Table 7.2**), it gives a total of 651 annual mortalities for Impofu West Scenario (Impofu West Wind Farm + all existing wind farms). These 651 bats are only about 40% of the cumulative acceptable annual mortality of bats for the Impofu West Wind Farm Scenario in **Table 7.3** which has an annual threshold of 1618 bats. This is considered to be the impact of the proposed Impofu West Wind Farm on the baseline scenario.

Similarly for Cumulative Scenario 1 (**Table 7.4** - all existing wind farms + all three proposed Impofu Wind Farms) the sum of the total current estimated annual fatalities of Wind Farms 1 – 4 (**Table 7.1** - total is 554), with the threshold for Impofu North (100), East (164) and West (97) (**Table 7.2**), results in a total of 915 annual mortalities for Cumulative Scenario 1. These 915 bats are only about 50% of the cumulative acceptable annual mortality of bats for the Cumulative Scenario 1 in **Table 7.3** which has annual threshold of 1988 bats. This is considered to be the impact of all three proposed Impofu Wind Farms on the baseline scenario.

Table 7.4 below summarises these figures for Impofu West Wind Farm Scenario and Cumulative Scenario 1.

Table 7.4: Cumulative impact scenarios involving the Impofu West Wind Farm site and other nearby existing wind farms.

Cumulative scenario	Acceptable annual mortality of bats (based on 2% calculation)	Estimated annual mortalities for Wind Farms 1 to 4 plus Impofu Wind Farm thresholds
Impofu West Scenario (Existing Wind Farms 1 to 4 + Impofu West)	1618 bats	651 bats (40%)
Cumulative Scenario 1 (Existing Wind Farms 1 to 4 + Impofu East, West and North)	1988 bats	915 bats (46%)

Cumulative Scenario 2 further takes into account the additional impact of the other proposed wind farms in the area. Given that Ubuntu, Banna ba Pifhu and Oyster Bay wind farms don’t yet exist, no “Estimator fatalities/ year” has been established for them whereas this has been established for the existing wind farms (**Table 7.1**). If these other three wind farms are developed along with the three Impofu Wind Farms then assumptions can be made about the mortality levels. For the purposes of this assessment, it is assumed the current existing wind farm mortalities stay at the current levels and the three new wind farms and the Impofu Wind Farms mortality rates are estimated to be at the acceptable annual mortality of bats applicable to each wind farm. Based on these assumptions, the total bat mortalities for

Cumulative Scenario 2 should be well below the cumulative threshold as was the case for the other two scenarios.

Thus, it is concluded that the cumulative impacts for the area will be acceptable in both cumulative scenario 1 and 2 and are rated as High Moderate without mitigation and Low Moderate with mitigation. This is also further motivated by the fact that the annual bat mortalities at the two existing wind farms with the highest bat mortalities should start to show a reduction as mitigation is now being implemented at both of these. Furthermore, the iterative impact assessment process undertaken for the Impofu Wind Farms has incorporated mitigation in the form of avoidance based on bat no go areas and buffers; these no-go areas and buffers have become larger and more numerous when compared to those used in earlier studies done on wind farms that are now operational in this area. Therefore, the Impofu Wind Farms have in general applied the mitigation hierarchy principle of avoidance more rigorously than the older facilities in the area.

However, it still remains the responsibility of each wind farm to lower their estimator fatalities below the acceptable sustainability thresholds when bat fatalities are unsustainably high, which will lower the overall cumulative impact of all wind farms in the area. It will also avoid localised population declines, and resulting ecological effects, that may be experienced on a site-specific level if mortalities for a specific site is unsustainably high.

8 CONCLUSION

This report considers information gathered from 12 months of passive recordings, data of surrounding facilities, literature, and satellite imagery. The passive data as well as mortality records from nearby wind farms indicate that the three bat species most likely to be impacted on by the proposed wind farm are *Neoromicia capensis, Tadarida aegyptiaca* and *Miniopterus natalensis*. These more abundant species are of a large value to the local ecosystems as they provide a greater contribution to most ecological services than the rarer species, due to their higher numbers.

One of the Klasies River coastal caves is situated approximately 7km south-west of the site, and this cave is used by roosting bats. Thus, there is a probability of cave dwelling species utilising the site. *Miniopterus natalensis*, a cave dwelling species that can form large aggregations in caves, have been recorded by the passive systems on site. The temporal distribution of this species did not indicate any events that are clearly indicating evidence of migratory events, and overall the activity of this species was very low at 97m. Additionally, cave dwelling bat species carcasses were not detected in disproportionally high numbers on the surrounding wind farms during pre- and post-construction monitoring studies, and no operational data indicated any migration routes up to date.

Seven bat species were detected namely *Eptesicus hottentotus*, *Tadarida aegyptiaca, Pipistrellus hesperidus, Neoromicia capensis, Miniopterus natalensis and Myotis tricolor*. In general *Tadarida aegyptiaca* were most commonly detected on 97m, and *Neoromicia capensis* dominated at 10m except for SM2, SM2B, Met A2 and Met B. Such abundant species are of a large value to the local ecosystems as they provide a greater contribution to most ecological services than the rarer species, due to their higher numbers. SM3 had the highest bat activity levels, probably due to it being located in a high bat sensitivity area and high activity of cattle near a milkery combined with an open water source. Met B had the second highest overall activity levels. In all cases the 97m microphones recorded significantly less bats than the 10m microphones.

A sensitivity map was drawn up indicating potential roosting and foraging areas. The High Bat Sensitivity areas are expected to have elevated levels of bat activity and support greater bat diversity. High Bat Sensitivity areas and their buffers are ‘no – go’ areas due to expected elevated rates of bat fatalities due to wind turbines. During the preconstruction study the bat sensitivity map was revised and intensified. All of these ‘no-go’ areas were taken account of by the developer in the iterative design of the wind farm layout and **no turbines are located within these High Sensitivity areas and their buffers**, this includes the 75m maximum reach of the turbine blades. Avoidance, as has been done by exclusion of the ‘no-go’ areas for turbine placement, is the most effective mitigation measure for reducing the impact on bats, and has therefore been undertaken in the design. Turbines within Moderate Bat Sensitivity buffers and within Moderate Bat Sensitivities, have a higher likelihood of impacting bats. If the impact from one of these turbines (or any other turbine) is the cause of above acceptable thresholds, then mitigation measures may need to be applied to these turbines and this will need to be determined by the specialist undertaking the operational bat monitoring.

The cumulative assessment implies that as long as the proposed Impofu West wind farm, and the other wind farms that are not yet operational, remain below sustainable mortality thresholds, that the cumulative impacts for the area will be acceptable in all the cumulative scenarios. Therefore, the cumulative rating for Scenario 1 and 2 is High Moderate without mitigation and Low Moderate with mitigation. However, it still remains the responsibility of each wind farm to lower their estimator fatalities below the acceptable sustainability thresholds when bat fatalities are unsustainably high, which will lower the overall cumulative impact of all wind farms in the area.

It is recommended that curtailment be applied initially to all turbines at the start of operation at **Level 3** of the mitigation scale (see Section 6) as long as this is technically feasible with the turbines that are used for this wind farm. The impacts of the facility on bats will be monitored during the operational phase monitoring, and if necessary additional mitigation (**Table 6.1**) may need to be applied to any turbines or group of turbines identified as causing mortalities that are above the sustainable threshold levels. The levels and specifics of mitigation may need to be adjusted according to the results of the operational monitoring, based on robust scientific data. This is an adaptive management approach, and it is crucial that any changes suggested by the appointed bat specialist to the initial proposed mitigation schedule, be implemented as soon as practically possible.

In order to guide and preliminarily inform future operational monitoring and adaptive management/mitigation measures, **Table 6.1** is used when high mortalities are detected and insufficient bat activity data is gathered during the operational monitoring (e.g. at the start of the operational monitoring study). However, it’s preferable that bat activity gathered at actual problematic turbines during the operational phase be used to inform a mitigation schedule, when needed. Also refer to the separate “Impofu West Mitigation Action Plan” document which summarises the mitigation measures and should be available to the operator during operation of the facility.

From a bat impact perspective, and by considering the bat activity and mortality data from the surrounding wind farms pre- and post-construction studies, no reasons have been identified to withhold environmental authorisation for the proposed Impofu West Wind Farm. This is on the basis that the effective ‘avoidance mitigation’ has already been implemented (the Impofu Wind Farms no go areas and buffers used have become larger and more numerous earlier studies done on wind farms in this area that are now operational, thus the Impofu Wind Farms have in general been better mitigated through avoidance compared to the older facilities in the area), and that all recommended mitigation measures as well as the “Impofu West Mitigation Action Plan” are adhered to. The conditions of the environmental authorisation must make provision for additional suitable mitigation measures to be implemented if the operational monitoring indicates bat mortalities above acceptable thresholds.

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