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Appendix D3:

Preconstruction Bat Assessment

Final Environmental Impact Report:

Pre-construction Bat Monitoring Assessment for the Proposed Botterblom Wind Energy Facility located north of Loeriesfontein in the Northern Cape Province.

January 2022

Prepared For

FE Botterblom (Pty) Ltd

Prepared by

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Disclaimer by specialists

We,

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declare, that the work presented in this report is our own and has not been influenced in any way by the developer or the EAP. At no point has the developer asked us as specialists to manipulate the results in order to make it more favourable for the proposed development. We consider ourselves bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP) and the EIA Regulations (2014, as amended). We have the necessary qualifications and expertise to develop this specialist report.

Checklist according to SABAA guidelines (MacEwan *et al*., 2020b)

Scoping-specific Guideline requirement	**Section in report**	**Completed**
Literature review: collation and review of existing literature	3.1 Literature review	Yes
Identify habitats which may be used by bats	3. Results	Yes
Desktop search for any designated Protected Areas within 100 km of the site	3.1 Literature review	Yes
Indicate the entire area of interest supplied by the developer/ client.	1.2 Project Location and Area of Influence	Yes
A walkover survey for small sites/drive-through survey for large sites	2.2 Field Surveys	Yes
Pre-construction Guideline requirement		
Determine the assemblage of potentially occurring and detected bats and present their fatality risk	3.1 Literature review 3.2 Acoustic Monitoring	Yes
Determine presence of rare bats and Species of Conservation Concern (SCC)	3.2 Acoustic Monitoring	Yes
Locate bat roosting habitat in the study region	3.3 Roosting sites	Yes
Compare differences in the assemblage and activity of bats between ground level and rotor sweep height	3.2.1.3 Passes at height 3.4 Sensitive bat features	Yes
Compare differences in the assemblage and activity of bats between monitoring localities and between different habitat types	3.2 Acoustic Monitoring	Yes
Determine seasonal variation in the assemblage and activity of bats	3.2.1.2 Passes by species	Yes
Identify any incidence of bat migration	3.2.1.1 Passes by Bat Recorder	Yes
Determine variation in the assemblage and activity of bats between sunset and sunrise	3.2.1.1 Passes by Bat Recorder 3.2.1.2 Passes by species	Yes
Determine how wind speed and other meteorological conditions correlate with bat activity	3.2.1.4 Environmental variables and bat activity	Yes
Determine the relative importance/sensitivity of different parts of the site	3.2.1.1 Passes by Bat Recorder 3.2.2 Active Monitoring 3.3 Roosting sites 3.4 Sensitive Bat features 5 Discussion & Conclusion	Yes
Determine the relative importance/sensitivity of the site	3.4 Sensitive Bat features	Yes
Identify potential site-specific impacts of the proposed WEF on bats.	3.4 Sensitive Bat features 4 Possible Impacts	Yes
Describe effective site- and habitat/turbine-specific bat mitigation measures	4.2 Proposed Mitigation Measures	Yes
Monitoring duration in relation to the size of the WEF (MW) and its position relative to REDZ.	2.1 Regulatory 2.3.3 Passive song meters	Yes
The area of influence (AOI)/ study area and turbine layout if provided by the developer	1.2 Project Location and Area of 1.3 Description of the Affected Environment	Yes
Consider the potential impacts of ancillary developments	4. Possible Impacts	Yes
Roost surveys of potential and known roosts in Summer and Winter	3.3 Roosting sites	Yes
Identify medium to large roosts or caves within 20 km of study area	3.3 Roosting sites	Yes
Manual transect or point acoustic surveys for 8 nights even spread across all seasons	3.2.2 Active Monitoring	Yes
Static surveys with fixed acoustic song meters as per the site size and WEF design	2.3.3 Passive song meters 3.2 Acoustic Monitoring	Yes

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ACRONYMS & GLOSSARY OF TERMS

AOI: Area of Influence, the area that is affected by the proposed development.

Acoustic monitoring: Recording and analyses of echolocation calls to determine bat community species composition and abundance.

ACR: African Chiropteran Report.

AOI: Area of Influence, the area that is affected by potential impacts.

Bat call: An echolocation call emitted by a bat used to detect prey and navigate through its surroundings.

Bat detector: Electronic device for the detection and recording of bat echolocation calls. The terms Bat Detector and Song Meter are used interchangeably in this report.

Bat roost: A structure, natural or manmade, were bats roost during the day. This includes caves, trees, rocky outcrops, buildings and culverts.

Blade tip sweep height: Height between ground level and the lowest point of the wind turbine rotor sweep zone.

bp/h: Bat passes per hour, calculated as a mean or median value from the nightly average bat passes per hour.

Buffer zone: A zone established around areas that are identified as sensitive for bats and includes flyways, foraging areas and bat roosts.

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Cumulative Impact: Impacts created due to past, present and future activities and impacts associated with these activities.

Echolocation: A physiological process for locating distant or invisible objects (such as prey) by means of sound waves reflected back to the emitter (such as a bat) by the objects.

EMPr: Environmental Management Programme: A legally binding working document, which stipulates environmental and socio-economic mitigation measures which must be implemented by several responsible parties throughout the duration of the proposed project.

Endemic: A species that is restricted to a particular area.

EIA (Environmental Impact Assessment): The process of identifying environmental impacts due to activities and assessing and reporting these impacts.

GPS: Global Positioning System device.

IUCN: International Union for Conservation of Nature.

LEOCAP: Bat species *Laephotis capensis*.

LR1-10: Names for potential bat roost locations.

LSM1-6: Names for deployed Bat Detectors.

MW: Megawatts.

NEMA: National Environmental Management Act.

NYCTHE: Bat species *Nycteris thebaica.*

Pre-construction phase: The period prior to the construction of a wind energy facility.

Pulse: A single emission of sound by a bat.

Red data species: Species included in the Critically Endangered, Endangered, Vulnerable or Rare categories as defined by the IUCN.

REDZ (Renewable Energy Development Zones): Areas were wind and solar photovoltaic power development can occur in concentrated zones.

Rotor blades: The air foil of a wind turbine that catches the wind and rotates.

Rotor swept area: The area through which rotor blades of a wind turbine rotate.

S&EIA: Social and Environmental Impact Assessment (EIA): The process of identifying social and environmental impacts due to activities and assessing and reporting these impacts.

SABAA: South African Bat Assessment Association.

SABPG: South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities

SACNASP: South African Council for Natural Scientific Professions.

SANBI: South African National Biodiversity Institute.

SAUPET: Bat species *Sauromys petrophilus*.

Scoping Report: A report contemplated in regulation 21 of the NEMA amended EIA regulations R326 dated 7 April 2017.

Song meters: A particular brand of Bat Detector developed by Wildlife Acoustics. The terms Song Meter and Bat Detector are used interchangeably in this report.

SD card: A storage device for song meter recordings.

TADAEG: Bat species *Tadarida aegyptiaca.*

ToPS: Threatened or Protected Species.

Turbine: A device that harnesses wind energy and turns it into kinetic energy used for the generation of electricity.

WEF: Wind Energy Facility.

1 INTRODUCTION

1.1 PROJECT DETAILS AND BACKGROUND

Enviro-Insight CC was commissioned by FE Botterblom (Pty) Ltd to conduct a pre-construction bat survey for a proposed wind energy facility (WEF) and associated infrastructure which will be known as Botterblom WEF. The Botterblom WEF will consist of up to 35 wind turbines, with a generation capacity of between 4.5 and 7.5 MW per turbine, depending on the available technology at the time. Each turbine will have a hub height of up to 150m and a rotor diameter of up to 175m. The final turbine model to be utilised will only be determined closer to the time of construction, depending on the technology available at the time. Additional ancillary infrastructure to the WEF would include underground and above-ground cabling between project components, onsite substation/s, Battery Energy Storage Systems (BESS), foundations to support turbine towers, internal/ access roads linking the wind turbines and other infrastructure on the site, and permanent workshop area and office for control, maintenance and storage. As far as possible, existing roads will be utilised and upgraded (where needed) with the relevant stormwater infrastructure and gates constructed as required. The perimeter of the proposed WEF may be enclosed with suitable fencing. A formal laydown area for the construction period, containing a temporary maintenance and storage building along with a guard cabin will also be established. A 132 kV transmission power line measuring less than 5 km in length will be used to connect the WEF to the Helios Transmission Substation. This report serves as a pre-construction assessment of the bat activity and bat species present in the Area of Influence (AOI) of the proposed WEF.

1.2 PROJECT LOCATION AND AREA OF INFLUENCE

The proposed Botterblom WEF (WEF boundary in Figure 1-1) is located 53 km north of Loeriesfontein on the remaining extent of Farm Sous 226 in the Hantam Local Municipality in the greater Namakwa District Municipality of the Northern Cape province, South Africa, and covers an area of 5 796 ha. This site has historically been used for sheep grazing and is nearly undisturbed by human presence. A regional road and railway run through the AOI. The Khobab and Loeriesfontein 2 WEF (Animalia, 2011) have been constructed to the north and north-east of the area proposed for the current WEF, and as such, existing infrastructure is present on and in the vicinity of the current AOI, including the Helios sub-station in the eastern section of the AOI (Figure 1-1). The proposed turbine layout and project area of influence (AOI) is shown in Figure 1-2. The AOI was defined as the WEF boundary and additional habitat types to the south that appeared distinct from those present on the existing WEFs and which could be accessed.

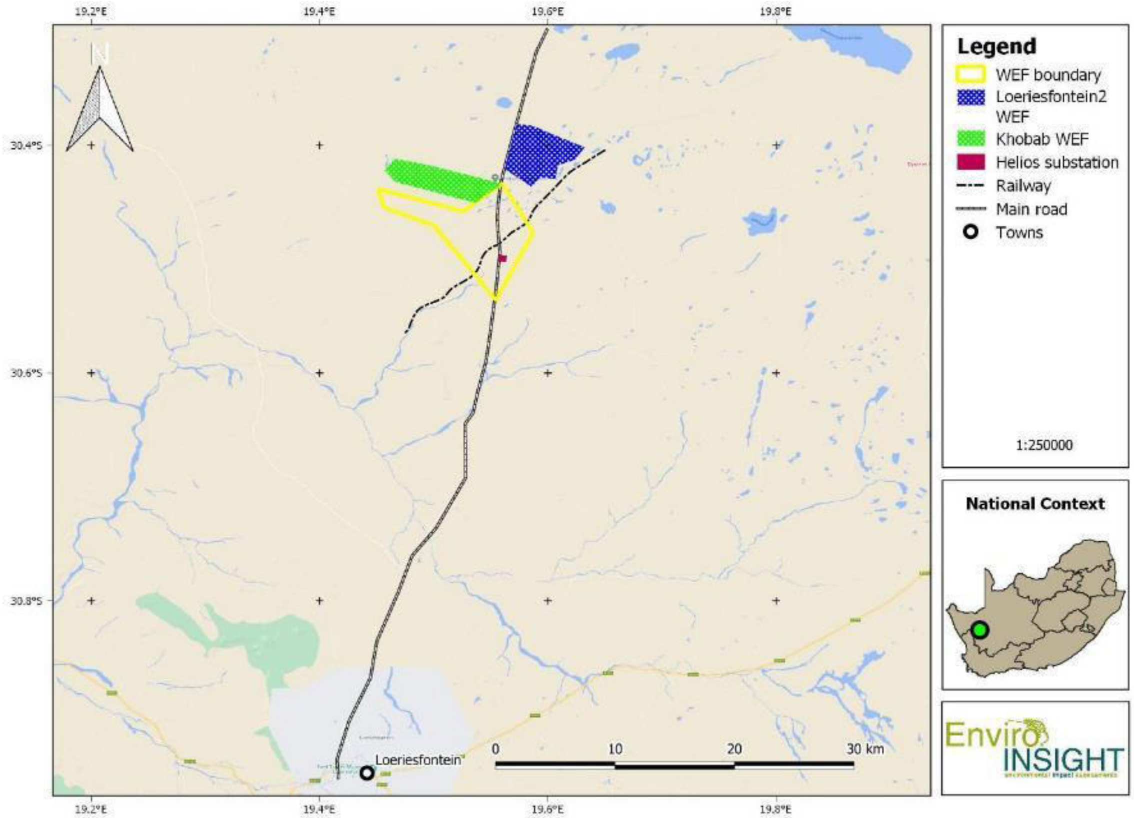


Figure 1-1: Location of the proposed Botterblom WEF (yellow).

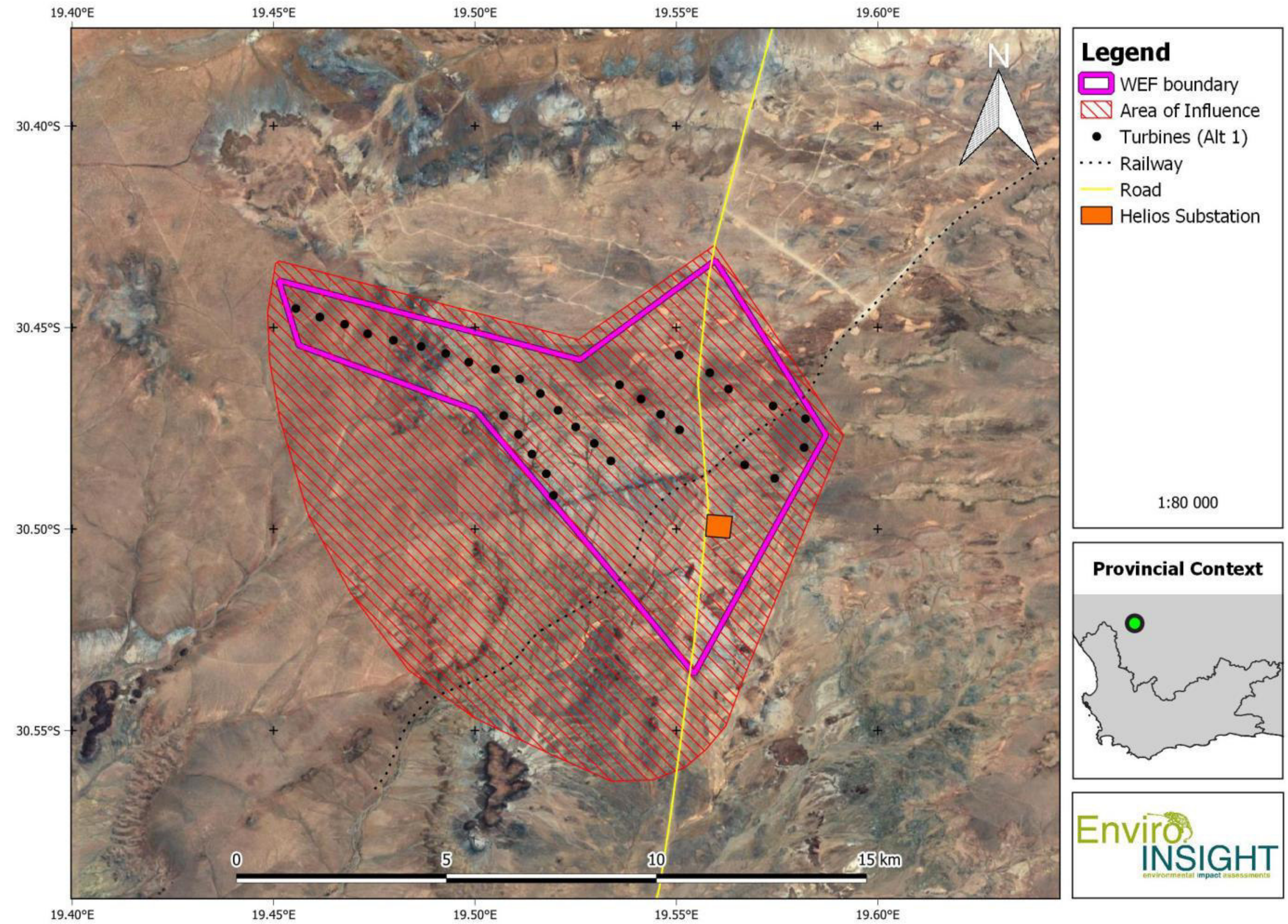


Figure 1-2: Proposed turbine layout and project Area of Influence (AOI) of the proposed Botterblom WEF.

1.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The project area is located in the Nama Karoo Biome and is characterized by Bushmanland Basin Shrubland (SANBI, 2018; Figure 1-3). Based on the ecoregions delineated by Dinerstein *et al*. (2017), the entire project area is located in the Gariep Karoo ecoregion (Figure 1-4), analogous to the Nama Karoo Shrublands ecoregion discussed in MacEwan *et al.* (2020b). Despite the more recent and updated nature of the ecoregions delineation provided by Dinerstein *et al.* (2017), the SABPG[1] (MacEwan *et al*., 2020b) preferentially use the ecoregions delineation of Olson *et al.* (2001), which indicates that a small portion in the southern part of the project area falls within the Succulent Karoo ecoregion (Figure 1-5). Given that there is no obvious difference in the recently delineated regional vegetation map (SANBI, 2018; Figure 1-3) and that our observations in the field also failed to detect any obvious vegetation differences in this southern portion, we preferentially apply the more recent and updated ecoregion

[1] South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities

delineation from Dinerstein *et al.* (2017) for this project area and therefore asses bat fatality risk for the whole project area according to the Nama Karoo ecoregion thresholds defined in Table 5 of the SABPG (MacEwan *et al*., 2020b).

The project area is characterised by small dry river courses and drainage lines, seasonal (ephemeral) pans and absence of permanent water. The topography is relatively flat, with areas of gently sloped hills and no steep rises. Average daily maximum temperature for the warmest month of the year (January) is *ca.* 30 °C and minimum for the same period 17 °C. Average maximum and minimum temperatures during the coldest months are 15 °C and 2 °C respectively (Animalia, 2011). The project area is located in a winter rainfall region with the wettest month being June and receives an average of 14.1 mm of rain per year (Animalia, 2011).

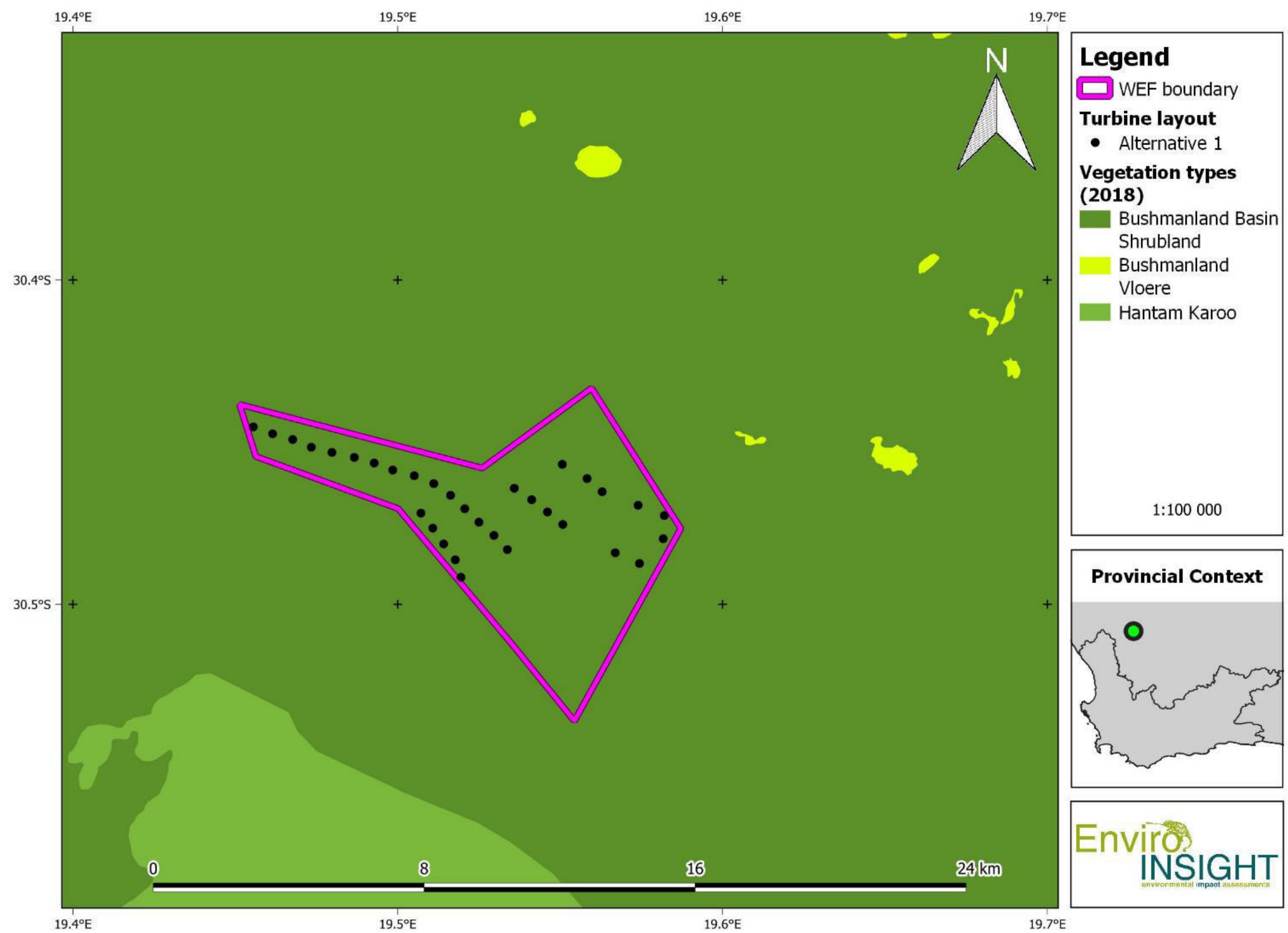


Figure 1-3: The proposed Botterblom WEF in relation to regional vegetation types.

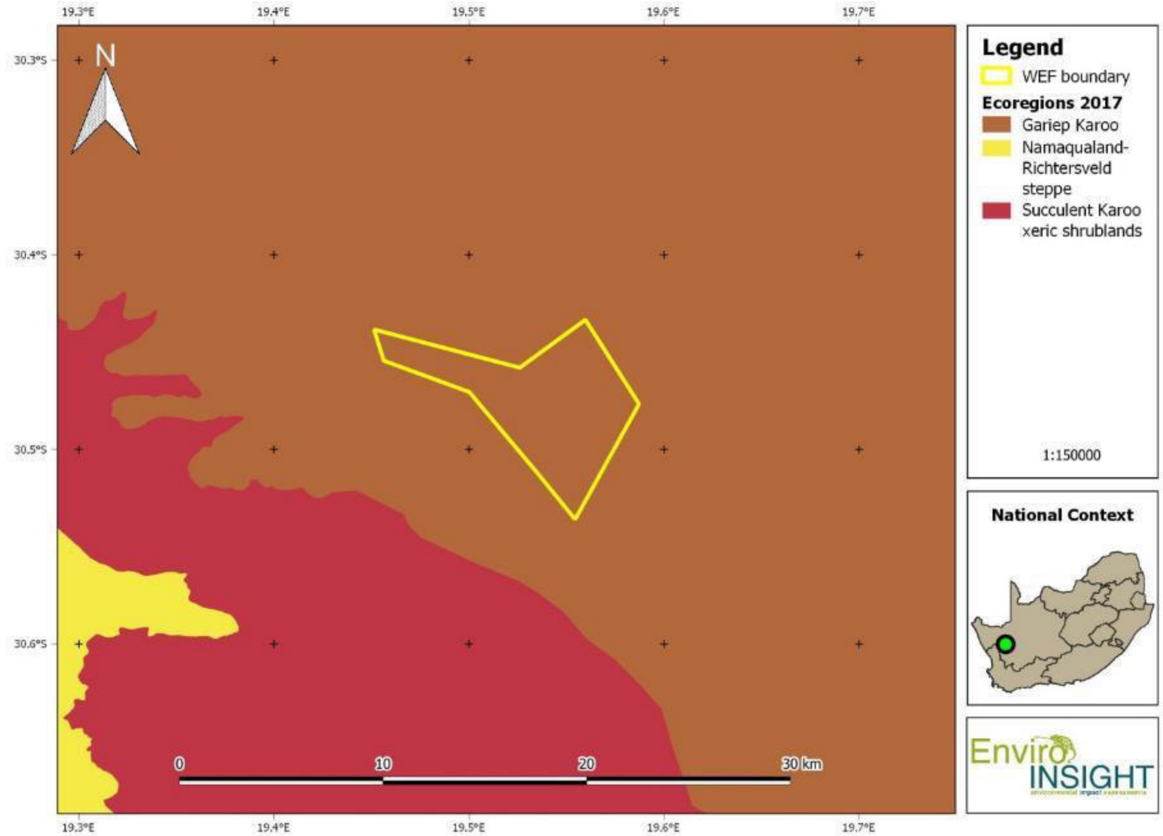


Figure 1-4: The proposed Botterblom WEF in relation to Ecoregions defined by Dinerstein et al. (2017).

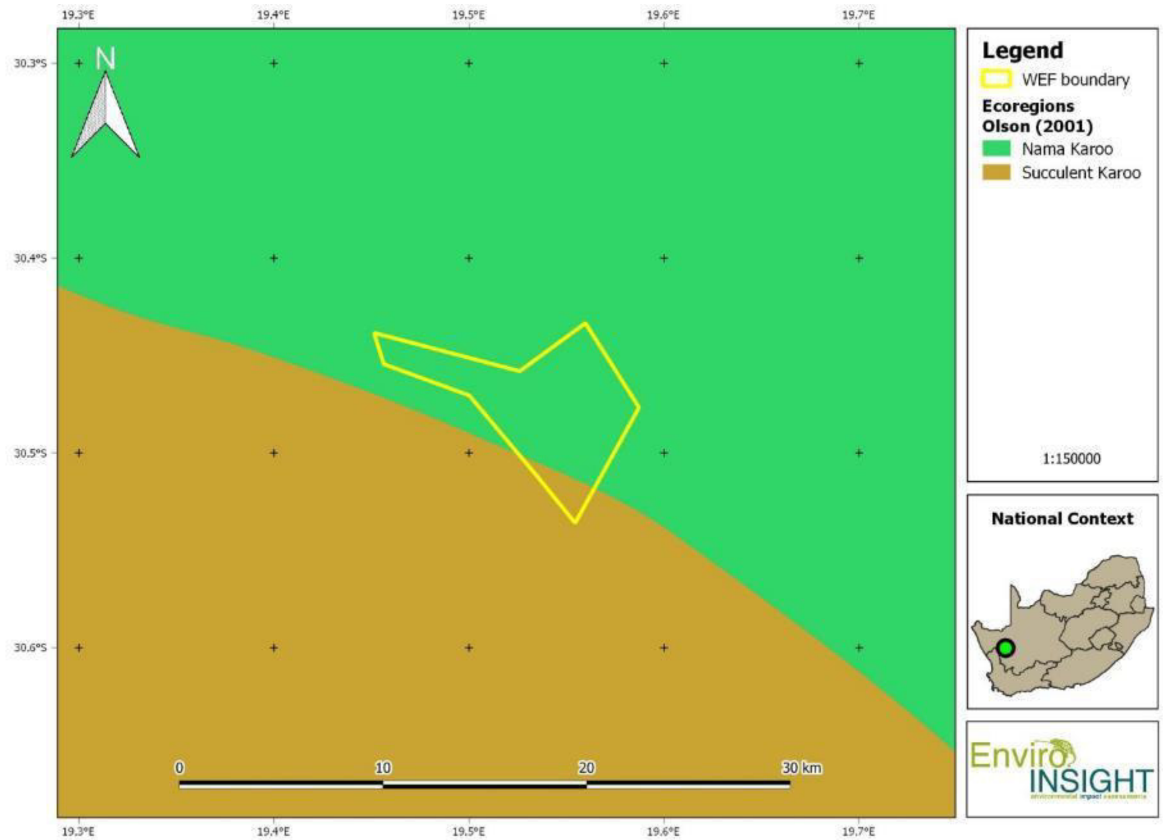


Figure 1-5: The proposed Botterblom WEF in relation to Ecoregions defined by Olson et al. (2001).

1.4 BAT STUDY VALIDITY PERIOD

The results obtained from the current survey is valid for a period of five years as stipulated in the SABPG (MacEwan *et al*., 2020b). If an application for environmental authorisation is only submitted after this five-year period an additional six months of monitoring is suggested to be conducted between October and May. An amended impact assessment will have to be conducted after comparison of data gathered during the original 12-month survey and the additional six-month study.

1.5 ASSUMPTIONS AND LIMITATIONS

Distribution records of bats in southern African are still poorly reported and limited for many species. In addition, migratory patterns of bats are largely unknown in South Africa. Studies have reported that bats do migrate, but the exact routes followed are not known (Pretorius *et al*., 2020). The same is true for breeding behaviour and the formation of maternity colonies for many species.

WEF pre-construction monitoring reports on bats are reliant on reporting echolocation calls (if no bat mortality data from adjacent facilities are available), but without echolocation call libraries accurate identification of calls is not always possible. Published libraries created from release and handheld calls from captured bats are available for southern Africa but are geographically limited. The echolocation calls of a particular species from different regions in South Africa are known to vary to some degree (Monadjem *et al*., 2020), and as such call libraries created in different regions are not always comparable. The South African Bat Assessment Association (SABAA) was contacted for assistance on how to obtain bat mortality data from post-construction monitoring of the existing Khobab WEF to the north. Such mortality data are considered essential for the interpretation of risk and evaluation of the potential mortality that can be expected from the proposed Botterblom WEF, given its immediate adjacent spatial location and similar land use. The original request for assistance in this regard from SABAA was sent on 9 February 2021, followed by a series of follow-up queries, the last which was on 10 January 2022. Unfortunately, no data or reporting has yet been received from SABAA at the time of submission of this report. SABAA did however provide communication during this period and did make several attempts to acquire this data and share it with Enviro-Insight. From these communications it appears that Mainstream, the operator of the Khobab WEF, have deliberately avoided sharing the data with SABAA.

The height of the turbines, diameter of the rotor blades and height of the meteorological mast were not readily available from the developer until after the monitoring had already commenced. As such, a bat detector was initially placed only at 50 m as required for met masts of 80 m by the current SABPG (MacEwan *et al*., 2020b), and an additional bat detector was not deployed above 80 m. This means that bats flying at a height of above 80 m were initially not recorded, and some bats foraging at height were not detected. At the beginning of December 2020, this was brought to the developers' attention, but an additional bat detector was only deployed in March 2021 at 100 m. The additional bat detector provided a better representation of bats that fly in the rotor sweep zone which could place them at risk of collision or barotrauma. All bat detectors continue to collect data until the end of February 2022. This is considered necessary to supplement the data presented in this report, should the competent authority and/or interested and affected parties have any queries.

Bat detectors are not always effective in recording echolocation calls for all bat species, and some species may be missed e.g., fruit bat species that do not echolocate. Additionally, species such as *Nycteris thebaica* emit low intensity calls that may not be recorded. Bat detectors are also limited in the range over which a call can be recorded, and this can be further influenced by environmental conditions such as humidity. In addition, the microphones that are coupled to the detectors are not omnidirectional and recording quality and number of recordings is influenced by the orientation of the call relative to the microphone.

Technical difficulties are inevitable when dealing with large quantities of data. Recording time was compromised by batteries going flat before being replaced, SD card corruption, recorder device failure and user error when replacing batteries and card (accidentally disabling device). However, these limitations did not result in a dataset that is non-compliant with the minimum requirements of the SABPG (MacEwan *et al*., 2020b).

Rainfall data was not provided and could thus not be used to assess bat activity patterns. Only wind speed, temperature, barometric pressure and relative humidity was available.

2 METHODOLOGY

2.1 REGULATORY REQUIREMENTS

Amendments were made to the NEMA: EIA Regulations of 2014: GNR 326 EIA Regulations; GNR 327 Listing Notice 1; GNR 325 Listing Notice 2; GNR 324 Listing Notice 3 which pertains to WEF and the activities surrounding their construction. Under Listing Notice 2 it is stated that a Scoping and Environmental Impact Assessment (S&EIA) is required for WEFs with an electricity output 20 MW or more and which is not located in an urban area or on existing infrastructure. Only a Basic Assessment (BA) is, however, required in cases where the entire boundary of the proposed WEF is located in a Renewable Energy Development Zone (REDZ). The Botterblom WEF is not located in a REDZ, and accordingly a S&EIA process was followed. The SABPG for WEF (MacEwan *et al*., 2020b) does, however, not differentiate between areas located within or outside of a REDZ, and as such the same guidelines must be followed and applied. Monitoring of bats must be conducted before the final BA or EIA is submitted.

2.2 DESKTOP SURVEY

A thorough desktop study was undertaken to estimate the likelihood of specific species of bats being present at the proposed WEF project AOI. This comprised a detailed study of available literature (Table 2-1), which included the pre-construction reports for the adjacent Khobab WEF (Animalia, 2011) and the Kokerboom 1 WEF (Animalia, 2017), and available distribution maps of bat species and records from the African Chiropteran Report (ACR, 2020), which includes museum records. In addition, a search was performed to identify all protected areas within 100 km of the AOI using data available from Protected Planet (https://www.protectedplanet.net/). Although requested, no bat mortality data could be obtained from the Khobab WEF to incorporate into the current report (see 1.5 Assumptions and Limitations).

Table 2-1: Reviewed reports for WEFs in close proximity to the proposed Botterblom WEF.

Project	Bat Assessment	Author and Company
SiVEST. 2012. Proposed Construction of Wind Farms near Loeriesfontein, Northern Cape Province, South Africa.	Environmental Constraints Analysis with regards to bat (Chiroptera) sensitivity - For the proposed Loeriesfontein Wind Energy Facility near Loeriesfontein, Northern Cape (2011).	Werner Marais – Animalia
SiVEST. 2015. Proposed Development of the Dwarsrug Wind Farm near Loeriesfontein, Northern Cape Province, South Africa. Final Environmental Impact Report. DEA Ref No: 14/12/16/3/3/2/690	Findings of a 12-month Long-Term Pre-Construction Bat Monitoring Study and Impact Assessment For the proposed Dwarsrug Wind Farm, Northern Cape (2015)	Werner Marais – Animalia
AURECON. 2017. Proposed Kokerboom 1 Wind energy Facility and associated infrastructure on Farms RE/227 and 1163, near Loeriesfontein in the Northern Cape: Final Environmental Impact Report. DEA REF. NO.: 14/12/16/3/3/2/985.	Findings of a 12-month Long-Term Pre-Construction Bat Monitoring Study and Impact Assessment For the proposed Kokerboom 1 Wind Farm, Northern Cape (2017)	Daleen Burger – Animalia
AURECON. 2017. Proposed Kokerboom 2 Wind energy Facility and associated infrastructure on Farms 1164 and RE/215, near Loeriesfontein in the Northern Cape: Final Environmental Impact Report. DEA REF. NO.: 14/12/16/3/3/2/986.	Findings of a 12-month Long-Term Pre-Construction Bat Monitoring Study and Impact Assessment For the proposed Kokerboom 2 Wind Farm, Northern Cape (2017)	Daleen Burger – Animalia
AURECON. 2017. Proposed Kokerboom 3 Wind energy Facility and associated infrastructure on Farms RE/213, 1/214 and 2/214, near Loeriesfontein	Findings of a 12-month Long-Term Pre-Construction Bat Monitoring Study and Impact Assessment For the proposed Kokerboom 3 Wind Farm, Northern Cape (2017)	Werner Marais – Animalia

in the Northern Cape: Final Environmental Impact Report DEA REF. NO.: 14/12/16/3/3/2/1009.		
SiVEST. 2017. Proposed Development of the !Xha Boom Wind Farm near Loeriesfontein, Northern Cape Province, South Africa. Draft Environmental Impact Report. DEA Ref No: 14/12/16/3/3/2/1018	Fifth and Final Progress Report of a 12-month Long-Term Bat Monitoring Study - For the proposed !Xha Boom Wind Energy Facility, Northern Cape (2017)	Daleen Burger – Animalia
Not available	Fifth and Final Progress Report of a 12-month Long-Term Bat Monitoring Study - For the proposed Graskoppies Wind Energy Facility, Northern Cape (2017)	Daleen Burger & Werner Marais – Animalia

2.3 FIELD SURVEYS

All methods applied for field surveys were performed in accordance with SABAA's document on best practice guidelines for pre-construction monitoring of bats at wind energy facilities in South Africa (MacEwan *et al*., 2020b).

2.3.1 Site visits

Several site visits were completed (Table 2-2) spanning a full year and therefore encompassing all seasons. A selection of representative photographs of the different bat detectors and the different habitats in the AOI is shown in Figure 2-2.

Table 2-2: Summary of site visits and work conducted.

Season and Dates	Methods	Weather and veld conditions	Comments
Spring: 1-5 September 2020	Scoping Phase	End of winter rain – vegetation sparse and plants starting to wilt.	The static bat detectors were deployed.
Early summer: 10-14 November 2020	Walk, Drive	Dry and hot conditions. Vegetation minimal, bare landscape.	Transect were walked and driven
Summer: 9-11 December 2020	Bat roosts	Dry and hot conditions. Vegetation minimal, bare landscape.	Roost inspections
Late summer: 15-17 March 2021	Bat roosts	After good rains. Green vegetation with grass cover. Pans filled with water.	Roost inspections
Autumn: 24-28 April 2021	Bat roosts, drive transects	Green vegetation still present in places. Pans dry.	Roost inspections and drive transects
Winter: 14-22 July 2021	Bat roosts, drive transects	Cold, windy and rainy conditions, vegetation present and flowers beginning to bloom	Roost inspections and drive transects
Spring: 6-11 September 2021	Bat roosts, drive transects	Mild temperatures, vegetation sparse and plants starting to wilt	Roost inspections and drive transects

2.3.2 Walkover survey

A survey was performed by walking and driving across the project area as a ground truthing exercise to identify suitable areas for placement of bat detectors, identify potential roosting sites and sensitive areas, and evaluate the level of monitoring that is required. This was performed prior to the deployment of the bat detectors.

2.3.3 Passive song meters

Twelve months of pre-Construction Monitoring are required for > 20 MW WEFs both inside and outside of REDZ. As Botterblom WEF exceeds 20 MW, bat detectors were deployed for the full 12 months. Nightly recordings of bats from dusk to dawn were captured using the Wildlife Acoustics Song Meter SM4BAT FS Ultrasonic Recorders (hereafter referred to as "bat detectors"). A total of six bat detectors were deployed throughout the project area, spatially arranged to cover all major habitat types and/or important bat habitat features (Table 2-1; Figure 2-1). As per the SABPG (MacEwan *et al*., 2020b), one bat detector must be deployed at a height of 7 - 10 m per 5 000 ha or for every significant biotope on the project AOI and one detector must be deployed at a height of 50 – 80 m per 10 000 ha for mast that are 80 m tall. If a mast is taller than 80 an additional bat detector must be deployed as close to the top of the mast as possible. This considered, four bat detectors were deployed with microphones positioned at 7 m above ground level, and one was deployed with microphone positioned at 50 m (Figure 2-2). An additional bat detector was deployed with microphone positioned at 100 m, but only started recording in March 2021. All devices were scheduled to record from 30 min before sunset to 30 min after sunrise at the location of the bat detector. During this time, the device is 'armed' and will begin a recording if a 'trigger' is detected. A trigger is defined as a sound within the set frequency range (Default: >16 kHz) amplitude (Default: 12 dB) for a minimum duration (Default: 1.5 ms). The recording then continues for the duration of the Trigger Window (Default: 3 second) after the last Trigger, and then saves the recorded data. If there are constant Triggers, the recording will save and close after the maximum length of a recording file (Default: 00m:15s). The batteries for the bat detectors were exchanged approximately every month and at this time all data were copied from the SD cards and backed up before formatting and replacing the SD cards.

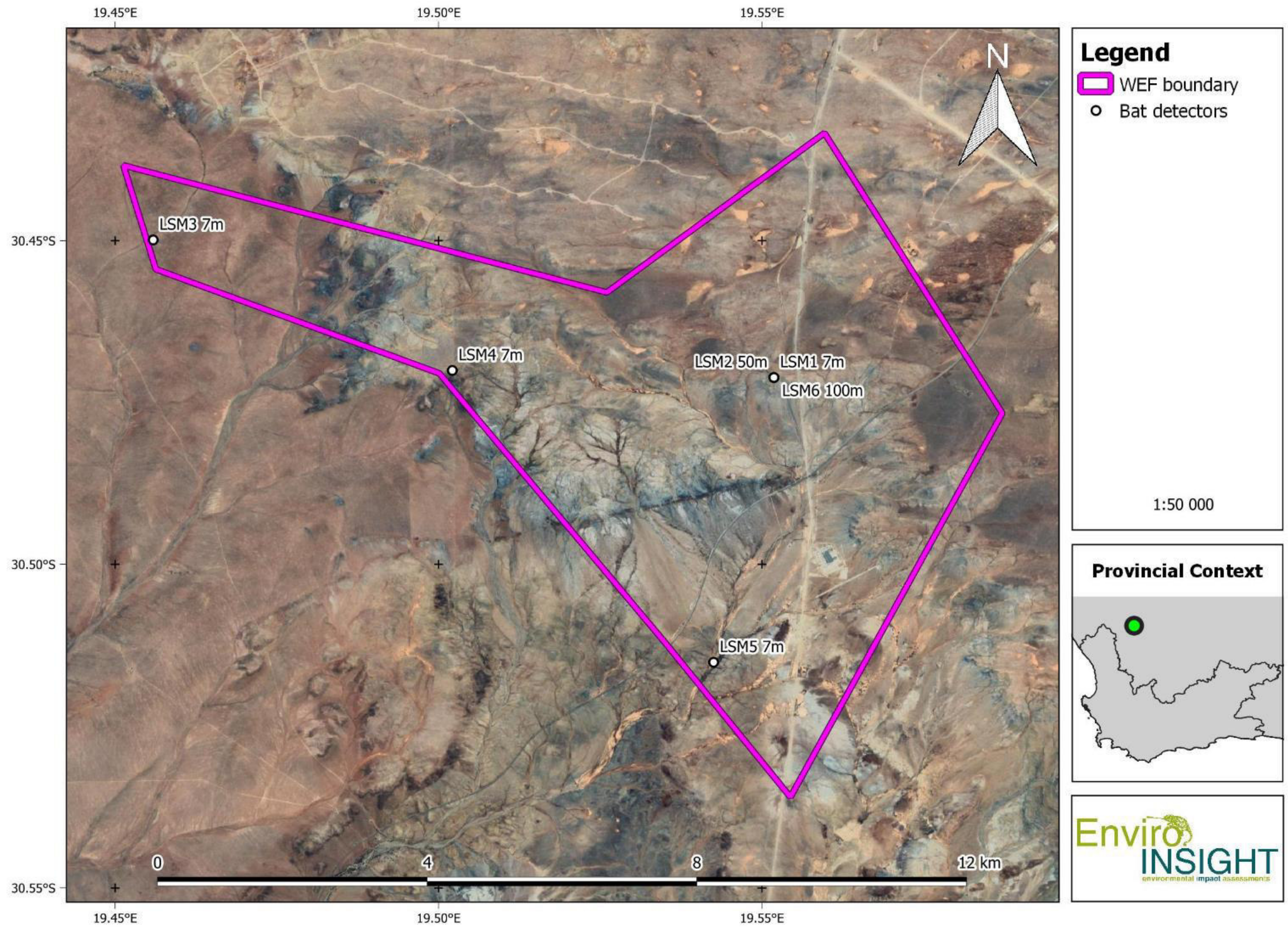


Figure 2-1: Positions of deployed passive bat detectors in relation to the proposed Botterblom WEF boundary.

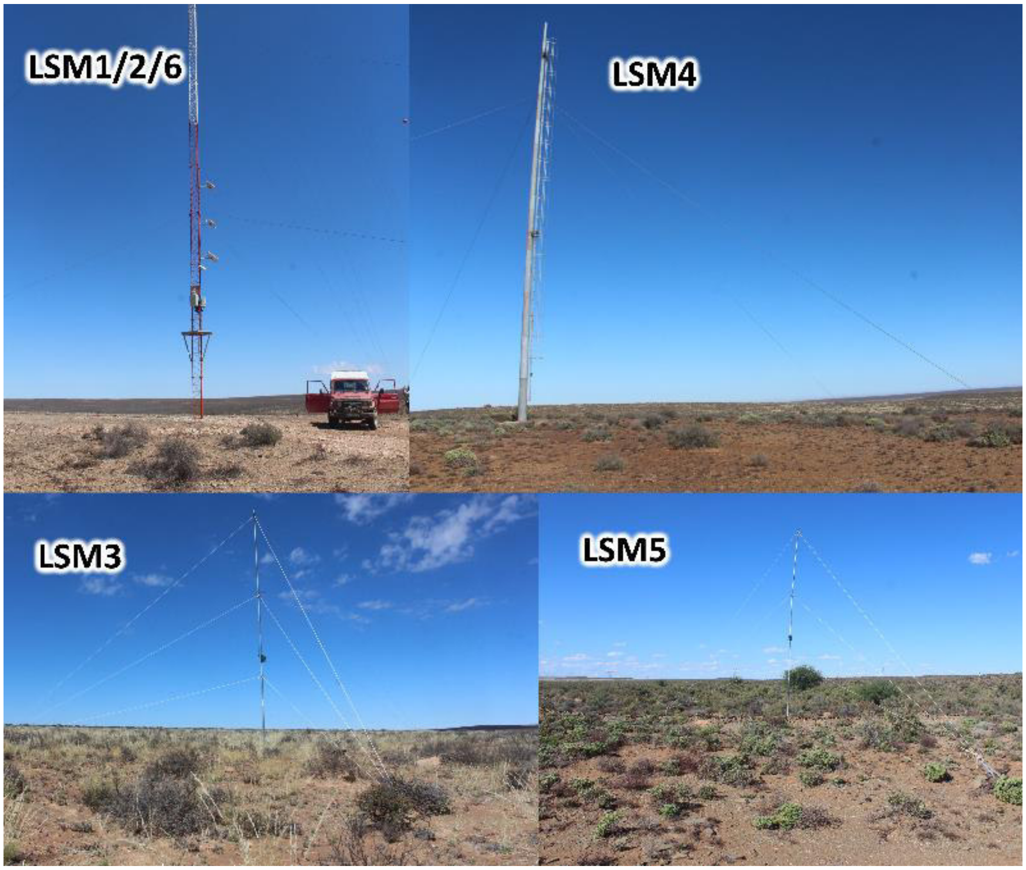


Figure 2-2: Photographs of the deployed passive song meters (bat detectors) showing the immediate surrounding habitat.

Table 2-3: Details of the deployed song meters (bat detectors).

Bat Detector ID	Microphone Height above ground	Latitude (°)	Longitude (°)	Date deployed
LSM1	50 m	-30.471144	19.551831	04/09/2020
LSM2	7 m	-30.471144	19.551831	04/09/2020
LSM3	7 m	-30.449887	19.45587	04/09/2020
LSM4	7 m	-30.47005	19.502112	05/09/2020
LSM5	7 m	-30.515138	19.542507	04/09/2020
LSM6	100 m	-30.471144	19.551831	20/03/2021

2.3.4 Active transects

Transects were driven for a minimum of two nights per season across the project AOI (Table 2-4), and some additional transects were walked to assess habitats away from the road. The transect duration each night did not always consist of a 2.5 hour period as outlined in the SABPG (MacEwan *et al*., 2020b), but the total transect duration exceeded the minimum requirement of 5 h total survey duration over 2 nights as stipulated in MacEwan *et al*. (2020b). Transects were only conducted under fair weather conditions (nights with rain or strong winds were avoided). Bats were recorded using a bat detector with the microphone held outside the vehicle while driving at a maximum of 35 km/h along the same transect routes between survey periods. All transects were tracked using a handheld GPS.

Table 2-4: The details of active transects completed.

Season	Date	Type	Start time	End time	Duration	Season total duration
Spring	03/09/2020	drive	18:04	20:07	2:03	
Spring	04/09/2020	drive	18:05	19:24	1:19	**3:22**
Summer	10/11/2020	drive	18:00	19:02	1:02	
Summer	10/11/2020	drive	19:10	19:53	0:43	
Summer	10/11/2020	drive	19:53	20:11	0:18	
Summer	11/11/2020	drive	20:17	20:42	0:25	
Summer	11/11/2020	walk	19:38	19:56	0:18	
Summer	11/11/2020	drive	18:57	19:23	0:26	
Summer	11/11/2020	drive	19:44	20:14	0:30	
Summer	12/11/2020	drive	20:22	20:37	0:15	
Summer	12/11/2020	walk	18:55	20:21	1:26	
Summer	13/11/2020	walk	18:47	19:46	0:59	**6:22**
Autumn	24/04/2021	drive	18:34	21:52	3:18	
Autumn	26/04/2021	drive	18:10	20:16	2:06	
Autumn	27/04/2021	drive	19:22	21:57	2:35	**7:49**
Winter	17/07/2021	drive	18:45	21:31	2:46	
Winter	21/07/2021	drive	18:25	21:07	2:42	**5:28**
Spring	08/09/2021	drive	18:52	21:23	2:31	
Spring	10/09/2021	drive	18:43	21:15	2:32	**5:03**
				Grand Total Duration		**28:14**

2.3.5 Bat roosts

Potential bat roosts, including buildings and other infrastructure, were visited and visually inspected during the day for signs of bats. No caves were found on the site, and none are expected within 20 km of the area due to the topography, but the railway cutting across the AOI can create potential artificial roosts. These were inspected for any signs of roosting bats, which included searching for faecal material and conducting acoustic monitoring with a handheld bat detector.

2.4 DATA ANALYSES

2.4.1 Passive song meters

The sound files recorded by the bat detectors (song meters) were processed using Kaleidoscope Pro v5.4.0 (www.wildlifeacoustics.com). Recordings for all bat detectors were analysed in batches, by running the auto-id and basic cluster analysis in Kaleidoscope Pro. The auto-id feature (using the Bats of South Africa v5.4.0 library) provides an identification for each call pulse, which can be useful to help identify bat species, but is unsatisfactory due to the absence of a comprehensive bat call library (the classifier only includes 19 bat species in the subregion) and occasional misclassification of species result due to limited training data. Only species expected in the project area were included in the auto-id analysis to reduce misclassification. The basic cluster analysis overcomes some of these limitations by grouping calls according to their acoustic properties. Clusters were subsequently identified manually to species using input from the auto-id feature and by manually verifying the identification against existing published data for bat calls (e.g. Monadjem *et al*., 2020) and assigning all passes within that cluster to that species. The signal parameters in Kaleidoscope were left as default for both the auto-id and cluster analyses:

- Minimum Frequency Range: 8kHz
- Maximum Frequency Range: 120kHz
- Minimum Length of Detected Pulses: 2 ms
- Maximum Length of Detected Pulses: 500 ms
- Maximum inter-syllable gap: 500 ms
- Minimum number of pulses: 2

A recording from each cluster was chosen to be used to identify the cluster. During the selection process, multiple calls were examined per cluster to ensure that the chosen call was representative of the cluster. This 'exemplar' call was chosen to minimise its distance to the cluster centre and with good amplitude and low background noise. The best pulse was chosen from the bat pass that showed the highest amplitude and clearest sonograph signature. The exemplar calls for all clusters were exported, processed with Audacity® (Audacity Team, 2021): clip, normalise peak amplitude -1 dB & remove DC offset, high-pass filter at 8000Hz & roll-off of 24 dB and visualised using the package 'seewave' (Sueur *et al*., 2008) in the R environment (R Core Team, 2020). The output spectrogram and waveform were compared with reference calls of Monadjem *et al*. (2020), and additional measurable call parameters (e.g. frequency at the knee) were consulted if deemed necessary. Due to their similarity, some calls could not be assigned reliably to a single species (e.g. *Tadarida aegyptiaca* & *Sauromys petrophilus*) and were thus grouped together.

2.4.2 Active transects

All sound files recorded during transects were analysed using the auto-id feature in Kaleidoscope Pro v5.4.0 with the same parameters defined for the passive recordings. However, this auto-identification feature of bat calls was found to be unreliable due to high levels of background noise created by wind and the vehicle. Furthermore, the small sample size precludes the use of a basic cluster analysis and thus all potential calls (and noise files) from bats were manually investigated and identified in Kaleidoscope. Ambiguous calls were processed further and identified as necessary. All identified bat passes were then matched to their respective GPS timestamp to obtain a geographic coordinate to allow mapping of each bat pass. In addition, the survey effort was determined using the number of times a transect was conducted in order to provide context to the bat observations.

2.4.3 Data Processing

Some recording clusters included a combination of two bat species consistently calling together. These clusters were duplicated to allow the calculation of appropriate number of passes per species. Conversely, single files can contain multiple clusters that are identified as the same species. Therefore, any clusters that contained duplicate detection of a species within a single file were removed to avoid overestimation of the number of passes. Two scenarios were run, one grouping all *Tadarida aegyptiaca* and *Sauromys petrophilus* calls and another keeping them as two separate groups (ambiguous calls were grouped with *Tadarida aegyptiaca*). Both scenarios produced very similar results (total bat passes: 14670, 15376; average bat passes/hour (bp/h): 0.73, 0.77; median bp/h 0.14, 0.14; respectively) and the former scenario is presented in the results of this report.

The recording times for each hour were calculated according to the dawn and dusk times of the location and date where the bat detector was deployed and used to correct the number of passes for hours that were less than 60 min in duration (MacEwan *et al*., 2020b). Incomplete recording hours occurred at dawn and dusk and if the bat detectors batteries were depleted before they could be replaced (this occurred only very rarely). The mean and median bp/h were calculated in two ways, one to show the hourly activity patterns only, and the other as the standardised bp/h over each night (as per MacEwan *et al*., 2020b). The former simply used the corrected number bp/h, in combination with either the species or the bat detector id, to calculate the median and average bat passes, and was only used to display patterns at hourly intervals through the night. The latter calculation took the total number of bat passes per night, divided this by the time recorded for that night (in hours), and finally the median and mean number of bat passes were then calculated from all the nights combined (in combination with the other variables e.g. month, season, species, bat detector, height) and this was used as the standardised measure for bat activity.

2.5 IMPACT ASSESSMENT

Once a potential impact has been determined it is necessary to identify which project activity will cause the impact, the probability of occurrence of the impact, and its magnitude and extent (spatial and temporal). This information is important for evaluating the significance of the impact, and for defining mitigation and monitoring strategies. Direct and indirect implications of the impacts identified during the specialist investigations were assessed in terms of five standard rating scales to determine their significance.

The rating system used for assessing impacts (or when specific impacts cannot be identified, the broader term issue should apply) is based on six criteria, namely:

- **Status** of impacts (Table 2-5) – determines whether the potential impact is positive (positive gain to the environment), negative (negative impact on the environment), or neutral (i.e. no perceived cost or benefit to the environment). Take note that a positive impact will have a low score value as the impact is considered favourable to the environment;
- **Spatial extent** of impacts (Table 2-6) – determines the spatial scale of the impact on a scale of localised to global effect. Many impacts are significant only within the immediate vicinity of the site or within the surrounding community, whilst others may be significant at a local or regional level. Potential impact is expressed numerically on a scale of 1 (site-specific) to 5 (global);
- **Duration** of impacts (Table 2-6) – refers to the length of time that the aspect may cause a change either positively or negatively on the environment. Potential impact is expressed numerically on a scale of 1 (project duration) to 5 (permanent);
- **Frequency of the activity** (Table 2-6)– The frequency of the activity refers to how regularly the activity takes place. The more frequent an activity, the more potential there is for a related impact to occur.
- **Severity** of impacts (Table 2-6) – quantifies the impact in terms of the magnitude of the effect on the baseline environment, and includes consideration of the following factors:
  - The reversibility of the impact;
  - The sensitivity of the receptor to the stressor;
  - The impact duration, its permanency and whether it increases or decreases with time;
  - Whether the aspect is controversial or would set a precedent;
  - The threat to environmental and health standards and objectives;
- **Probability** of impacts (Table 2-6) –quantifies the impact in terms of the likelihood of the impact occurring on a percentage scale of <5% (improbable) to >95% (definite).
- **Confidence** – The degree of confidence in predictions based on available information and specialist knowledge:
  - Low;
  - Medium; or
  - High.

In addition, each impact needs to be assessed in terms of reversibility and irreplaceability as indicated below:

- **Reversibility** of the Impacts - the extent to which the impacts/risks are reversible assuming that the project has reached the end of its life cycle (decommissioning phase):
  - High reversibility of impacts (impact is highly reversible at end of project life i.e. this is the most favourable assessment for the environment);
  - Moderate reversibility of impacts;
  - Low reversibility of impacts; or
  - Impacts are non-reversible (impact is permanent, i.e. this is the least favourable assessment for the environment).
- **Irreplaceability** of Receiving Environment/Resource Loss caused by impacts/risks – the degree to which the impact causes irreplaceable loss of resources assuming that the project has reached the end of its life cycle (decommissioning phase):
  - High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment);
  - Moderate irreplaceability of resources;
  - Low irreplaceability of resources; or
  - Resources are replaceable (the affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment).

Table 2-5: Status of Impacts

Rating	Description	Quantitative Rating
Positive	A benefit to the receiving environment (positive impact)	+
Neutral	No determined cost or benefit to the receiving environment	N
Negative	At cost to the receiving environment (negative impact)	-

Determination of Impact Significance

The information presented above in terms of identifying and describing the aspects and impacts is summarised in below in Table 2-6 and significance is assigned with supporting rational.

Table 2-6: Consolidated Table of Aspects and Impacts Scoring

Spatial Scale	Rating	Duration	Rating	Severity	Rating
Activity specific	1	One day to one month	1	Insignificant/non-harmful	1
Area specific	2	One month to one year	2	Small/potentially harmful	2
Whole site/plant/mine	3	One year to ten years	3	Significant/slightly harmful	3
Regional/neighbouring areas	4	Life of operation	4	Great/harmful	4
National	5	Post closure	5	Disastrous/extremely harmful	5

Frequency of Activity	Rating	Probability of Impact	Rating
Annually / Once-off	1	Almost never/almost impossible	1
6 monthly	2	Very seldom/highly unlikely	2
Monthly	3	Infrequent/unlikely/seldom	3
Weekly	4	Often/regularly/likely/possible	4
Daily / Regularly	5	Daily/highly likely/definitely	5

Significance Rating of Impacts	Timing
Very Low (1-25)	
Low (26-50)	Pre-construction
Low – Medium (51-75)	Construction
Medium – High (76-100)	Operation
High (101-125)	Decommissioning
Very High (126-150)	
Adjusted Significance Rating	

The environmental significance rating is an attempt to evaluate the importance of a particular impact, the consequence and likelihood of which is assessed by the relevant specialist. The description and assessment of the aspects and impacts is presented in a consolidated table with the significance of the impact assigned using the process and matrix detailed below.

The sum of the first three criteria (spatial scope, duration and severity) provides a collective score for the consequence of each impact. The sum of the last two criteria (frequency of activity and frequency of impact) determines the likelihood of the impact occurring. The product of consequence and likelihood leads to the assessment of the significance of the impact (Significance = Consequence X Likelihood), shown in the significance matrix below in Table 2-7.

Table 2-7: Significance Assessment Matrix.

	Consequence (Severity + Spatial Scope + Duration)														
Likelihood (Frequency of Activity + Probability of Impact)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	08	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 2-8: Positive and Negative Impact Mitigation Ratings.

Colour Code	Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
	Very High	126-150	Avoidance – consider alternatives	Optimal contribution from Project
	High	101-125	Avoidance as far as possible; implement strict mitigation measures to account for residual impacts	Positive contribution from Project with scope to improve
	Medium-High	76-100	Where avoidance is not possible, consider strict mitigation measures	Moderate contribution from Project with scope to improve
	Low-Medium	51-75	Mitigation measures to lower impacts and manage the project impacts appropriately	Improve on mitigation measures
	Low	26-50	Appropriate mitigation measures to manage the project impacts	Improve on mitigation measures; consider alternatives to improve on
	Very Low	1-25	Ensure impacts remain very low	Consider alternatives to improve on

The model outcome is then assessed in terms of impact certainty and consideration of available information. Where a particular variable rationally requires weighting or an additional variable requires consideration the model outcome is adjusted accordingly.

3 RESULTS

3.1 LITERATURE REVIEW

The ACR (2020) indicated that no bat species have previously been found within 100 km of the proposed site and as such no museum records have been collected for the area. The closest records are *Rhinolophus clivosus* (104 km from site) and *Laephotis capensis* (107 km from site). Based on Monadjem *et al*. (2020), the ACR (2020) and previous surveys conducted for WEFs in the area (Animalia 2011, Animalia 2017), 11 bat species could potentially occur in the AOI (Table 3-1), all of which are considered to be of Least Concern by the IUCN and are not endemic to South Africa. Two of these, *Laephotis capensis* and *Tadarida aegyptiaca*, were confirmed on the Khobab WEF site (Animalia, 2011) that was constructed just to the north of the Botterblom WEF project AOI. During the survey for the proposed Kokerboom WEF (Animalia, 2017), *L. capensis*, *Miniopterus natalensis* and *T. aegyptiaca* were commonly found in the area. In addition, *Myotis tricolor* and *Eptesicus hottentotus* were detected, but in low numbers. These species therefore have a high likelihood of occurring within the Botterblom project AOI. Finally, no nationally recognized protected areas exist within 100 km of the Botterblom WEF project area.

Table 3-1: Species of bats that could potentially occur in the project AOI.

Species name	Common name	Conservation Status	Foraging habits	Risk of Impact[2]
Laephotis capensis	Cape serotine	Least concern	Clutter-edge	Low
Laephotis namibensis,	Namibian long-eared bat	Least concern	Clutter-edge	Low
Rhinolophus clivosus	Geoffroy's horseshoe bat	Least concern	Clutter	Low
Rhinolophus capensis	Cape horseshoe bat	Least concern	Clutter	Low
Cistugo sebrae	Angolan wing-gland bat	Least concern	Clutter-edge	Low
Miniopterus natalensis	Natal longfingered bat	Least concern	Clutter-edge	High
Nycteris thebaica	Egyptian slit-faced bat	Least concern	Clutter	Low
Myotis tricolor	Temminck's myotis	Least concern	Clutter-edge	Medium to high
Eptesicus hottentotus	Long-tailed serotine	Least concern	Clutter-edge	Medium
Tadarida aegyptiaca	Egyptian free-tailed bat	Least concern	Open-air	High
Sauromys petrophilus	Robert's flat-headed bat	Least concern	Open-air	High

[2] MacEwan *et al*., 2020b

3.2 ACOUSTIC MONITORING

3.2.1 Passive monitoring

Six static bat detectors were deployed for the survey, four with the microphone at 7 m, one at 50 m and one at 100 m (Table 2-3). The bat detectors were active for a total of 19 822 hours and captured a total of 14 670 bat passes with a median of 0.14 bp/h (see details for each bat detector in Table 3-2). It must be noted that LSM1 did not record from the 11 November to 12 December 2020, LSM2 from 13 to 21 January 2021 and LSM3 from 8 October to 11 November 2020 (Figure 3-1; refer to the limitations in section 1.5). LSM6 was only deployed in March 2021, but as stipulated above, it will remain deployed and collecting data. Even with the downtime on the bat detectors, data were recorded for more than 75% of the monitoring year and as such comply with the minimum requirements regarding duration recorded (MacEwan *et al*., 2020b).

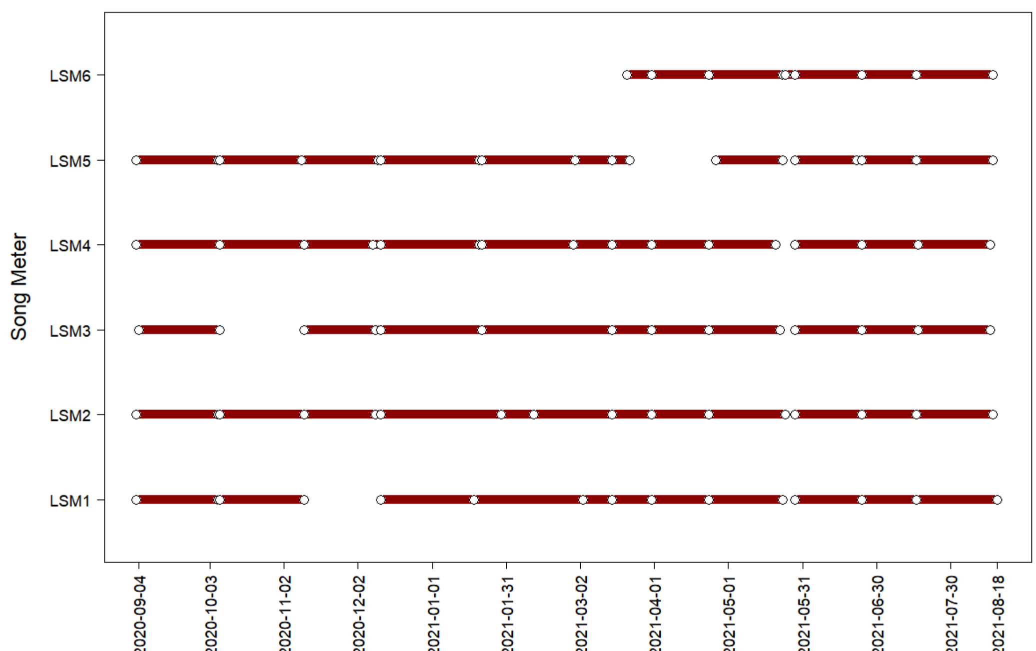


Figure 3-1: Active recording times for all bat detectors (song meters) deployed at Botterblom WEF showing periods of downtime.

Table 3-2: Summary bat recording data for each of the deployed bat detectors.

Bat Detector ID	Microphone Height	Total bat passes	Time recorded (hours)	Median bat passes/hour	Average bat passes/hour
LSM1	7 m	4641	3271	0.23	1.32
LSM2	50 m	5125	3895	0.24	1.23
LSM3	7 m	716	3610	0.07	0.18
LSM4	7 m	1185	3767	0.00	0.29
LSM5	7 m	2924	3369	0.50	0.86
LSM6	100 m	785	1910	0.00	0.38

3.2.1.1 Passes by Bat Recorder

Bat activity increased steadily after sunset and was highest between 20:00 and 1:00 (Figure 3-3). Bat activity tends to be high in the period directly following sunset due to bats leaving their roosts, and the pattern observed here could suggest that bats do not roost on or near the project AOI but take some time to reach the area from roosts that are located further away. The high activity detected directly after sunset at LSM5 indicated that there are potentially bats roosting close to this detector. However, if bats did roosts close to LSM5 activity would be expected to peak again just before sunrise, and as such it is possible that this is just the first section on the AOI that bats traverse through at night on their route to foraging areas. The average and median recordings of hourly bat passes per microphone were 0.73 (range: 0.18-1.32) and 0.14 (range: 0.00-0.50) respectively. There is a distinct peak in bat activity during November and April, and this is especially pronounced for LSM1 and 2 (Figure 3-4). This could indicate that bats move through the area during that time, using the eastern section on the AOI as a fly through. These two months are times when many bats migrate between winter roosts and maternity colonies (Pretorius *et al.,* 2020), and these migratory patterns could be the reason behind the patterns observed. There is, however, no evidence that there is a maternity colony present in close proximity to the AOI since an increase in bat activity would have been observed throughout the summer period as pups mature and start foraging, and as such it is expected that only winter roosts are located close to the area. Mortality of bats at WEF has also been correlated with insects migrating through an area at height (Rydell *et al*., 2010), and this could be a possible explanation for the peak in activity observed during April (see 3.2.1.4).

Seasonal activity was highest between autumn and spring (Figure 3-5), suggesting that bats move out of the area, or forage elsewhere, during the dry summer and cold winter months, and that there are no breeding colonies present on the project AOI. Activity was relatively high during summer at LSM5. This is the only area on the AOI with more complex vegetation and is located in a large drainage line, and it is thus possible that bats prefer the area around LSM5 as foraging grounds during these months. Average bat activity was highest at LSM5, as well as LSM1 and 2 around the met mast, indicating that these areas are preferred foraging zones for bats (Figure 3-6). Viewed in isolation, there is no obvious explanation for increased activity in the area around the met mast as this area does not differ in a significant manner from the surrounding landscape. However, LSM5 and the two bat detectors on the met mast were positioned in close proximity to the main road passing through the project area (Figure 2-1). It is hypothesised that bats may be using this road as a north-south flyway and foraging in a broad strip adjacent to the main road. There are four main contributing factors influencing this suggested hypothesis:

1. Vegetation and insects - Rainwater runoff from roads onto the road verges and absence of sheep and goats to graze on the road verges promotes vegetation growth and associated insect abundance. This is a well-documented phenomenon in arid regions where vegetation and associated insect diversity and abundance has been shown to be greater on the road verges (using ants as a proxy; Tshiguvho *et al*, 1999) and raptors preferentially forage in these areas (Accipitridae and Falconidae not attracted to roadkill but rather greater productivity of road verges for prey; Dean & Milton, 2003). It is therefore plausible that bats may preferentially forage along the productive road verge;
2. Lighting and insects - several sources of light along the main road may offer improved foraging opportunities for bats due to insects being attracted to these lights. The Helios substation, the aviation lights on the met mast (LSM1&2), the guard house at the entrance of the Khobab WEF and the internal Khobab substation all produce lighting capable of attracting insects (Figure 3-2). In a large open landscape with very limited light sources in the surrounding landscape, these lights are visible from great distances and could therefore attract many insects on a regular basis. Bats are quick

to learn of such resources and exploit them. Since these light sources are arranged in a linear configuration along the road it is plausible that bats would move along the road between these light sources on a regular basis for foraging purposes;

3. North-South flyway corridor - while there are no obvious roosting sites within the project area for bats, the large rocky ridges to the south of the project area likely offer suitable roosting habitat (Figure 3-2). The most likely northward flyways for foraging bats exiting roosts from these rocky ridges would be a combination of using the major vegetated riverbed and/or the main road (Figure 3-2). Given the potential insect attractants along the main road discussed above, it is plausible that bats moving in a north-south axis would most likely need to utilise the road and road verges to safely pass between the Khobab and Loeriesforntein2 WEFs, situated to the north of the project area.
4. Bats are known to use linear features to orientate themselves between foraging sites and roosts (Altringham, 2011) and have been shown to use roads and road verges specifically as flyways towards foraging sites (Ramalho *et al*., 2021). It is therefore plausible that the main road could be used by bats as a guide to known areas where they forage or for migration betwee their roosting sites. In addition, these linear features could themselves be used for foraging (Downs and Racey, 2006).

Given the above, it is considered prudent to buffer the main road appropriately (200 m) from development infrastructure and activities other than the crossing by access roads, in order to maintain the hypothesised foraging patterns and potential flyway between the existing and planned WEFs.

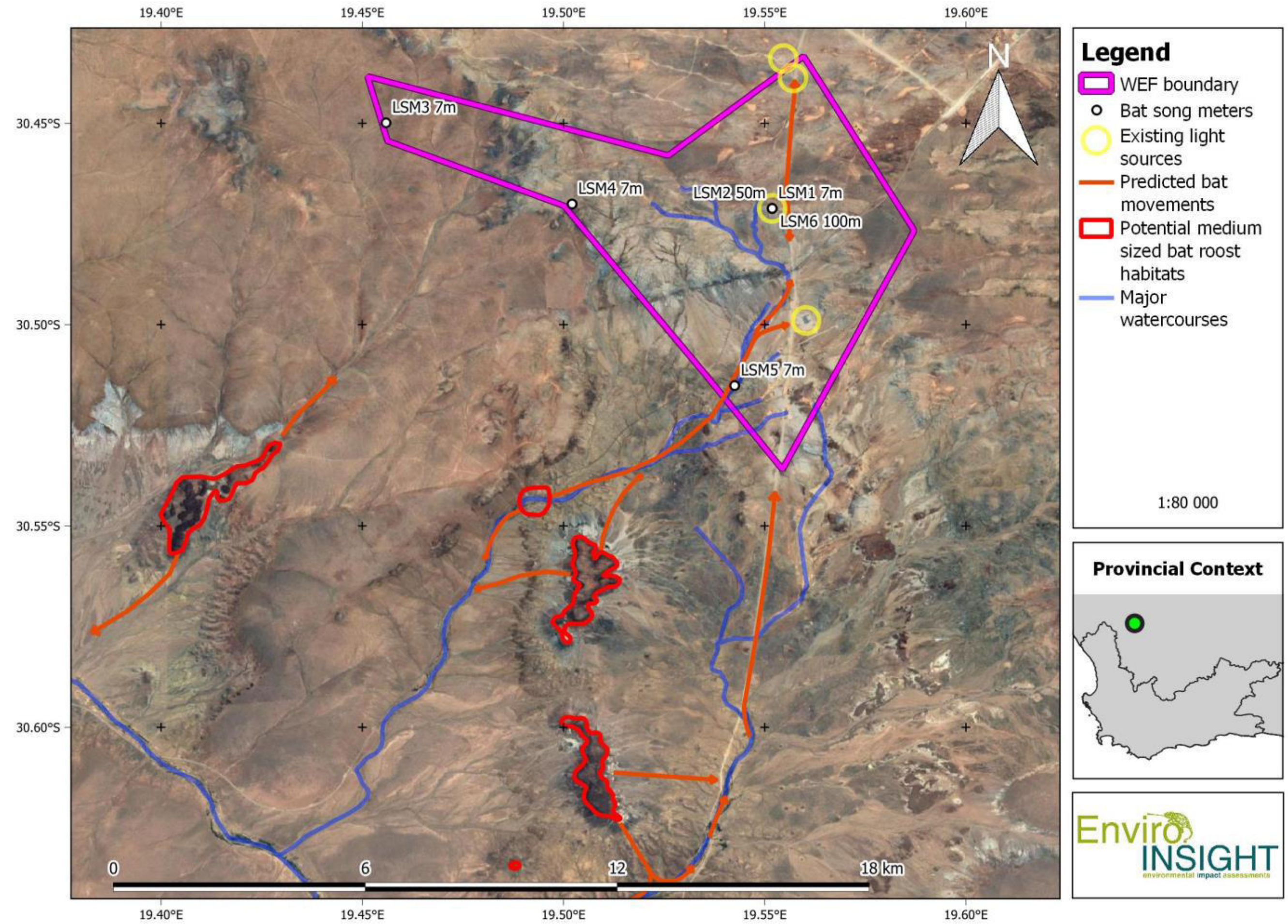


Figure 3-2: Predicted roosts and movement patterns for bats in relation to existing light sources and the proposed Botterblom WEF.

Based on the SABPG (MacEwan *et al*., 2020b) for the Nama Karoo Shrublands ecoregion, analogous to the Gariep Karoo ecoregion as defined by Dinerstein *et al.* (2017; see Figure 1-4), a median of between 0.18 and 1.01 bp/h over the entire sampling period classifies as a Medium Risk for fatalities and above 1.01 as a High Risk. The highest median bp/h recorded at a specific detector over the entire sampling period was ~ 0.5 at LSM5 (Figure 3-6), while the median bp/h for the whole project area was 0.14, which suggests that the project area in general represents a Low Risk for bat fatalities, but that there are certain areas/habitats which represent a Medium Risk for bat fatalities.

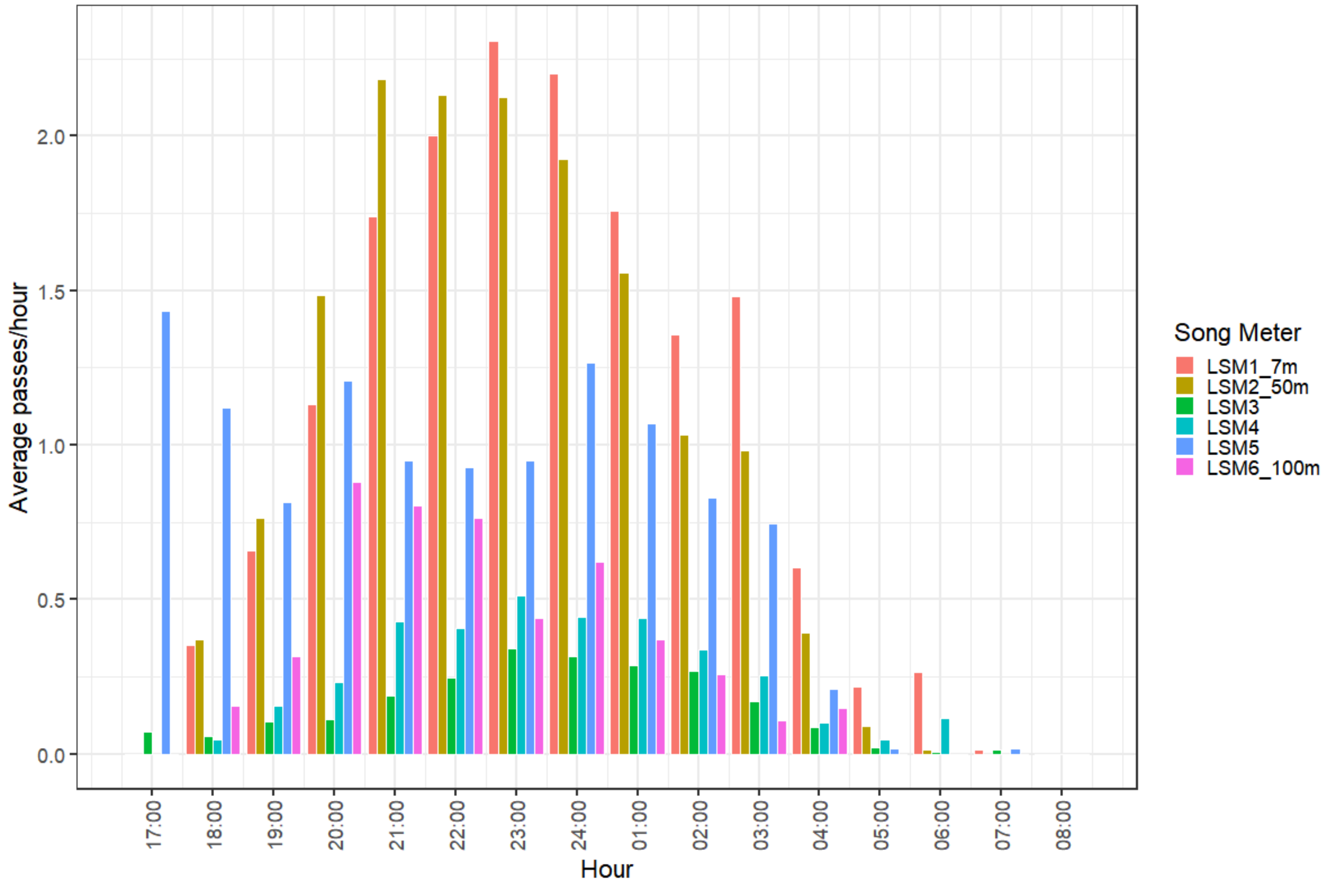


Figure 3-3: Hourly average activity of bats per bat detector.

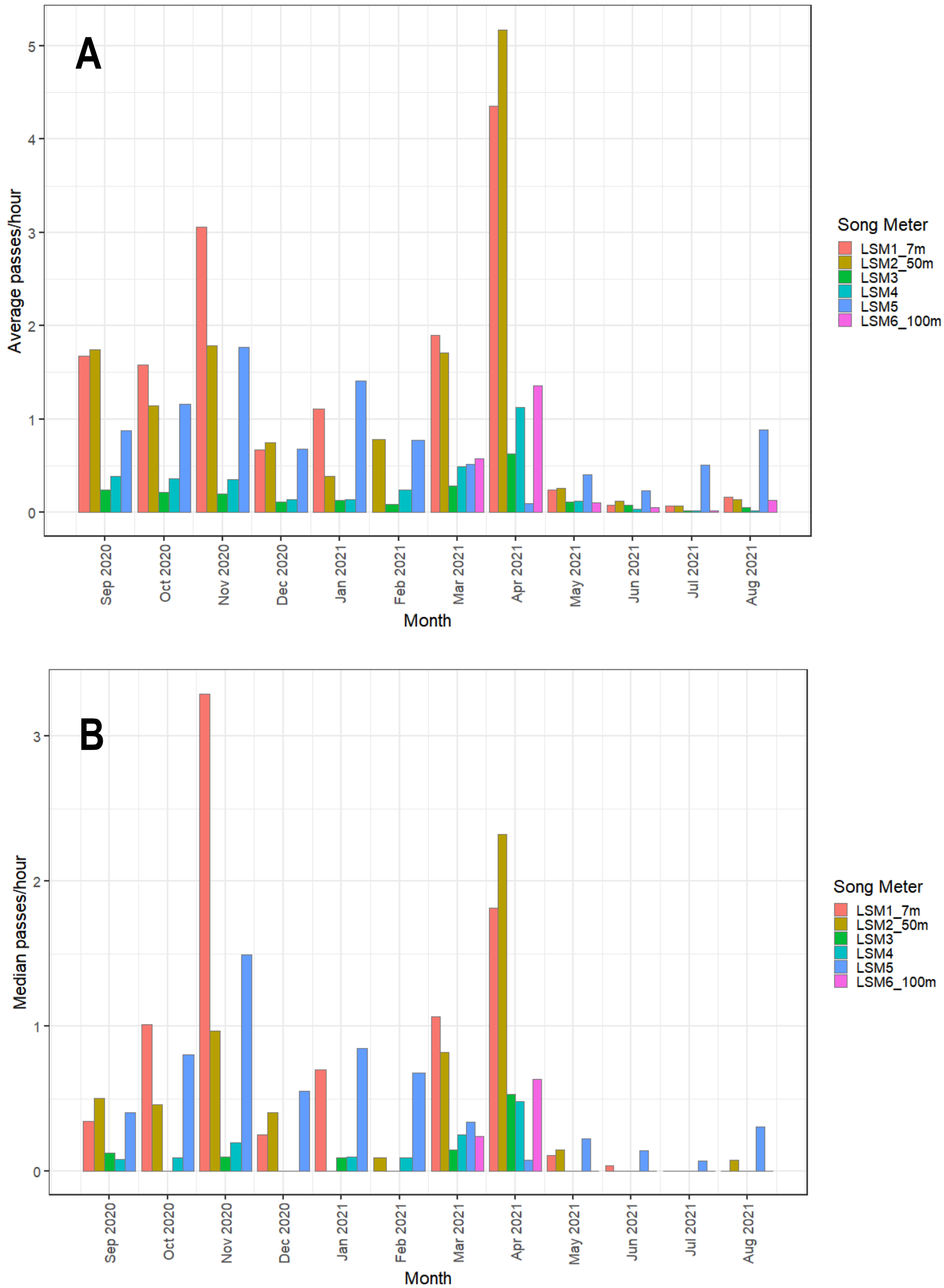
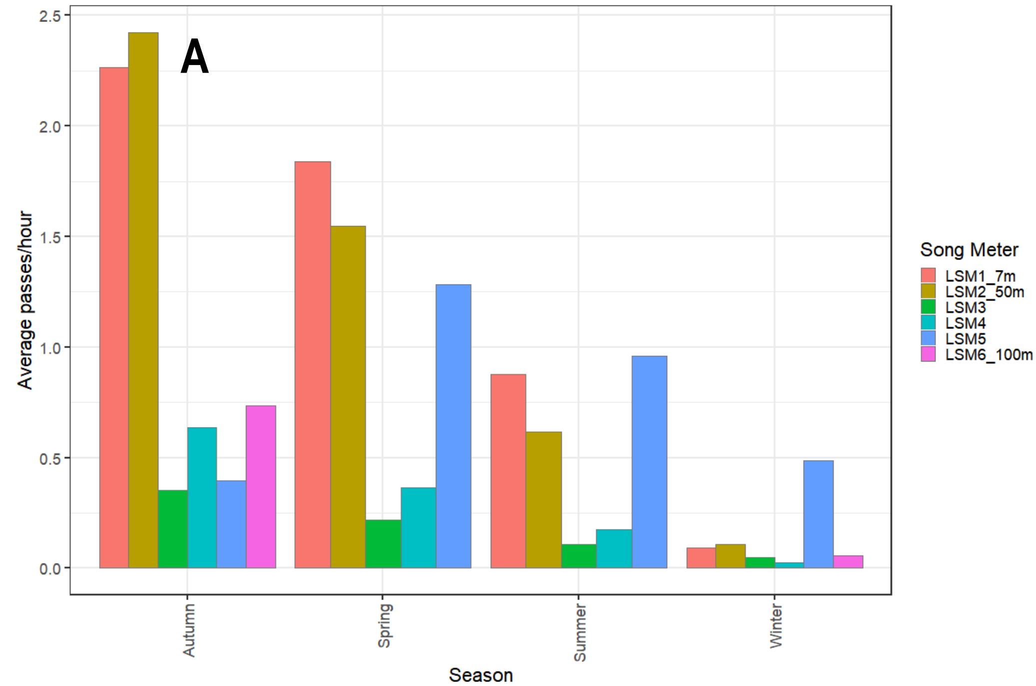


Figure 3-4: Monthly recordings of echolocation calls of bats per bat detector. A] average bp/h B] median bp/h.



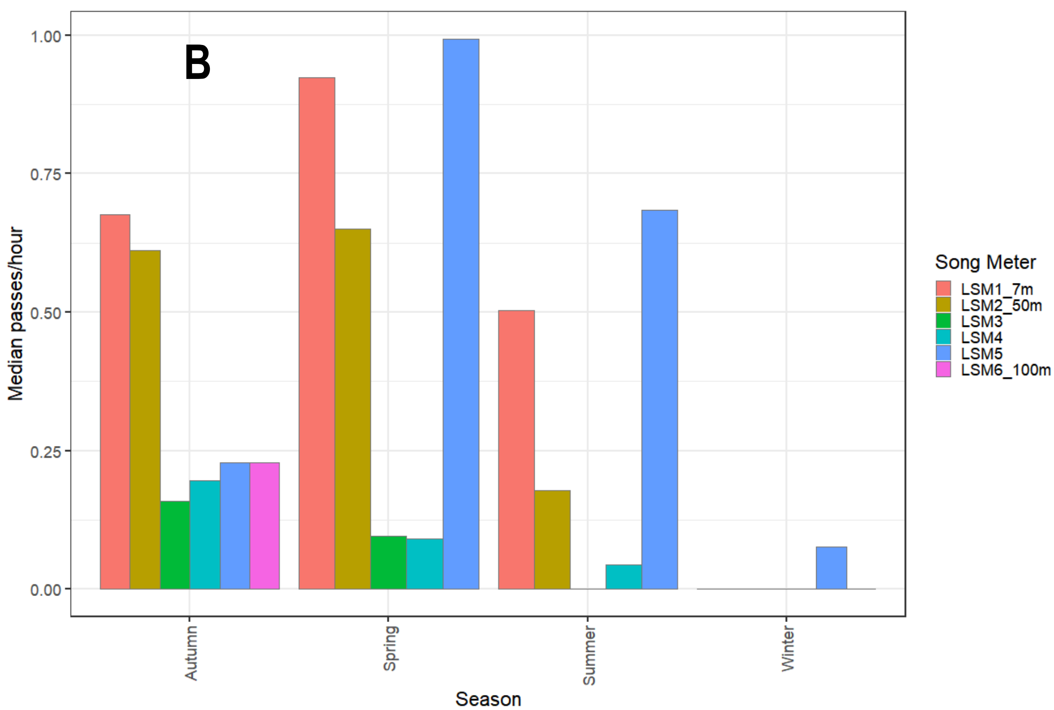


Figure 3-5: Mean seasonal recordings of bat passes per bat detector. A] average bp/h B] median bp/h.

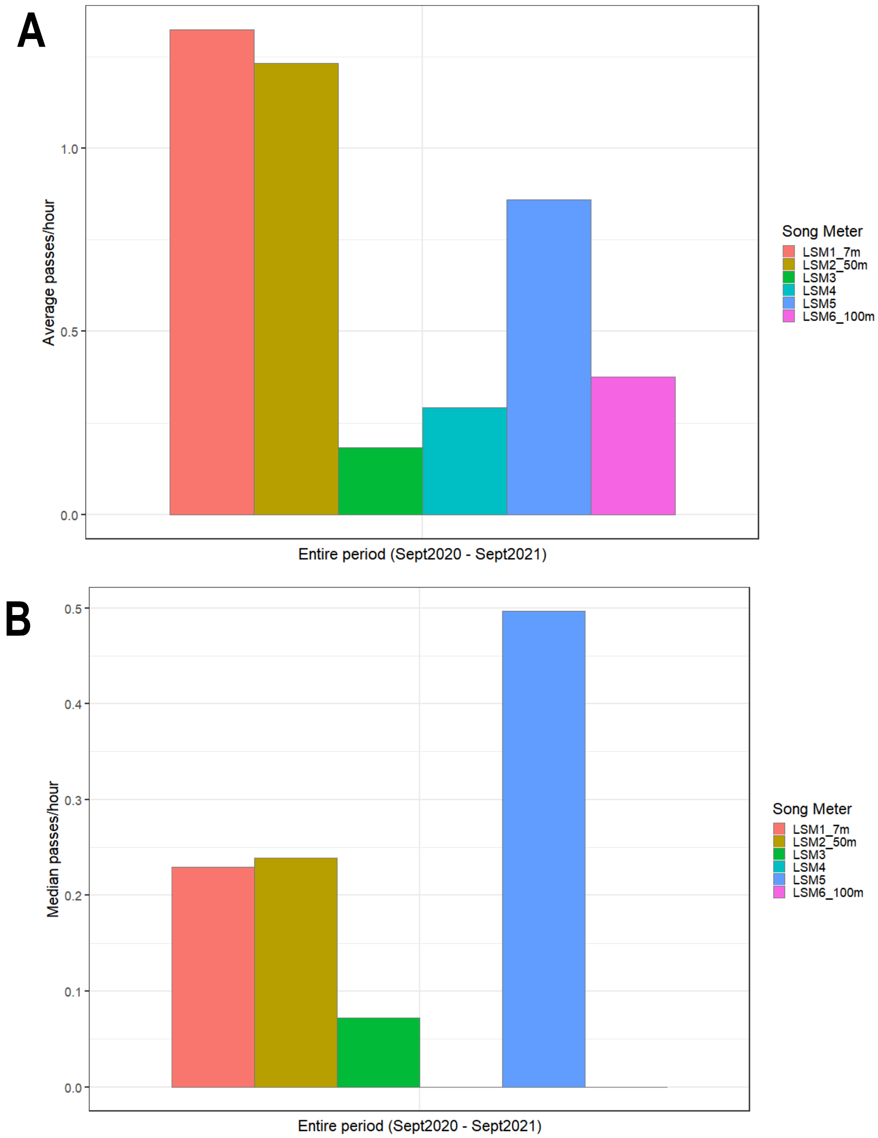


Figure 3-6: Mean yearly recordings of echolocation calls of bats per bat detector. A] average bp/h B] median bp/h.

3.2.1.2 Passes by species

Three bat species were recorded by the bat detectors during the Sep 2020 – Sept 2021 survey period (Figure 3-7; Table 3-3), all of which are listed as Least Concern on the IUCN Red Data List, are not regarded as ToPS species, are not CITES listed or endemic to South Africa (IUCN, 2021). Due to uncertainty in the identification of calls between call T. aegyptiaca and S. petrophilus these two species were grouped together for all analyses. These two species were the most detected species in the area with a total of 14 480 passes and a median of 0.10 bp/h, followed by L. capensis with a total of 190 passes and a median of 0 bp/h (

Table 3-4). *Tadarida aegyptiaca* and *S. petrophilus* are open-air foragers, and this habitat structure thus provides excellent foraging opportunities for these species. *Laephotis capensis* is a clutter-edge forager, and the lack of a more complex vegetation structure does not suite their foraging requirements. As such it is expected that their presence in the project area will be limited. However, *Laephotis capensis* has been known to roost in houses, and buildings on or close to the AOI could thus provide roosting sites for this species. *Tadarida aegyptiaca* and *S. petrophilus* will roost in rock crevices and because the project area lacks suitable habitat these species are expected to roost outside of the project area.

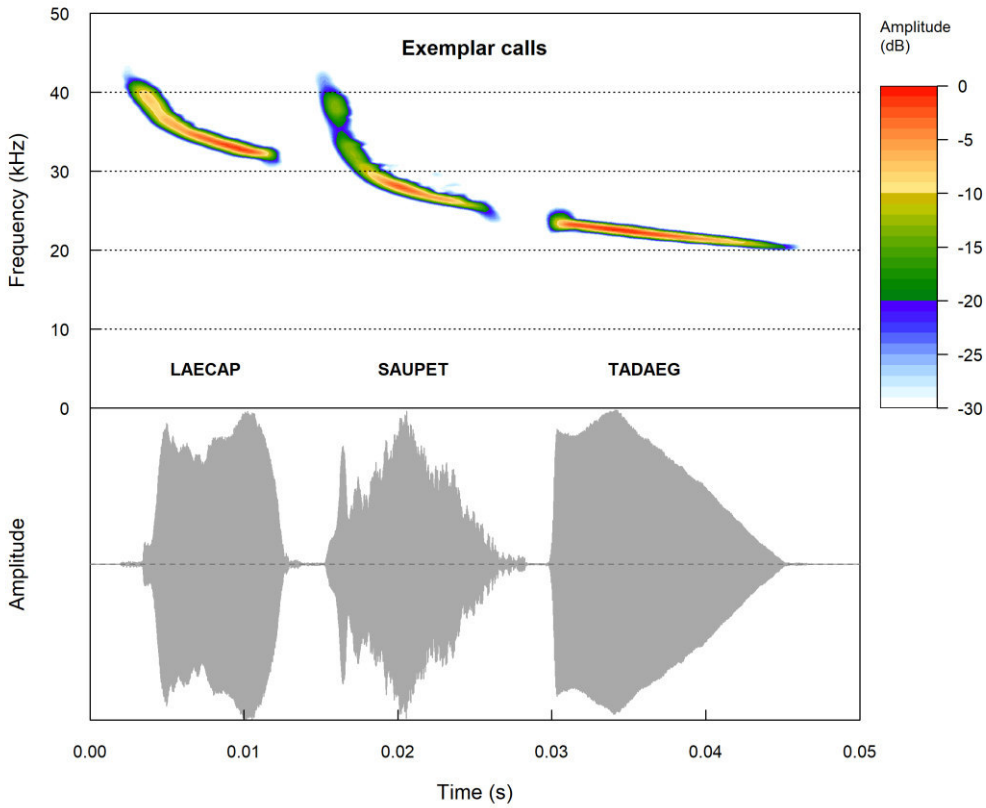


Figure 3-7: Exemplar recordings for each of the three bat species recorded during the monitoring survey.

Table 3-3: Confirmed bat species[3] during static monitoring with additional information.

Species	IUCN Red List Status	Likely risk of wind turbine mortality	Endemic
LEOCAP	LC	Low	No
SAUPET	LC	High	No
TADAEG	LC	High	No

Table 3-4: Bat activity during static monitoring for species groups identified from basic cluster analysis[4].

Species	Sum of passes	Median passes/hour	Average passes/hour
LEOCAP	190	0	0.009
TADAEG and SAUPET	14 480	0.101	0.724

[3] LEOCAP: *Laephotis capensis*, SAUPET: *Sauromys petrophilus*, TADAEG: *Tadarida aegyptiaca*
[4] LEOCAP: *Laephotis capensis*, SAUPET: *Sauromys petrophilus*, TADAEG: *Tadarida aegyptiaca*

Nightly activity patterns of *T. aegyptiaca* and *S. petrophilus* shows a similar pattern to that observed in Figure 3-3 with the activity peaking between 21:00 and 01:00. Due to *T. aegyptiaca* and *S. petrophilus* being recorded substantially more often than *L. capensis*, their activity pattern will strongly influence the collated observed results. (Figure 3-8).

Monthly activity patterns show activity levels of *T. aegyptiaca* and *S. petrophilus* peaking during November after which it declines substantially, and again peaks during April 2021. This is similar to the patterns observed in Figure 3-4, and again indicates activity in the area either by a peak in foraging activity or movement through the area by migrating bats. The low levels of activity between Nov 2020 and April 2021 would, however, suggest that *T. aegyptiaca* and *S. petrophilus* do not breed in the area. Activity was again low during the winter months, and it is thus possible that the area is also not suited as a winter roost for large bat colonies. The most likely scenario is that the AOI falls on a migratory flight path for these species, and that there are small colonies present around the AOI which use the area as foraging zones. Considering the heightened activity observed at LSM1, LSM2 and LSM5 during periods of migration it is likely that the eastern section of the project area forms part of the migratory route.

Seasonal activity of all three species is higher during autumn and spring than summer and winter when considering average bp/h (Figure 3-10), similar to the data presented in Figure 3-5. The overall activity for all bat species reveals that the median is low throughout the year, with around 0.10 bat pass per night for *T. aegyptiaca* and *S. petrophilus* combined (Figure 3-11), which places the project AOI in a Low Risk of collision area based on the SABPG (MacEwan *et al*., 2020b), which defines a median of between 0.18 and 1.01 bp/h as a Medium Risk for fatalities and above 1.01 as a High Risk, in the for the Nama Karoo Shrublands ecoregion.

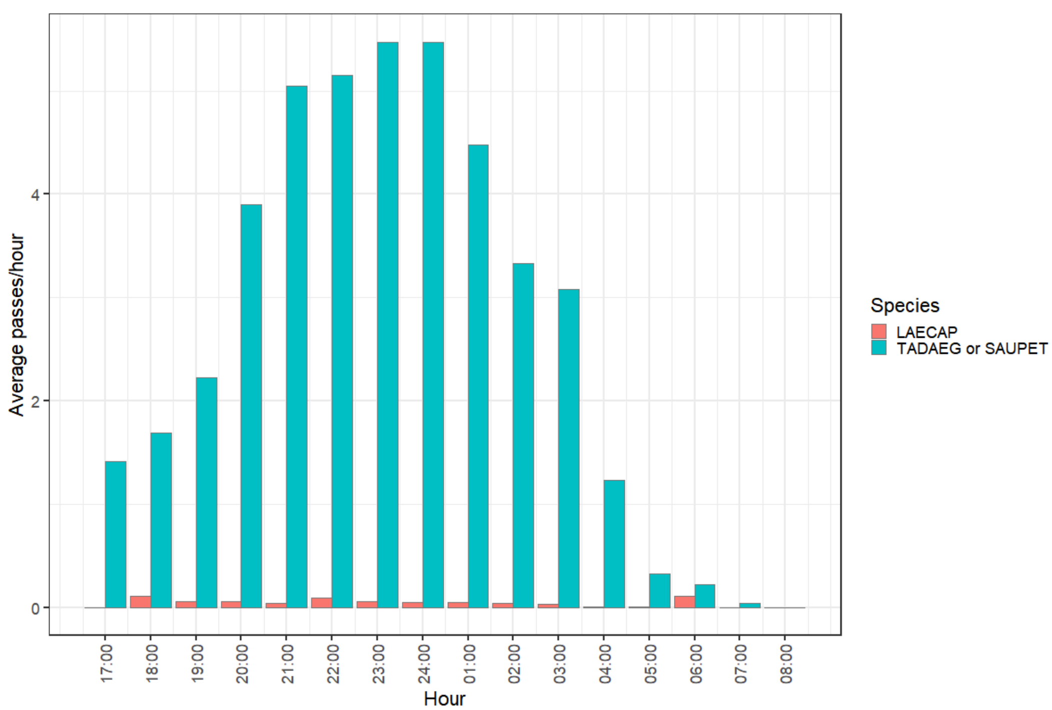


Figure 3-8: Average hourly activity of bats per species.

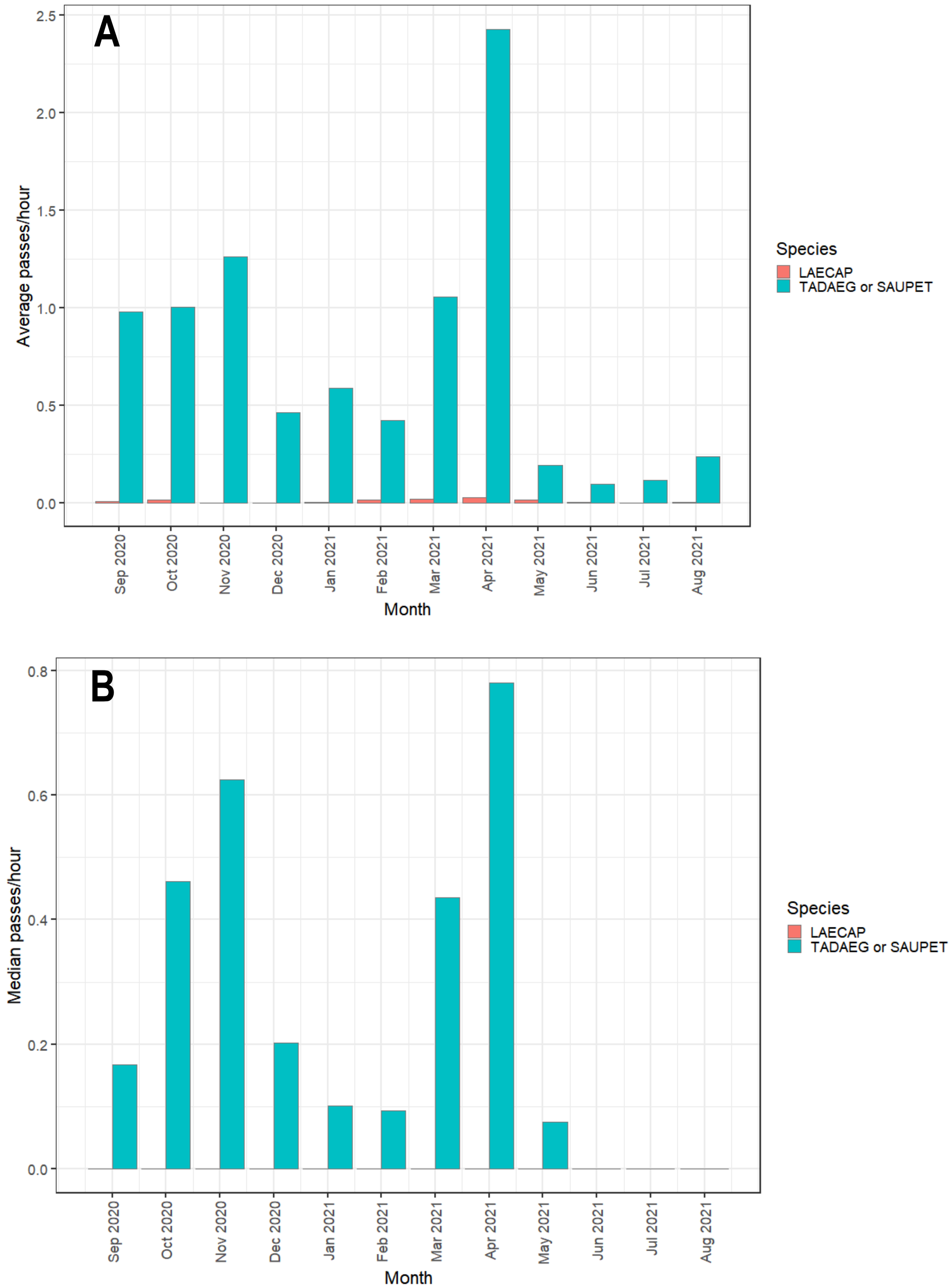


Figure 3-9: Monthly recordings of echolocation calls of bats per bat species. A] average bp/h B] median bp/h.

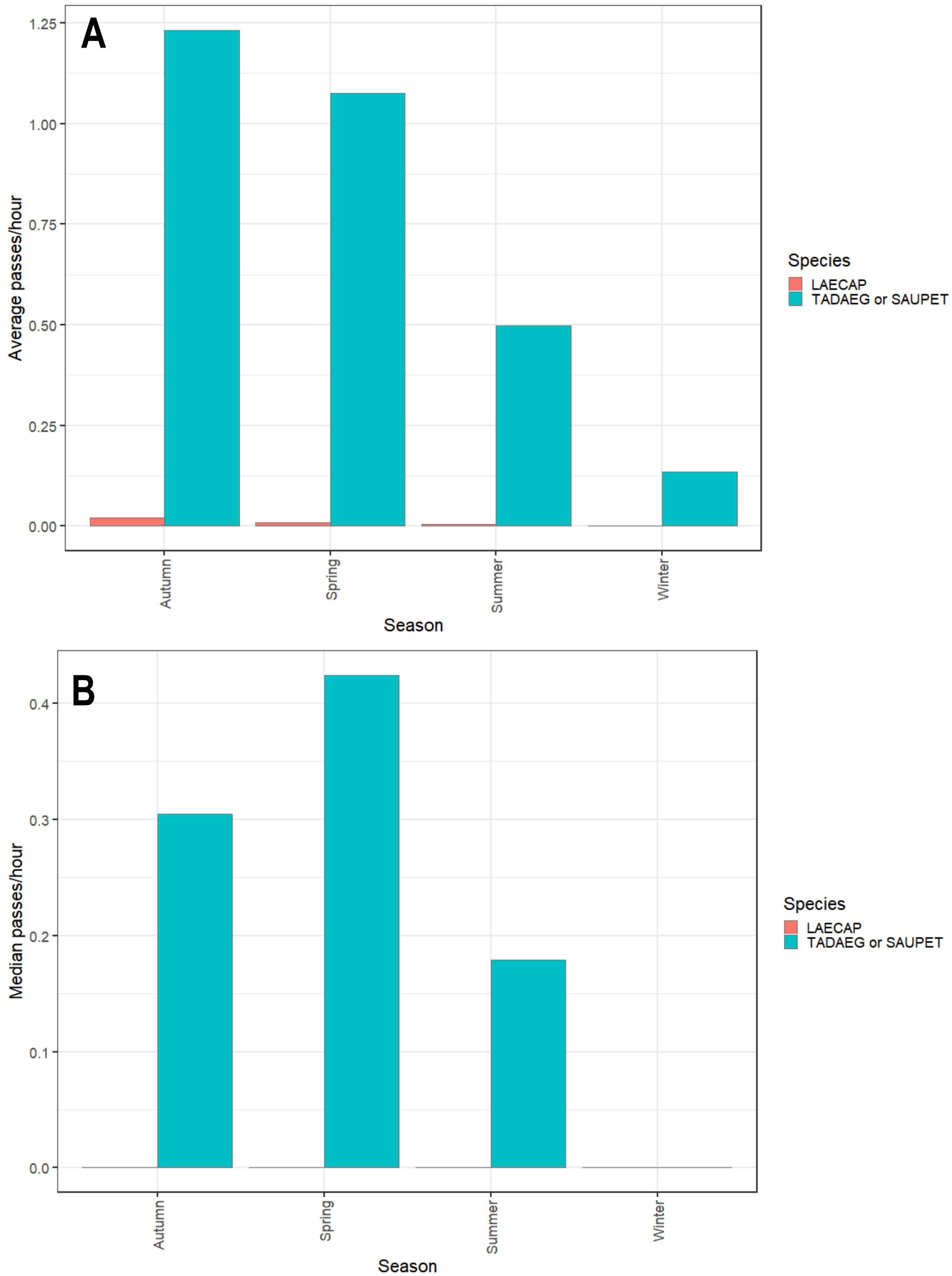


Figure 3-10: Mean seasonal recordings of bat passes per bat species. A] average bp/h B] median bp/h.

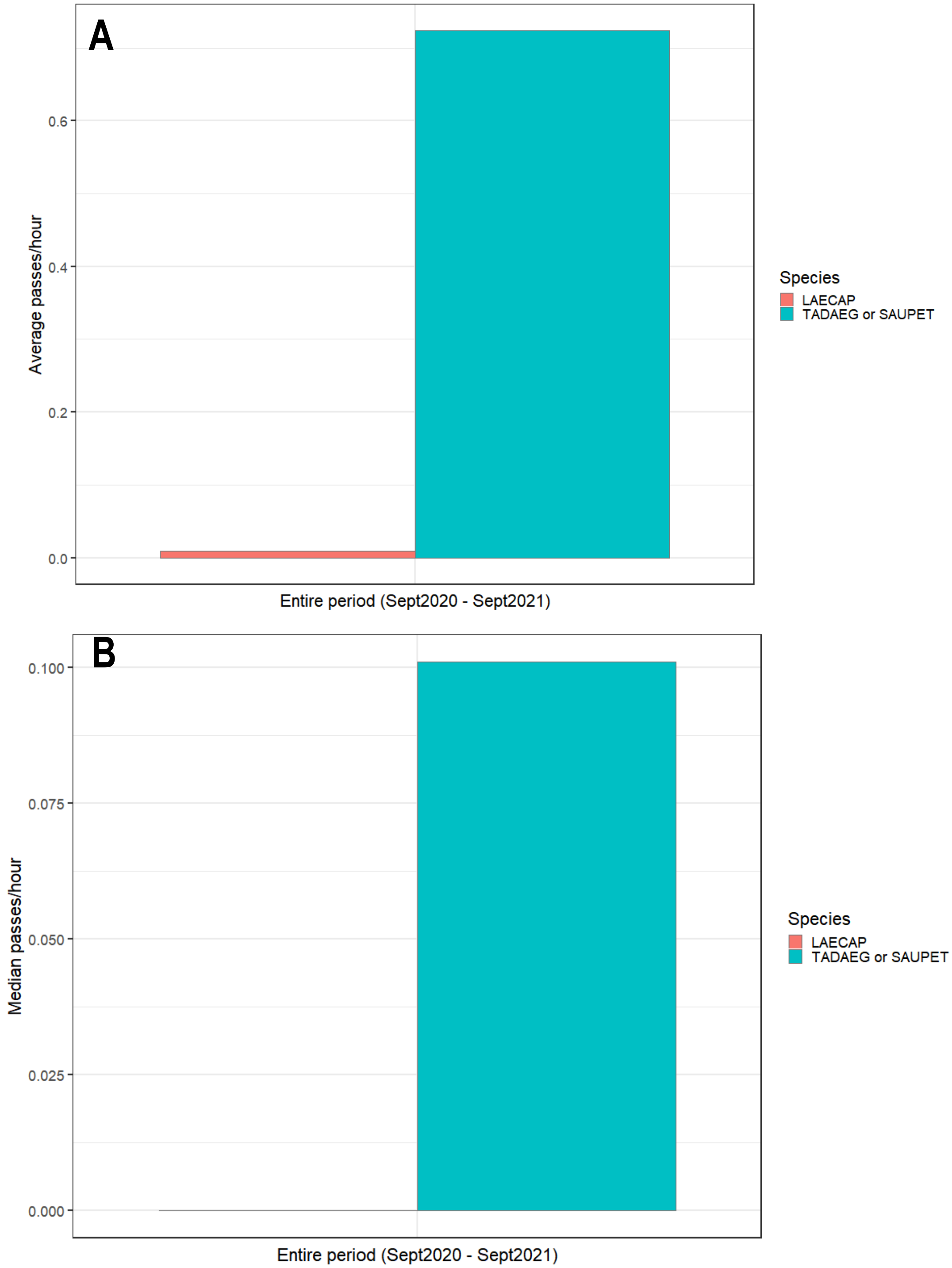


Figure 3-11: Mean yearly recordings of echolocation calls of bats per bat detector. A] average bp/h B] median bp/h.

3.2.1.3 Passes at height

Bat activity was higher at the microphone deployed at 50 m than the 100 m microphone and all microphones deployed at 7 m combined (Figure 3-12), but similar between the 50 m (LSM2) and 7 m (LSM1) bat detector pair (Figure 3-13). The bat detector placed at 50 m recorded a median of 0.24 bp/h, while in comparison, the median for all the combined 7 m bat detectors only recorded 0.10 bp/h, and the 7 m microphone at the same geographic location as the 50 m recorded a median of 0.23 bp/h. This suggests that the location of the bat detector has a greater influence on bat activity recorded than height, and that at this location bats, specifically *T. aegyptiaca* and *S. petrophilus* divide their foraging time equally between ground level and at height. The lower activity observed for all bat detectors at ground level (7 m) is most likely due to the lower levels of activity observed in the western section of the project area. *Laephotis capensis* was more commonly recorded at the 7 m microphone (average of 0.66 bp/h) than the 50 m microphone (average of 0.0015 bp/h), due to their clutter-edge foraging behaviour, flying close to the ground and not flying at height as much as either *T. aegyptiaca* or *S. petrophilus.*

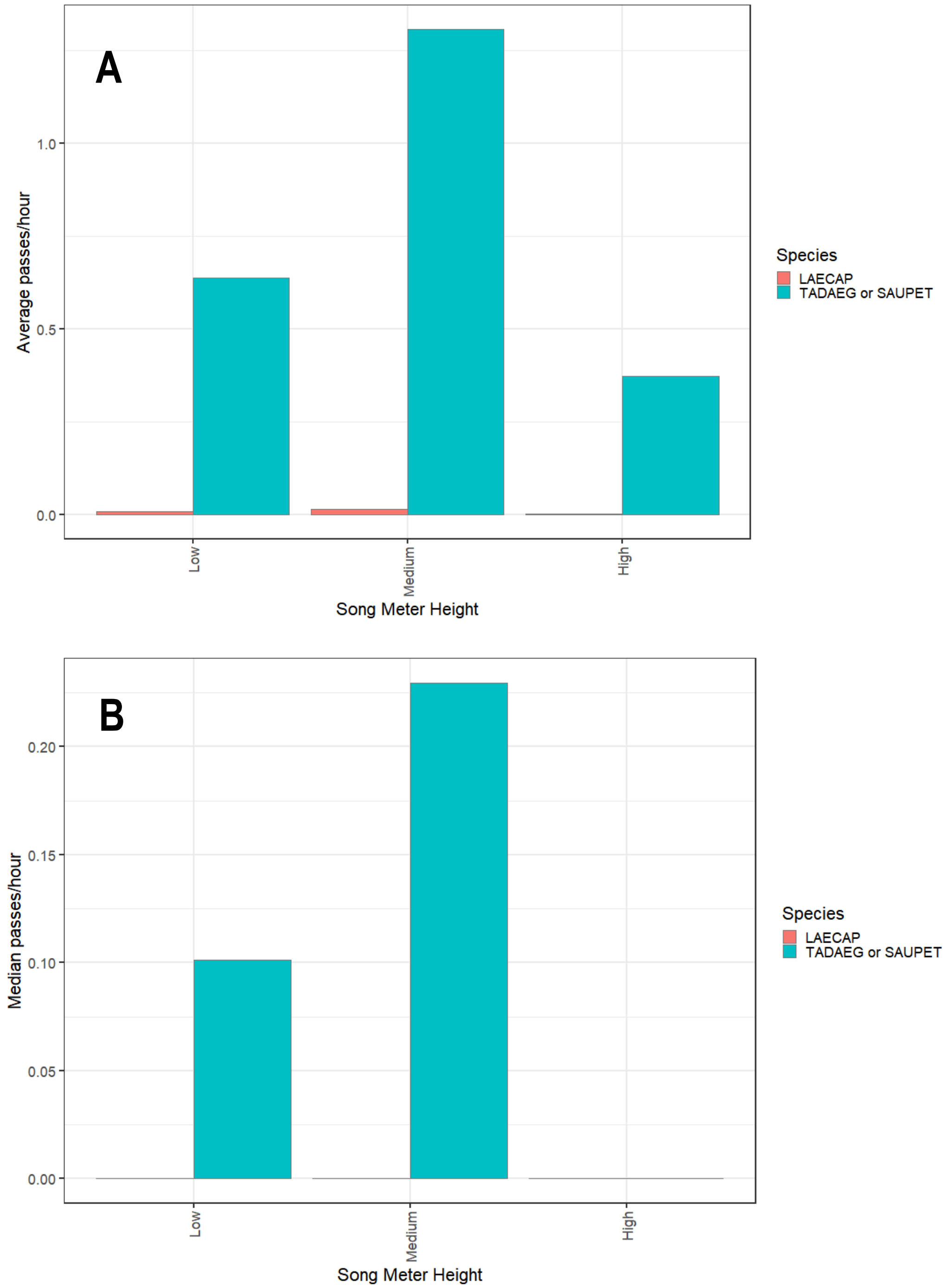


Figure 3-12: Bat activity comparison between all bat detectors (song meters) at different heights. A] average bp/h B] median bp/h.

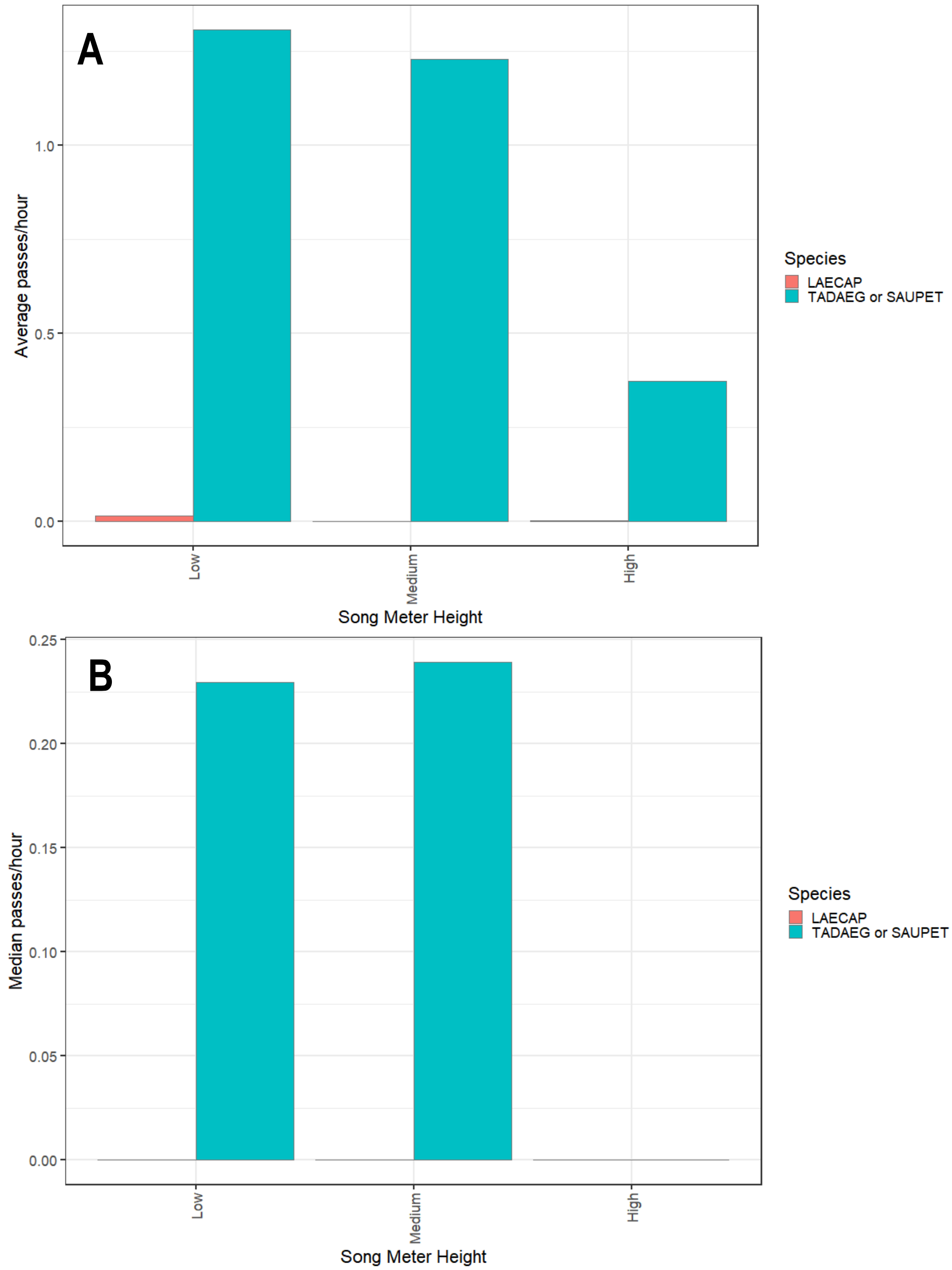


Figure 3-13: Bat activity comparison between the high (LSM6: 100 m), medium (LSM2: 50 m) and low (LSM1: 7 m) bat recorders (song meters) at the same geographic location. A] average bp/h B] median bp/h.

3.2.1.4 Environmental variables and bat activity

Unfortunately, rainfall data was not available for the monitoring period and only wind speed, temperature, relative humidity and barometric pressure were measured and could be used as environmental variables. An overview of the bat activity in relation to the environmental variables is shown in Figure 3-14 and detailed plots are provided in 7.1 Appendix 1: Detailed plots of bat activity in relation to environmental variables.

Wind speed did not clearly influence bat activity (Figure 3-14) and showed little variation across the monitoring period with a fluctuation of ~2 m/s in mean wind speed across the 12-month monitoring period (Figure 7-6). It is highly unlikely that this variation can account for the observed variation in bat activity.

Temperature, barometric pressure (BP) and relative humidity (RH) are strongly related and show similar (albeit inverted for RH) fluctuations over time (Figure 3-14). It appears that an increase in temperature and BP along with a resultant decrease in RH during April, initiates a sharp increase in bat activity patterns. To understand this effect better in the absence of rainfall data, we calculated vapour pressure deficit (VPD[5]), which is a much better measure of the "dryness" of air than RH as it negates the effect of temperature. A low VPD indicates air that is nearly saturated with vapour pressure and therefore has a low "drying power". A VPD of 0 and a RH of 100% occur when it is raining. The low VPD concomitant with increased bat activity in early April 2021 (Figure 3-14 and magnified in Figure 3-15) indicates the presence of much moisture in the air despite the low RH. An increase in temperature accompanied by moisture is generally associated with a large frontal system which pushes warm air in front of it causing the observed increase in temperature, barometric pressure and VPD followed by a drop in barometric pressure and temperature but not VPD. It is therefore likely that this event was the first major frontal system of the rainfall season which triggered an increase in bat activity. In South Africa it has been found that bat migration is related to photoperiod rather than climatic conditions (Pretorius *et al.*, 2020), and is thus likely that the increase in bat activity was due to an eruption of insects (e.g. moths and/or termite and ant alates) which in turn triggered increased feeding activity. It is thus possible that the few days of increased activity during April 2022 were once-off events not linked to migration, but the November activity peaks may be attributable to migration events. Although this observed increase in activity may be indirectly attributed to the described environmental variables, it does not appear to be a sufficient increase in activity directly related to specific environmental variables with sufficient predictability to warrant mitigation measures under these environmental conditions.

While it has been shown for certain bat populations that bat activity increases during low wind speeds and high temperatures (Amorim *et al*., 2012), no such effect was observed during the pre-construction monitoring period and changes in bat activity observed could be more easily ascribed to seasonal dependence.

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[5] VPD was calculated as follows. First, saturation vapour pressure (SVP) is calculated at the temperature (T):
$\text{SVP (Pascals)} = 610.7*10^{7.5T/(237.3+T)}$ followed by the calculation of VPD from relative humidity (RH): $\text{VPD} = ((100 - \text{RH})/100)*\text{SVP}$

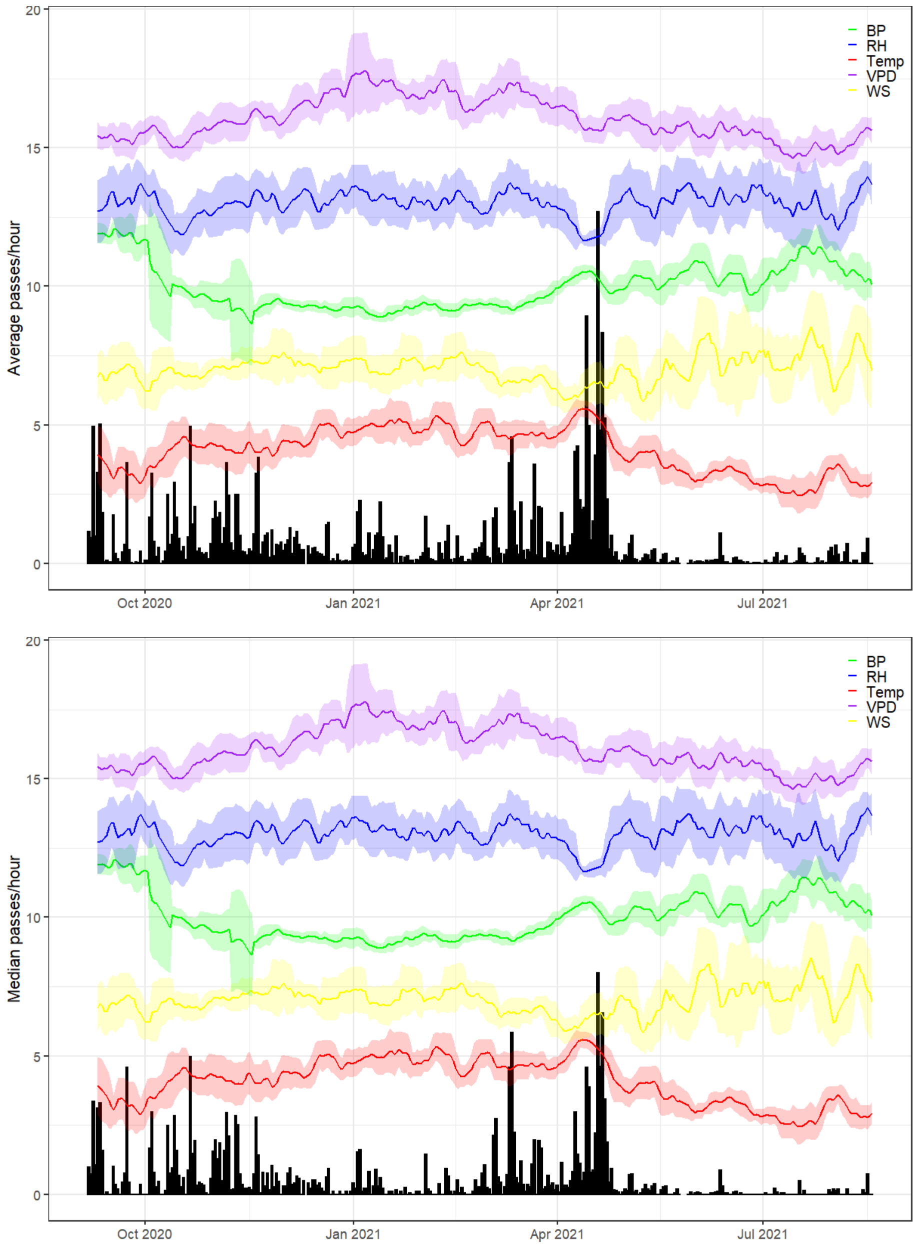

Figure 3-14: Overview of bat activity (bp/h) in relation to rescaled environmental variables[6] shown as centered moving averages and 1 standard deviation (window = 10 days). Average (top) and median (bottom) bp/h.

6 BP = barometric pressure; RH = relative humidity; Temp = temperature; VPD = vapour pressure deficit; WS = wind speed

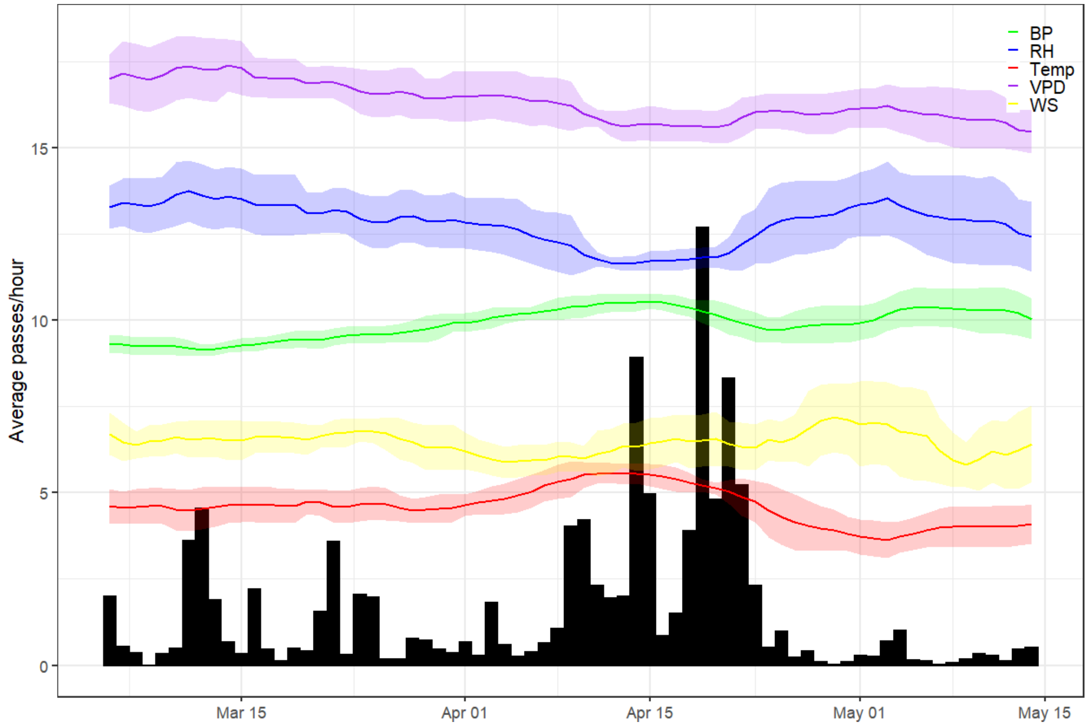

Figure 3-15: Magnified view of increased bat activity (bp/h) in relation to rescaled environmental variables[7] shown as centered moving averages and 1 standard deviation (window = 10 days).

3.2.2 Active Monitoring

Because roads were limited within the project AOI and portions thereof were driven/walked on multiple nights, transect effort was calculated as the number of times a particular area was traversed (Figure 3-16). In total, 115 echolocation calls were recorded during all seasons with most bats recorded during spring (Table 3-5). No pattern of activity for *T. aegyptiaca* could be detected and this species was detected across the entire AOI (Figure 3-16). *Sauromys petrophilus* were detected on only ten occasions and these were spread out across the project AOI. *Laephotis capensis* was only detected on four occasions, and all these records were on the road next to the railway line. This might indicate that *L. capensis* forages mostly in the area around the railway, potentially because there are more structures associated with the railway line, including culverts and pylons. During summer, too few calls were recorded to make any inferences, but during autumn activity was higher in the western section of the project AOI and mostly outside of the boundary of the proposed WEF. Winter transects indicated that activity was fairly spread out across the project AOI. During spring most of the calls were recorded within the boundary of the project AOI.

[7] BP = barometric pressure; RH = relative humidity; Temp = temperature; VPD = vapour pressure deficit; WS = wind speed

Table 3-5. Bat species recorded during each season on the Area of Influence

Season	*T. aegyptiaca*	*S. petrophilus*	*L. capensis*	*T. aegyptiaca* or *S. petrophilus*	Total	Average passes/hour
Summer	4	0	0	0	4	0.63
Autumn	21	0	0	0	21	2.69
Winter	16	0	0	1	17	3.11
Spring	51	10	4	8	73	8.67
Total	92	10	4	9	115	4.10

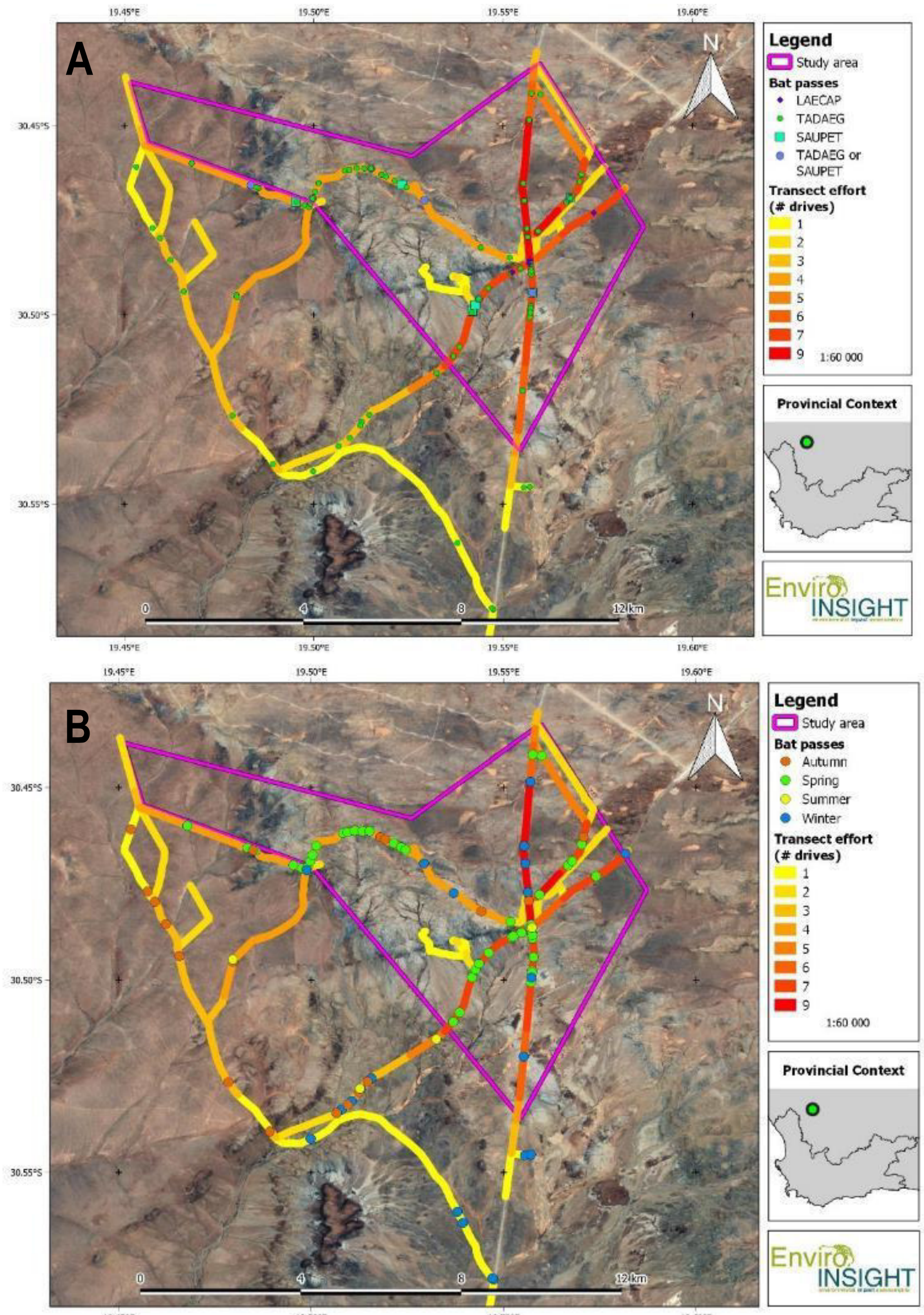

Figure 3-16: The sampling effort of active transects and detection of bat passes during active transects. Areas with high sample effort have a proportionally higher likelihood of detecting a bat pass[8]. A] species of bats detected B] bat calls per season.

[8] LAECAP: *Laephotis capensis*, SAUPET: *Sauromys petrophilus*, TADAEG: *Tadarida aegyptiaca*

3.3 ROOSTING SITES

The surrounding topography does not lend itself to cave structures and no mention was made of large roosts or caves in any previous surveys. Ten potential roost sites were investigated for the presence of bats (see dates in Table 2-2), and at four of these signs of bats were present (Table 3-6; Figure 3-18). A single *N. thebaica* was found near a homestead (LR8) approximately 15 km from the study site. This species was never recorded by the bat detectors, but since they are known as "whispering bats" with low intensity calls this is not surprising (Monadjem *et al*., 2020). LR2 and LR9 are located close to each other, but both are outside of the WEF boundary. At both of these sites the presence of bats was detected, with echolocations calls of *T. aegyptiaca* or *S. petrophilus* recorded at LR2 and a dead bat, identified as *L. capensis* based on a forearm length of 33.4 mm, found outside of LR9 (Figure 3-17). Bat droppings were detected on the floor in an abandoned farmhouse (LR5), but no bats were seen or recorded over multiple seasons at this site. This site is therefore probably not a permanent roost but could act as a night roost for bat species. Other potential roosts sites were identified and are discussed below.

Table 3-6: The details of bat roost inspections.

Roost id	Habitat feature	Latitude (°)	Longitude (°)	Bat presence
LR1	Railway road underpass	-30.486504	19.557184	None
LR2	Railway road overpass	-30.541286	19.490915	TADAEG or SAUPET recorded
LR3	Railway water underpass	-30.503408	19.540763	None
LR4	Railway in-cut banks	-30.540895	19.491753	None
LR5	Abandoned farmhouse	-30.47576	19.564543	Bat droppings observed
LR6	Natural rock outcrop	-30.489887	19.537563	None
LR7	Existing homestead	-30.544862	19.492741	None
LR8	Existing homestead	-30.59227348	19.69595265	*Nycteris thebaica*
LR9	Existing homestead	-30.59227348	19.67191502	Dead bat found next to house
LR10	Existing homestead	-30,5449	19,49274	None

Figure 3-17: Bat carcass collected at LR9.

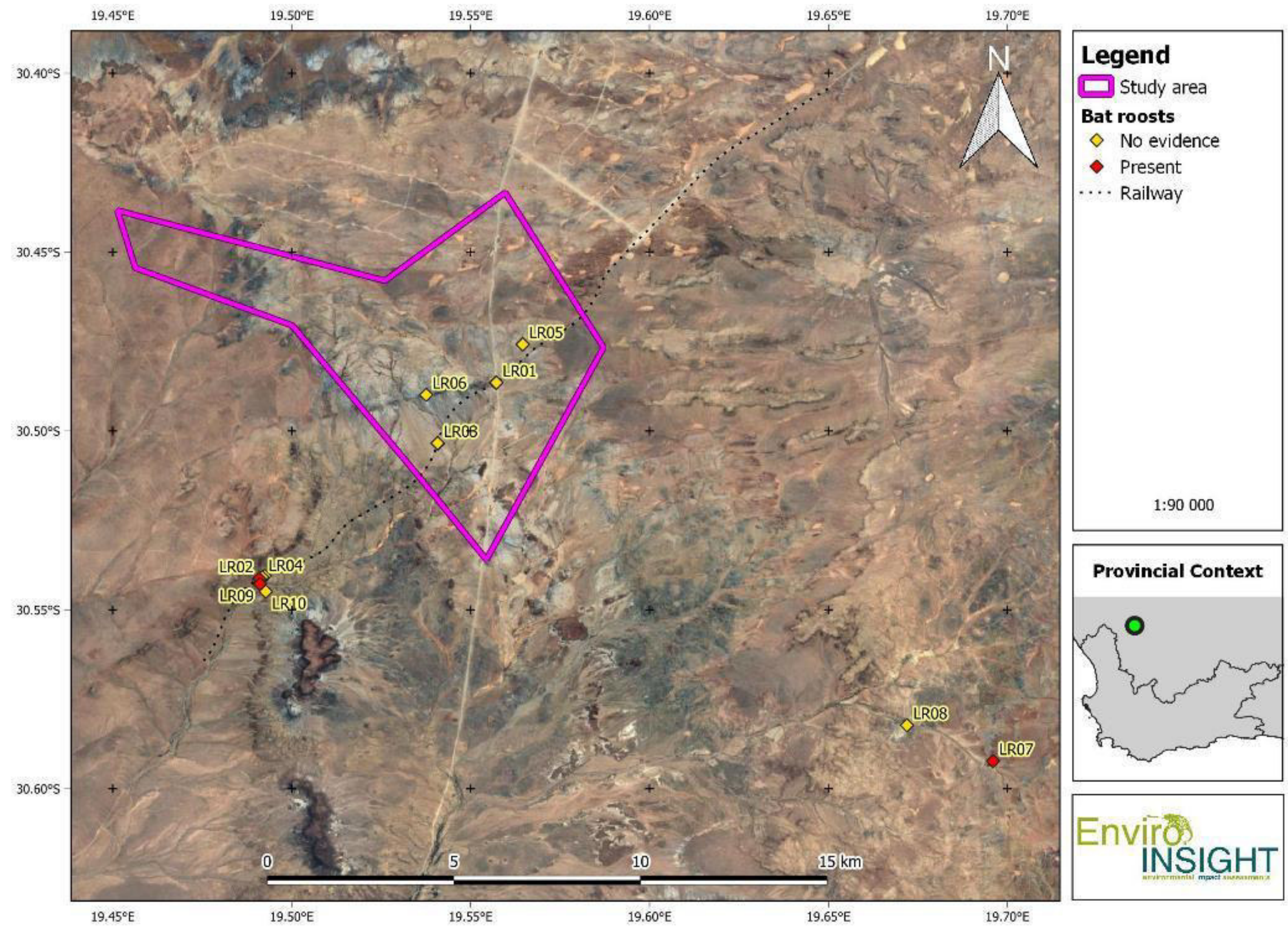

***Figure 3-18: Potential roost sites investigated for the presence of bats*[9].**

3.3.1 Railway roosts

The railway bisects the project area from north-east to south-west and is used for the transport of ore to the coast. Various infrastructure is associated with the railway that includes water underpasses, road underpasses, road overpasses and in-cut banks into the bedrock.

Water underpasses are common along the length of the railway and usually consist of multiple sections of round concrete pipes (Figure 3-19). The seams of the connections between the pipes have a gap that may be suitable for bats to roost, and occasionally open into the foundational rubble under the railway track. A number of these pipes were investigated during the day for bats, but none were observed.

[9] NYCTHE: *Nycteris thebaica*

Figure 3-19: Photographs of the railway water underpasses and features relevant for potential bat roosts.

There is a single road underpass and overpass within and adjacent to the project area which are constructed from concrete and has various seams and cavities that could be used as bat roosts (Figure 3-20;Figure 3-21). No bats were observed within the seams, but the structures could not be comprehensively searched from the ground.

Figure 3-20: Photographs of the railway road underpass and features relevant for potential bat roosts.

Figure 3-21: Photographs of the railway road overpasses and features relevant for potential bat roosts.

In-cut banks that were incised to make the railway level have exposed a shale-like bedrock adjacent to the project area (Figure 3-23). These rock faces are characterised by long, and in some cases, deep cracks and crevices that could be used by bats as roosting sites.

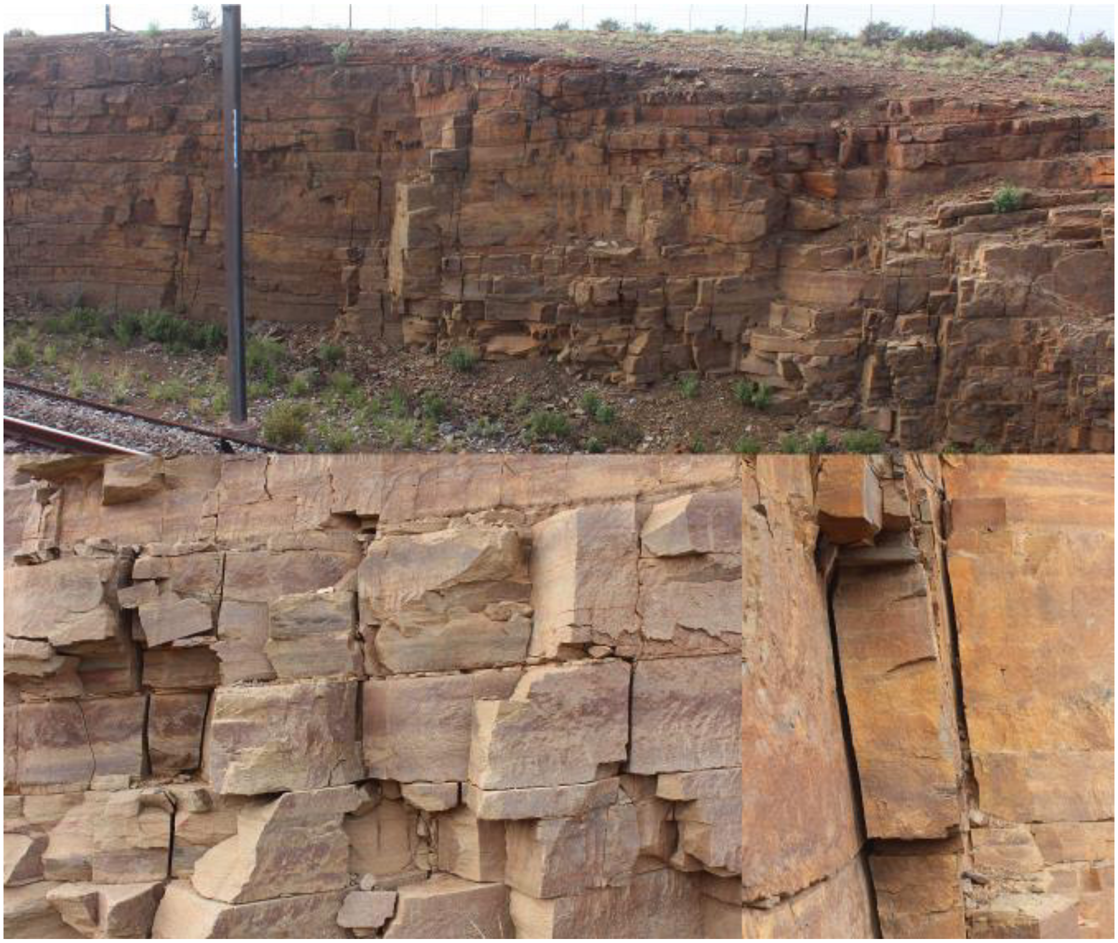

Figure 3-22: Photographs of the railway in-cut banks showing crevices relevant for potential bat roosts (LR4).

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3.3.2 Abandoned / unused farmhouses

Only one abandoned farmhouse is present on the project area in a dilapidated state with little structure. However, there are ceilings in two of the rooms with some gaps that might allow bats to roost (Figure 3-23). The ceilings could not be extensively investigated during the day without destructively sampling the building. Bat droppings were found inside the house, but it is unlikely to act as a roost for a large colony.

Figure 3-23: Photographs of the abandoned farmhouse and features relevant for potential bat roosts (LR5).

3.3.3 Existing / used farmhouses

A large homestead approximately 14.9 km west of the project area was identified during the scoping phase (Figure 3-24). t may provide suitable features for roosting bats.

Figure 3-24: Aerial image of the homestead showing numerous buildings with potential for providing bat roots (LR9). These buildings are approximately 14.9 km west of the project area.

3.4 SENSITIVE BAT FEATURES

During the 12 month monitoring period the median number of bat passes per hour across the site was 0.14, which classifies the current project area as a Low Risk for bat collision based on the SABPG (MacEwan *et al*., 2020b) for the Nama Karoo Shrublands ecoregion. The bat detector placed at 100 m in the rotor sweep zone had a median of 0.00 and average of 0.38 bp/h, which again (according to the median) classifies this as Low Risk for bat collisions. It must, however, be stated that this detector has only been active for eight months and a more informed conclusion will be drawn after a full 12 months of monitoring, although it is unlikely that a full 12 month period will result in a different bat collision risk classification, given the data collected from the other two bat detectors on the same met mast with microphones at different heights. All considered, the proposed WEF is likely to have an overall low impact on bats in the area. Nevertheless, based on static bat detectors, driven transects and roost inspections, sensitive areas have been identified that should be buffered and excluded from development. Certain habitats are expected to have a higher abundance of bats due to their potential for roosting, foraging and migration routes and should be viewed as sensitive. As per the SABPG (McEwan *et al*., 2020) no turbines or any other structure, including infrastructure and major roads, may be constructed within 200 m of bat sensitive areas.

The bat detector (LSM5) placed in the largest water course had a median of 0.50 bp/h, which was the highest for any bat detector deployed in the project area. These water courses, although mostly dry and episodic, nevertheless provide a seemingly greater density of vegetation that remains green for longer than the vegetation of the surrounding plains and therefore, are likely of importance for bats as a foraging resource because vegetation is required for their insect prey to feed on. While these water courses are only classified as a Medium Risk, it is recommended that a 200 m buffer be placed around all the large water courses. Smaller water courses do not seem to support habitat that provides adequate foraging opportunities. This is evident from the low number of bp/h detected at LSM3 which is situated next to one of these smaller water courses. The area around the met mast (LSM1/2/6) also had a comparatively high number of bp/h. The median bp/h for the LSM 1 (7 m) and LSM 2 (50 m) were above 0.18, indicating relatively high levels of activity that could potentially warrant application of buffers. However, as discussed above, the elevated activity detected for LSM1, LSM2 & LSM5 is hypothesised to be due in part to the proximity to the main road and consequently, it is recommended that a 200 m buffer be placed around the main road as described in 3.2.1.1 Passes by Bat Recorder.

The driven/walked transects indicated that the railway line might offer foraging areas for clutter-edge foragers. In addition, while no roosting bats were detected, the buildings and culverts associated with the railway could act as roosts for bats. As such it is recommended that a 200 m buffer be implemented around the railway line.

Evidence of bats was found only at the abandoned farmhouse (LR5) and inhabited houses (LR9). Although no roosting bats were observed at these sites they are used at times by bats, either as a roosting site or a night roost and possibly for foraging too. A 200 m buffer is thus recommended for the abandoned farmhouse within the project area (LR5). Despite no evidence of bats detected at other infrastructure on the project AOI, a precautionary 200 m buffer was implemented around each of these as bats may have been overlooked and could potentially use such infrastructure as night-time roosts. LR9 falls outside of the project area and therefore the buffers are not applicable to the project.

It is clear from Figure 3-25, which maps the sensitive features for bats (with the appropriate 200 m buffer) within the project AOI, that the presence of sensitive bat features within the WEF boundary must be taken into account for the placement of the turbines and auxiliary infrastructure.

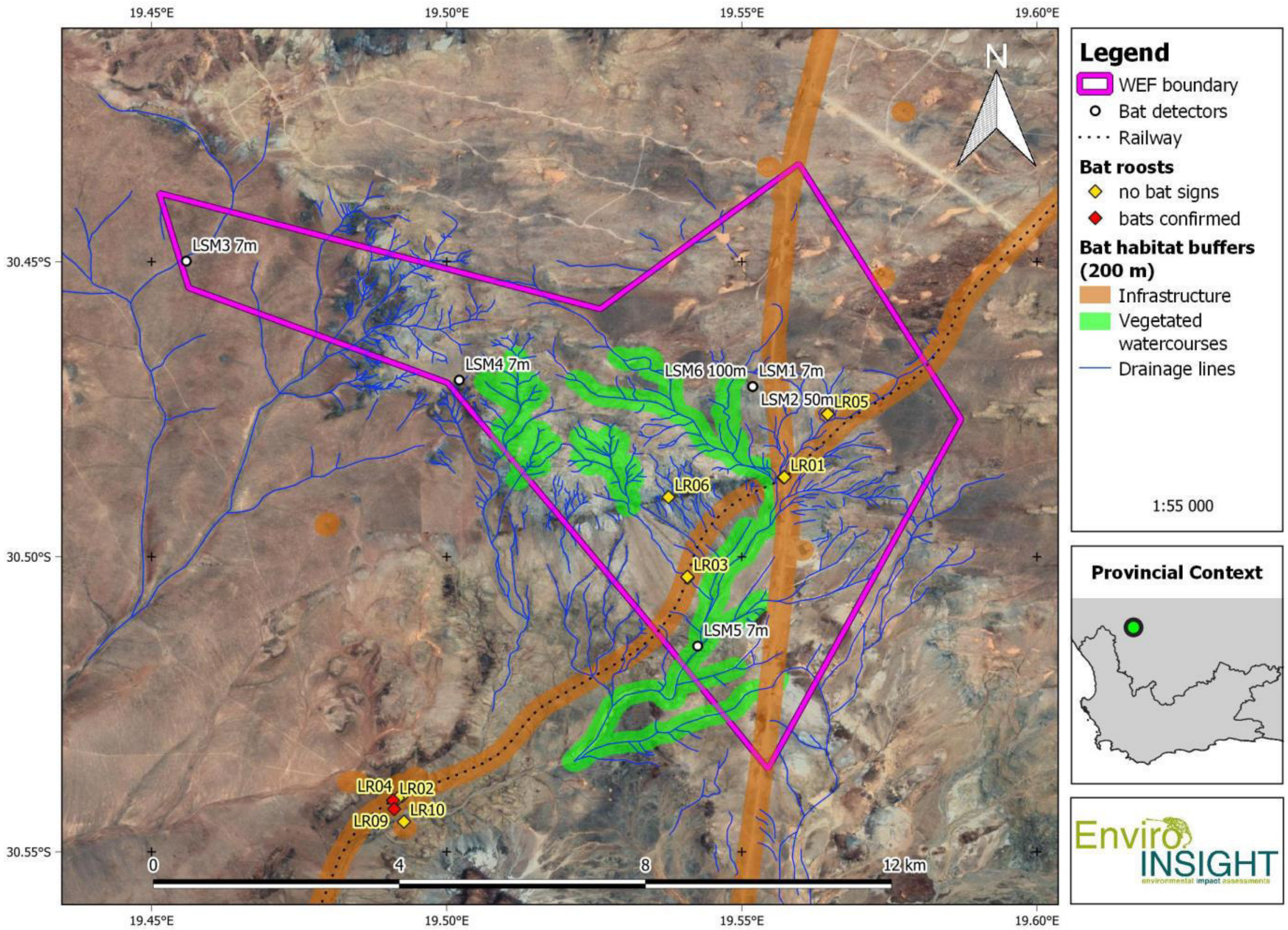

Figure 3-25: Sensitive bat features within the project AOI showing the appropriate buffers (200 m).

4 POSSIBLE IMPACTS

4.1 IMPACTS IDENTIFIED

Construction Phase:

- **Habitat destruction:** access roads and turbine or infrastructure construction may necessitate the removal of foraging habitat and sensitive bat features, such as migratory routes (Table 4-2).
- **Destruction or disturbance of bat roosts:** access roads and turbines or other infrastructure construction may necessitate the removal or disturbance of bat roosts (Table 4-3).

Operational Phase:

- **Bat mortality:** physical bat strikes and barometric trauma caused by spinning blades of the turbines during the operational phase (Table 4-4).

- **Artificial lighting:** Artificial lights can have a negative effect on bat behaviour by affecting flight paths used or attracting them to lights due to higher insect abundance and elevating the likelihood of collision mortality (Table 4-5).
- **Flight/migratory paths**: Turbines placed on pathways used for migration can have severe effects on bats moving through the area during times when bats move between winter and summer roosts (Table 4-6).

4.2 PROPOSED MITIGATION MEASURES

Habitat destruction: Apply necessary buffers (200 m) for roost sites and sensitive bat features, avoiding the construction of turbines, other infrastructure, clearing or laydown areas and access roads in these areas. Roads must follow existing farm roads as far as possible. It is recommended that NO development (including the full rotor swept zone of wind turbines) takes place within 200 m from larger watercourses.

Bat mortality: Avoid placement of turbines near sensitive bat features and roosts. Increase turbine cut in speed as this has been shown to reduce collisions (Arnett *et al.,* 2009). This will is especially relevant in the eastern section of the AOI since this section had higher bat activity and between the hours of 20:00 and 02:00 since this is when activity peaks. Apply adaptive mitigation measures according to post-construction monitoring results (counted strikes) informed by environmental correlates of bat activity, such as slowing or curtailment of strategic turbines during certain times or conditions.

Artificial lighting: With the exception of compulsory civil aviation lighting, minimise artificial lighting at night, especially high-intensity lighting, steady-burning, or bright lights such as sodium vapour, quartz, halogen, or other bright spotlights at sub-station, offices and turbines. Lights should be directed where needed to reduce spill-lighting into surrounding environments as far as possible. Use of non-UV lights is essential, as light emitted at one wavelength has a low level of attraction to insects. Where possible situate infrastructure requiring lighting close to the main road along the hypothesised flyway that already has artificial lighting alongside it (Figure 3-2).

Flight/migratory paths: Blanket curtailment, where turbine blades rotate at a slower rate during lower wind speeds or cut-in speed is increased, must be employed if any bat migration is detected during post construction monitoring as this has been shown to reduce bat mortalities (Adams *et al.,* 2021). Additionally, adaptive mitigation measures must be applied according to post-construction monitoring results (counted strikes) as well as informed by environmental correlates of bat activity, such as slowing or curtailment of strategic turbines during certain times or conditions. From the collected data there is an increased feeding response during April and November and there is some evidence to indicate that increased activity is associated with the first cold front of the season (see 3.2.1.4 Environmental variables and bat activity) and these periods should be targeted for most effective mortality mitigation.

4.3 CUMULATIVE IMPACTS

Several renewable energy development applications have been submitted and/or authorised within the immediate area of the proposed Botterblom WEF (Figure 4-1) which will likely already have a negative impact on bats in the region. Considering that there is already two WEFs to the north and north-east of the current site the proposed WEF will add to the impacts currently experienced in the greater area (magnitude currently unknown due to absence of mortality data, see 1.5 Assumptions and Limitations). Furthermore, several additional WEFs are being planned for this area based on approved environmental authorisations. As such, the results obtained during this survey should be considered in conjunction with the impacts created by these WEFs.

A major cumulative impact is expected by the creation of a long continuous front of turbines that seem to be orientated in rows along a NW to SE axis and that may block migratory pathways and result in mortalities of bats moving or migrating on the north to south axis (specifically SW to NE). Some provision for a flyway that excludes turbines should be considered for the region, especially if future WEFs are proposed on the east to west axis. Based on results obtained during this survey it appears that bats are utilising specific landscape features in the eastern section of the project AOI as flyways, such as the larger watercourse, and therefore it is recommended that this section is left open (without turbines) so that it can be maintained as a flyway. With a number of potential WEFs being planned in the area future, surveys should consider similar landscape features and incorporate existing flyways from neighbouring WEFs to reduce bat mortalities across the area. Furthermore, it is recommended that SABAA obtain bat mortality data from post-construction monitoring surveys of all the WEFs to evaluate this impact, consolidate evidence to gain better insight into seasonal migrations in the region and propose necessary mitigation measures, since no single WEF is likely to be able/willing to do this.

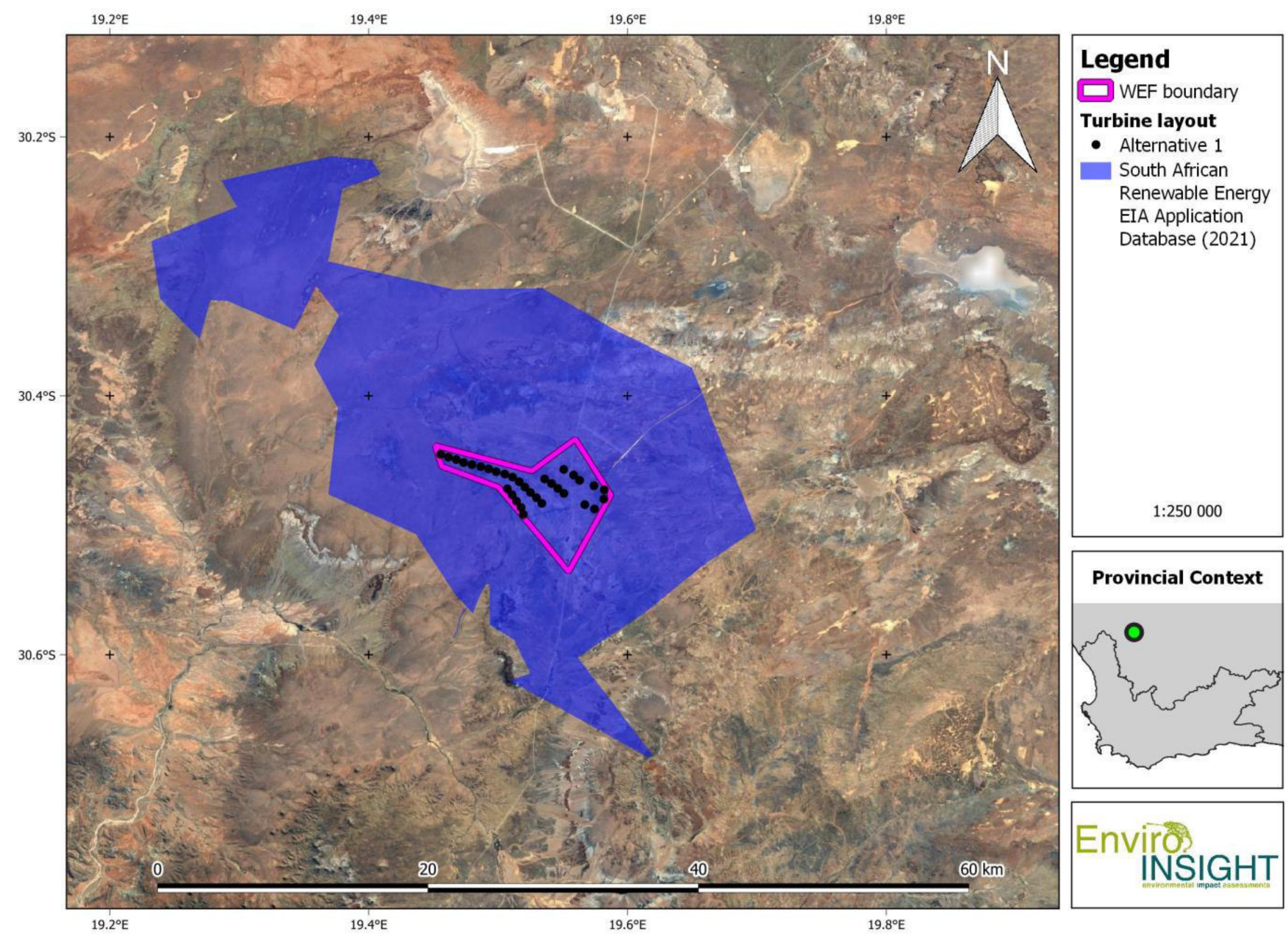

Figure 4-1: Current and proposed WEFs surrounding the proposed Botterblom WEF.

4.4 IMPACT EVALUATION

This section provides detailed evaluation of each of the anticipated impacts on bats from the proposed WEF. A summary overview of these impacts is provided in Table 4-1, followed by more detailed evaluation of each impact in turn.

Table 4-1: Summary of potential negative impacts evaluated pre-mitigation and post-mitigation.

Impact	Pre-mitigation Significance	Post-mitigation Significance	Specialist Confidence	Residual impacts	Potential Fatal Flaw
Loss or destruction of foraging habitat	Medium	Low	High	No	No
Loss or destruction of bat roosts	Low - Medium	Very Low	High	No	No
Bat mortality	High	Low	Medium	Potentially	Unlikely
Artificial lighting	Low - Medium	Very Low	Low	No	No
Flight/migratory paths	Low - Medium	Low	Low	Potentially	Unlikely

Impacts associated with the loss of foraging habitat due to construction activity (Table 4-2) can be mitigated by avoiding bat sensitive areas, such as vegetated watercourses, which will ultimately reduce the spatial extent of this impact and limit it to a once-off event. Although these impacts are certain to occur, the severity of the impact can be reduced to being insignificant if avoidance mitigation is applied related to the positioning of infrastructure and minimisation mitigation is applied through reduction of the total area that must be cleared.

Table 4-2: Consolidation table of impacts due to habitat destruction during construction phase.

	Spatial Scale	Rating	Duration	Rating	Severity	Rating
Without mitigation	Whole Site	3	One year to ten years	3	Slightly harmful	3
With mitigation	Activity specific	1	One year to ten years	3	Insignificant	1
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	Weekly		4	Definite		5
With mitigation	Annually / Once-off		1	Definite		5
	Significance Rating of Impacts			**Timing**		
Without mitigation	81 – Medium			Construction		
With mitigation	30 – Low			Construction		

Impacts associated with the with the destruction or disturbance of bat roosts (Table 4-3) can be mitigated by avoiding structures that could act as potential bat roosts as highlighted above. This impact can potentially be eliminated if mitigation measures are observed and applied across the area.

Table 4-3: Consolidation table of impacts due to the destruction or disturbance of bat roosts during the construction phase.

	Spatial Scale	**Rating**	**Duration**	**Rating**	**Severity**	**Rating**
Without mitigation	Area Specific	2	One year to ten years	3	Harmful	4
With mitigation	Activity specific	1	One month to one year	2	Insignificant	1
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	Weekly		4	Possible		3
With mitigation	Annually / Once-off		1	Almost impossible		1
	Significance Rating of Impacts			**Timing**		
Without mitigation	63 – Low-Medium			Construction		
With mitigation	8 – Very Low			Construction		

Impacts due to bat mortalities during the operational phase is practically unavoidable for any WEF, but with the appropriate mitigation measures these impacts can be minimised. Although the bat activity in the area is relatively low, there are certain times of the year when this activity peaks. With the proposed mitigation measure will allow the current WEF to have a Low significance of impact on the bat population in the area (Table 4-4).

Table 4-4: Consolidation table of impacts from bat mortalities during the operational phase.

	Spatial Scale	**Rating**	**Duration**	**Rating**	**Severity**	**Rating**
Without mitigation	Regional	4	Life of operation	4	Harmful	4
With mitigation	Regional	4	Life of operation	4	Potentially harmful	2
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	Weekly		4	Almost certain		5
With mitigation	Monthly		3	Almost impossible		1
	Significance Rating of Impacts			**Timing**		

Without mitigation	108 – High	Operational
With mitigation	40 – Low	Operational

Artificial lights are known to have a potential negative impact on bats by interfering with activity patters. In addition, lights attract insects which in turns attracts bats which will increase bat activity in the area and could potentially increase the bat mortalities. By reducing the number of artificial lights and having only civil aviation lights on turbines the significance of this impact can be decreased to Very Low (Table 4-5).

Table 4-5: Consolidation table of impacts due to artificial light during the operational phase.

	Spatial Scale	Rating	Duration	Rating	Severity	Rating
Without mitigation	Whole Site	3	Life of operation	4	Potentially harmful	2
With mitigation	Activity specific	1	Life of operation	4	Insignificant	1
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	Weekly		4	Infrequent		3
With mitigation	Annually		1	Almost impossible		1
	Significance Rating of Impacts			**Timing**		
Without mitigation	63 – Low - Medium			Operational		
With mitigation	12 – Very Low			Operational		

Migratory pathways of bats cannot be changed, and as such the impacts associated with bat migrations are virtually unavoidable but can be reduced with appropriate mitigation measures. By incorporating curtailment measures during times of increased bat activity, including April and November, the significance of the impact by the proposed WEF can be reduced to acceptable levels. Although migration events and pathways could not be explicitly identified on the project AOI during the monitoring survey, application of the precautionary approach by assuming that these could be present for the assessment of pre-mitigation impacts is appropriate in the absence of comprehensive knowledge. Application of the suggested mitigation measures must be informed by post-construction monitoring surveys so that a migration event can be detected rapidly and impacts mitigated effectively in the absence of predictive environmental variables for such events.

Table 4-6: Consolidation table of impacts due to disruption of bat migratory pathways during the operational phase.

	Spatial Scale	Rating	Duration	Rating	Severity	Rating
Without mitigation	Regional	4	Life of operation	4	Harmful	4

With mitigation	Regional	4	Life of operation	4	Potentially harmful	2
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	6 monthly		2	Infrequent		3
With mitigation	6 Monthly		2	Almost impossible		1
	Significance Rating of Impacts			**Timing**		
Without mitigation	60 – Low-Medium			Operational		
With mitigation	30 – Low			Operational		

4.5 ENVIRONMENTAL MANAGEMENT PROGRAMME CONDITIONS

All potential bat roosts must be avoided by applying a 200 m buffer.

The buffered sensitive areas shown in Figure 3-25 must be excluded from all activities related to the WEF. Access roads may cross these however if required.

All artificial lights should be kept at a minimum with only civil aviation lights being used if possible. In cases where lighting is needed close to buildings the use of these lights must be limited and directed only where needed. Non-UV emitting lights must be used.

Cut-in speeds of turbines should be increased at strategic times based on bat mortalities observed during post-construction monitoring. An annual threshold for bat mortality in Nama Karoo is estimated at 0.0106 bats/hectare (MacEwan *et al*., 2020a) per annum. Therefore, the total annual bat mortality threshold for the Botterblom WEF is estimated at 61.4 bats. Mortality estimates must be corrected according to detection probabilities and scavenger removal as many mortalities will not be detected (see MacEwan *et al*., 2020a). Therefore, it is likely that a single detected mortality will require implementation of adaptive mitigation strategies, especially if more than 2 mortalities are detected within a single week. These corrected mortality estimates and appropriate adaptive mitigation thresholds and strategies will need to be determined during the post-construction monitoring. Increasing the cut-in speed of turbines is especially relevant for periods of migration and/or increased feeding activity during frontal activity as seen in April and possible migration during November when higher than normal number of bats are expected in the area and curtailment of turbines may be required if mortalities during monitoring indicate immediate mitigation action. This will necessitate increased monitoring activities during these times with rapid dissemination of number of carcasses detected so that on-the-fly mitigation can occur. In addition, during post-construction monitoring continuous assessment of bat mortalities must be made, and additional curtailment imposed if necessary.

Currently, all three proposed alternative arrangements for the turbine positions infringe on the buffers for sensitive bat areas (Figure 4-2). We recommend that the turbines are placed based on **an adjusted Alternative 1** to ensure that no turbines infringe on the sensitive bat features. This arrangement favours a larger number of the turbines in the western less sensitive section of the project area. The eastern section has been shown to have a higher activity level of bats than the western section and is also potentially a migratory pathway, which may become more important with cumulative impacts (see Figure 4-1). As such, this portion within the WEF boundary should be avoided as much as possible.

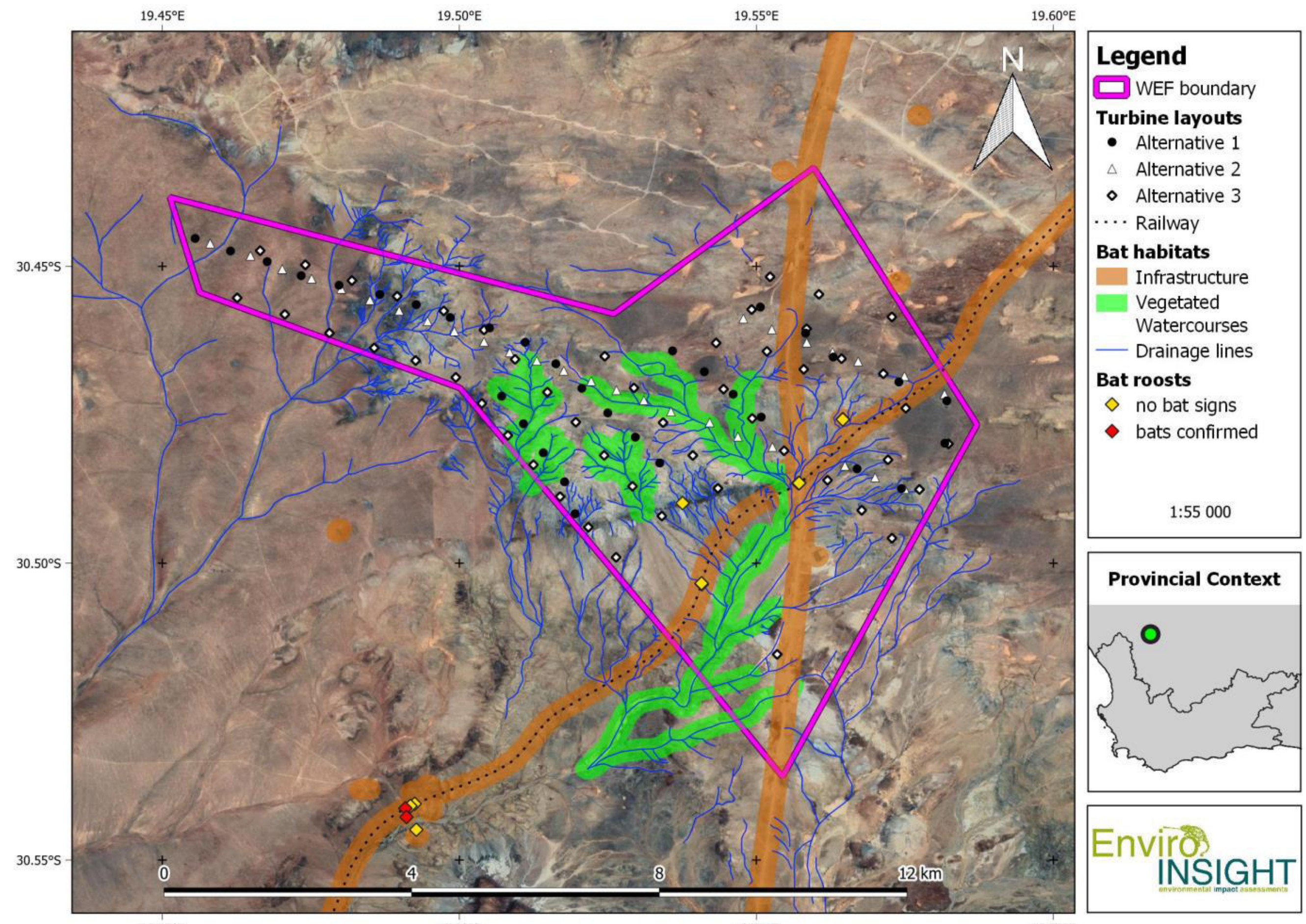

Figure 4-2: The proposed turbine layout alternatives for the proposed Botterblom WEF in relation to sensitive bat features.

5 DISCUSSION AND CONCLUSION

This final report for pre-construction bat monitoring presents data collected from September 2020 to September 2021 wherein data were collected from four 7 m masts, one 50 m and one 100 m meteorological mast. A few technical failures occurred during this period; however, these failures do not compromise the findings of this assessment since an adequate amount of data were recorded during this period. In addition, active sampling transects and roost inspections were performed for all seasons. No active roosts were confirmed within the project AOI.

A total of three species were detected on the project AOI namely: *T. aegyptiaca, S. petrophilus,* and *L. capensis*, all listed as Least Concern by the IUCN (2021). Based on the SABPG (MacEwan *et al.*, 2020b) a median of under 0.18 bp/h for the bat detectors placed at ground level is regarded as a Low Fatality Risk and between 0.18 and 1.01 is Medium Risk for the Nama

Karoo Shrublands ecoregion. The median bp/h recorded at ground level for LSM3 and 4 during the current survey was below 0.18, qualifying as a Low Risk for bat mortalities, whereas the median bp/h recorded at ground level for LSM1 and LSM5 was above 0.18 qualifying as a Medium Risk. The median bp/h recorded at 50 m (LSM2) was 0.24, and this indicates a Medium Risk. The detector deployed at 100 m (LSM6) recorded a median bp/h of 0.00 indicating a Low Risk, and while it has only been active for eight months and was not recording during the November peak, it was shown to record less bat activity than LSM1 & LSM2 during the time that it was active (including the April peak).

Bat activity peaks during November and April, a possible indication of bats feeding during insect eruptions or migrating through the area. It is highly recommended that additional mitigation measures are incorporated during these times, particularly when the first major frontal activity of autumn/winter occurs, including higher cut in speeds, in order to minimise bat mortalities. Additionally, it is recommended that mortality search effort is increased throughout the post-construction during the months of April and November in an attempt to obtain a more reliable estimate of bat mortalities during these periods of higher activity. In addition, sensitive bat areas have been defined and buffered with the appropriate distance and these areas must be avoided. This includes all potential bat roosts and the major water courses with appropriate vegetation across the AOI.

From the available data collected, the construction of a WEF on the proposed WEF boundary will have a Low-Medium Risk of impacting the bat population in the area before mitigation measures have been applied. Currently, after mitigation measures have been implemented this risk will be reduced to Low. Currently, it is advised that bat mortality mitigation measures be implemented during the spring and autumn months considering the peak bat activity levels during this period. These mitigation measures would include a higher cut-in speed as this has been shown to significantly reduce bat mortalities (Arnett *et al.*, 2009) or curtailment during peak activity periods.

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7 APPENDIX

7.1 APPENDIX 1: DETAILED PLOTS OF BAT ACTIVITY IN RELATION TO ENVIRONMENTAL VARIABLES

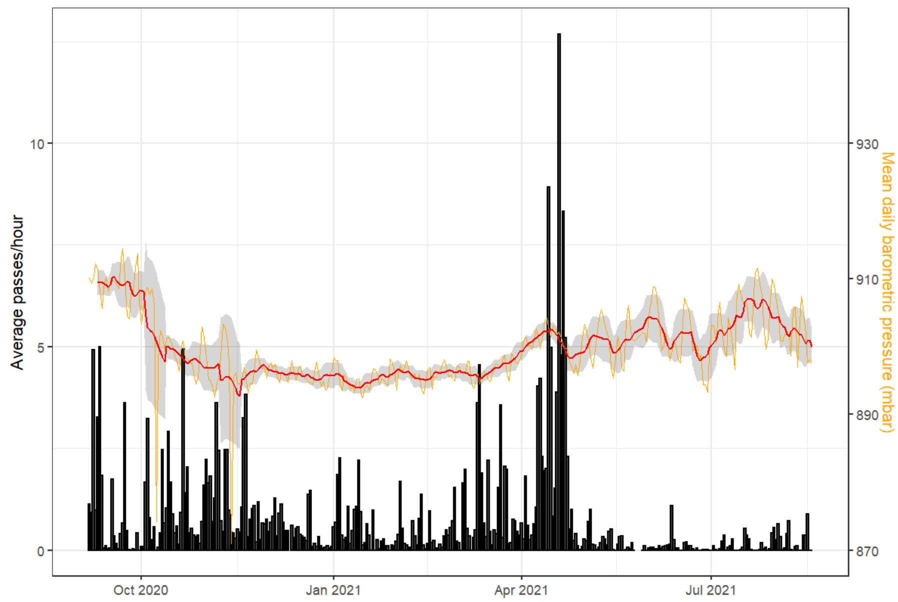

Figure 7-1: Bat activity (average bp/h) in relation to mean daily barometric pressure (orange). The centered moving averages and 1 standard deviation for barometric pressure (window = 10 days) are shown in red and grey, respectively.

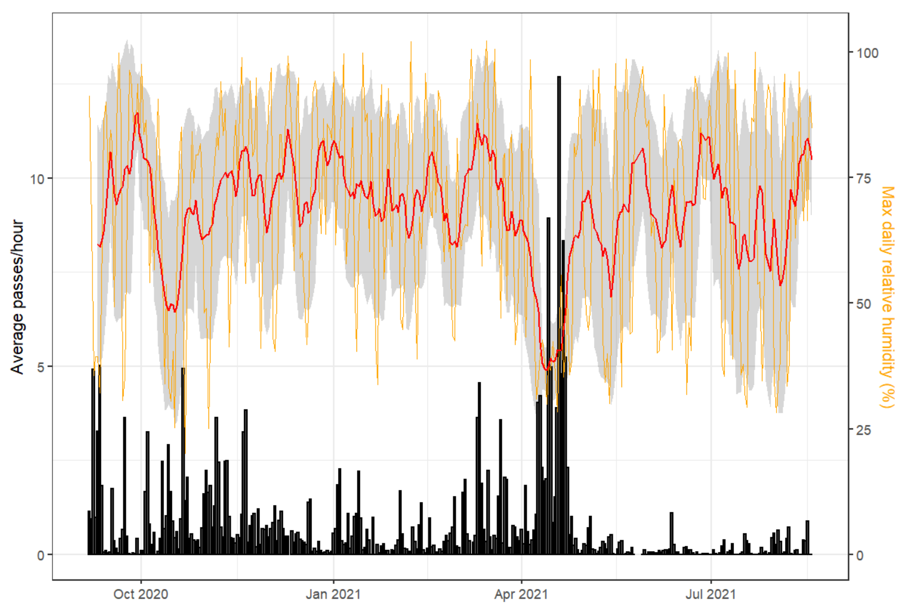

Figure 7-2: Bat activity (average bp/h) in relation to maximum daily relative humidity (orange). The centered moving averages and 1 standard deviation for relative humidity (window = 10 days) are shown in red and grey, respectively.

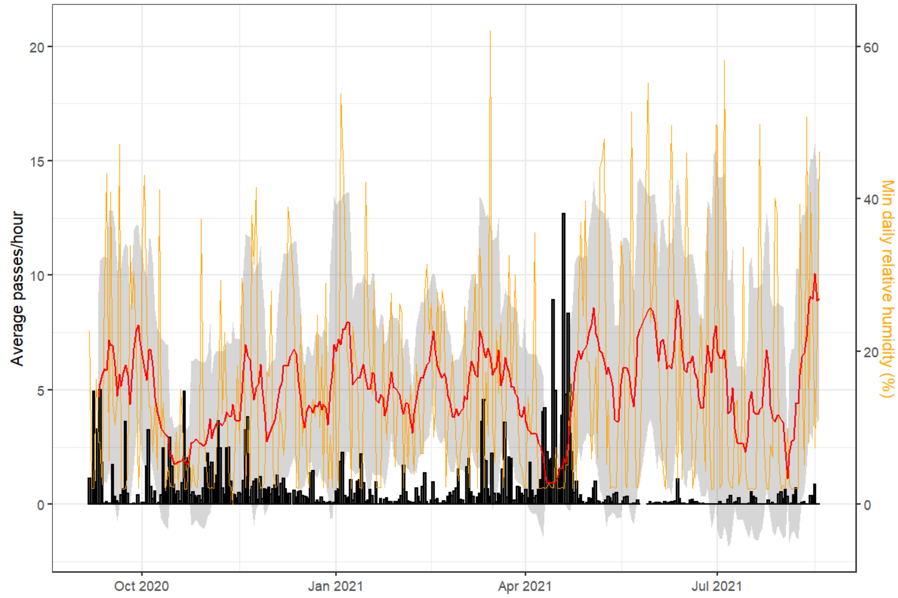

Figure 7-3: Bat activity (average bp/h) in relation to minimum daily relative humidity (orange). The centered moving averages and 1 standard deviation for relative humidity (window = 10 days) are shown in red and grey, respectively.

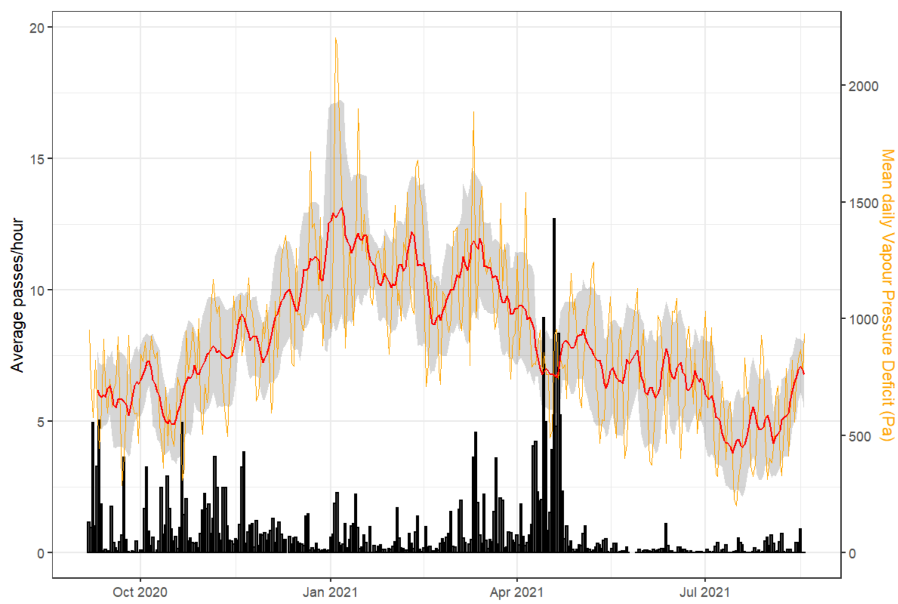

Figure 7-4: Bat activity (average bp/h) in relation to mean daily vapour pressure deficit (orange). The centered moving averages and 1 standard deviation for vapour pressure deficit (window = 10 days) are shown in red and grey, respectively.

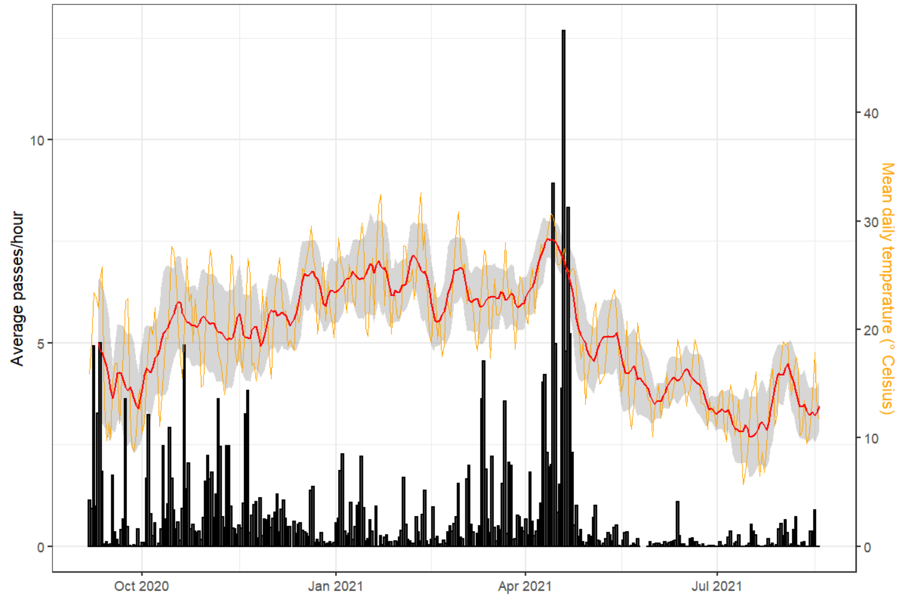

Figure 7-5: Bat activity (average bp/h) in relation to mean daily temperature (orange). The centered moving averages and 1 standard deviation for temperature (window = 10 days) are shown in red and grey, respectively.

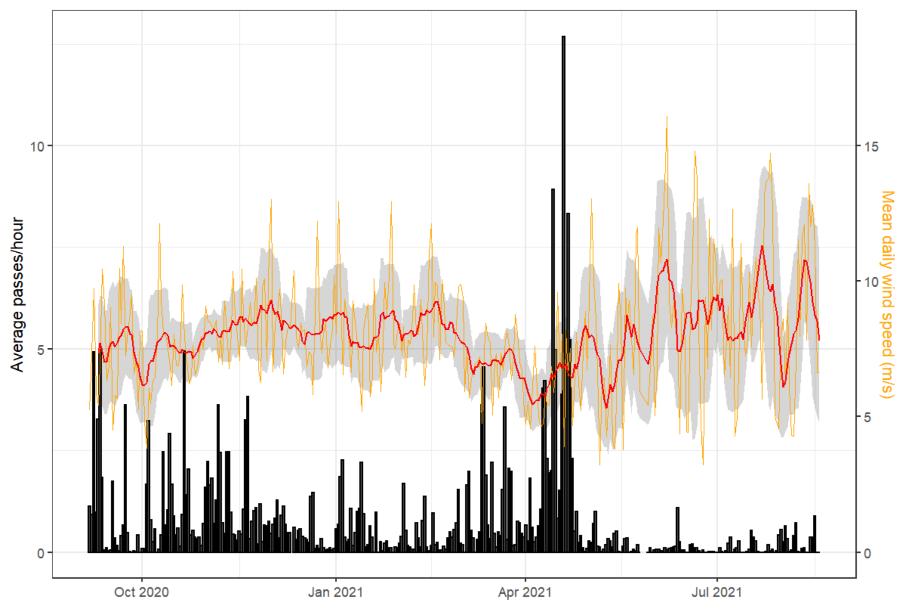

Figure 7-6: Bat activity (average bp/h) in relation to mean daily wind speed (orange). The centered moving averages and 1 standard deviation for wind speed (window = 10 days) are shown in red and grey, respectively.

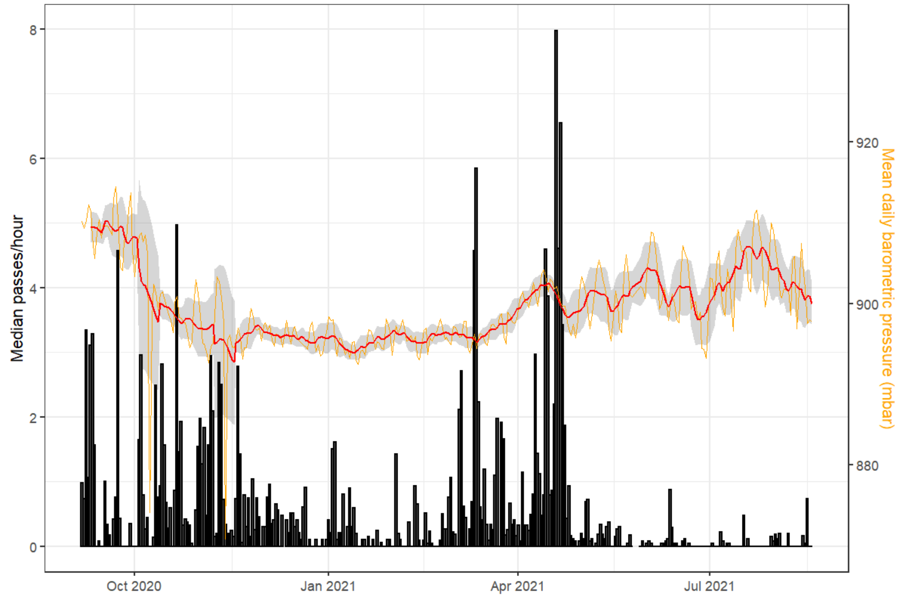

Figure 7-7: Bat activity (median bp/h) in relation to mean daily barometric pressure (orange). The centered moving averages and 1 standard deviation for barometric pressure (window = 10 days) are shown in red and grey, respectively.

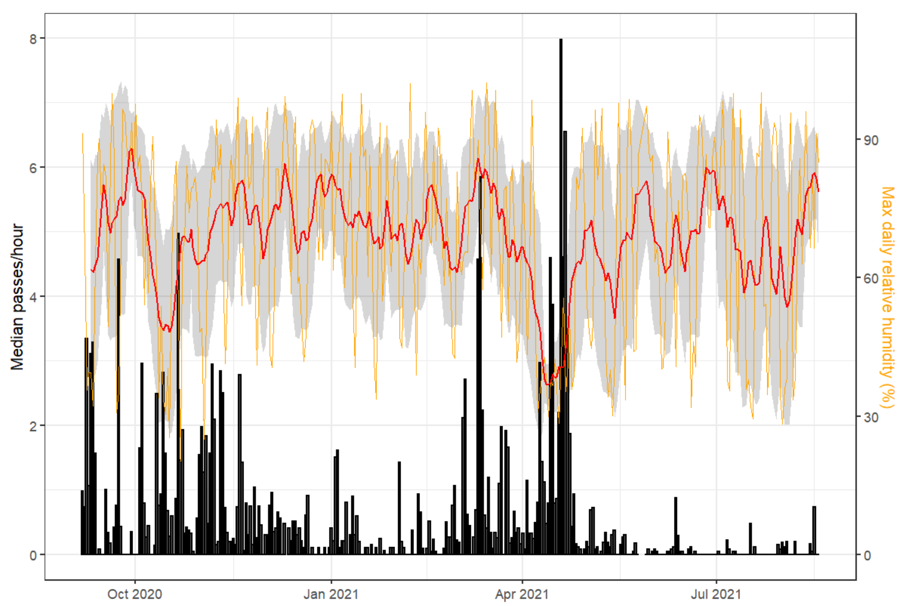

Figure 7-8: Bat activity (median bp/h) in relation to maximum daily relative humidity (orange). The centered moving averages and 1 standard deviation for relative humidity (window = 10 days) are shown in red and grey, respectively.

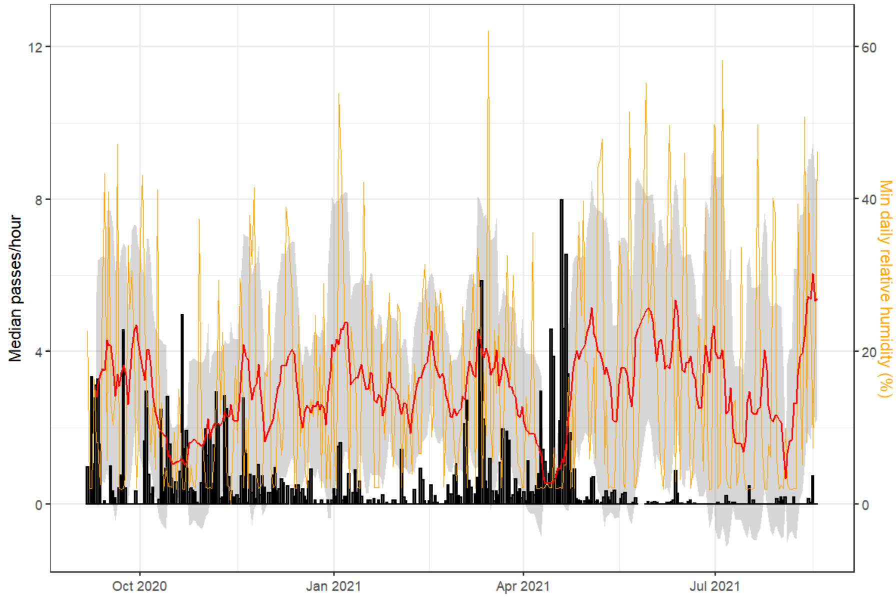

Figure 7-9: Bat activity (median bp/h) in relation to minimum daily relative humidity (orange). The centered moving averages and 1 standard deviation for relative humidity (window = 10 days) are shown in red and grey, respectively.

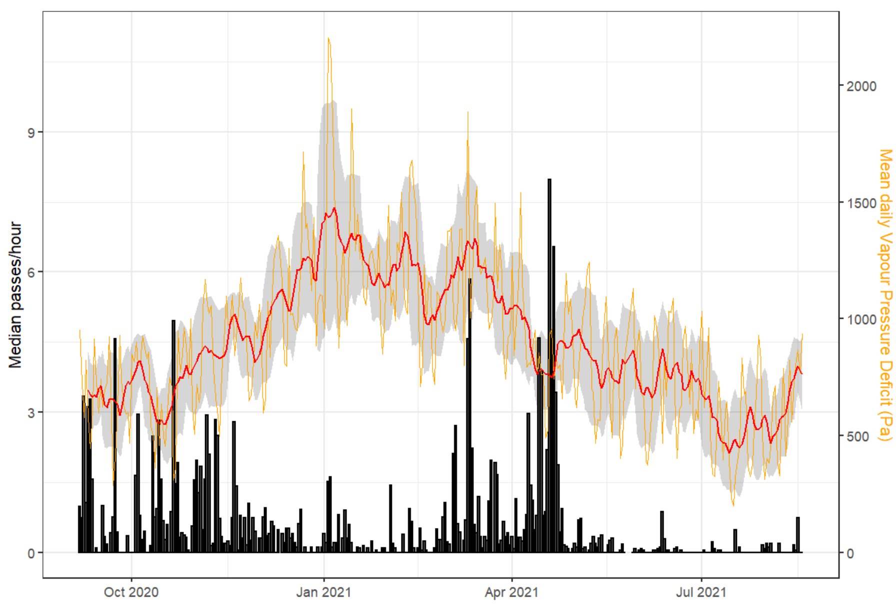

Figure 7-10: Bat activity (median bp/h) in relation to mean daily vapour pressure deficit (orange). The centered moving averages and 1 standard deviation for vapour pressure deficit (window = 10 days) are shown in red and grey, respectively.

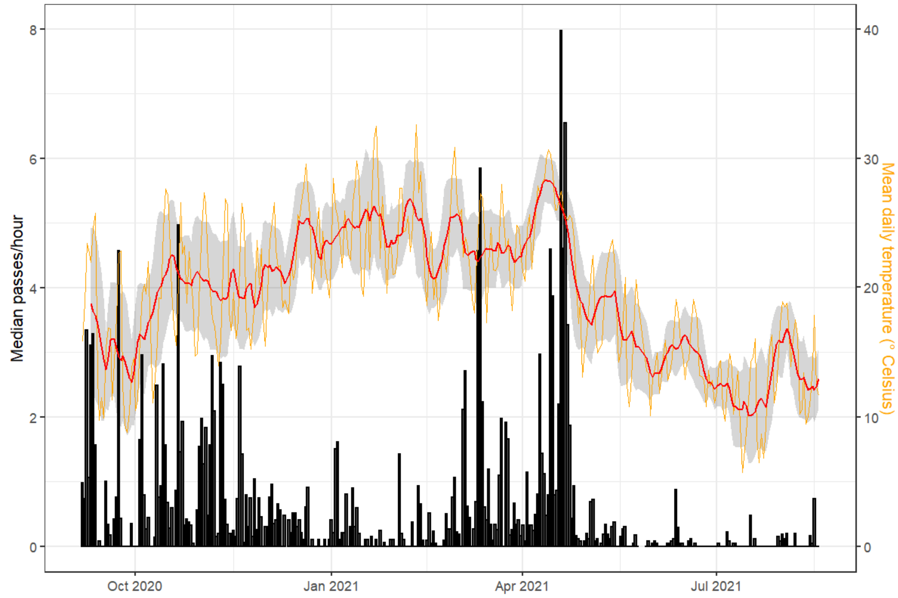

Figure 7-11: Bat activity (median bp/h) in relation to mean daily temperature (orange). The centered moving averages and 1 standard deviation for daily temperature (window = 10 days) are shown in red and grey, respectively.

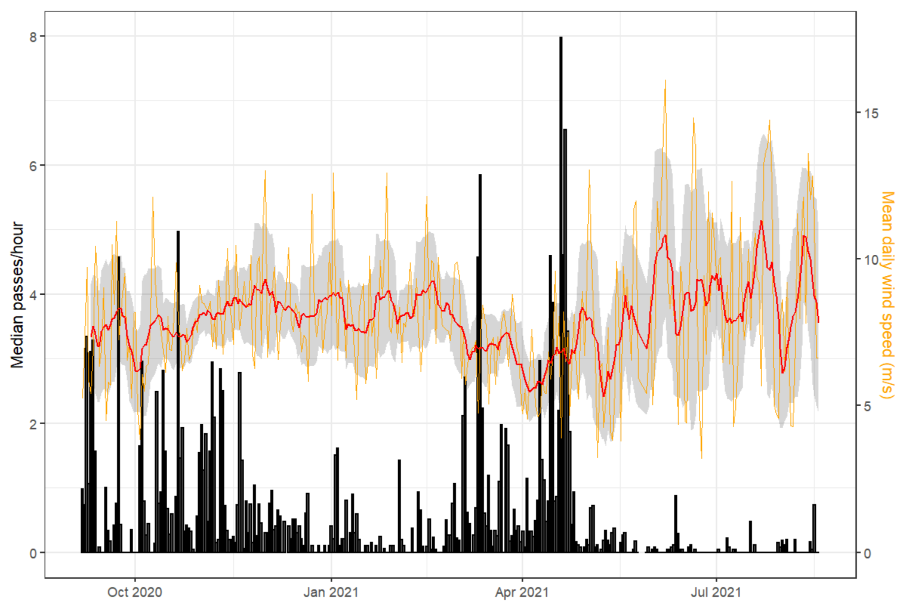

Figure 7-12: Bat activity (median bp/h) in relation to mean daily wind speed (orange). The centered moving averages and 1 standard deviation for wind speed (window = 10 days) are shown in red and grey, respectively.

7.2 APPENDIX 2: SPECIALISTS PROOF OF QUALIFICATION

SACNASP
South African Council for Natural Scientific Professions

herewith certifies that

Low de Vries

Registration Number: 124178

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Zoological Science (Professional Natural Scientist)

Effective **13 November 2019** Expires **31 March 2022**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Samuel David Laurence

Registration number: 400450/13

is registered as a

Professional Natural Scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice (Schedule I of the Act)

Zoological Science	20 November 2013
Ecological Science	20 November 2013

20 November 2013		
Pretoria	President	Executive Director

THE SOUTH AFRICAN COUNCIL FOR NATURAL SCIENTIFIC PROFESSIONS

herewith certifies that

Luke Verburgt
Registration number: 400506/11

is registered as a

Professional Natural Scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice
(Schedule I of the Act)

Zoological Science **02 November 2011**

2 November 2011
Pretoria

President

Chief Executive Officer

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Alexander Douglas Rebelo

Registration Number: 124030

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003 (Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Zoological Science (Candidate Natural Scientist)

Effective **11 September 2019** Expires **31 March 2022**

Botha
Chairperson

Chief Executive Officer

To verify this certificate scan this code