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Appendix D3:

Preconstruction Bat Assessment

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Enviro INSIGHT
environmental impact assessments

Environmental Impact Assessment Report

Pre-construction Bat Monitoring Assessment for the Proposed De Rust Wind Energy Facility near Pofadder, Northern Cape

April 2023

Prepared For

EnergyTeam

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 (*Pr. Sci. Nat. Zoological Science)* in conducting this specialist report.

Expertise of Bat Specialist Reviewer

Low de Vries is a bat assessment specialist registered with SABAA and has consulted for numerous field projects, which included bird surveys and the removal of dangerous snakes in Mozambique, as well as several biodiversity surveys in South Africa. He obtained a PhD in Zoology while investigating the general ecology of aardwolves with special focus on home range, diet and prey abundance. After his PhD he spent 14 months on Marion Island assisting with field work on elephant seals, fur seals and killer whales. During his subsequent postdoctoral position at the University of Pretoria he spent six years conducting research on the ecology of bats and has obtained extensive knowledge on bat behaviour and experience in bat handling. He has been involved with pre-construction monitoring and scoping bat surveys at numerous proposed Wind Energy Facilities.

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

Scoping-specific Guideline requirement	**Section in report**	**Complete**
Literature review: collation and review of existing literature	3.2 Literature Review	Yes
Identify habitats which may be used by bats	2.3.4 Active Transects 2.3.5 Bat Roosts 2.4.3 Sensitive Habitat Delineation	Yes
Desktop search for any designated Protected Areas within 100 km of the site	3.2.3 Protected Areas	Yes
Indicate the entire area of interest supplied by the developer/ client.	1.2 Project Location and Project Area	Yes
A walkover survey for small sites/drive-through survey for large sites	2.3 Field Surveys	Yes
Pre-construction Guideline requirement		
Determine the assemblage of potentially occurring and detected bats and present their fatality risk	3.2.2 Expected Species	Yes
Determine presence of rare bats and Species of Conservation Concern (SCC)	3.2.2 Expected Species & 3.3.1.3 Passes by Species	Yes
Locate bat roosting habitat in the study region	3.4 Roosting Sites	Yes
Compare differences in the assemblage and activity of bats between ground level and rotor sweep height	3.3.1.4 Passes by Height	Yes
Compare differences in the assemblage and activity of bats between monitoring localities and between different habitat types	3.3.1.3 Passes by Species & 3.3.2 Active Acoustic Monitoring & 3.4.1 Short-term Passive Acoustic Monitoring & 3.4.1 Bat Sensitive Features	Yes
Determine seasonal variation in the assemblage and activity of bats	3.3.1.2.3 Monthly/Seasonally (by bat detector) & 3.3.1.3.2 Monthly/Seasonally (by bat species)	Yes
Identify any incidence of bat migration	3.3.1 Passive Acoustic Monitoring	Yes
Determine variation in the assemblage and activity of bats between sunset and sunrise	3.3.1.3.1 Hourly (by bat species)	Yes
Determine how wind speed and other meteorological conditions correlate with bat activity	3.3.1.5. Environmental Variables on Bat Activity	Yes
Determine the relative importance/sensitivity of different parts of the site	3.5 Bat Sensitive Features	Yes
Determine the relative importance/sensitivity of the site	5 Discussion and Conclusion	Yes
Describe effective site- and habitat/turbine-specific bat mitigation measures	4 Possible impacts 4.3 EMP conditions 5 Discussion and Conclusion	Yes
Monitoring duration in relation to the size of the WEF (MW) and its position relative to REDZ.	2.1 Regulatory and Guideline Requirements	Yes
The area of influence (AOI)/ study area and turbine layout if provided by the developer	1.2 Project Location and Project Area	Yes
Roost surveys of potential and known roosts in Summer and Winter	3.4 Roosting Sites	Yes
Identify medium to large roosts or caves within 20 km of study area	3.2 Literature Review & 3.4 Roosting Sites	Yes
Manual transect or point acoustic surveys for 8 nights evenly spread across all seasons	3.3.2 Active Acoustic Monitoring	Yes
Static surveys with fixed acoustic bat detectors as per the site size and WEF design	2.3.3 Passive Bat Detectors	Yes

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GLOSSARY OF TERMS

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

ACR: African Chiropteran Report.

B1-9: Names for deployed Bat Detectors.

BA: Basic Assessment.

Basic Assessment (BA): To follow the processes set out in regulations 19 of GN 326 of 7 April 2017.

Bat call: An echolocation call emitted by a bat used to detect its surroundings and navigate through the habitat it inhabits.

Bat detector: Electronic device for the recording of bat echolocation calls. Also called a bat song meter.

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

BESS: Battery Energy Storage System.

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

BP: bat passes.

bp/h: bat passes per hour.

BPUE: bat passes per unit effort.

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

CSP: Concentrated solar power.

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

Echolocation: Navigation through the use of ultrasound.

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.

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

EPTHOT: Bat species *Eptesicus hottentotus*.

GN: Government notice.

GPS: Global positioning system (device),

IUCN: International Union for Conservation of Nature.

kHz: Kilohertz.

LAECAP: Bat species *Laephotis capensis*.

MINNAT: Bat species *Miniopterus natalensis*.

ms: Millisecond.

MW: Megawatt.

NDA: Non-disclosure agreement.

NDVI: Normalized difference vegetation index.

NEMA: National Environmental Management Act.

NGO: Non-governmental organisation.

PA: Project area, the area that is affected by the proposed development.

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

Pulse: A single discreet emission of a sound by a bat.

R1-R27: Names for potential bat roost locations.

Red data species: Species included in the endangered, vulnerable or rare categories as defined by the IUCN.

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

Renewable Energy EIA Application EEA (REEA): latest spatial data for renewable energy applications for environmental authorisation in South Africa.

RH: Relative humidity.

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

Rotor swept area: The area through which rotor blades rotate.

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.

SAPAD: South African Protected Areas Database.

SAUPET: Bat species *Sauromys petrophilus*.

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

SD card: A storage device for song meter recordings.

SEI: Site ecological importance.

STAM1-3: Short-term acoustic monitoring sites.

TADAEG: Bat species *Tadarida aegyptiaca*.

ToPS: Threatened or Protected Species.

UV: Ultraviolet.

VPD: Vapour pressure deficit.

WEF: Wind energy facility.

1 INTRODUCTION

1.1 PROJECT DETAILS AND BACKGROUND

Enviro-Insight CC was commissioned by EnergyTeam (Pty) Ltd to conduct a pre-construction monitoring bat survey for the proposed wind energy facilities (WEFs) and associated infrastructure which will be known as the De Rust WEF. This WEF consists of two separate projects (individually submitted for environmental authorisation), FE De Rust North WEF and FE De Rust South WEF. Both projects are addressed in this report. The proposed WEFs will consist of up to 74 wind turbines in total, with a generation capacity of up to 7.5 MW per turbine. 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 would include underground and above-ground cabling between project components, onsite substation/s, Battery Energy Storage System (BESS), foundations to support turbine towers, internal/ access roads (up to 10 m in width) 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. This report serves as a pre-construction assessment of the bat activity and bat species present in the Project Area (PA) of the proposed De Rust WEF and associated infrastructure.

1.2 PROJECT LOCATION AND PROJECT AREA

The proposed De Rust WEF (boundary in Figure 1-1) is located 13 km south-south-east of Pofadder and 47 km east of Aggeneys in the Khâi-Ma Local Municipality in the Northern Cape Province of South Africa. It is accessed from the R358 from Pofadder, which bisects the PA (defined as the boundary shown in Figure 1-1). The minimum convex hull of the preferred turbine placement (alternative 1), with an 87.5 m buffer (to account for rotor sweep), covers an area of *ca.* 8,469 ha. The only land use in the area is sheep ranching due to the lack of rainfall and nearby permanent water sources, and several occupied farm smallholdings are present within or near to the PA. The closest existing WEF is the Kangnas WEF, which is situated approximately 85 km west-south-west of the proposed De Rust WEF PA (the current project).

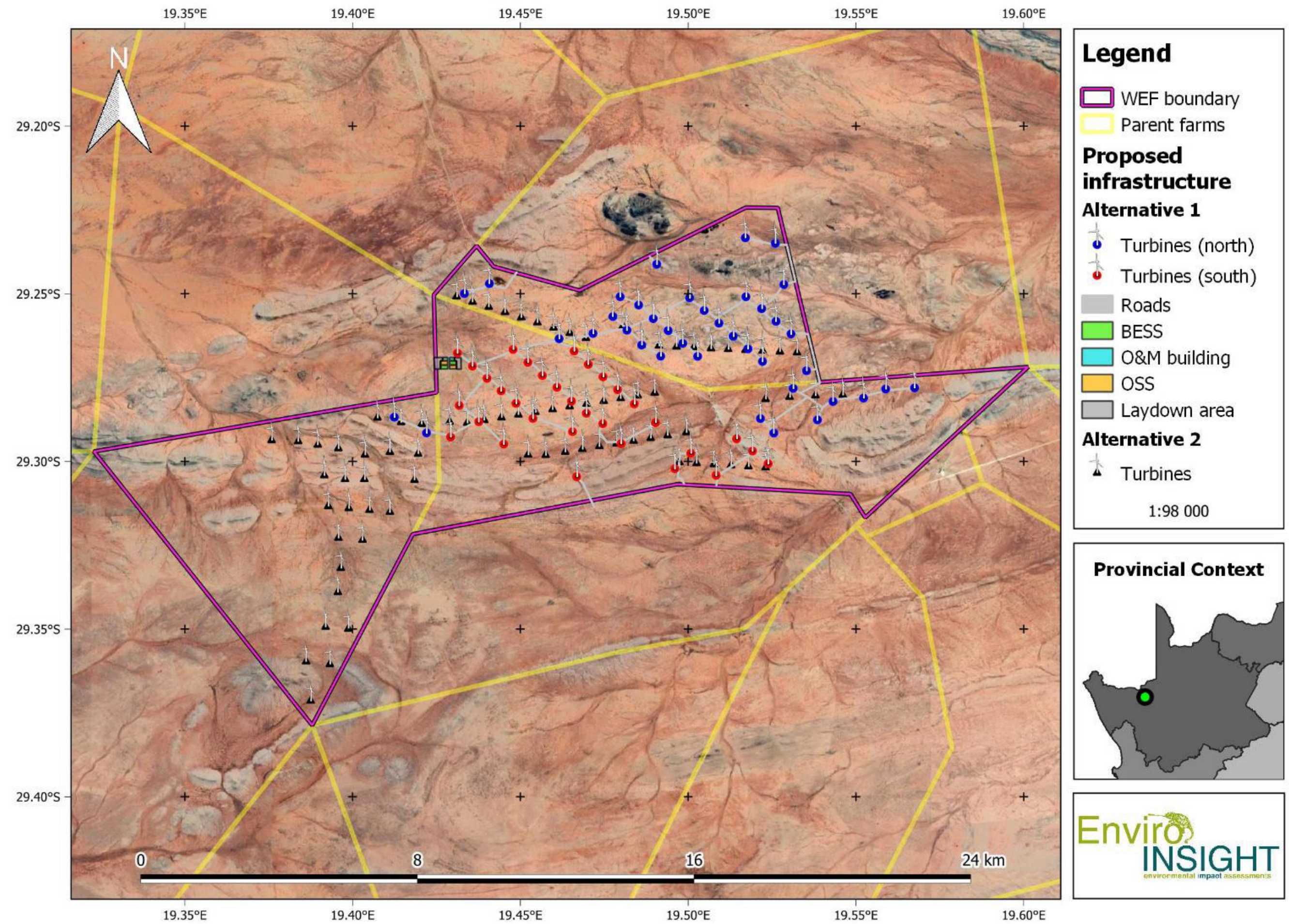

Figure 1-1: Location of the project area (WEF boundary) for the proposed De Rust WEF development, showing proposed turbine layout alternatives and associated infrastructure.

1.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The project area (PA) consists of various vegetation types, with Bushmanland Arid Grassland and Aggeneys Gravel Vygieveld covering the most area in the low-lying parts of the PA, Bushmanland Inselberg Shrubland and Namaqualand Klipkloppe Shrubland on the quartzite ridges/hills, and Bushmanland Basin Shrubland to the north west near the dolerite outcrops (SANBI 2018, Figure 1-2). However, structural differences of vegetation between these vegetation types was not always obvious during site visits, except for the vegetation associated with the quartzite ridges/hills. Watercourses are typically poorly defined but usually have denser and larger bushes than the surrounding landscapes. There are no large/perennial streams or rivers close to the PA, but there are numerous small ephemeral watercourses, some with extensive alluvial plains, that drain towards the west, north and east. These systems do not form deep valleys or in-cut banks. The PA has varied terrain, consisting of a relatively flat plain with small quartzite ridges and koppies that form linear hilly regions across the PA, with especially large hills in the south east, and dolerite outcrops forming small to large conical koppies in the north east (Figure 1-3; Figure 1-4). There are some rocky areas on the flats that are not associated with higher terrain, located in the northern central portion of the PA.

The PA is situated in an arid region between the summer and winter rainfall zone, with rainfall being highly variable in the region. The nearby town of Pofadder receives most of its rainfall between February and April (data from 1985; https://www.meteoblue.com/), and recent data (2009-2021) indicates that most rainfall occurs from October to March, with a mean annual rainfall of 135 mm (https://wapor.apps.fao.org/). The warmest months are October through to April with a mean daily maximum of 33 °C and minimum of 17°C (February) and winter maximum temperatures of 18 °C and minimum 2 °C (July; https://www.meteoblue.com/).

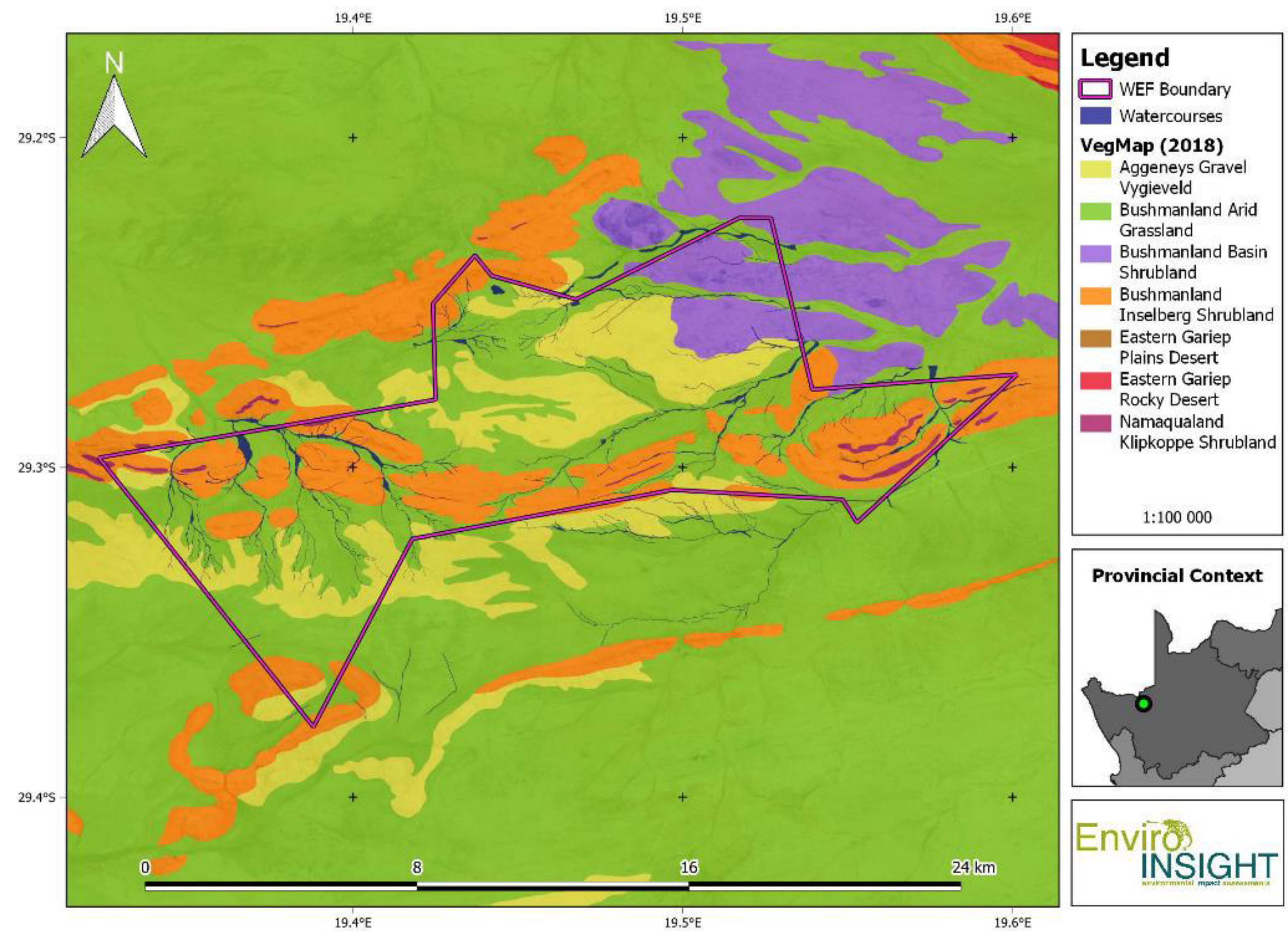

Figure 1-2: The proposed De Rust Wind Energy Facility (WEF boundary) in relation to major vegetation types and aquatic habitats.

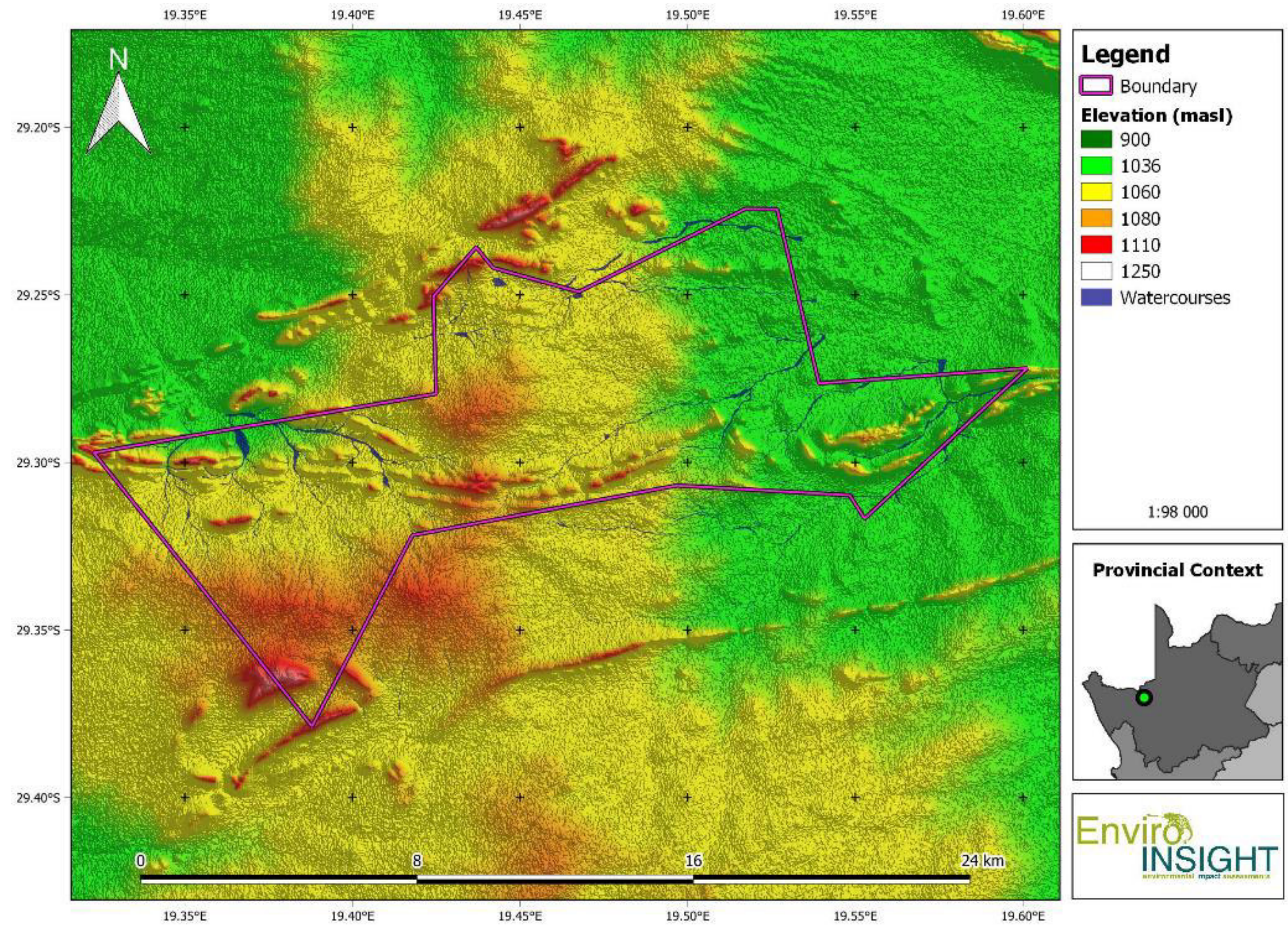

Figure 1-3: The proposed De Rust Wind Energy Facility (WEF boundary) in relation to the terrain elevation and aquatic habitats.

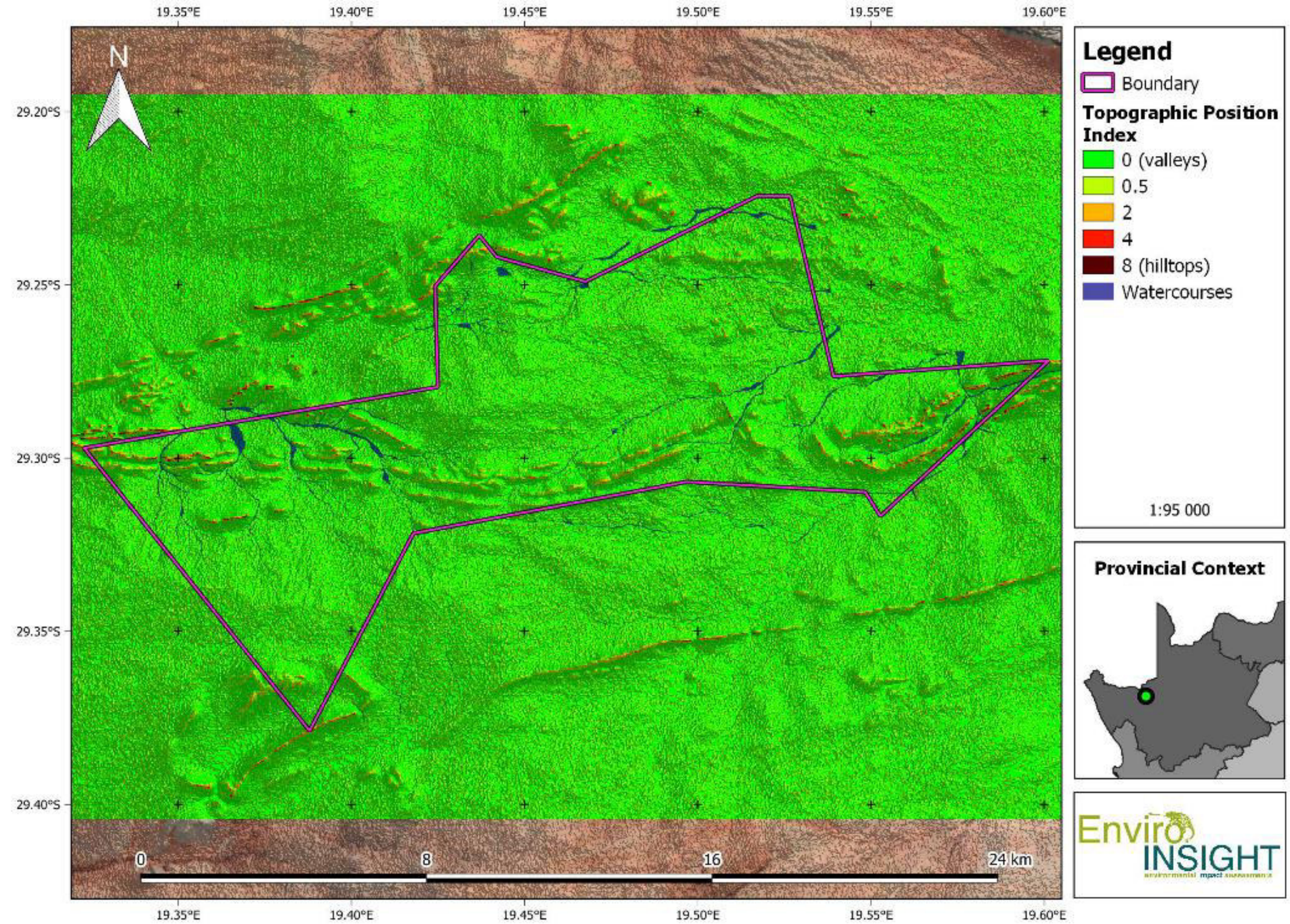

Figure 1-4: The proposed De Rust Wind Energy Facility (WEF boundary) in relation to the topographic position index and aquatic habitats.

1.4 BAT STUDY VALIDITY PERIOD

The results obtained from the current survey are 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 will have to be conducted.

1.5 ASSUMPTIONS AND LIMITATIONS

Distribution records of bats in southern African are poorly documented, especially for some species. In addition, migratory patterns, breeding behaviour and maternal colony formation are largely unknown for many South African bat species. Studies have reported that bats do migrate, but the exact routes followed are not known (Pretorius *et al.*, 2020).

WEF pre-construction monitoring reports on bats depend on data derived mostly from echolocation calls and the identification of species from these calls, but without echolocation call libraries accurate identification is not always possible. Published libraries created from release and handheld calls of captured bats are available, but limited, for southern Africa. Acoustic monitoring records vast numbers of bat passes with repertoires of calls which have not been captured by handheld calls, and calls may vary geographically within species (Monadjem *et al.*, 2017). As such these call libraries cannot accurately identify all echolocations, and there are too many calls to identify manually, resulting in a certain amount of error that must be expected and interpreted along with the data.

A number of problems resulted in extended periods of inactivity (or downtime) for some of the passive bat detectors.

- Bat detector memory card slot failure and SD card corruption;
- The mast on which bat detector 3 (B3) was mounted collapsed around (1 February 2022) due to the soft substrate and high rainfall, and was dismantled and removed because the PA had been reduced in size due to the presence of nesting birds and bat detector 3 was no longer placed within the WEF developable area. This event does not affect the monitoring requirements of the current study as the WEF developable area was reduced.

Microphones at height were placed at 65 m and 110 m, while the proposed turbines are expected to have a rotor sweep zone from 62.5 – 237.5 m above ground. The meteorological masts had a maximum height of 120 m, and bat detector microphone placements were limited by this maximum height. Therefore, bat activity was only monitored at the lower limit of the rotor sweep zone. Bats are expected to be more active closer to the ground, so it is likely (but not certain) that bat activity will be overestimated for this height zone in general.

Bat detectors are not always effective in recording echolocation calls for all bat species, and some species may be missed e.g., some fruit bat species that do not echolocate. Other species, such as *Nycteris thebaica*, emit low intensity calls and are not expected to be recorded by bat detectors. 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 and wind. 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.

2 METHODOLOGY

2.1 REGULATORY AND GUIDELINE 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 (EIA) is required for WEF 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 proposed De Rust WEF is not located in a REDZ, and accordingly an EIA process must be followed. The South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities - ed 5 (SABPG, MacEwan *et al.*, 2020b) does not differentiate between areas located within or outside of a REDZ, and as such all recommendations outlined in the Guidelines must be followed and applied. Monitoring of bats must be conducted before the final BA or EIA is submitted. All methods used to inform desktop studies and conduct field surveys were implemented according to the SABPG (MacEwan *et al.*, 2020b).

MacEwan (2020b) stipulates the minimum number of bat detectors at height (>50 m) to be one per 10,000 ha. This was made clear during discussions with the client and it was agreed that 20,000 ha would not be exceeded as only 2 meteorological masts would be constructed. The current project area of influence combined with the proposed Houmoed WEF, immediately adjacent to the proposed De Rust WEF and to be submitted as a standalone report for environmental authorisation, calculated as a convex hull of the turbine layout (including blade lengths), is less than 20,000 ha (~13,708 ha), and the 3 bat detector stations on both meteorological masts are sufficient for the pre-construction monitoring survey. However, future turbine placement adjustments must be limited to within a total area of 20,000 ha.

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 PA. This included investigations into available literature, including Bats of Southern and Central Africa (Monadjem *et al.*, 2020), the African Chiroptera Report (ACR, 2021) and any other bat surveys or monitoring reports for nearby WEF applications (see Table 2-1) as determined from the Renewable Energy EIA Application (REEA, 2022 Q1) information. Available reports were searched for online and post-construction monitoring reports were requested from the nearby Kangnas WEF through SABAA (first request sent on 12 July 2022), which culminated in a non-disclosure agreement (NDA) being signed between Enviro-Insight and Kangnas WEF, but no report being received in time for evaluation and inclusion in this report. It is also questionable whether any information could have been used since the NDA Enviro-Insight had to sign was very restrictive in terms of which information could be shared. Lack of public access to existing monitoring reports for WEFs is a recurring problem in the industry and one that severely hampers pre-construction monitoring studies and the recommendations therein, a problem to be addressed by relevant NGOs and the governmental institutions.

A search was conducted to identify any protected areas present within 100 km of the proposed WEF project area using the South African Protected Area Data (SAPAD, 2022 Q3[1]).

[1] available from: https://egis.environment.gov.za/

Table 2-1: Bat reports for Wind Energy Facilities (and other developments) in the region of the proposed De Rust WEF.

Project	Report details	Consultant
Kangnas WEF (Aurecon, 2012)	Proposed Wind and Solar (Photovoltaic) Energy Facilities on Kangnas Farm near Springbok in the Northern Cape: Final EIR. (Completed before current guideline were in place, limited data collection).	Werner Marias (Animalia Zoological and Ecological Consultation)
Kangnas WEF (Bio[3] & Savannah Environmental, 2013)	Bat and Bird Community Monitoring. Interim Status Report (Pre-construction). For Mainstream. (Completed before current guideline were in place, limited data collection).	Unknown (Bio[3] & Savannah Environmental)
Korana WEF (Savannah Environmental, 2015a)	Final EIAr Korana WEF (14/12/16/3/3/2/682). Bat appendix not available online.	Jonathan Aronson & Jennifer Slack (Arcus Consultancy Services)
Khai-Ma WEF (Savannah Environmental, 2015b)	Final EIAr Khai-Ma WEF (14/12/16/3/3/2/680). Bat appendix not available online.	Jonathan Aronson & Jennifer Slack (Arcus Consultancy Services)
Poortjies WEF (Savannah Environmental, 2015c)	Final EIAr Poortjies WEF (14/12/16/3/3/2/681). Bat appendix not available online.	Jonathan Aronson & Jennifer Slack (Arcus Consultancy Services)
Korana WEF (Stephanie Dippenaar Consulting, 2019a)	Korana WEF Bat Impact Assessment Amendment. Change to larger turbine design. Literature review only, no new data collection.	Monika Moir (Stephanie Dippenaar Consulting)
Khai-Ma WEF (Stephanie Dippenaar Consulting, 2019b)	Khai-Ma WEF Bat Impact Assessment Amendment. Change to larger turbine design. Literature review only, no new data collection.	Monika Moir (Stephanie Dippenaar Consulting)
Paulputs WEF (Arcus Consulting, 2019)	Final EIAr Paulputs WEF. For Paulputs Wind Energy Facility.	Jonathan Aronson (Arcus Consulting)
Poortjies WEF (Camissa Sustainability Consulting, 2021)	Poortjies WEF Bat Impact Assessment Amendment Part 2. Change to larger turbine design. For Savannah Environmental. Literature review only, no new data collection.	Unknown (Camissa Sustainability Consulting)

Sol Invictus Overhead Powerline (Inkululeko Wildlife Services, 2021)	Bat Impact Assessment for the proposed Sol Invictus Overhead Powerline. For The Biodiversity Company. Desktop only.	Caroline Lötter & Kate MacEwan
Red Sands WEF (Enviro-Insight 2023)	Pre-construction Bat Monitoring Assessment for the Proposed Red Sands Wind Energy Facility near Aggeneys, Northern Cape	Alex Rebelo & Luke Verburgt, reviewed by Low de Vries

2.3 FIELD SURVEYS

All methods used 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. Photos of the deployed bat detectors and respective habitats are shown in section 2.3.3.

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

Season and Dates	Methods	Weather and veld conditions
Autumn: 9-12th March 2021	Walkdown; rapid roost inspection	Dry, warm conditions, veld parched and appearing lifeless.
Spring: 11-14th October 2021	Deployment of bat detectors, transect drives, farmstead roost inspections.	Moderate temperatures with some cloudy days and first rains in a long time, veld still parched and appearing lifeless.
Summer: 13-19th January 2022	Passive detector data retrieval, transect drives, farmstead roost inspections.	Warm temperatures with sporadic cloudy days and rainfall events throughout visit (on/off from October through to February). Veld with some green growth beginning on shrubs, but limited grass.
Autumn: 25-31th May 2022	Passive detector data retrieval, transect drives, farmstead roost inspections.	Cool temperatures, veld green and abundant new grass cover.
Winter: 5-7th August 2022	Passive detector data retrieval, transect drives, targeted roost inspections.	Clear skies and warm temperatures. Shrubs still green and grasses present.

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 the placement of bat detectors, identify potential bat roosting sites and other sensitive areas, and evaluate the level of monitoring that would be required. This was performed prior to the deployment of the bat detectors.

2.3.3 Passive Bat Detectors

Twelve months of Pre-Construction Monitoring are required for => 20 MW WEFs both inside and outside of a REDz. As the proposed De Rust 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"). 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 PA and one detector must be deployed at a height of 50 – 80 m per 10 000 ha for masts that are 80 m tall. If a mast is taller than 80 m an additional bat detector must be deployed as close to the top of the mast as possible. As described above, the proposed WEF (including the proposed Houmoed WEF) has a turbine development area of less than 20 000 ha[2] and therefore 4 bat detectors at 7-10 m and 2 bat detector stations at a height of 50 – 80 m are sufficient. Five bat detectors were deployed with microphones positioned at 10 m above ground level (two of these at meteorological masts- only two meteorological masts were constructed for the site), each meteorological mast with a 10 m, 65 m and 110 m microphone (Figure 2-1; Table 2-3). 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: 18 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 bat detectors were connected to a 12 V (7.2 A) battery and a 20 W solar panel. On the meteorological masts all three bat detectors were connected to the same battery and solar panel. The bat detectors were serviced on a quarterly (seasonal) basis where all data were copied from the SD cards and backed up before formatting and replacing the SD cards. The equipment was also checked for faults and repaired if necessary.

Table 2-3: Details of the deployed bat detectors[3].

Name	ID	Meteorological Mast	Microphone Height above ground (m)	Latitude (°)	Longitude (°)	Date deployed
B1	S4U10652	No	10	-29.245444°	19.507455°	23/10/2021
B2	S4U10667	No	10	-29.291209°	19.533712°	23/10/2021
B4	S4U11304	MM1	10	-29.274161°	19.460981°	09/10/2021

[2] Note that this differs from the WEF boundary area in Figure 1-1 which has a surface area of 31,600 ha
[3] Bat detector B3 was removed from the analysis, see 1.5 Assumptions and Limitations

B5	S4U11290	MM1	65	-29.274161°	19.460981°	09/10/2021
B6	S4U11361	MM1	110	-29.274161°	19.460981°	09/10/2021
B7	S4U11265	MM2	10	-29.338486°	19.406775°	09/10/2021
B8	S4U11356	MM2	65	-29.338486°	19.406775°	09/10/2021
B9	S4U11341	MM2	110	-29.338486°	19.406775°	15/10/2021

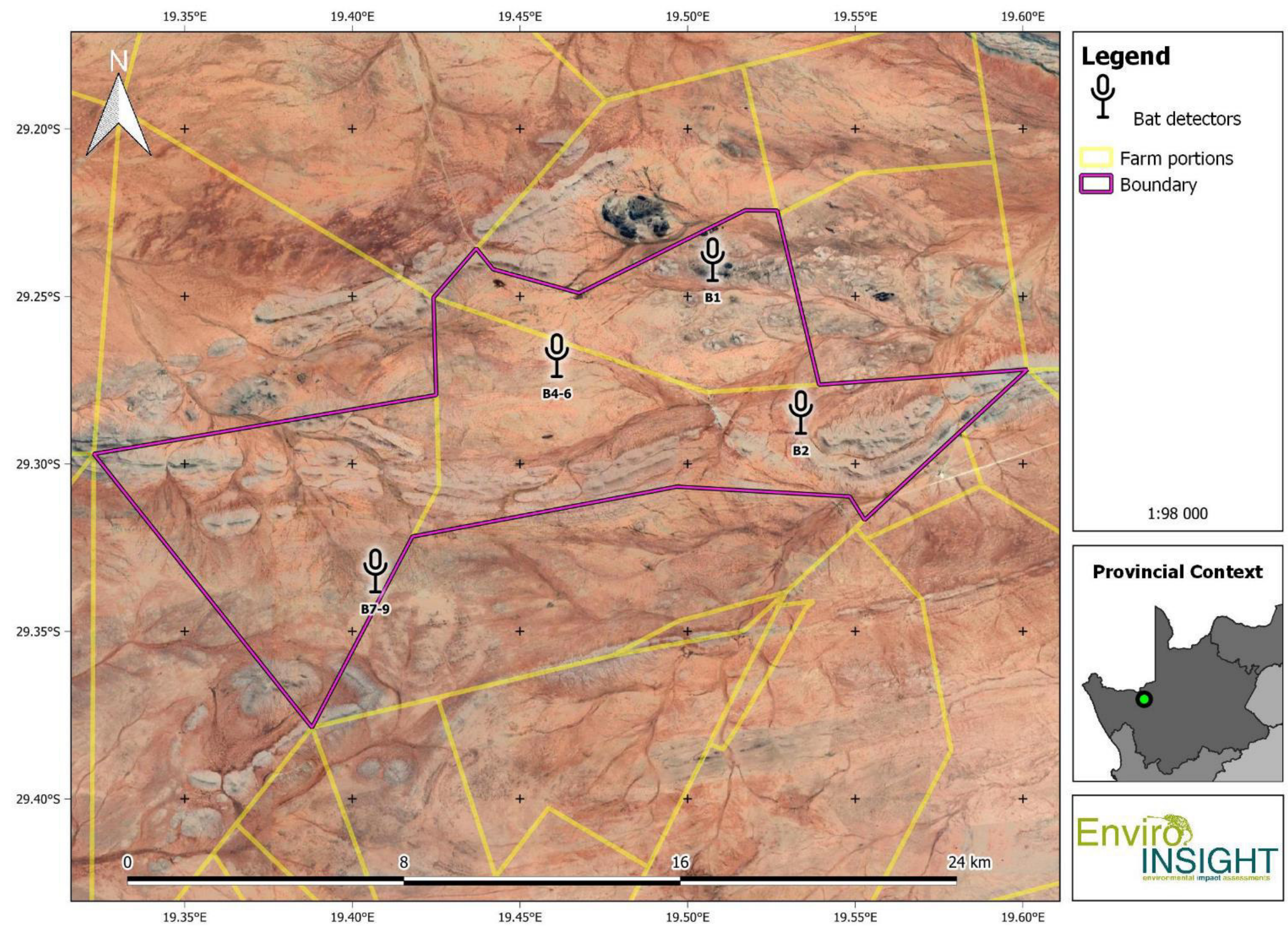

Figure 2-1: Locations for the eight passive bat detectors deployed within the proposed De Rust WEF boundary.

A total of eight bat detectors were therefore deployed across the PA, triplets at two meteorological masts and two singletons on individual 10 m masts (Figure 2-1). The two meteorological masts were constructed at locations predefined by the client, but the 10 m masts were spatially arranged within the proposed PA to represent the major habitat types. The major habitats include flat gravel or sandy plains, raised quartzite ridges with outcrop crests of quartzite and smaller plants and more succulents on their slopes, and stacked dolerite boulder outcrops and cones. Some bedrock is present within low-lying parts of the PA, appearing to be of igneous origin and having weathered extensively, but still forming outcrops, stacked boulders and crevices in some locations. Watercourses are ephemeral and typically have larger bushes or small trees within their drainage lines, with denser vegetation than in the surrounding landscape. One of the watercourses near the main farmstead has been dammed and maintains some level of water for an extended period after rain.

Detector B1 was located on a sandy plain, 160 m north of the alluvial plain of a dry watercourse and 240 m south of a medium-sized dolerite outcrop. The vegetation cover was very sparse and low to the ground, with a few small scattered bushes and small grasses coming up after the rains (Figure 2-2).

Figure 2-2: Passive bat detector B1 showing immediate surrounding habitat.

Detector B2 was located on a sandy plain 140 m from a dry watercourse and adjacent (150 m) to the start of a quartzite ridge/hill with a rocky crest. The vegetation cover was sparse and low, but numerous small bushes grew after the rainfall occurred. The watercourse had larger and denser bushes, while the quartzite ridge was very sparsely covered with vegetation (Figure 2-3).

Figure 2-3: Passive bat detector B2 showing immediate surrounding habitat.

Detectors B4-6 were located on a meteorological mast on a flat open plain gravel plain with medium sized scrub bushes and abundant grasses emerging after the rainfall on site (Figure 2-4). No nearby watercourses or hills were present in the immediate vicinity.

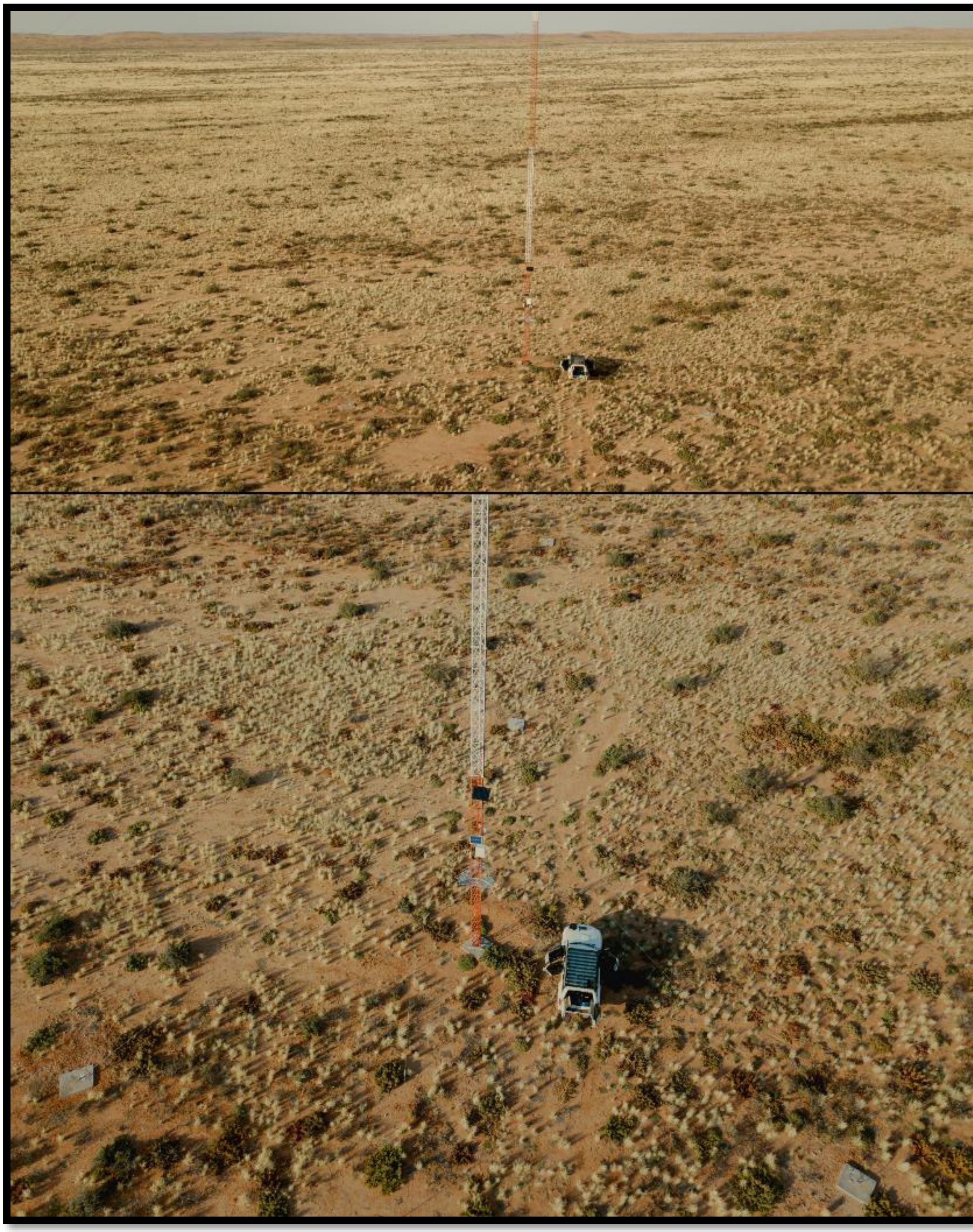

Figure 2-4: Passive bat detector B4-6 showing immediate surrounding habitat.

Detectors B7-9 were located on a meteorological mast on a flat open plain gravel plain with very sparse and low vegetation, and some small patches of slightly denser vegetation, possibly due to small depressions, and some denser grassy areas a distance away (Figure 2-5). A small watercourse begins about 300 m from the mast with some scattered medium-sized scrub bushes.

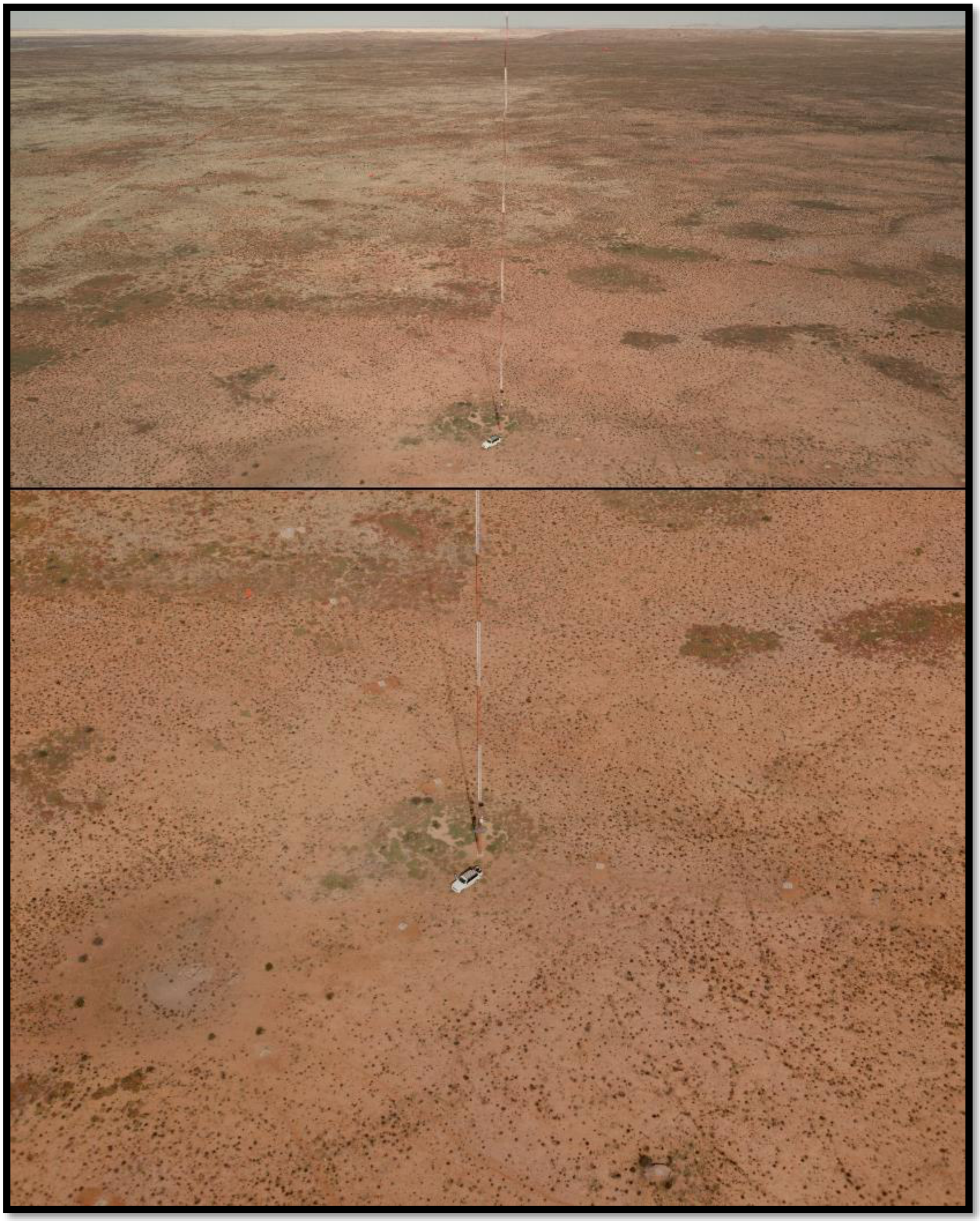

Figure 2-5: Passive bat detector B7-9 showing immediate surrounding habitat.

2.3.4 Active Transects

Transects were driven for a minimum of two nights per season across the PA (Table 2-4), no additional walk transects were conducted as the road network was extensive and intersected with all major habitats within the PA. The transect durations satisfied the requirements outlined in the SABPG (MacEwan *et al.*, 2020b), with at least 2.5 hours duration per night and a total transect duration of at least 5 h per season over 2 nights. Transects were only conducted under fair weather conditions where possible (nights with rain or strong winds were avoided, some transects did have moderate winds but no rain). Three different transect routes were driven each night per season due to the large size of the study area. Bats were recorded using a bat detector with the microphone attached to a pole held outside the vehicle approximately 3 m above the ground (Figure 2-6), while driving at an average speed of 20 km/h (maximum < 30 km/h) along the same transect routes between survey periods. All transects were tracked using a handheld GPS.

Table 2-4: Details of completed bat transects.

Season	Date	Type	Start time	End time	Duration	Season total duration
Spring	10/10/2021	Drive	19:03	21:33	02:30	
Spring	12/10/2021	Drive	19:04	21:31	02:27	
Spring	14/10/2021	Drive	19:04	21:36	02:32	**07:29**
Summer	14/01/2022	Drive	19:46	22:35	02:49	
Summer	17/01/2022	Drive	19:45	22:15	02:30	
Summer	18/01/2022	Drive	19:56	22:28	02:32	**07:51**
Autumn	27/05/2022	Drive	17:57	20:27	02:30	
Autumn	29/05/2022	Drive	17:56	20:28	02:32	
Autumn	30/05/2022	Drive	18:13	20:34	02:21	**07:23**
Winter	05/08/2022	Drive	18:15	20:51	02:36	
Winter	09/08/2022	Drive	18:22	20:52	02:30	
Winter	10/08/2022	Drive	18:18	20:52	02:34	**07:40**
				Grand Total Duration		**30:32**

Figure 2-6: Bat detector microphone deployed on a vehicle for use during driven bat transects.

2.3.5 Bat Roosts

Potential bat roosts, including rocky outcrops, buildings, trees and other infrastructure, were visited and visually inspected during the day for signs of bats, which included searching for faecal material and conducting acoustic monitoring with a handheld bat detector (if considered necessary). No caves were found on or near the site. There are also small mountains present ~18 km to the north, which may also have potential for caves and small bat colonies, but no caves have been reported nearby from other studies.

Three sites were selected for short-term passive acoustic activity monitoring to ascertain if bats were using these habitats for roosting sites. This was necessary as the habitats could not be adequately surveyed using visual inspections due to deep cracks or inaccessible spaces between rocks and boulders. Bat detectors and microphones were deployed at ground level (~ 1 m high) for at least 2 nights close to the potential roost habitat. Recordings were identified and plotted against time to determine if activity patterns indicated resident bats using the features as roosts, such as a spike in activity at dusk and dawn when bats emerge or retreat to their roosts.

2.4 DATA ANALYSES

2.4.1 Passive Bat Detectors

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 a single batch at the end of the monitoring period, 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 and variety of noise recordings. 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. However, sometimes clusters can group bat and non-bat vocalisation or noise together, to avoid this each cluster was sorted by the cluster and then cluster distance and the first and last 10 calls per cluster were manually checked and any non-bat vocalisations were removed from the cluster. At the same time, calls within each cluster were checked to ensure that the cluster included calls with similar acoustic properties, identified if cluster included multiple bats and/or multiple bat species consistently, or contained noise or non-bat vocalisation. If clusters contained distinctly different bat vocalisation (than other calls in the cluster), those calls within that cluster were manually identified accordingly. Clusters consisting of only noise or non-bat vocalisations were identified as such. The recordings were then rescanned using the 'cluster.csv' file with the updated manual identifications, and the resulting .kcs file was used to create a new cluster for the input recordings. These resulting clusters were subsequently identified manually to species (or group) 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. Clusters with consistently multiple species or individuals vocalising were noted as such and multiplied out for the final analysis. 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

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). 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. Environmental variables were calculated as averages for temperature and wind speed, where recordings were taken from more than one meteorological mast.

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. Recordings with at 2 or 3 individuals of bats calling were duplicated to better represent bat activity. All identified bat passes were then matched to their respective GPS timestamp to obtain a geographic coordinate to allow spatial mapping of each bat pass. In addition, the survey effort was calculated from the GPS tracks by taking the sum of the inverse of the average speed (m/s) per transect within hexagonal grid cells (diameter ~ 550 m), correcting for the speed driven due to differences in terrain, gate opening etc. The bat passes per unit effort (BPUE) was calculated for each hexagonal grid cell in total and for each season, dividing the total bat passes by the survey effort. Seasonal and total corrected bat activity was plotted to highlight any seasonal activity trends. Comparisons between general habitats present in the PA (vegetated watercourse, rocky habitats and hills/ridges) were made by intersecting the hexagonal grid cells and their BPUEs and calculating these averages across seasons.

2.4.3 Sensitive Habitat Delineation

Acoustic surveys (both passive and active) and roost survey results were consulted to determine which habitats could be considered sensitive for WEF development regarding bats, for either roosting or foraging activity. Pans and waterbodies are known to attract bats, especially in dry regions, and these features were delineated and marked as sensitive irrespective of the acoustic data because these features are too small to correlate with bat activity.

Sensitive bat habitats were delineated using information from site visits, satellite imagery and watercourse delineations from the aquatic specialist (derived from ALOS PALSAR DEM, NBA 2018 and manual delineation from site visits).

2.4.3.1 Site Ecological Importance

Site ecological importance (SEI) is a standardised metric for determining the ecological importance, based partly on species extinction risk as determined by the IUCN criteria (SANBI 2020). This metric was not used in the current report for the following reasons:

- Fatality is the main impact of the proposed activity on bats, which potentially depletes bat populations while leaving the original habitat mostly intact. The habitat is not protected if turbines deplete bat populations nearby. In addition, these affected species are often common and widespread, and would not 'trigger' the conservation importance component of the SEI;

- No threatened bat species were detected, and thus no habitat can be associated with these species;
- Bat activity is spatially diffuse due to their aerial foraging behaviour, and this often makes it difficult to associate specific habitats with specific bat species and activity patterns. Often the surrounding landscape may be more important than the habitats under investigation themselves;
- The guidelines (MacEwan *et al.*, 2020b) provide a highly tailored methodology specifically for monitoring and mitigating potential bat fatality in the context of wind energy facilities which is followed in this report. It is the opinion of the authors that this supersedes the SEI described in the Species Environmental Assessment Guideline (SANBI 2020) in this context.

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 – 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 – 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 – 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** – 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 – 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 – 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	

Significance was classified according to the following:

- **Low**: it will not have an influence on the decision;
- **Medium**: it should have an influence on the decision unless it is appropriately mitigated;
- **High:** it will have an influence on the decision unless it is appropriately mitigated. Alternative options including rehabilitation and/or offset mitigation should be investigated if avoidance and minimisation mitigation measures are not considered feasible or effective enough.

- **Very High**: it would influence the decision regardless of any possible mitigation. Alternative options including rehabilitation and/or offset should be investigated.

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.

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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 BASIC HABITAT DESCRIPTION

The following major habitat features were delineated and given the appropriate buffer (as per the guidelines: MacEwan *et al.*, 2020b).

3.1.1 Quartz hills and ridges

These are the most prominent habitat features within the PA, comprising hills and ridges of varied sizes and often an exposed solid quartz outcrop at the crest. The slopes are typically gentle and are strewn with medium to small quartz rocks and pebbles, often with an expansive flat base made up of small quartz pebbles and few plants. This habitat is easy to distinguish using satellite imagery due to the lighter ('white') colouration of the quartz rocks, which contrasts with the redder sands in the lowlands, and the change in elevation associated with the hills. However, eroded quartz hills may be flat and begin to mix with other surrounding substrate. These areas were excluded from the habitat delineation as the structure of the habitat is no longer present. No buffer was given to this habitat to assess bat activity, due to the expansive area that the ridge bases covered. Bat activity does not indicate that these general habitat features require buffering in terms of habitat sensitivity (see below).

3.1.2 Brown bedrock

Exposed bedrock is present within parts of the PA, with a brown colouration and igneous properties, often showing advanced stages of weathering. These rocks are not associated with hills in the PA, but may form some small koppies where boulders are stacked. This habitat is difficult to distinguish using satellite imagery, as it is similar in colour to the surrounding landscape and because exposed bedrock can also occur in flat expanses which lack the structural components assigned to this habitat. Extensive surveys of the rocks were undertaken on foot to identify areas that possess potential cracks and crevices suitable for bat roosting sites and these delineations were used to define this habitat. The habitat was buffered by 200 m for the purposes of assessing bat activity associated with this habitat. However, because bats were shown to roost in this habitat a buffer of 500 m should be applied (MacEwan *et al.*, 2020b).

3.1.3 Dolerite koppies

These rocky features are immediately recognisable by the black colouration of the dolerite boulders. They consist of large piles, outcrops or even large conical hills consisting of large, stacked boulders. Some areas have boulders with a browner colouration, but the boulders are similar, which are large and rounded, and often with expansive cavities between the boulders that extend into the centre of the feature. While these outcrops are easily recognised in satellite imagery from their dark colouration, site verification was also necessary as some areas have boulders embedded in the substrate, rather than forming deep cavities when boulders are stacked in a large pile. These outcrops (with cavities) were buffered by 200 m for the purposes of assessing bat activity associated with this habitat. Because bats (*Rhinolophus damarensis*) were shown to roost in this habitat they should be buffered by 500 m (MacEwan *et al.*, 2020b).

3.1.4 Vegetated watercourses

Watercourses often form an important habitat feature for bats, which use them for movement corridors as well as foraging areas as the lush vegetation and moisture often associated with these areas increases the insect abundance and therefore the foraging potential for bats.

Dense vegetation was calculated using a median NDVI value from Sentinel 2 imagery (between July 2017- July 2022). The median was taken due to the pronounced effect of patchy and isolated rainfall events on vegetation growth, and low NDVI values over the dry seasons. The NDVI values were manually inspected against Google satellite imagery to select cut-off values to indicate a high density of vegetation, and cells with values above 0.121 were reclassified into a high NDVI category. A Sieve filter (threshold: 10; 8-connectedness: true) was applied to the output raster to remove small slivers and spots of dense vegetation and this resulting raster was then vectorised.

Watercourses, as delineated by the aquatic ecologist, were utilised to delineate potential foraging habitat for bats by clipping all dense vegetation (calculated above) within a 500 m buffer of the watercourses. This dense riparian vegetation was then buffered by 200 m. We chose a relatively wide buffer of the watercourse to select riparian associated vegetation because the drainage line vegetation was sometimes indistinct within the PA, and this reduced the potential for watercourses that may have been overlooked or too small for delineation. All other watercourses between sections of dense vegetation were considered as potential flyways and buffered by 200 m, and combined together forming part of the vegetated watercourses habitat feature. Watercourses with no dense vegetation in their upper catchments were not included or buffered.

3.1.5 Minor habitat types

Additional 'micro' habitats were also delineated and buffered for sensitivity accordingly. These included the following:

- Confirmed or likely bat roosts (500 m buffer – small bat roosts);
- Dams likely to have surface water (200 m buffer);
- Building infrastructure likely to have roosting potential (200 m buffer);
- Exposed bedrock and pans likely to have surface water (200 m buffer); and
- Tree clumps likely to be associated with foraging activity (200 m buffer).

3.2 LITERATURE REVIEW

3.2.1 Previous Studies in the Region:

All nearby existing and proposed WEFs were searched for online to find additional data regarding important bat findings that might be of importance to the proposed De Rust WEF. Some EIA reports and bat specialist reports were available online and these are reported on below, but despite requesting additional reports from SABAA, bat appendices and some additional reports were not available (e.g. Namies WEF). No post-construction reports or results were available.

3.2.1.1 Kangnas WEF

Constructed and operational. The bat specialist study as included in the EIAr (Aurecon, 2012) noted the following:

- One species was confirmed in the study area (*Tadarida aegyptiaca*) and additional recordings were tentatively identified as *Cistugo seabrae*.
- Two caves located in the study area, to the north of the turbines, in the rocky inselberg small mountains about 30 km to the west of the current study site, bat roosting was confirmed by the presence of bat guano (Figure 3-1).
- Potential impact of the proposed WEF on bats of low significance without mitigation.

The interim status report (Bio^3 & Savannah Environmental, 2013) reported the following:

- Site is homogenous, no distinct biotopes could be assessed.
- No bat echolocations could be identified to species-level, but the following families and genera were likely present based on the recordings: Molossidae, Verpertilionidae and Miniopteridae. A possible echolocation of *Vansonia rueppellii* was recorded. No sonograms or spectrograms for these calls were provided in the report for external review.
- Bats are expected to be most abundant in spring and summer due to greater availability of food at higher temperatures, but no trends were observed from the limited (2 months) passive bat acoustic monitoring results.

Further monitoring needed to determine areas of high risk for bat collisions.

3.2.1.2 Korana WEF:

To be constructed. The bat specialist study summarised in the EIAr (Savannah Environmental, 2015a) and Bat Impact Assessment Amendment (Stephanie Dippenaar Consulting, 2019a) noted the following:

- Bat species detected included *Eptesicus hottentotus*, *Laephotis capensis*, *Miniopterus natalensis* and *T. aegyptiaca. Tadarida aegyptiaca* being the most abundant species.
- Bat activity was low over the winter season, and peaked in January.
- Bat activity was greater in the early evening, just after sunset, with a second peak around 02:00 – 04:00 am.
- Bat roosts buffered by 300 or 500 m and no turbines should enter these buffers.

3.2.1.3 Khai-Ma WEF:

To be constructed. The bat specialist study summarised in the EIAr (Savannah Environmental, 2015b) and Bat Impact Assessment Amendment (Stephanie Dippenaar Consulting, 2019b) noted the following:

- Outcrops and inselberg on the perimeter of the site is suitable for bat roosting
- Potential for migrants of *Eidolon helvum* foraging in fruit trees of farmers.
- Bat species recorded by passive bat detectors predominantly *E. hottentotus*, *L. capensis* and *T. aegyptiaca. Miniopterus natalensis* was also detected with a low abundance.
- Bat activity not strongly associated with specific parts of the site.
- Bat activity was greater closer to the ground than at rotor sweep height.
- 'Moderate' level of bat activity (specialist experience).
- Highest activity in summer, with very little activity during other season except at one location where roosts were in close proximity.
- Bat activity was mostly concentrated in the early evening.
- Following design modifications and implementation of mitigation measures allow for acceptable risk to bats.

3.2.1.4 Poortjies WEF

To be constructed. The bat specialist study summarised in the EIAr (Savannah Environmental, 2015c) noted the following:

- Most abundant bat species detected included *E. hottentotus*, *L. capensis* and *T.aegyptiaca. Miniopterus natalensis* was also detected with a low abundance.
- No evidence for migration of *M. natalensis* through the study site was detected over the 12-month monitoring period.
- Bat roosts limited to farm steads, rocky outcrops in nearby inselbergs and large (alien) trees.

No data were reported on in the Amendment Report (Camissa, 2021).

3.2.1.5 Sol Invictus Overhead Powerline

A desktop study for an overhead powerline connecting the Sol Invictus Photo Voltaic Solar Energy Facility. The bat impact assessment (Inkululeko Wildlife Services, 2021) noted that *L. capensis* and *T. aegyptiaca* are likely to be common, and that *E. hottentotus, M. natalensis, S. petrophilus* and *N. thebaica* may also be present in the area. No fieldwork was done to confirm these predictions. No nearby caves or significant roosts were reportedly known from the nearby area. Seasonal watercourses, all surface water and ephemeral watercourses were considered as sensitive areas for bat foraging.

3.2.1.6 Paulputs WEF

To be constructed. The bat specialist study (Arcus Consulting, 2019) noted the following:

- *Tadarida aegyptiaca* was the most common bat species by far, followed by *E. hottentotus* and *S. petrophilus*. *Laephotis capensis* were relatively uncommon in comparison and *M. natalensis*, and *Rhinolophus* spp. were rare.
- Bat activity was greater closer to the ground;
- Trees and shrubs and proximity to wetlands are associated with higher bat activity at one of the bat detectors;
- Curtailment parameters proposed for specific high activity months (if fatality threshold exceeded) for warm temperature, low wind speeds and specific relative humidity parameters.
- Low to moderate bat activity overall, but with high or very high activity in February, August and October. Bat fatality is predicted to be of high significance before mitigation and medium after mitigation.
- Outcrops and inselberg on the perimeter have moderate roosting potential, but no roosting bats were confirmed.

3.2.2 Expected Species

Based on Monadjem *et al.* (2020), the ACR (2021) and previous surveys conducted for WEFs in the region, 13 bat species could potentially occur on the PA (Table 3-1). However, only 10 species are considered to have a medium to high probability of occurrence given their roost requirements and known distribution, all of which are classified as Least Concern by the IUCN and not of conservation importance, with the exception of *C. seabrae* which is poorly known (few locations) and was previously considered to be Vulnerable (but is now Least Concern). The likely risk of fatality from turbines is high for the open-air foragers (*Sauromys petrophilus* & *T. aegyptiaca*), medium / high for clutter-edge foragers (*E. hottentotus, L. capensis* & *M. natalensis*) and low for the clutter foragers and species with restricted ranges (remaining spp.). Roosting requirements for species requiring caves, rocky outcrops and large trees are absent from the PA and only species known to utilise man-made infrastructure, such as buildings and walls are likely to roost in the area, including: *Cistugo seabrae*, *L. capensis*, *Nycteris thebaica, Rhinolophus clivosus* and *T. aegyptiaca*.

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Table 3-1: Bat species that could potential occur on the proposed De Rust WEF Project Area. Bold fields indicate noteworthy or unique categories. Species of conservation concern are highlighted in red. Med: Medium.

Taxon name	Common name	Likelihood of Occurrence	Closest records (ACR 2021)	CI [4]	Conservation Status [5]	Risk of Impact [6]	Echolocate?	Foraging habits	Day roosting habits and migrations.
Cistugo seabrae	Seabra's wing-gland bat	**Med**	100 km	**1**	LC	Low	Y	Clutter-edge	Unknown, may roost in buildings. Migration unknown
Eidolon helvum	Straw-coloured Fruit-bat	Low	200 km		**NT**	High	**N**	Frugivore	Trees. Migratory
Eptesicus hottentotus	Long-tailed serotine	**Med**	200 km		LC	Med	Y	Clutter-edge	Small groups in caves and rock crevices of rocky outcrops. Migration unknown
Laephotis capensis	Cape serotine	**Med**	200 km		LC	High	Y	Clutter-edge	Single or small groups in trees, aloe leaves and in the rooves of houses. No migration
Miniopterus natalensis	Natal longfingered bat	Low	300 km		LC	High	Y	Clutter-edge	Cave dependent, high cavities in cave ceiling. Late winter/spring to warmer maternity roosts and back at summers end
Myotis tricolor	Temminck's myotis	**Med**	200 km		LC	Med - High	Y	Clutter-edge	Gregarious, vertical crevices in caves. Summer maternity roosts
Nycteris thebaica	Egyptian slit-faced bat	**High**	50 km		LC	Low	**N** [7]	Clutter	Caves, aardvark burrows, road culverts, large tree trunks and buildings. No migration
Rhinolophus capensis	Cape horseshoe bat	Low	200 km	**1**	LC	Low	Y	Clutter	Gregarious, caves and mine adits, free-hanging from ceiling deep in darkness. No migration
Rhinolophus clivosus	Geoffroy's horseshoe bat	**High**	50 km		LC	Low	Y	Clutter	Gregarious, caves and mine adits, free-hanging from ceiling deep in darkness as well as dark spaces in buildings. No migration
Rhinolophus damarensis	Damara horseshoe bat	**High**	50 km		LC	Low	Y	Clutter	Medium sized colonies in caves and mine adits, and singly or smaller groups in culverts and boulder pile cavities. No migration
Sauromys petrophilus	Robert's flat-headed bat	**High**	100 km		LC	High	Y	Open-air	Small groups in narrow rocky crevices, including boulders at ground level, and under exfoliating rocks. No migration
Tadarida aegyptiaca	Egyptian free-tailed bat	**Med**	200 km		LC	High	Y	Open-air	Small to medium-sized groups in horizontal rock crevices, caves, bark and hollows of trees and buildings (especially roofs). Maternity colonies occupied from November, but migrations not documented
Vansonia rueppellii	Rüppell's bat	**Med**	200 km		LC	Med - High	Y	Clutter-edge	Unknown, possibly associated with trees. Migration unknown

[4] Conservation Importance: includes threatened, rare or range-restricted species (MacEwan *et al.*, 2020a)
[5] LC: Least Concern; NT: Near-Threatened
[6] The likelihood of fatalities from turbines due to broad ecological traits, excluding migration (MacEwan *et al.*, 2020b)
[7] Does echolocate, but not for foraging where it listens for sounds produced by insects

3.2.3 Protected Areas

The nearby Gamsberg Nature Reserve is divided into two areas and is located 15 km to the west and 45 km to the west-north-west, Augrabies Falls National Park is located 85 km to the north-east of the proposed WEF, and Kara and Marietjie van Niekerk Nature Reserve to the west-south-west of the proposed WEF (Figure 3-1). Known caves are located in the Marietjie van Niekerk Nature Reserve.

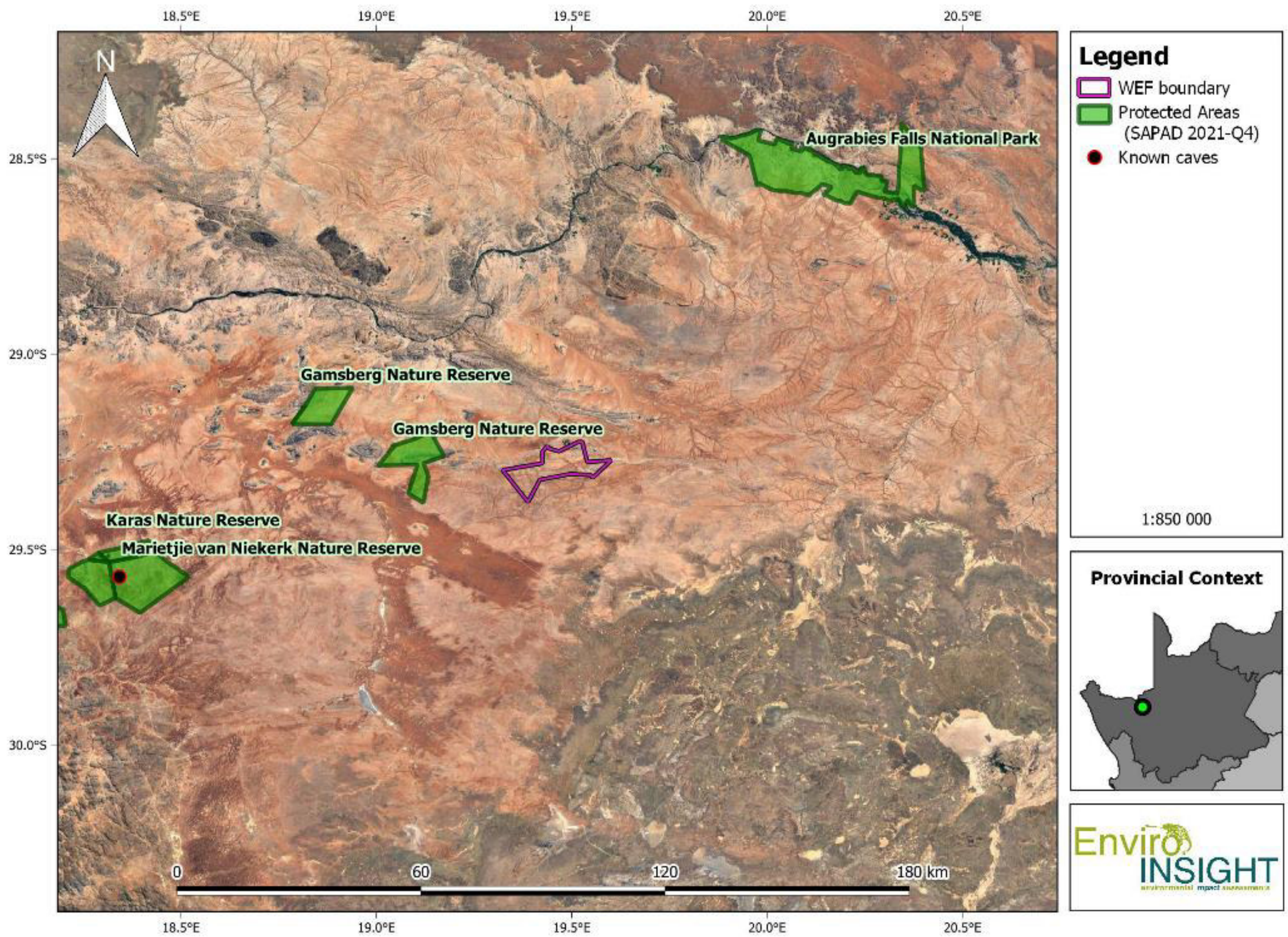

Figure 3-1: Location of protected areas and known caves in relation to the proposed De Rust WEF boundary.

3.3 ACOUSTIC BAT MONITORING

3.3.1 Passive Acoustic Monitoring

3.3.1.1 Overview

Eight static bat detectors were deployed for the pre-construction monitoring, two stand-alone detectors with microphones at 10 m and three bat detectors for each meteorological mast, each including microphones at 10 m, 65 m, and 110 m respectively

(Table 2-3). The bat detectors recorded data for a total of 29 870 hours and captured 168 161 bat passes (Figure 3-2). This represents an average of approximately 86 % acoustic coverage across the current monitoring period, which is above the minimum requirements of 75 % (MacEwan *et al.*, 2020b).

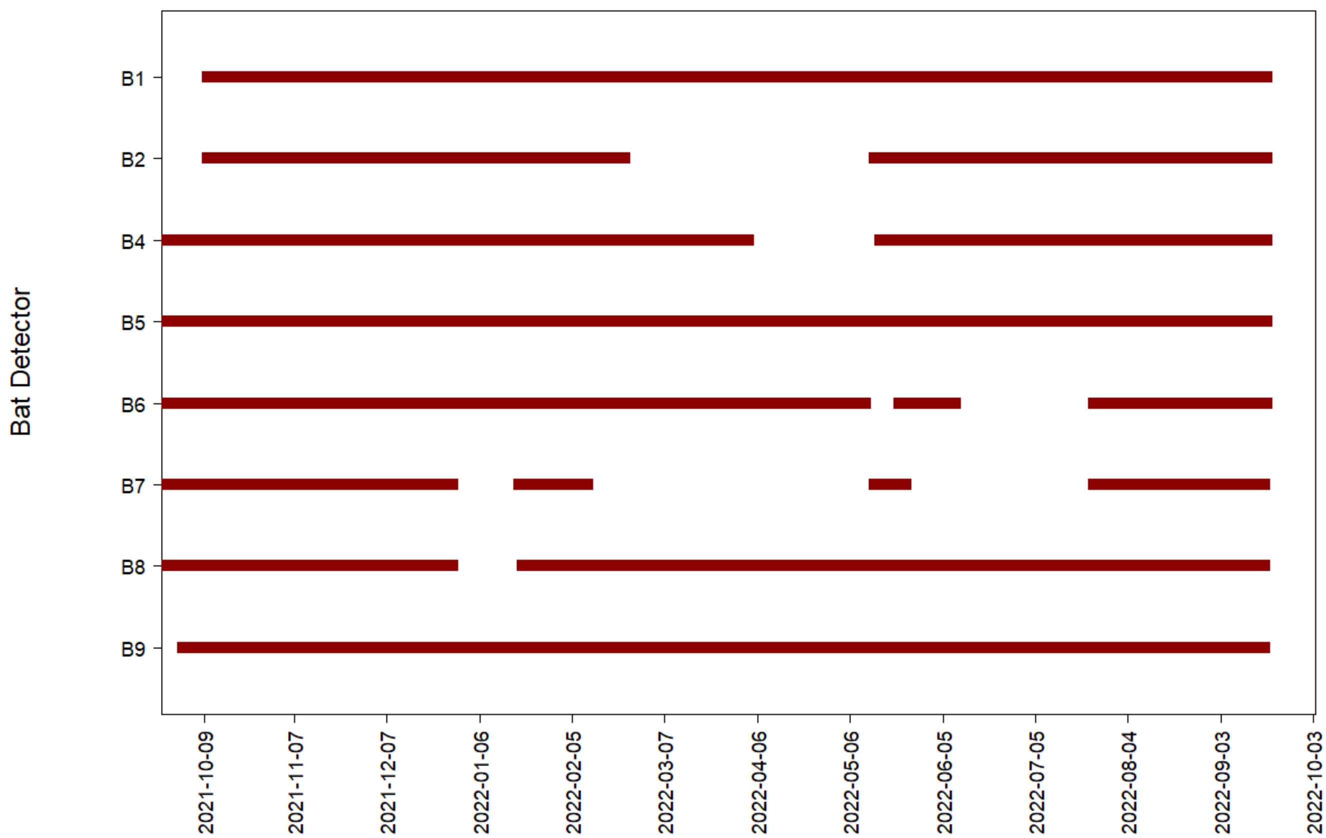

Figure 3-2: Recording times for the nine bat detectors deployed at De Rust WEF (solid red lines indicate periods that were recorded). B1-4 & 7 had microphones at 10 m, B5 & 8 at 65 m and B6 & 9 at 110 m.

Nightly bat activity started off low in October 2021, and began to increase in mid-December and reached the highest activity at the start of February 2022, and high activity was maintained until mid-March after which a moderate level of bat activity persisted until June before dropping back down (similar to activity recorded in October 2021) for August, and increasing in September and October. A few notable activity spikes were detected across all recording data, taking place predominantly in Summer and Autumn, but also to a lesser extent from August to September. Large activity spikes (>40 bp/h) took place on 1, 4, 16, 22 February 2022, 6, 27 March 2022, and smaller spikes (>5 bp/h) on 19 December 2021, 8, 15, 19 January 2022, 12, 17 April 2022, 12, 25 May 2022, 23, 24 August 2022, 1, 9, 14, 15, 28 September 2022, and 1 October 2022.

Five potential bat species were recorded during static acoustic monitoring, *L. capensis*, *M. natalensis* and *T. aegyptiaca* were identified with certainty, while *E. hottentotus* and *S. petrophilus* were only tentatively identified. The majority of bat activity was represented by *T. aegyptiaca* and/or *S. petrophilus* (Table 3-3), open-air foragers, and few clutter-edge foragers and very few clutter-foragers, as can be expected from the low vegetation and the flat terrain where the masts were erected. Bat activity at ground level was markedly highest at recorder B2 (median of 1.34 bp/h) and was roughly comparable between the other bat detectors (0.63-0.88 bp/h; Table 3-2). Although B2 had more downtime during periods of low bat activity and will be biased toward higher values, the activity was still higher than other detectors at ground level during high activity periods where all detectors were recording, with the exception of B7 (Figure 3-7).

No signs of large bat roosts were detected from patterns in the passive acoustic data. There was no evidence of bat migrations, but large and regular activity spikes of *T. aegyptiaca* and/or *S. petrophilus* during summer and autumn suggest that these open-air foragers are foraging widely during these seasons and appear to congregate on isolated nights.

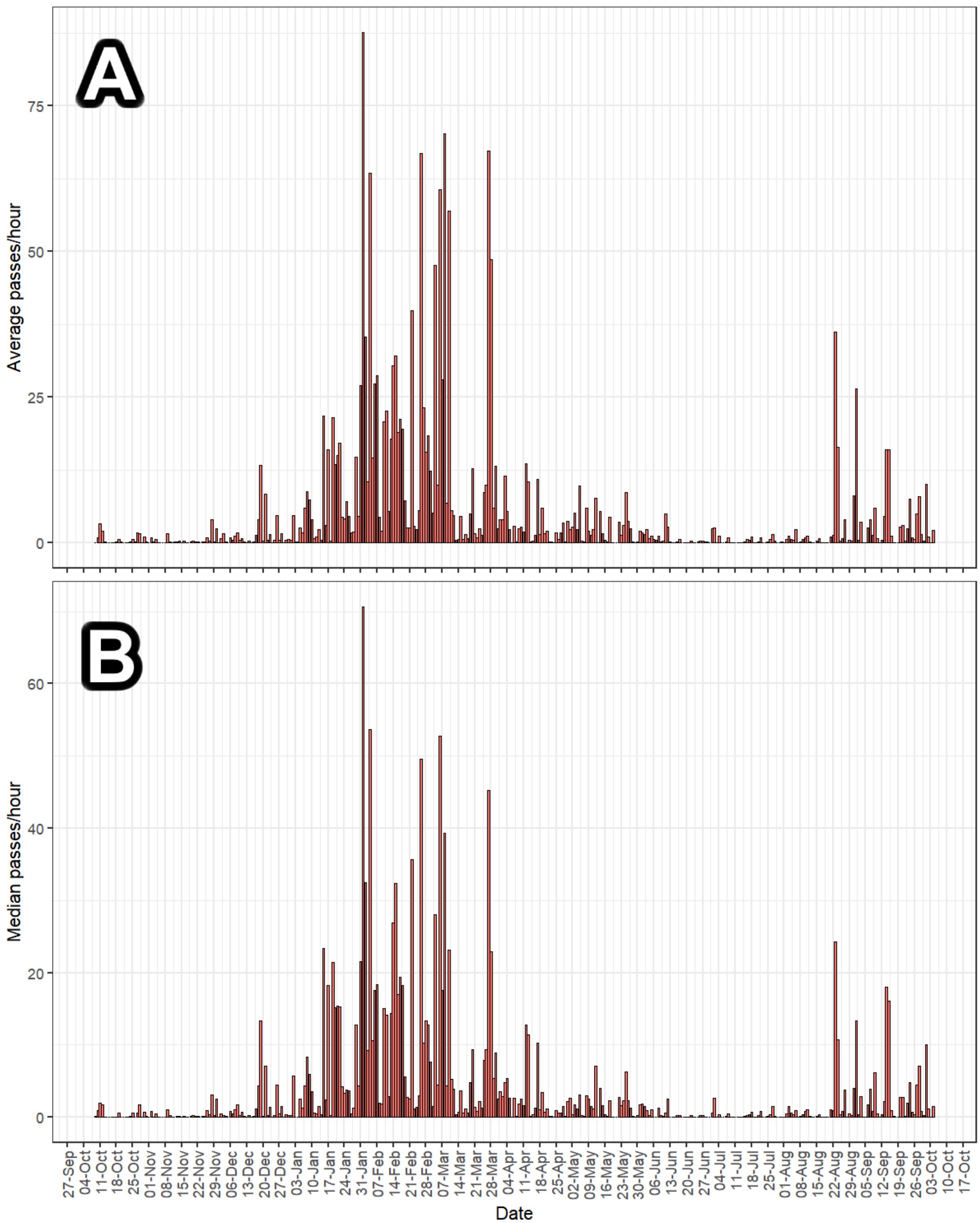

Figure 3-3: Combined median and average nightly bat passes/hour for all bat detectors. A] average passes/hour B] median passes/hour.

3.3.1.2 Passes by Bat Detector

3.3.1.2.1 Hourly

Hourly activity is only depicted as an average because the median values were mostly zero at this fine temporal resolution. Bat activity steadily increased from sunset and reached a plateau (21:00 - 04:00), decreasing dramatically from 04:00-05:00, with almost no activity thereafter (Figure 3-4).

Across all detectors, bat activity stays consistently high for a prolonged period (21:00-03:00), but then drops off. There are no obvious morning and evening spikes in activity which may indicate that the majority of bats are not roosting nearby if they forage until dawn, similar to the findings at the nearby Red Sands proposed WEF (Enviro-Insight 2023).

There were seasonal differences in relative bat activity (Figure 3-5):

- summer activity was more restricted, as expected from the longer daylight hours in this season.
- spring and autumn activity showed a peak in the middle of the night, while summer reaches a plateau of activity through much of the night.
- winter activity is greatest early in the night (19:00) and declines throughout the night., This is particularly evident for the recorders at height (B5, B6, B8, B9) but less so for those at ground level.

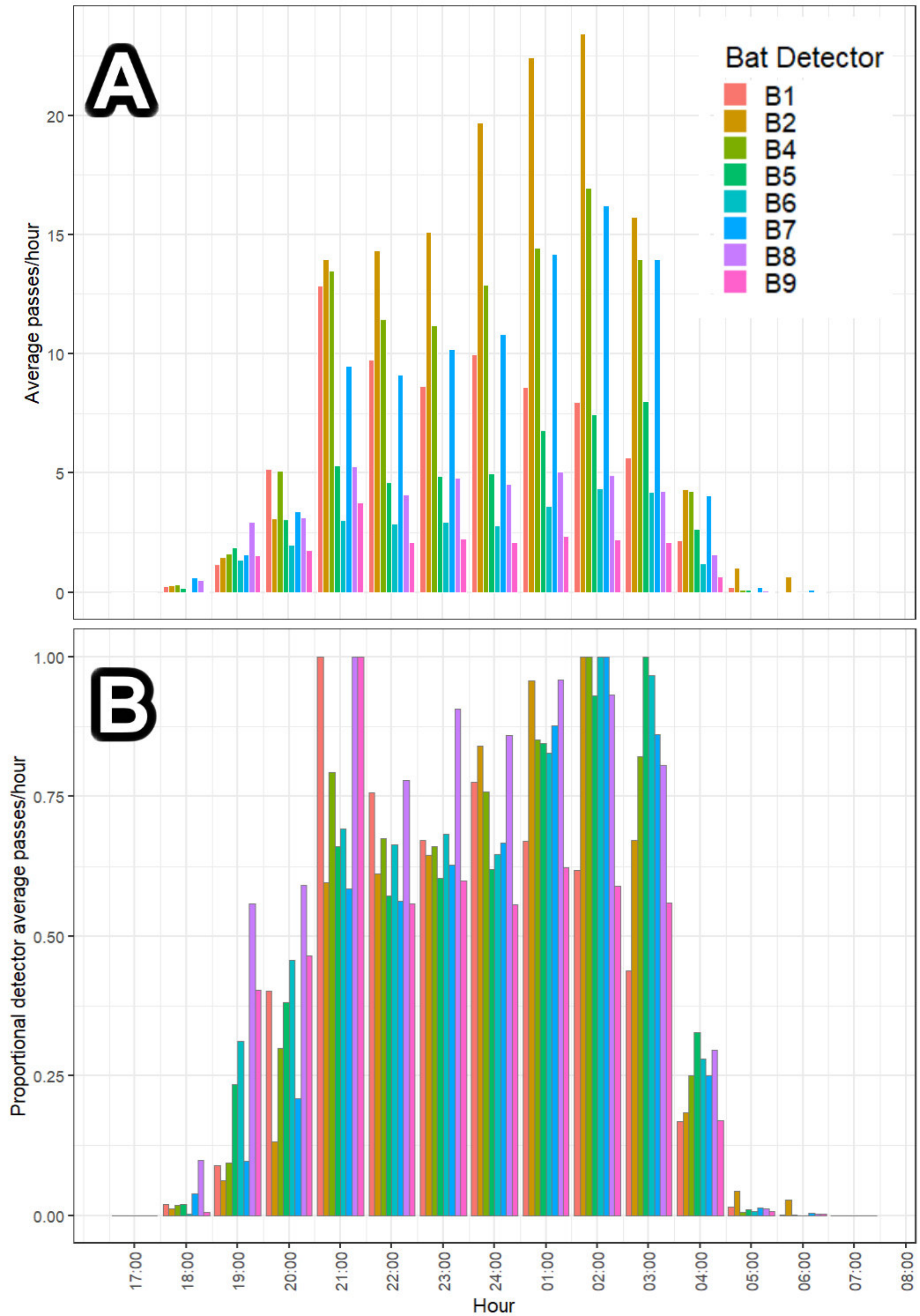

Figure 3-4: Average hourly activity of bats per bat detector. A] average passes/hour B] proportional average passes/hour.

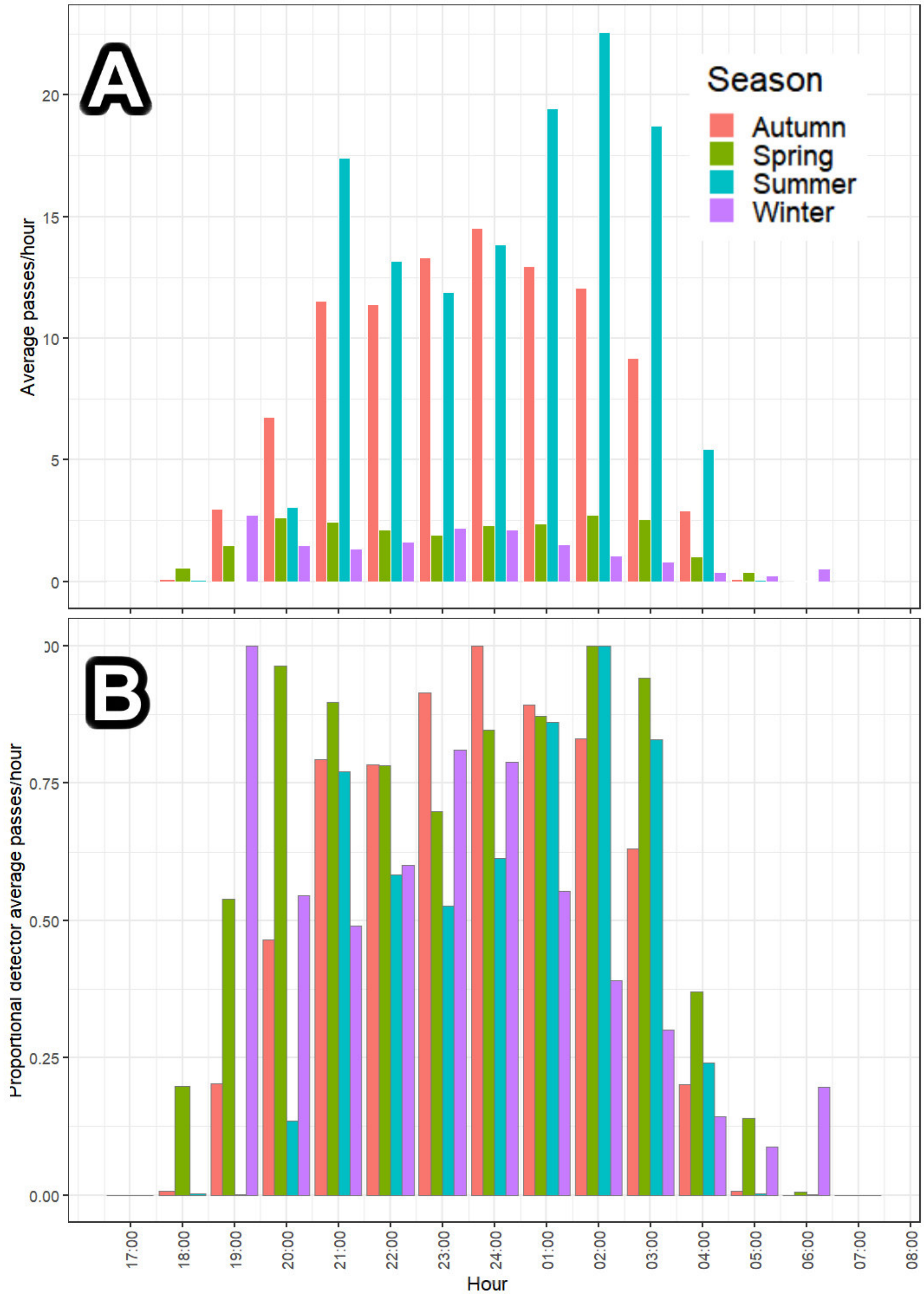

Figure 3-5: Average hourly activity of bats per season. A] average passes/hour B] proportional average passes/hour.

3.3.1.2.2 Yearly

Bat detectors ranged from a median of 0.29 to 1.35 bp/h for the entire monitoring period. Detectors recorded similar median bp/h with B2 recording the highest median values, with average values greatest for B2, B4 and B7, indicating the greatest activity, followed closely by B1 (Table 3-2; Figure 3-6). However, detector downtime in B2 and B7 during some of the peak activity period is likely to have resulted in an underestimate of activity for these detectors, and their maximum activity values indicate that bat activity was likely higher at these sites than the others, where B7 has the greatest activity when considering bat activity from the main activity peak period, which had good recording coverage for all recorders. Detectors B5-6 and B8-9 had microphones at height and these are discussed in section 3.3.1.4.

Table 3-2: Bat detector recording time and bat pass summary.

Bat detector	Microphone Height (m)	Summed bat passes	Time recorded (hours)	Overall median bp/h	Overall average bp/h	Median bp/h (01 Feb – 28 Feb 2022)	Average bp/h (01 Feb – 26 Feb 2022)
B1 - S4U10652	10	25040	4096.27	0.88	5.90	8.34	13.74
B2 - S4U10667	10	36317	3236.92	1.35	10.95	19.54	28.07
B4 - S4U11304	10	33772	3853.93	0.69	8.49	24.39	28.07
B5 - S4U11290	65	17653	4272.42	0.73	3.96	13.10	15.25
B6 - S4U11361	110	8780	3776.36	0.51	2.24	5.60	6.61
B7 - S4U11265	10	23525	2442.04	0.63	8.04	32.99	35.81
B8 - S4U11356	65	15725	4006.66	0.60	3.26	10.05	12.87
B9 - S4U11341	110	7158	4185.10	0.29	1.64	3.22	5.59

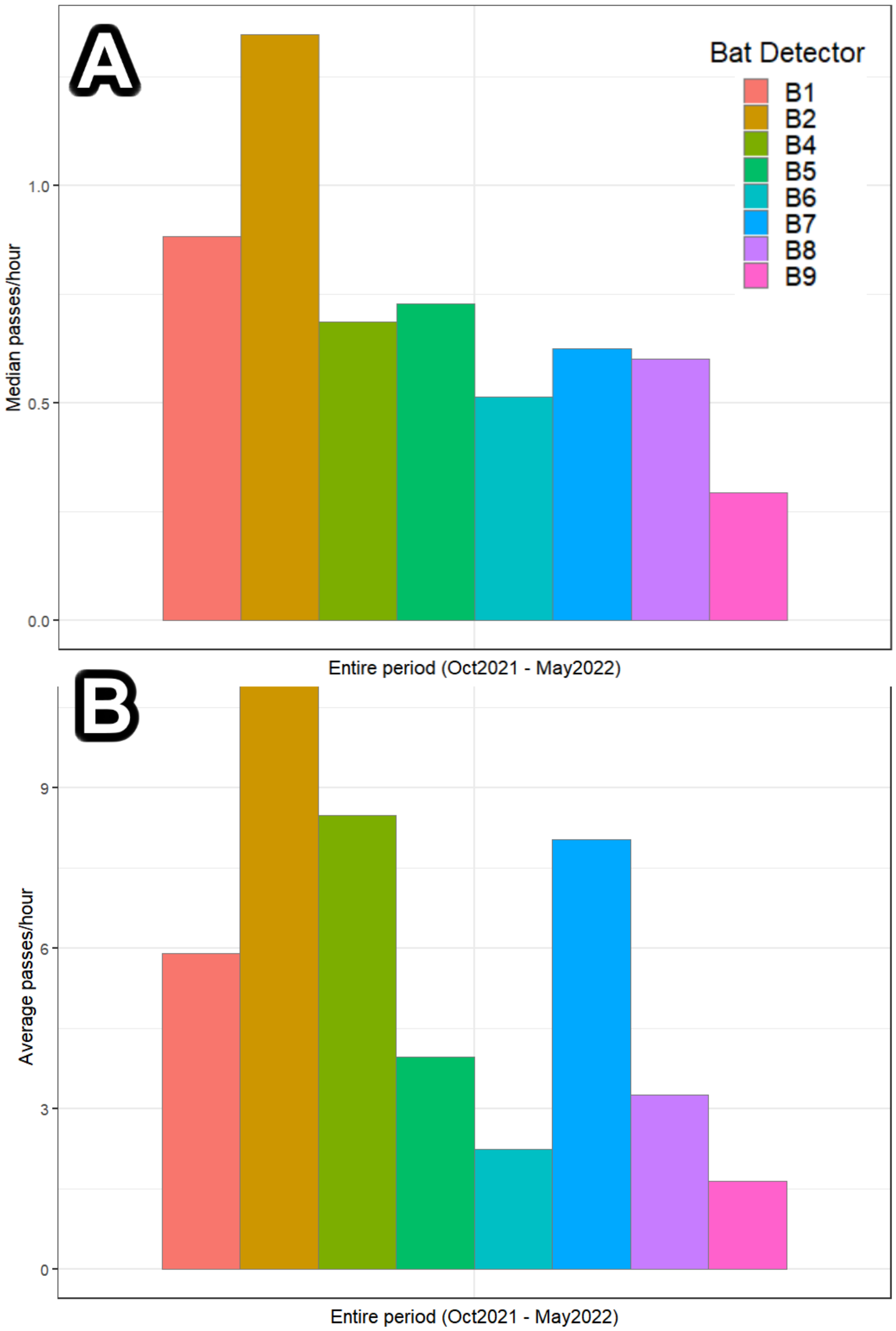

Figure 3-6: Yearly recordings of echolocation calls of bats per bat detector (median calculated from sum per night). A] average passes/hour B] median passes/hour.[8]

[8] Note that B2 & 7 had considerable downtime which has affected the overall activity figures.

Habitat differences between the bat detectors are mostly geomorphological, as vegetation is predominantly sparse and low throughout the PA. However, habitat differences between bat detectors does not appear to have a large effect on bat activity, although this could also be attributed to detectors being placed some distance away from notable habitat features.

Detector B1 was placed in proximity (240 m) to a series of small dolerite koppies and 160 m from a dry watercourse alluvial plain. Both short-term acoustic monitoring at the large dolerite koppies, and active transects indicated that these dolerite koppies are associated with elevated levels of bat activity (as well as roosting for *Rhinolophus* in the former), however, the passive bat detector did not pick up greater levels of bat activity than the other detectors. This may be due to the detector being placed a distance away from this habitat. Detector B2 was placed between a well vegetated watercourse (140 m) and the start of a quartz ridge with quartz outcrops on its crest (150 m). This detector picked up high activity levels in comparison to B1. This may be due to bats foraging close to the denser vegetation along the nearby watercourse.

Detectors B4-6 and B7-9 were placed on meteorological mast 1 and 2 respectively, both located on a flat open plain with no notable terrain or watercourses nearby. Despite this, activity at ground level was comparable to B2, being greater at meteorological mast 1 overall. Detectors B5 and B6 also showed slightly higher activity (at height) than the detectors B8 and B9 on meteorological mast 2. However, when considering the peak activity period, B7 recorded the (markedly) highest bat activity across the entire PA. One potential explanation is the presence of small scattered circular depressions with denser vegetation which appear to be ephemeral water pans at meteorological mast 2, and that bats are attracted to these pans for drinking or emerging volant insects with aquatic larvae when surface water is present.

The greater bat activity at the meteorological mast in comparison to B1, despite the lack of major habitat differences (at meteorological mast 1) may be attributable to the large meteorological mast structures themselves being an attractant to bats, potentially because, as reviewed by Guest *et al.* (2021), bats using meteorological masts to mark and seek scents, or use it as a navigation point or landmark for mating bats, some bats forming aggregations, and thus recording a higher activity of bats than might be expected without the structure. However, without greatly elevated bat activity at these met masts, as recorded at the nearby proposed Red Sands WEF (Enviro-Insight 2023), it is also possible that bat activity at B1 is reduced for some other reason, such as bats in the area preferring to forage or socialise at the dolerite koppies nearby.

3.3.1.2.3 Monthly/Seasonally

Monthly activity is very congruent between bat detectors, showing very low bat activity from October to December 2021, which then increases from mid December 2022 and reaches the annual maximum in early February and March, before decreasing slightly to moderate activity levels for April and May, returning to very low activity for June to July 2022 and increasing slightly in August and September 2022 (Figure 3-8). **Seasonal patterns** of bat activity in the PA are starkly contrasted and follows the same trend between detectors: bat activity increases drastically in late summer and stays high in early autumn before decreasing to very low levels over winter and spring (Figure 3-9).

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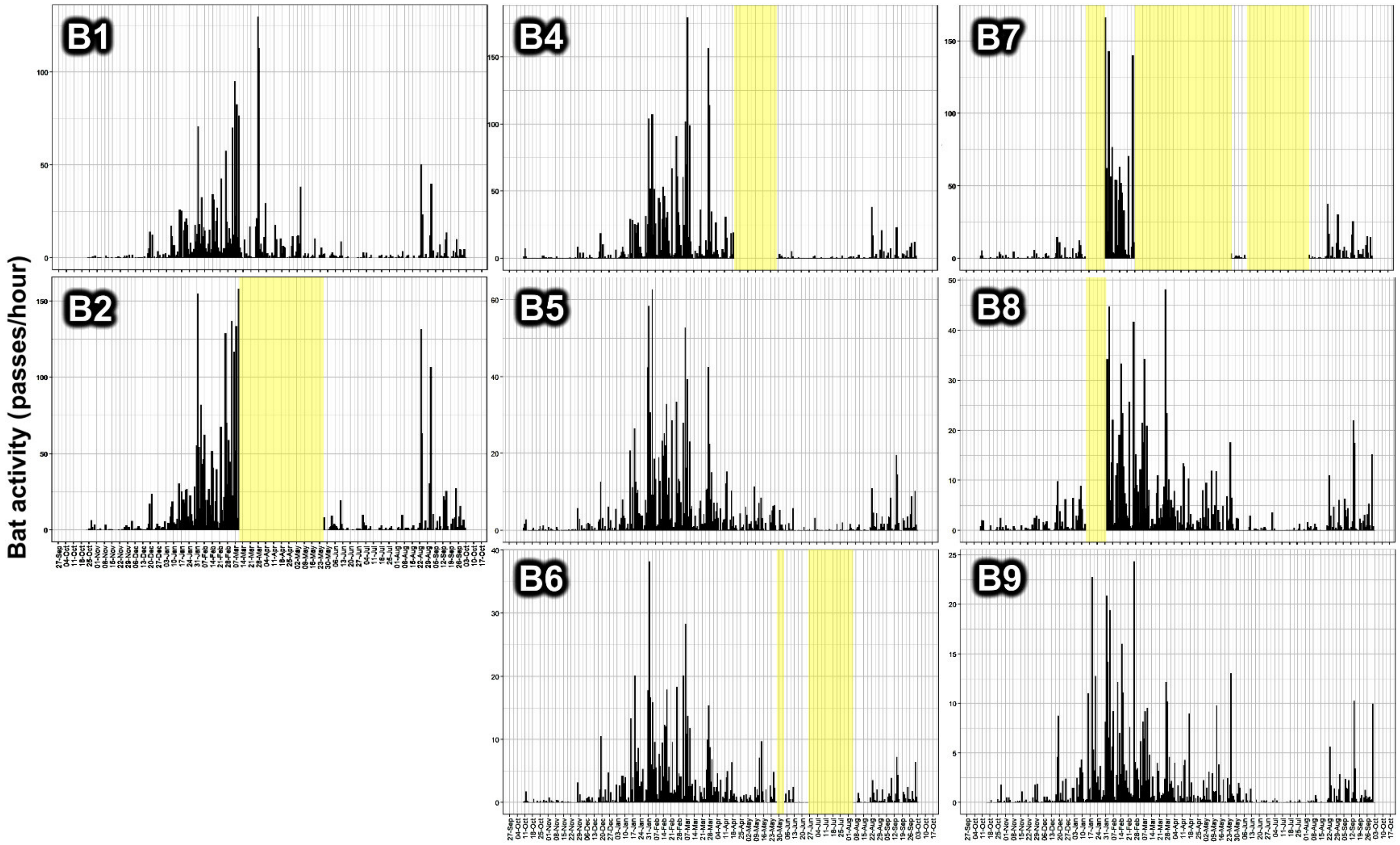


Figure 3-7: Nightly activity of all bat species per bat detector and for all detectors combined. The scale of bat activity (y-axis) differs between recorders, but the dates (x-axis) are aligned. Yellow shaded areas indicate recorder downtime. Bat activity calculated as the median of the nightly average of passes per hour for each night.

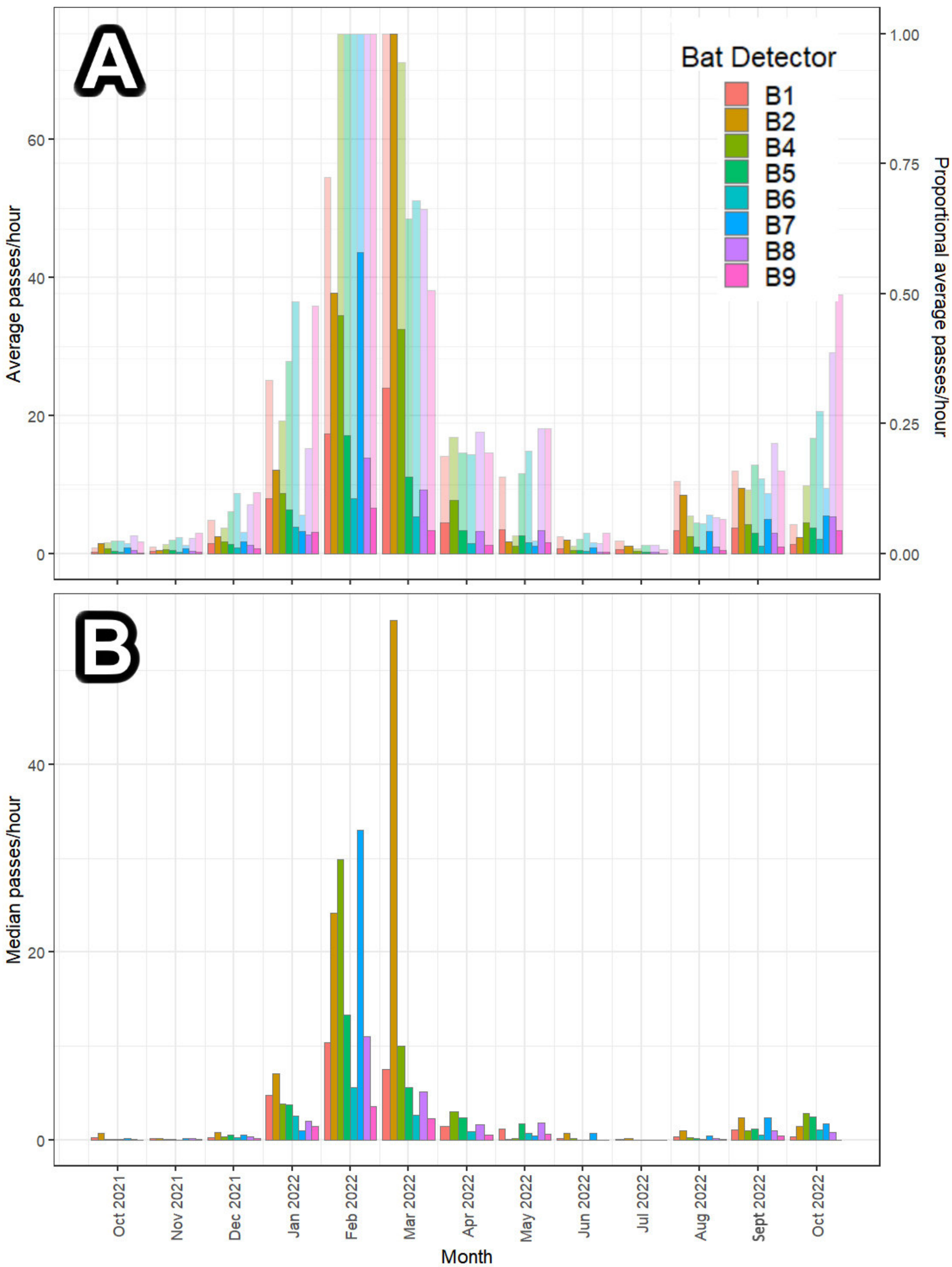


Figure 3-8: Monthly recordings of echolocation calls of bats per bat detector. A] average and proportional average (opaque) passes/hour B] median passes/hour.

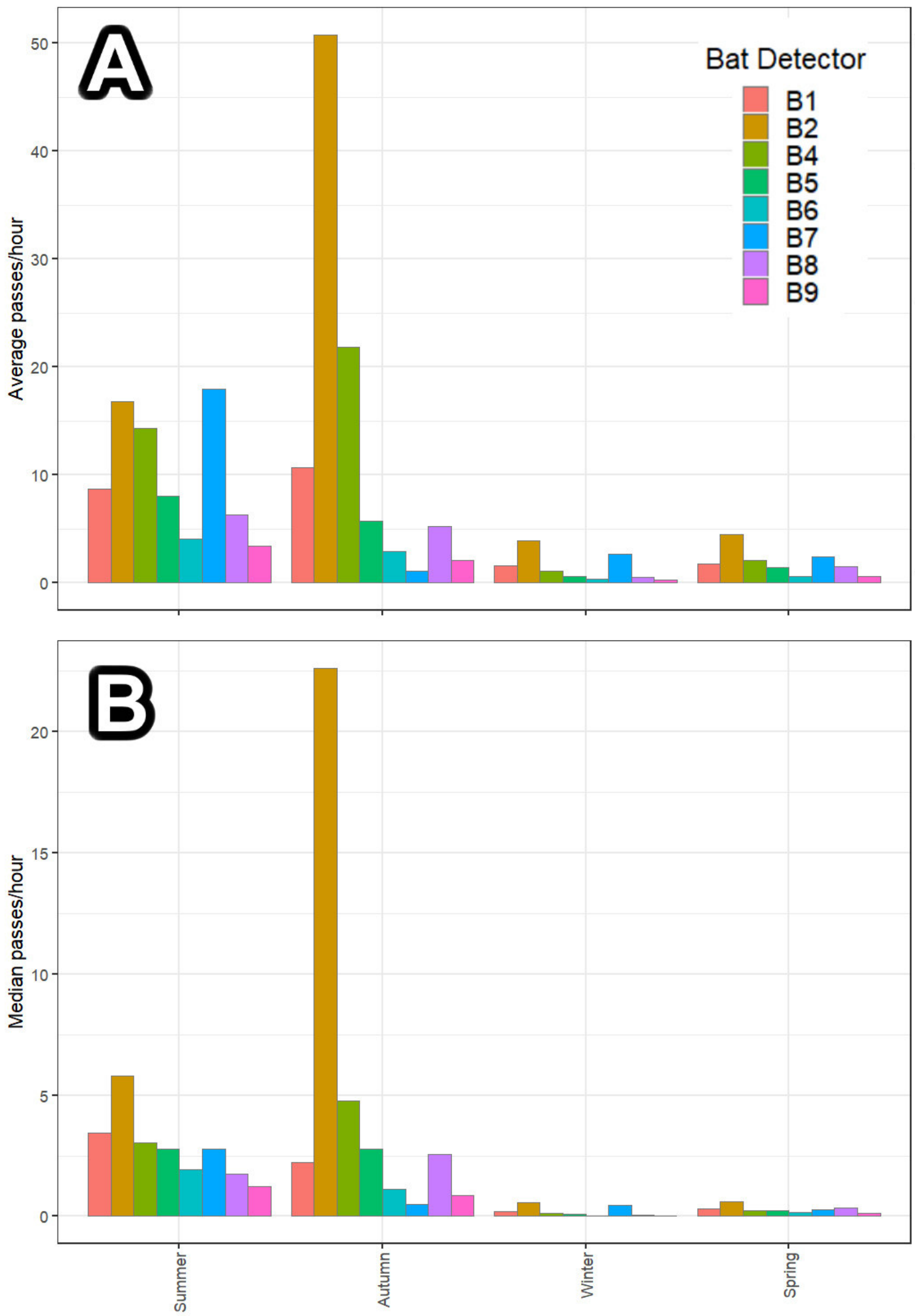


Figure 3-9: Mean seasonal recordings of bats per bat detector (median calculated from sum per night). A] average passes/hour B] median passes/hour. [9]

[9] Note that recording downtime for B2 has resulted in inflated values for Autumn.

3.3.1.3 Passes by Species

Calls from potentially five species of bats were recorded and confirmed on the passive bat detectors, namely: *L. capensis*, *E. hottentotus, M. natalensis*, *S. petrophilus* and *T. aegyptiaca*. *Rhinolophus damarensis* was only detected during the additional roost acoustic surveys (Figure 3-10). As mentioned above, some calls from *E. hottentotus* and *S. petrophilus*, and *S. petrophilus* and *T. aegyptiaca* were grouped due to similarities between them.

From the total of 168 161 bat passes recorded during the survey period to date, most passes were identified as *T. aegyptiaca* (72 640), *T. aegyptiaca* or *S. petrophilus* (56 545), *S. petrophilus* (32 959), *S. petrophilus* or *E. hottentotus* (5 183), *E. hottentotus* (697), and lastly *M. natalensis* (137; Table 3-3; Figure 3-15). *Laephotis capensis* calls were infrequent, and did not form a distinct cluster, being grouped with *E. hottentotus* in the cluster analysis. All of these species are listed as Least Concern on the IUCN Red Data List and are not regarded as ToPS species. Some species have a high risk of turbine fatality, such as *T. aegyptiaca*, *S. petrophilus, M. natalensis* and *L. capensis,* while *E. hottentotus* is medium risk and *Rhinolophus* is low risk. Species are at greater risk if they fly within the rotor sweep area (open-air foragers) or are known to migrate. It is clear that the open-air foragers are by far the most abundant bat species in the PA, representing at least 96 % of all bat passes, and this indicates that fatality due to turbines is highly likely to occur due to the foraging behaviour of these species.

The clutter-edge foragers, *E. hottentotus*, *L. capensis* and *M. natalensis*, and clutter foraging *Rhinolophus denti*. were recorded in the PA (the latter only in short-term acoustic monitoring), but were detected at very low densities. It is likely that most of the habitat in the PA is too dry and vegetation too short for these species to forage effectively, with the clutter-edge foragers *M. natalensis* and *L. capensis* being recorded very seldomly. *Laephotis capensis* was only detected in low numbers in the PA, but is a locally abundant species in other locations in the Northern Cape province. Furthermore, the lack of caves close to the PA is also likely to limit roosting opportunities for species preferring caves, especially some species of *Rhinolophus*. *Nycteris thebaica* emits low intensity echolocation and thus is not expected to be detected by acoustic monitoring, but has a high likelihood of occurring on site due to suitable roosts (buildings) and nearby roosting individuals found 70 km from the PA (Figure 3-11). The other non-echolocating species is *Eidolon helvum*, but this species is highly unlikely to be present on site due to the lack of suitable fruit trees for foraging. The geographic distribution of this species does appear to have a gap over the dry sandy regions of Namaqualand, with some records along the Orange River to the north (Monadjem *et al.,* 2020) and its low abundances is likely due to the sparse vegetation of the PA. *Cistugo seabrae* was predicted to have a medium likelihood of being present in the PA and was reported from surveys performed at the Kangas WEF (100 km away), but no vocalisations from this survey could be assigned to this species. It is a species worthy of note (as with *Rhinolophus* sp.) as one fatality per annum triggers additional mitigation measures for a WEF (MacEwan *et al.*, 2020a), but the call is quite distinct and therefore recognisable from the other species and was not detected as a distinct cluster, and thus it is likely that the species is either absent or at very low densities within the PA.

Table 3-3: Total number of passes per bat species and their conservation status/extinction risk.

Species	Number of passes	Median number of passes/hour	IUCN Red List Status	CITES listed	NEM:BA ToPS	Likely risk of wind turbine fatality	Endemic/other important considerations?
T. aegyptiaca	72 640	0.42	LC	No	No	High	No
T. aegyptiaca / S. petrophilus	56 545	0.15	LC	No	No	High	No
S. petrophilus	32 959	0.00	LC	No	No	High	No
S. petrophilus / E. hottentotus	5 183	0.00	LC	No	No	High/Medium	No
E. hottentotus	697	0.00	LC	No	No	Medium	No
M. natalensis	90	0.00	LC	No	No	High	No
Total	**127 495**						

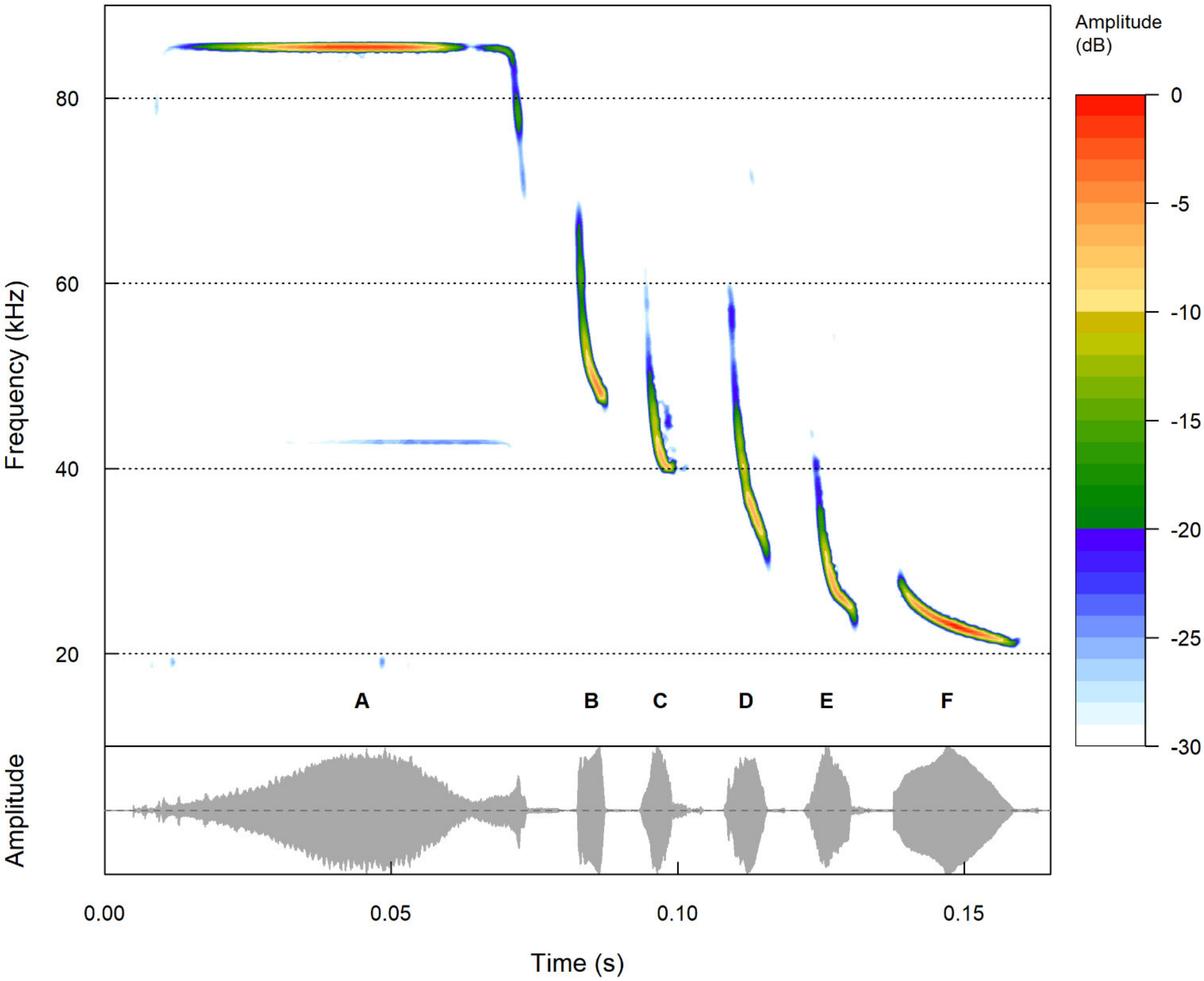


Figure 3-10: Exemplar recordings for each of the six (tentative) bat species recorded during pre-construction monitoring [10].

[10] A: *Rhinolophus denti*; B: *Miniopterus natalensis*; C: *Laephotis capensis*; D: *Eptesicus hottentotus* (or *Sauromys petrophilus*); E: *S. petrophilus* (or *Tadarida aegyptiaca*); F: *Tadarida. aegyptiaca*.

Figure 3-11: Photo of a roosting Egyptian Slit-faced Bat (Nycteris thebaica) photographed by a farmer in R4 (see Roosting Sites) just outside the PA, with reportedly 5 individuals roosting in the farmstead.

3.3.1.3.1 Hourly

Hourly activity patterns differed between some of the species groups identified (Figure 3-12). *Tadarida aegyptiaca* and *S. petrophilus* were the most active species, with *E. hottentotus*. present in low numbers and *M. natalensis* and *L. capensis* with very low activity levels. Although *R. damarensis* are known to be present in the PA (section 3.4.1), none were picked up by the bat detectors (which were not situated near cluttered habitats).

The general trend across species is a slow increase in activity from dusk to 21:00 PM, followed by either sustained or diminished activity and a sharp drop-off after 04:00 AM. The open-air foragers, *T. aegyptiaca* and *S. petrophilus,* maintain activity levels later into the night, being most active at 02:00 AM and sharply decreasing activity by 04:00 AM. The clutter-edge foragers, *E. hottentotus* and *M. natalensis* differ by activity levels declining earlier in the night, with *M. natalensis* peaking gently at 12:00 AM, and *E. hottentotus* peaking sharply between 21:00-22:00 AM and decreasing drastically thereafter. No notable species-specific hourly patterns of bat activity were observed between the seasons beyond that described in the section below.

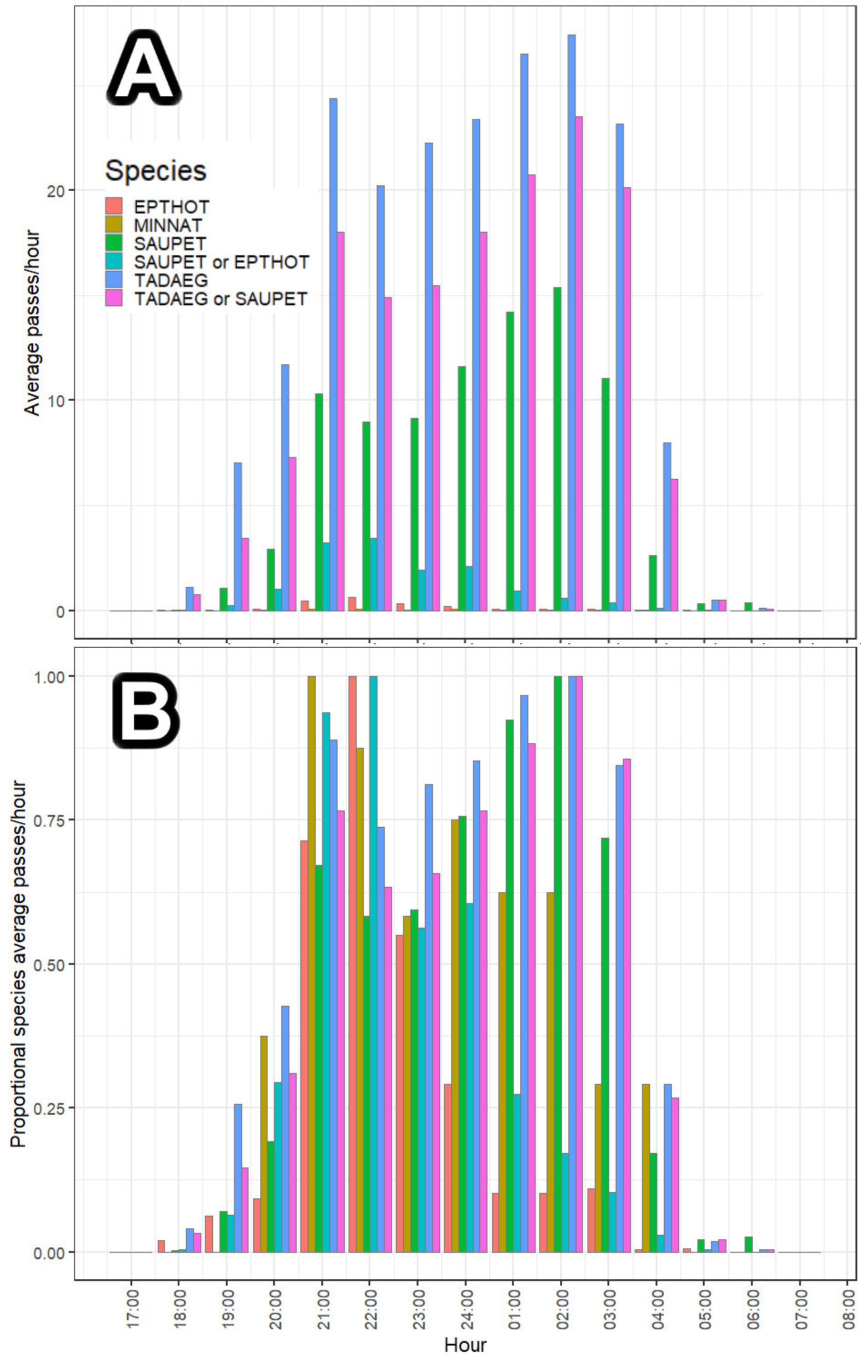


Figure 3-12: Average bat passes per hour at all bat recorders for detected species groups. A] average passes/hour B] proportional average passes/hour[11].

[11] Species acronyms: EPTHOT: *Eptesicus hottentotus*; MINNAT: *Miniopterus natalensis*; SAUPET: *Sauromys petrophilus*; TADAEG: *Tadarida aegyptiaca*

3.3.1.3.2 Monthly/Seasonally

Monthly activity is relatively congruent between bat species, especially in *E. hottentotus*, *S. petrophilus* and *T. aegyptiaca*, with a large peak (~37x higher average activity than least active months) in activity in the summer to autumn transition (late January to late March 2022) and a second smaller peak in the winter to spring transition (late August to early October 2022; ~37x and ~7x higher average activity than least active months, respectively; Figure 3-13). Species-specific differences in seasonal activity were observed for *M. natalensis* which was relatively more active in April 2022 when other species were reducing their activity, and more active earlier in the second peak (August and September 2022; Figure 3-13). In addition, *E. hottentotus* activity shares the same peaks in activity as other open-air foragers, but is almost absent during the rest of the year. The shared peaks in bat activity across the species may indicate a feeding response to increased availability of food that is hunted by all these species, such as large eruptions of small volant insects like dipterans, termite alates and certain moth species. These eruptions are seasonal and probably linked to rainfall and temperatures (discussed in more detail in section 3.3.1.5), and might explain the large regular spikes in bat activity (Figure 3-7). These activity peaks may comprise some non-resident foraging bats as there are few large roosts (such as caves) and the (expected) low availability of food during the drier seasons. There are likely to be larger colonies of bats roosting in inselbergs and koppies within a few 100 kilometres of the PA, especially close to the Orange River which probably provides a stable source of food during the dry months, and some of these bats may forage more widely during certain seasons. *Tadarida brasiliensis* have been observed flying at exceptionally high altitudes and have remarkable capabilities for covering long distances in a short amount of time (Williams *et al.,* 1973), so it is possible that *T. aegyptiaca* shares some of these characteristics and may be searching for erupting volant insects and feeding intensively when these phenomena are encountered, as hypothesised for the nearby Red Sands WEF (Enviro-Insight 2023). However, this hypothesis requires further investigation.

Tadarida aegyptiaca (the most abundant species) has been reported to migrate to maternity colonies *circa* November and gives birth in November or December (Monadjem *et al.,* 2020). However, data from the PA show that activity is relatively low over this time, potentially indicating that maternal roosts are not greatly sought out in the region. Alternatively, maternity roosts may only be occupied slightly later in this area, and that the peak activity in mid-summer is due to mating behaviour, and peaks in February and March are pups becoming volant. There were high levels of bat activity recorded during active transects (see section 3.3.2) around the dolerite outcrops for the February surveys, and it is possible that these large outcrops are used as maternity roosts. Hibernating bats are known to prefer warm humid roosts in summer, but will move to cool roosts in winter to induce torpor and conserve energy (Monadjem *et al.,* 2020), such as deep caves or mine adits. Short periods of hibernation (up to 9 days) have been recorded in *T. aegyptiaca* during the cool season and periods of low food availability (Toussaint *et al.*, 2009), and it is possible that small peaks in activity during winter and spring represent short breaks in hibernation for the resident bats. The primary land use in the region is sheep ranching. It is therefore unlikely that activity patterns of bats are linked to changes in land use as may be expected in cultivated areas.

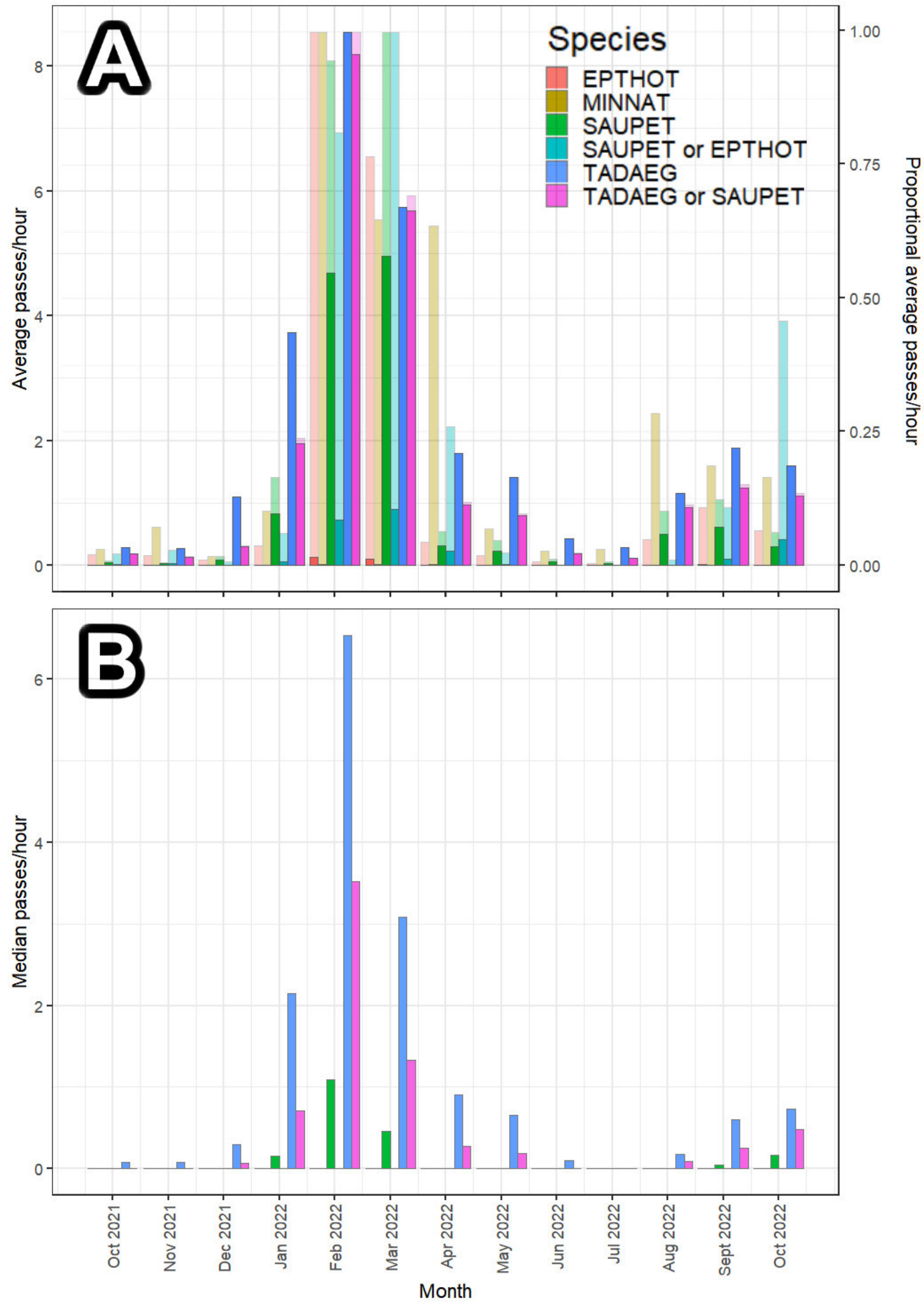


Figure 3-13: Monthly recordings of echolocation calls of bats per bat species (median calculated from sum per night). A] average passes/hour and proportional average passes/hour (opaque) B] median passes/hour[12].

[12] Species acronyms: EPTHOT: *Eptesicus hottentotus*; MINNAT: *Miniopterus natalensis*; SAUPET: *Sauromys petrophilus*; TADAEG: *Tadarida aegyptiaca*

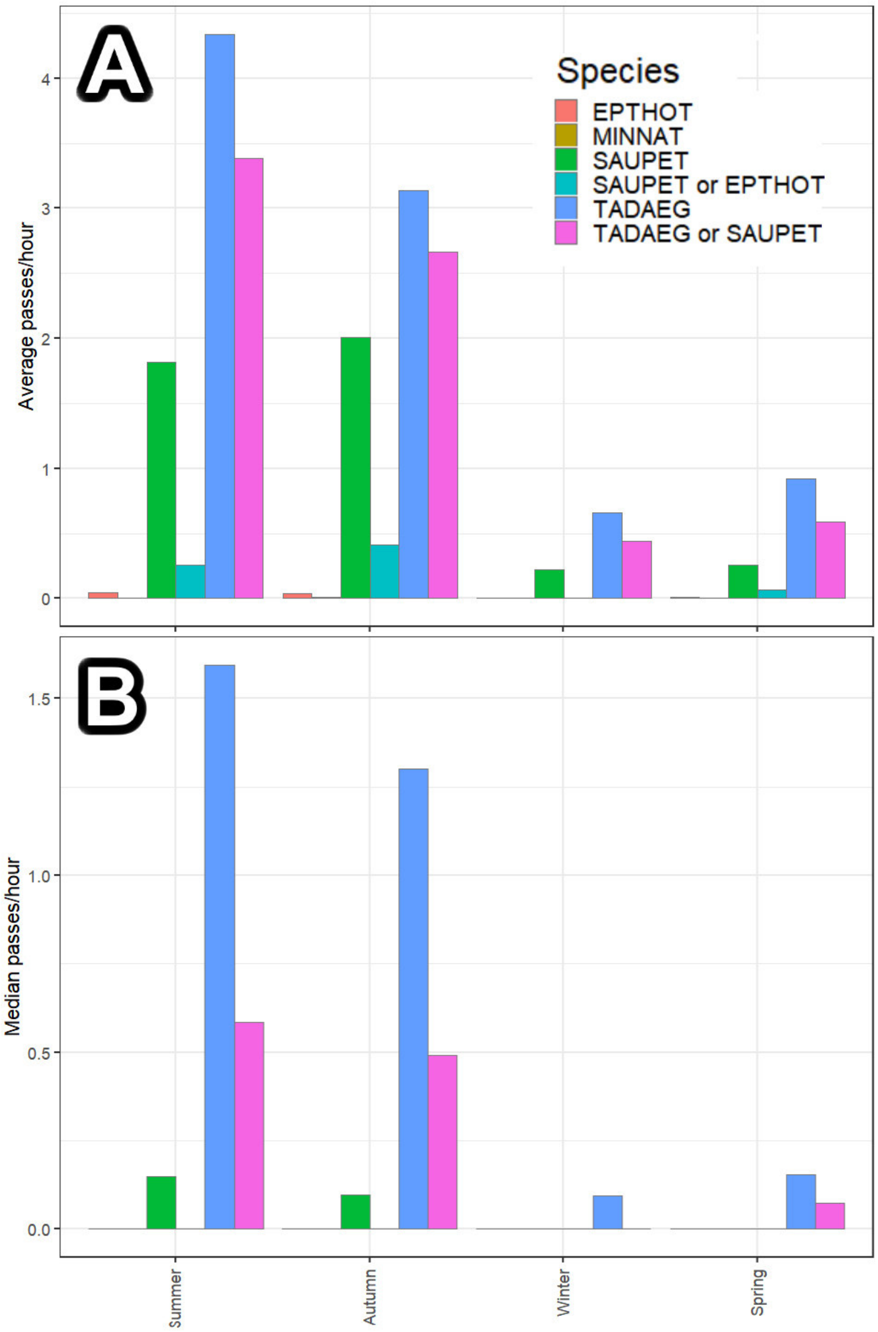


Figure 3-14: Seasonal recordings of bats per bat species (median calculated from sum per night). A] average passes/hour B] median passes/hour[13].

[13] Species acronyms: EPTHOT: *Eptesicus hottentotus*; MINNAT: *Miniopterus natalensis*; SAUPET: *Sauromys petrophilus*; TADAEG: *Tadarida aegyptiaca*

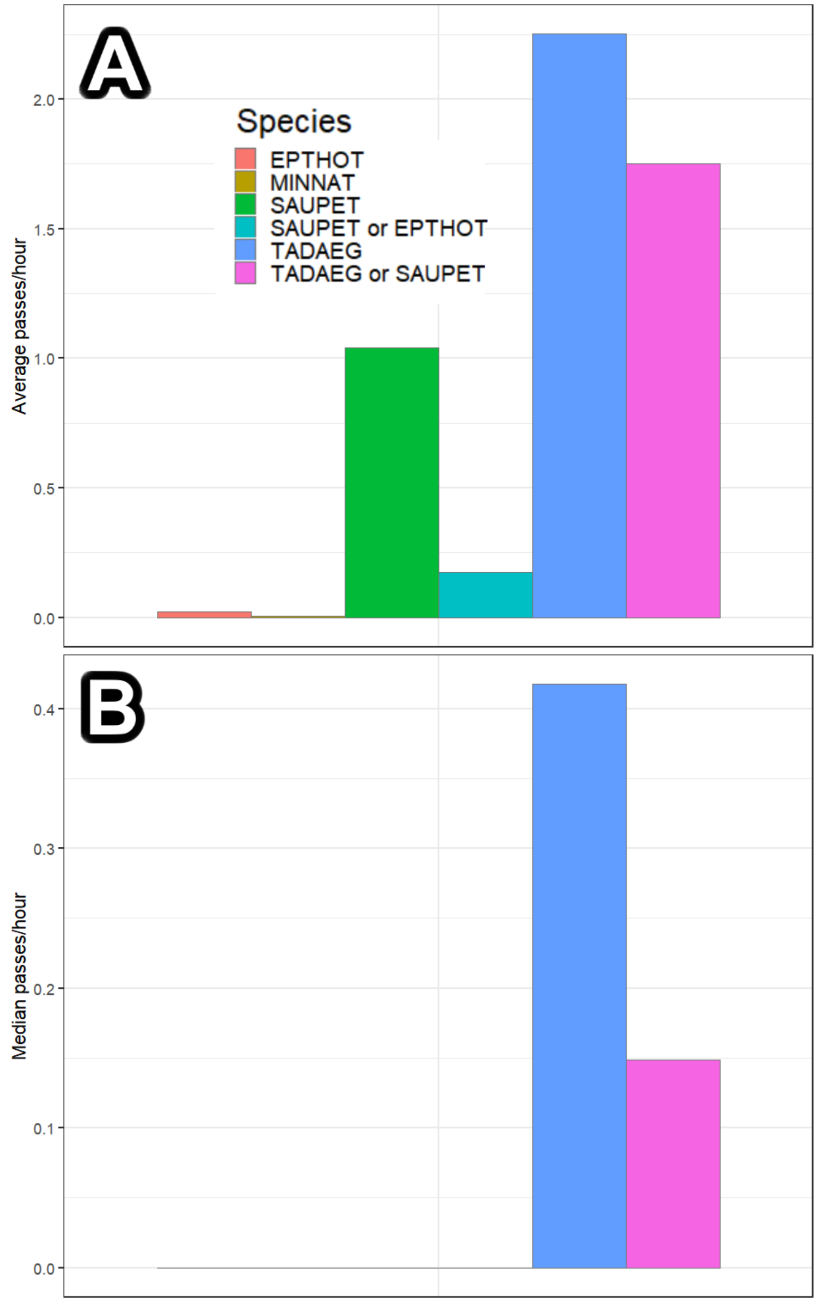


Figure 3-15: Yearly recordings of echolocation calls of bats per bat detector (median calculated from sum per night). A] average passes/hour B] median passes/hour[14].

[14] Species acronyms: EPTHOT: *Eptesicus hottentotus*; MINNAT: *Miniopterus natalensis*; SAUPET: *Sauromys petrophilus*; TADAEG: *Tadarida aegyptiaca*

3.3.1.4 Passes at Height

The proposed turbines have a hub height of 150 m with a rotor diameter of up to 175 m (blade length of up to 87.5 m), and the rotor swept heights are thus within the range 62.5 – 237.5 m above ground. Therefore, bats recorded by detectors with microphones at 65 m and 110 m above ground are considered to be within the rotor sweep area.

Bat activity decreased as a function of height above ground for both meteorological mast stations, both showing similar changes in activity, with a reduction in average bat activity of ~56 % at 65 m and ~77 % at 110 m (Figure 3-16; Figure 3-17). The differences were less pronounced when considering the median bat passes, suggesting that infrequent spikes in bat activity at lower heights were responsible for the discrepancy in median and average bat activity figures. The same pattern exists when considering all bat detectors together (Figure 3-18), with comparable median bp/h. Interestingly this difference is less pronounced than recorded at the nearby proposed Red Sands WEF (Enviro-Insight 2023). It is important to take recorder downtime into account for this comparison, which is illustrated in Figure 3-3. Recorder B7 (10 m; mm 2) did not record during some of the peak activity period. Therefore, it is likely that the bat activity near-ground level has been slightly underestimated.

Hourly bat activity indicates that bats are slightly more active earlier in the night at height (65 or 110 m) than at ground level (Figure 3-4). Species-specific patterns show that *T. aegyptiaca* flies proportionally most within the rotor sweep heights (~67% of ground level activity at 65 m; ~38% at 110 m), followed by *S. petrophilus* (~18-43% at 65 m; ~8-21% at 110 m), *E. hottentotus* (5-12% at 65 m; 3-8% at 110 m), and *M. natalensis* (5% at 65 m; 4% at 110 m; Figure 3-18). This pattern is expected based on the foraging habits of these species. The lack of bat activity at height at specific times of the year suggests that there is no major migratory pathway within the PA.

According to the Nama Karoo Ecoregion thresholds (MacEwan *et al.*, 2020b) the PA has a **Medium** level of fatality risk from turbines at ground level (10 m above ground) with a median nightly value of 0.88 bp/h and average of 8.21 bp/h. At 65 m above ground there is a **High** level of fatality risk from turbines (within rotor sweep), with median nightly value of 0.66 bp/h and average of 3.62 bp/h. At 110 m above ground there is a **Medium** level of fatality risk from turbines (within rotor sweep), with median nightly value of 0.36 bp/h and average of 1.92 bp/h. The high average values (relative to median values) indicate that there are large spikes of activity, and these periods are likely to result in a **Very High** level of fatality risk without suitable mitigation.

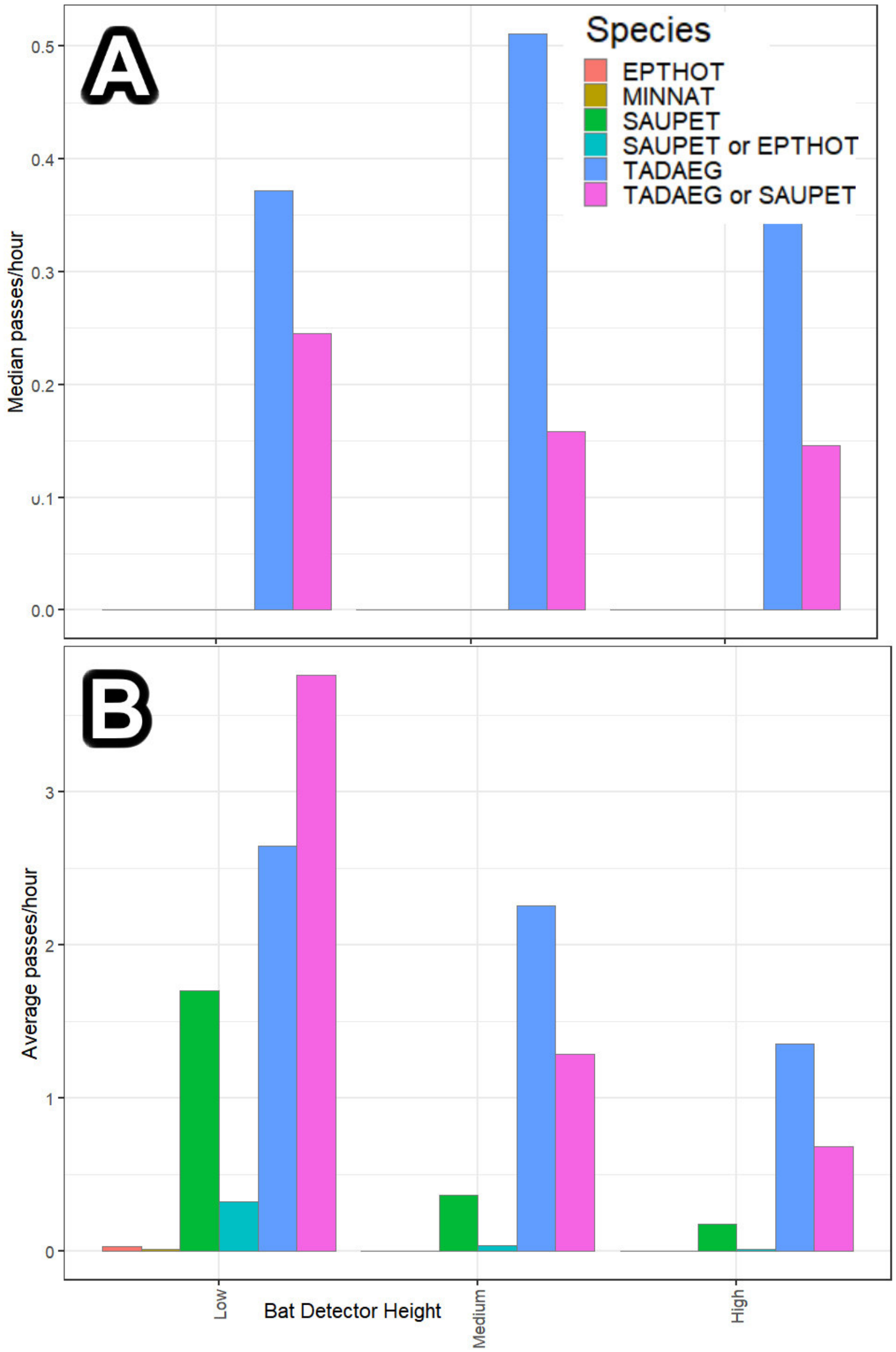


Figure 3-16: Comparison of bat species activity at meteorological mast 1 including detectors B4 (10 m), B5 (65 m) and B6 (110 m). A] average passes/hour B] median passes/hour[15].

[15] Species acronyms: LAECAP: *Laephotis capensis*; EPTHOT: *Eptesicus hottentotus*; MINNAT: *Miniopterus natalensis*; SAUPET: *Sauromys petrophilus*; TADAEG: *Tadarida aegyptiaca*

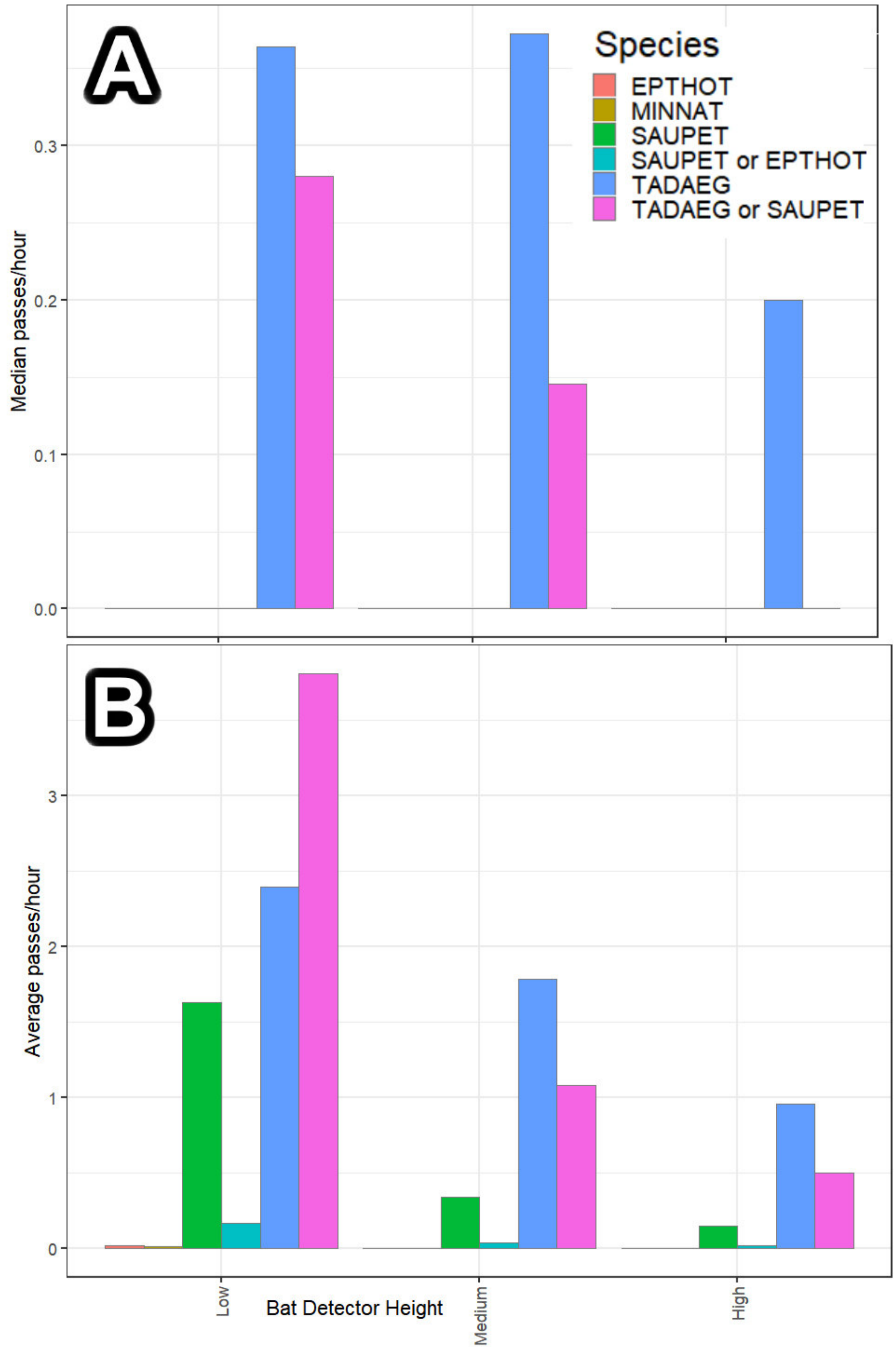


Figure 3-17: Comparison of bat species activity at meteorological mast 2 including detectors B7 (10 m), B8 (65 m) and B9 (110 m). A] average passes/hour B] median passes/hour[16].

[16] Species acronyms: LAECAP: *Laephotis capensis*; EPTHOT: *Eptesicus hottentotus*; MINNAT: *Miniopterus natalensis*; SAUPET: *Sauromys petrophilus*; TADAEG: *Tadarida aegyptiaca*

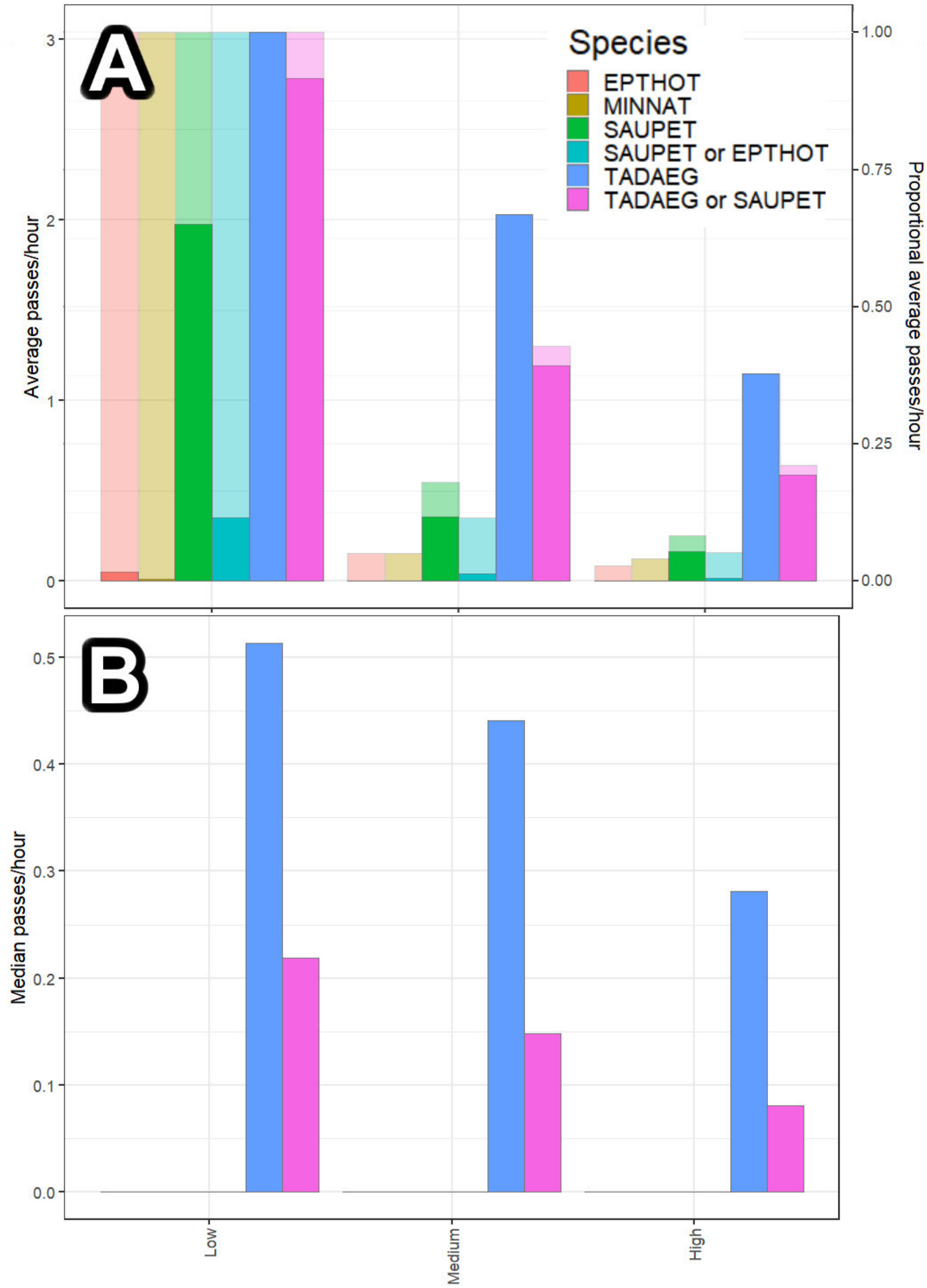


Figure 3-18: Comparison of bat species activity between microphone heights for all bat detectors combined. A] average passes/hour and proportional average (opaque) B] median passes/hour[17].

[17] Species acronyms: LAECAP: *Laephotis capensis*; EPTHOT: *Eptesicus hottentotus*; MINNAT: *Miniopterus natalensis*; SAUPET: *Sauromys petrophilus*; TADAEG: *Tadarida aegyptiaca*

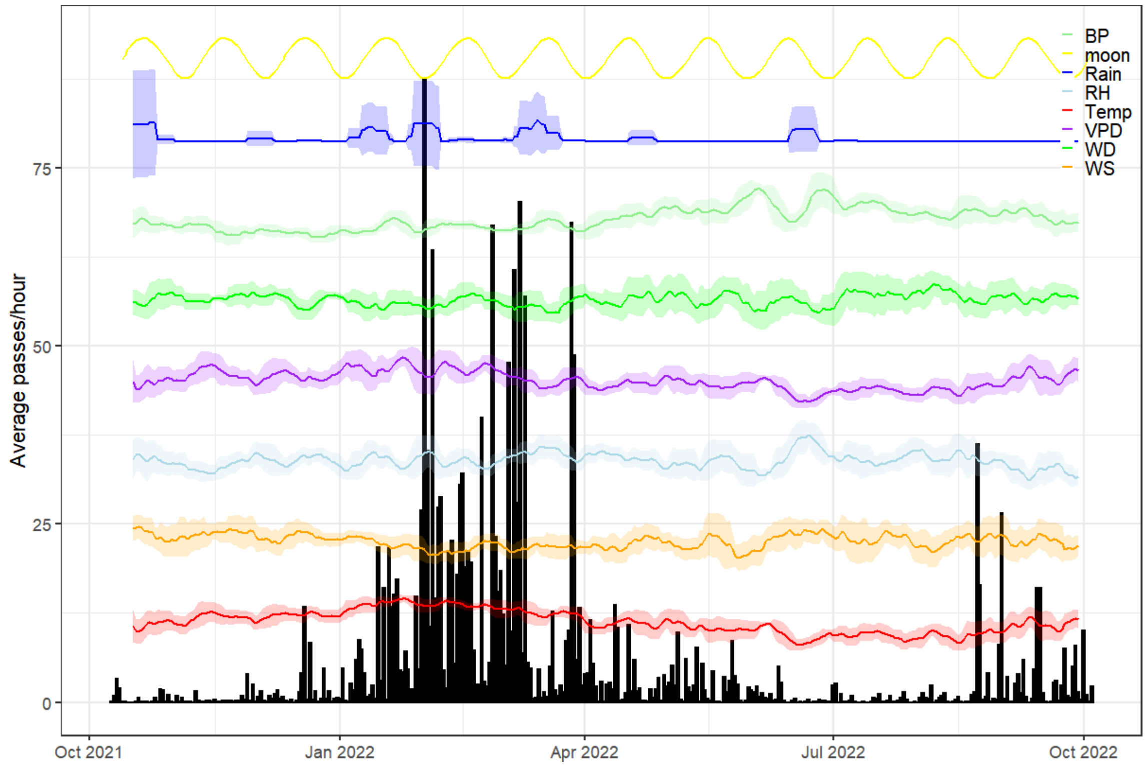
3.3.1.5 Environmental Variables on Bat Activity

Rainfall data, wind speed, wind direction, temperature, relative humidity and barometric pressure were measured and could be used as environmental variables. The moon cycle was also incorporated as the percentage of its surface illuminated by the sun. The client provided the data on condition that certain variables were not disclosed as raw values, and these have been converted to relative measures for the purposes of this report.

3.3.1.5.1 Seasonal patterns (Figure 3-19)

The PA has a cold winter and warm summer with minimal and sporadic rainfall that usually is greatest over the autumn season and lowest in August and September. The temperature fluctuated greatly across much of the monitoring period, with the warmest period being January – February 2022, where average daily temperatures remained relatively high, between 20 - 30°C. Temperatures rose from October 2021 to January 2022, and then decreased from February 2022 to mid-June, remain low and begin to increase again in late August. Wind speed fluctuated greatly throughout the year, with a slight decrease over the summer period. Relative humidity (RH) and Vapour Pressure Deficit (VPD) fluctuated throughout the monitoring period, which coincided well with rainfall events and possibly also due to cloudy/misty days. A winter rainfall event with cold temperatures resulted in a spike in RH and a decrease in VPD in mid-June. In winter the VPD was lowest, probably due to the cooler temperatures at this time. Barometric pressure (BP) followed a seasonal pattern with high pressures during winter and low pressures in summer. Low pressure systems resulting in BP fluctuations often resulted in rainfall events, which is demonstrated in the large winter rainfall event.

Seasonal bat activity is greatest over late summer and autumn, when temperatures are consistently warm (resulting in slightly higher VPD), with the greatest precipitation and slightly decreased and less erratic wind speed (Figure 3-19). A second, smaller peak in bat activity is observed around September, which coincides with the rise in temperature. Numerous spikes in activity are spread throughout the peak activities and these are discussed below in section 3.3.1.5.7.



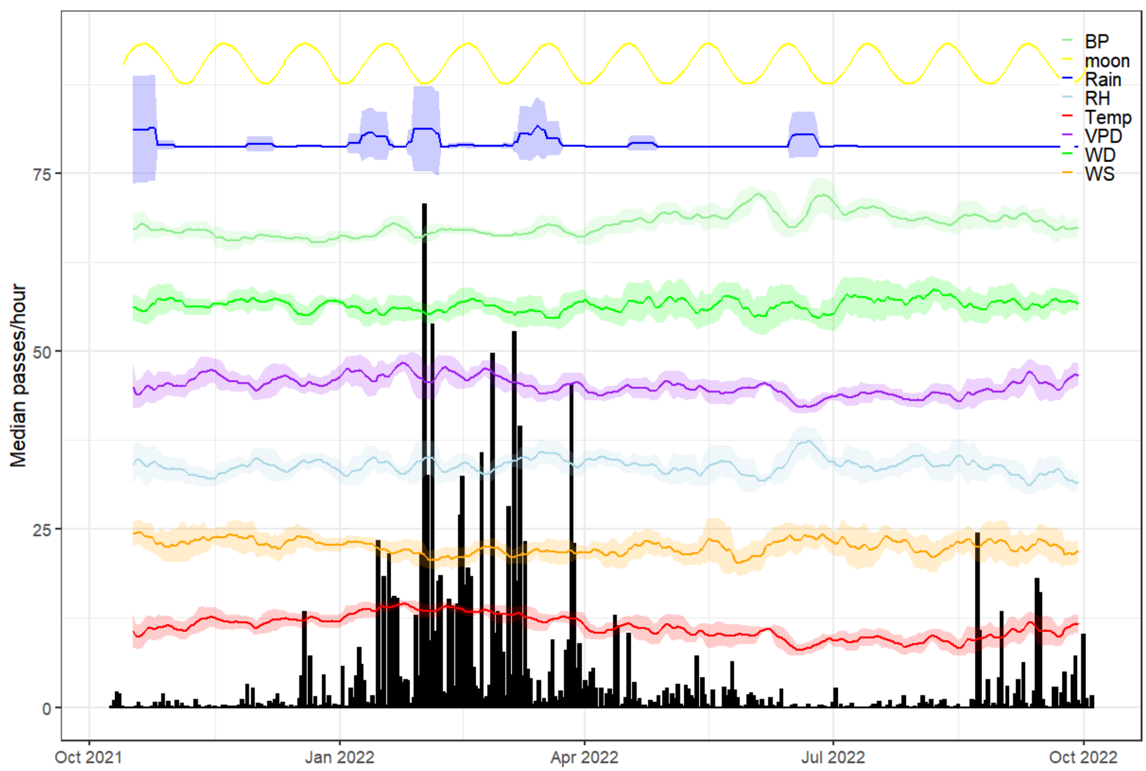


Figure 3-19: Overview of bat activity (bp/h) in relation to rescaled environmental variables shown as centered moving averages and 1 standard deviation (window = 10 days). Average (top) and median (bottom) bp/h.

3.3.1.5.2 Temperature

Hourly bat activity shows a strong positive correlative with the prevailing temperature, a result that is well supported in the scientific literature (Erikson & West, 2002; Amorim *et al.*, 2012; de Jong *et al.*, 2021). Bats were not active below 5°C, but a marked increase in activity is observed above 12°C, with a steady linear increase up to 23°C after which bat activity levels off and starts to decline slightly above 29°C (Figure 3-20). Insect prey is ectothermic and activity is strongly linked to ambient temperatures, thus higher activity of bats in warmer conditions is probably directly linked to the higher abundance of active insects, although de Jong *et al.* (2021) found that, while bat activity is positively correlated with insect activity, weather conditions showed a stronger link to bat activity. Cold temperatures will also impose energetic costs as bats will spend more energy maintaining body temperatures. The disjunct low activity levels below 12°C may be an indication of the temperatures at which these bats remain in torpor or are hibernating over a short period due to cold temperatures and poor foraging conditions (Toussaint *et al.*, 2009).

Nightly bat activity is best correlated with temperatures measured 15 nights previously (using average over a number of days). This is possibly related to delayed insect activity or the required warmth for breaking of hibernation periods.

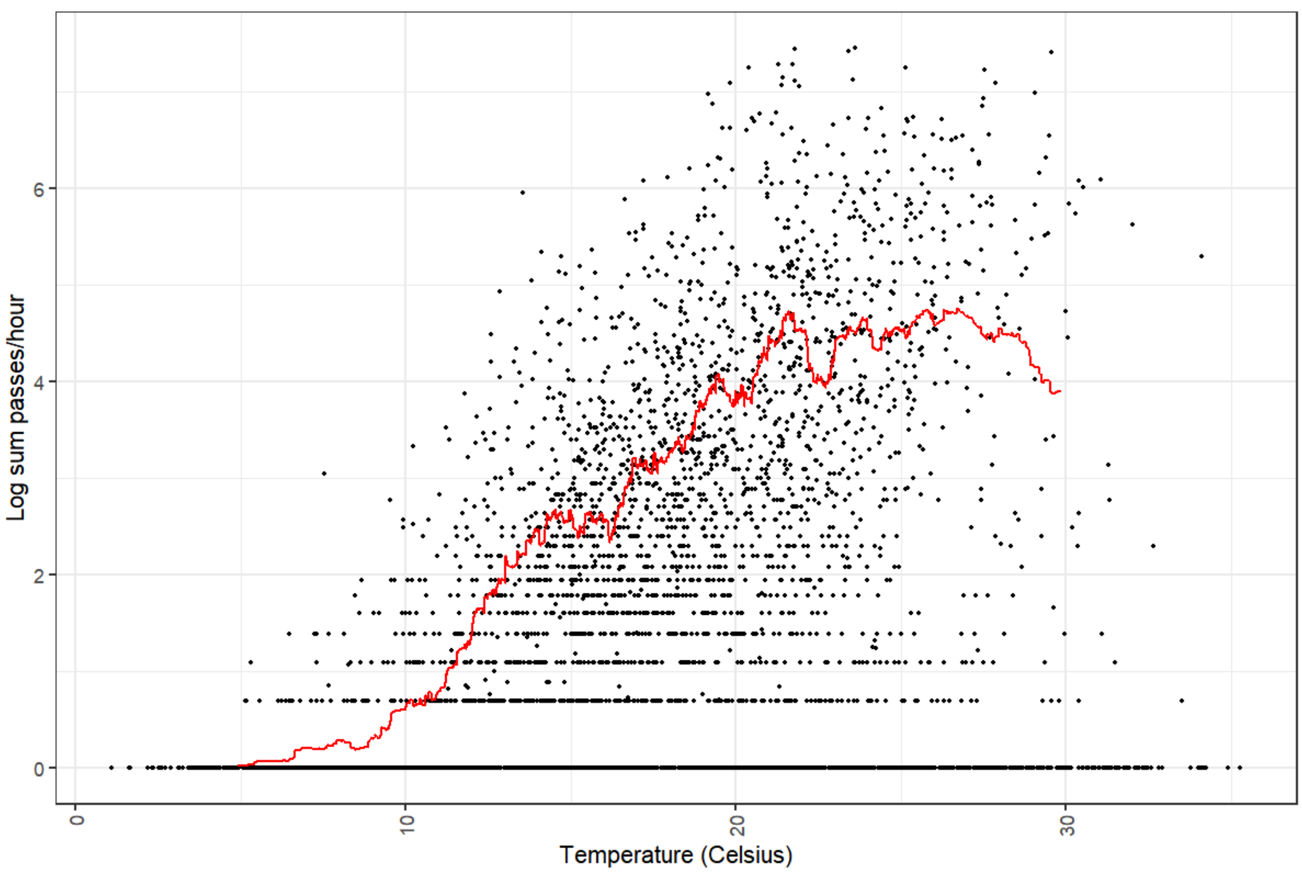


Figure 3-20. Comparison of logged average temperature (°C) against the logged sum of bat passes per hour with a centered moving average in red (window = 200).

3.3.1.5.3 Wind (relative speed & direction)

Bat activity shows a strong negative association with relative wind speed. At low wind speeds (up to 20 % max.), this change is negligible but bat activity decreases linearly as relative wind speed become progressively stronger, with bats being half as active at winds speeds of ~40 % of the maximum recorded wind speed[18] (Figure 3-21). This relationship is well established in the scientific literature (Erikson & West, 2002; Amorim *et al.*, 2012; de Jong *et al.*, 2021). Insect prey is less active in windy conditions (de Jong *et al.*, 2021) and bats are probably less effective at locating and capturing prey in windy conditions. Strong winds also impose energetic costs as bats will need to expend more energy flying against the wind. There are no large, consistent differences in bat activity between different wind directions, but the few differences present are likely due to certain wind directions being associated with stronger winds (Figure 3-22).

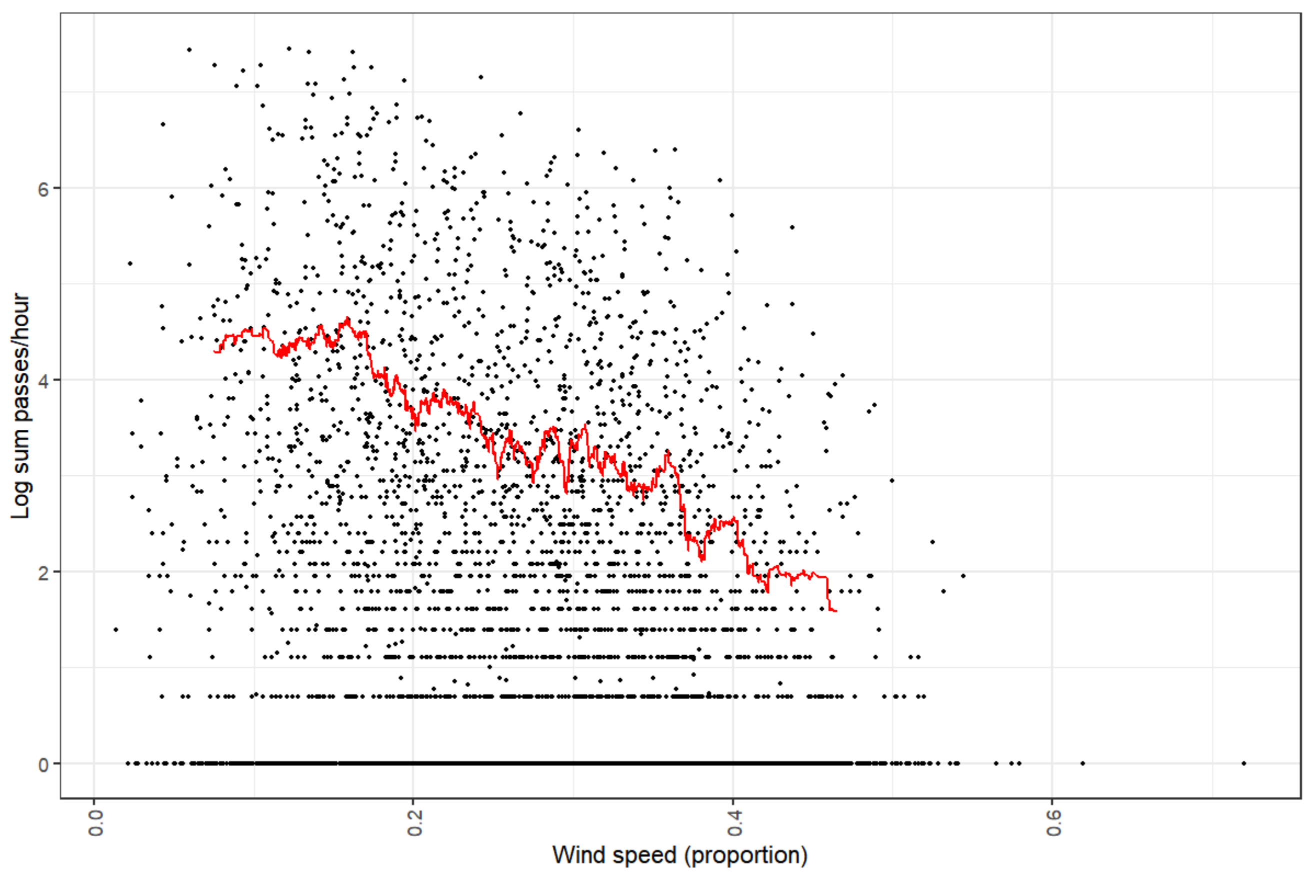


Figure 3-21: Comparison of logged average wind speed (proportional) against the logged sum of bat passes per hour with a centered moving average in red (window = 200).

[18] The client chose not to disclose specific wind speed values, and as such only the relative wind speed is considered, calculated as a percentage of the maximum

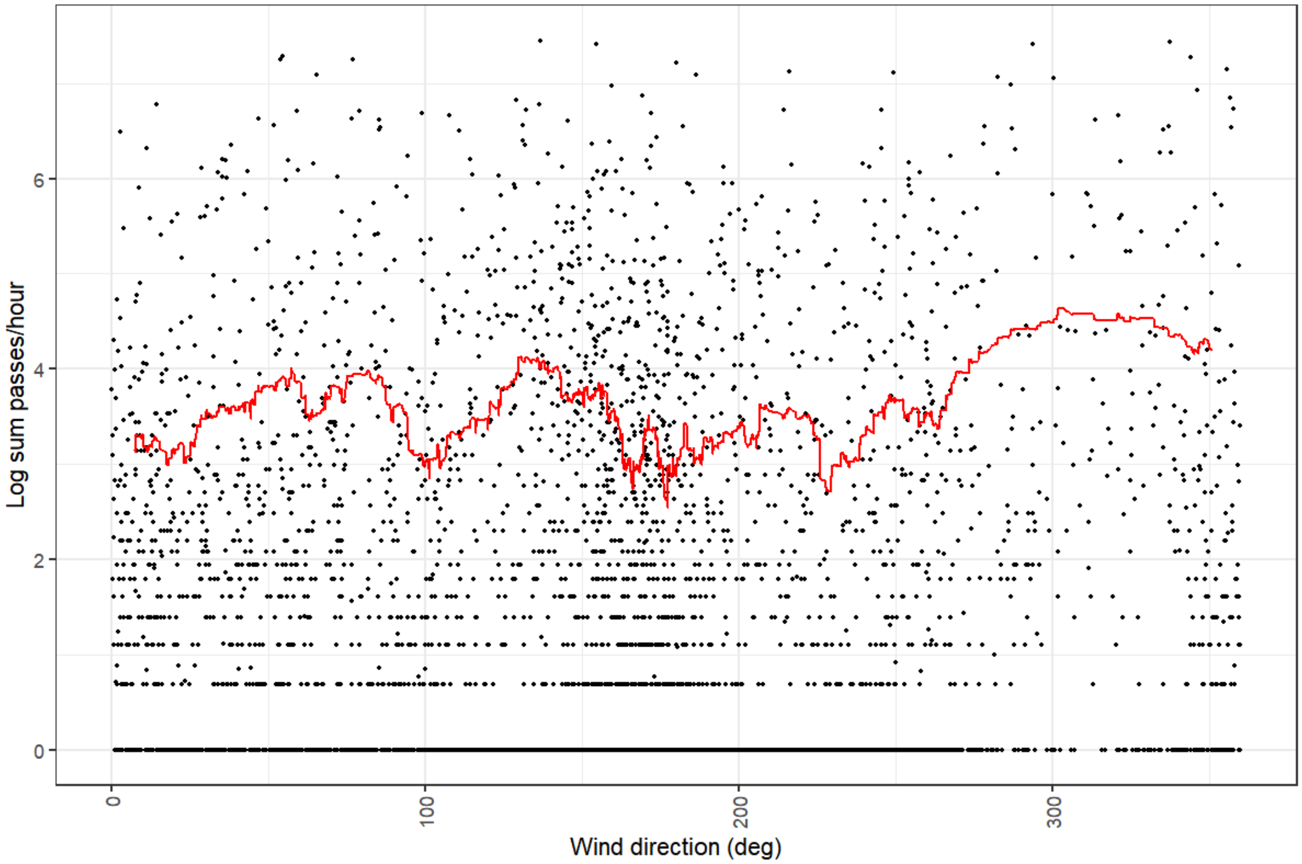


Figure 3-22: Comparison of logged average wind direction (degrees from north) against the logged sum of bat passes per hour with a centered moving average in red (window = 200).

3.3.1.5.4 Rainfall (including VPD / RH)

Rainfall has been reported to have varied effects on bat activity (de Jong *et al.*, 2021; or see Erikson & West, 2002; Perks & Goodenough 2020; Squires *et al.*, 2021), but relative humidity can be associated with the development of insect larvae, which could increase bat activity due to prey availability (Amorim *et al.*, 2012). In regions or seasons where rainfall is associated with cold temperatures, it may indirectly reduce bat activity through lowering the temperature (see section 3.3.1.5.2).

We also calculated VPD, which is a better functional measure of the "dryness" of air than RH. Episodes of rainfall result in the increase in RH and decrease in VPD, but other events not resulting in rainfall also influence RH and VPD, such as mist and overcast days. It was a wet year preceding the monitoring period, and there was a fair amount of precipitation during the monitoring, with rainfall events in November 2021, January to March 2022, April, June and October 2022. Rainfall events were typically prolonged over multiple days and comprised small volumes of precipitation. These wetter conditions were likely associated with the La Niña event and therefore may not represent normal (average) bat activity in the region.

Hourly bat activity decreased slightly with rainfall, especially with heavier rainfall (Figure 3-23). Activity was low at very low VPD and had a slight positive correlation (Figure 3-24), but this is probably an indirect effect of the cold temperatures associated with overcast conditions or direct cooling from rain, and the warmer temperature raising the VPD as bats tend to be less active in cold temperatures. Overall, there appears to be no direct association between VPD and hourly bat activity. Relative humidity shows no relationship with bat activity (Figure 3-25). Rainfall, lower VPD and higher humidity should be positively associated with insect activity in arid habitats such as for the PA, because activity is negatively correlated with weather conditions that promote desiccation. However, insects are also reliant on plant growth, which takes a certain amount of time following rainfall events, delaying the subsequent growth and eruptions of insect populations.

Nightly bat activity is best correlated with rainfall measured 21 nights previously (using average over a number of days). This is actually a slight positive correlation and may represent the time delay from plants growing and insect populations increasing.

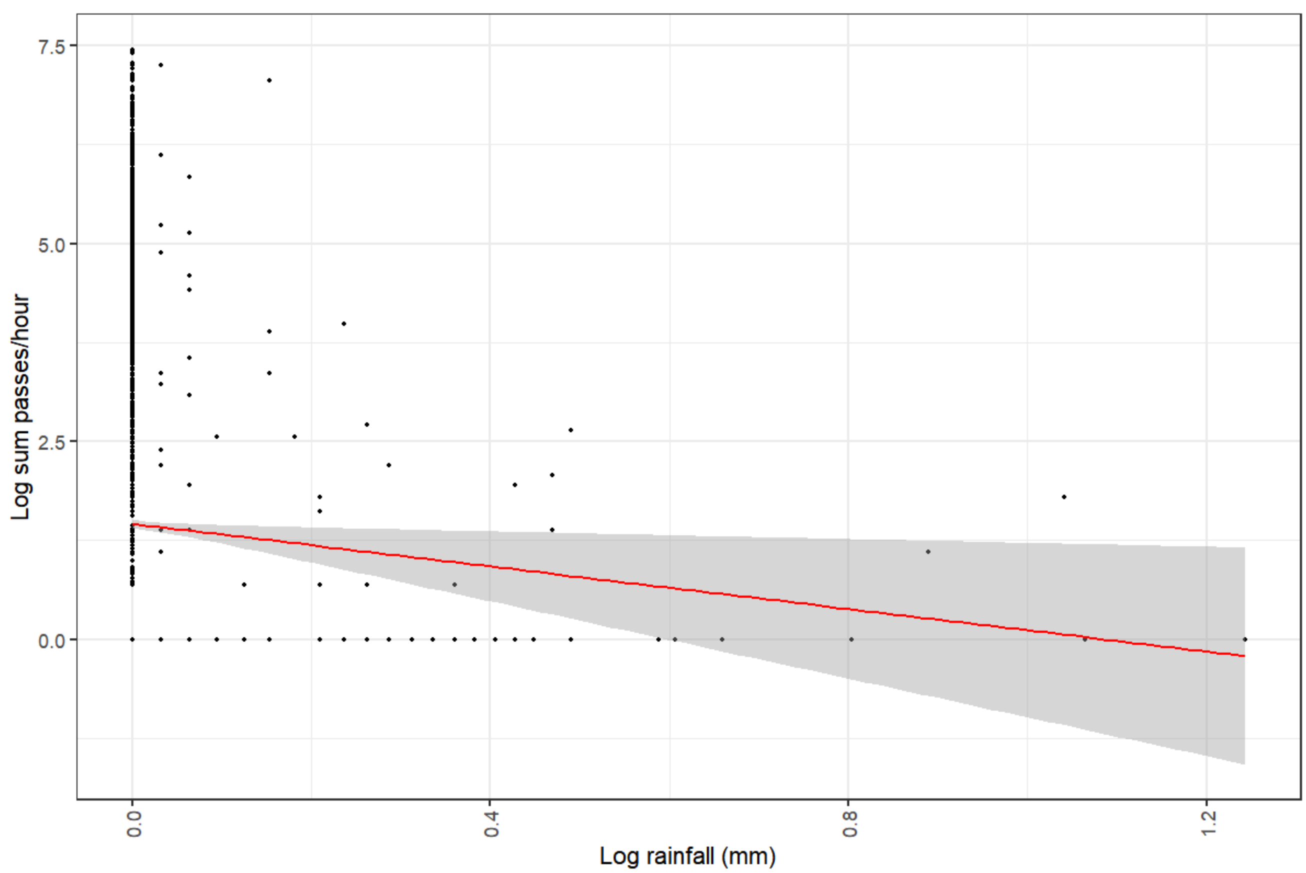


Figure 3-23. Comparison of logged average hourly rainfall (mm) against the logged sum of bat passes per hour with a fitted linear model, with fitted values as the red line and 95% confidence interval shaded in grey.

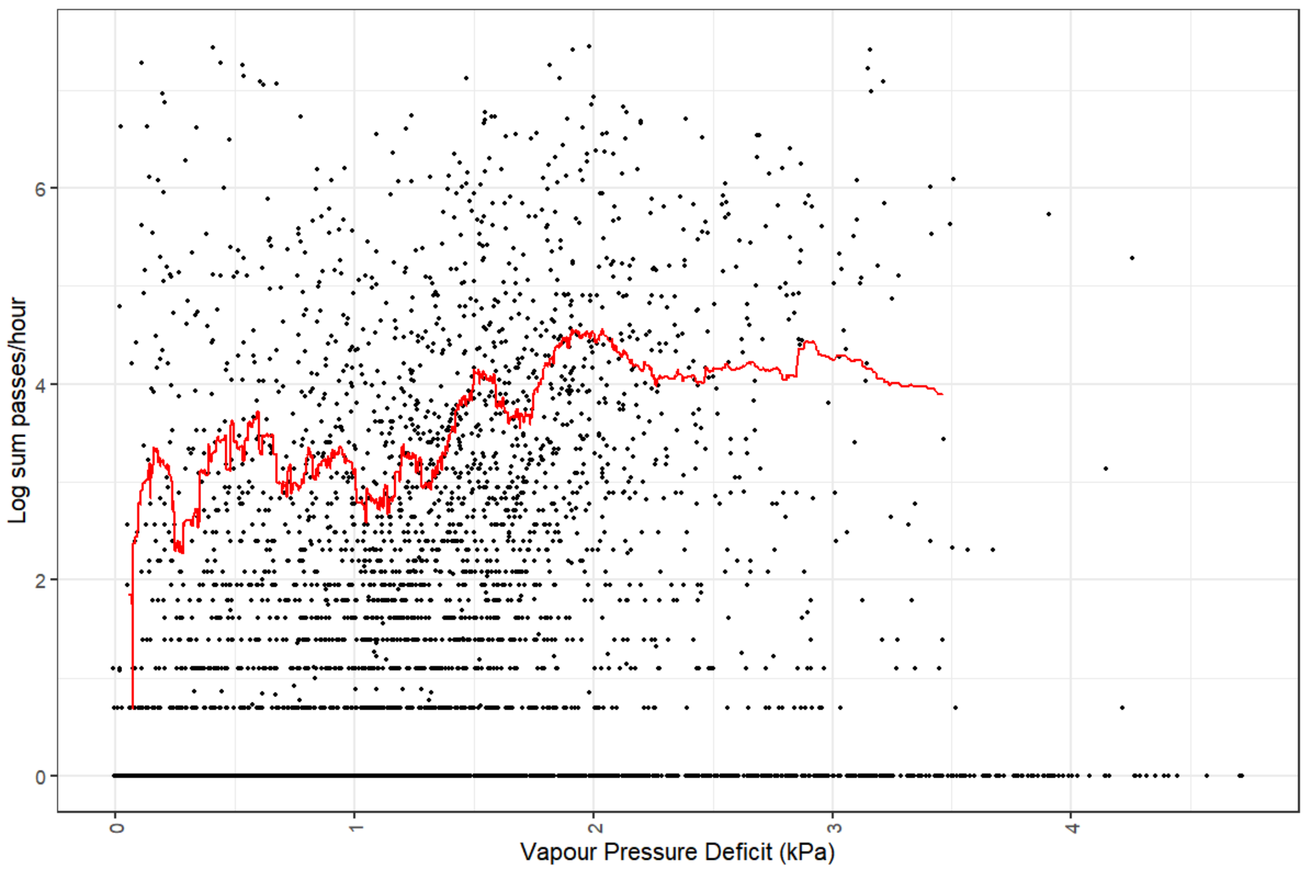


Figure 3-24. Comparison of logged average Vapor Pressure Deficit (kPa) against the logged sum of bat passes per hour with a centered moving average in red (window = 200).

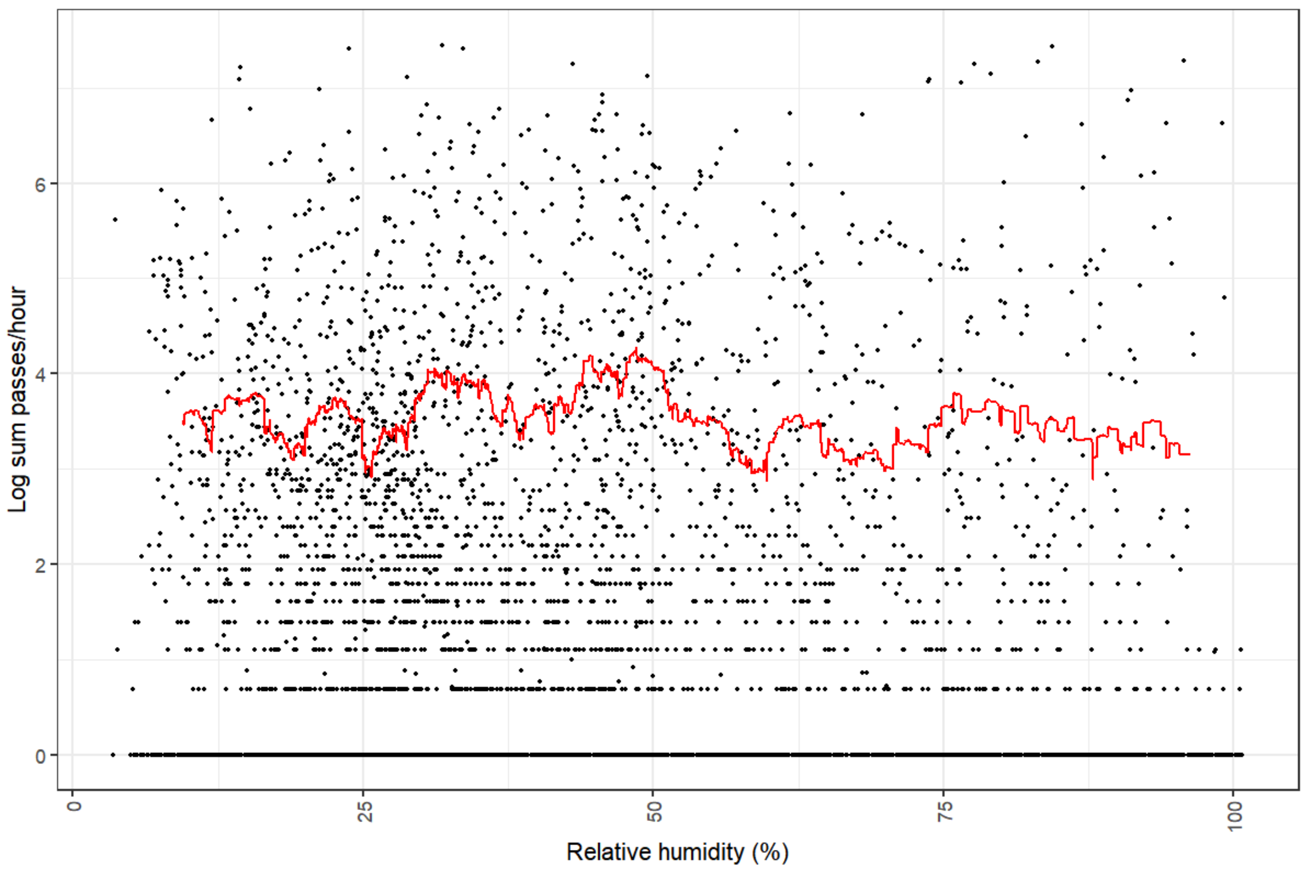


Figure 3-25. Comparison of logged average Relative Humidity (%) against the logged sum of bat passes per hour with a centered moving average in red (window = 200).

3.3.1.5.5 Moon illumination

Moon illumination is generally negatively associated with bat activity (Perks & Goodenough 2020, Squires *et al.*, 2021), where bright moons typically result in reduced insect activity and less foraging for bats, although this is not always the case (Appel *et al.,* 2017). An additional factor is an increased risk that bats are captured by their predators, and some bats appear to increase their activity in cluttered environments during periods of bright moon illumination while restricting activity in exposed areas (Erikson & West, 2002). Moon illumination had a slight effect on bat activity, with slightly more activity when less of the moon was illuminated (Figure 3-26).

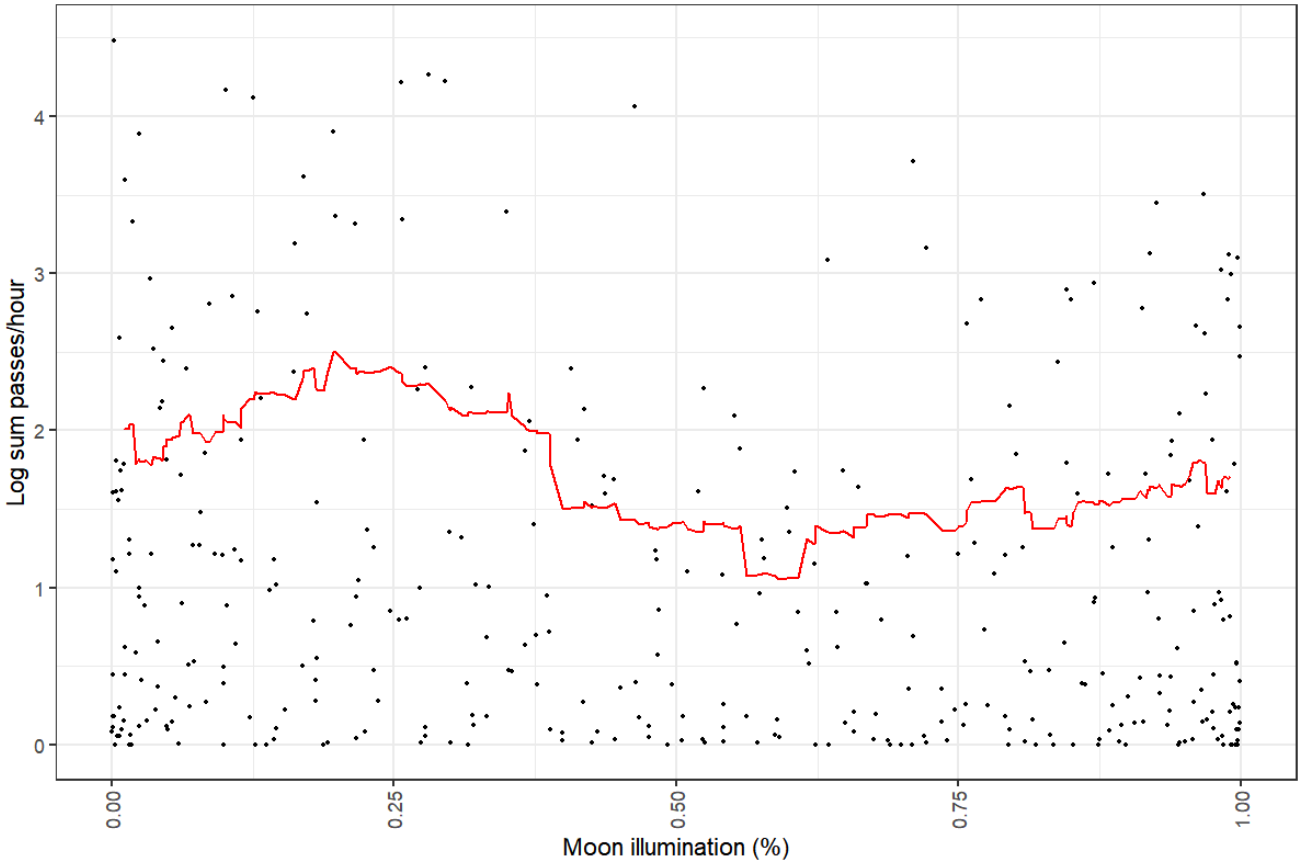


Figure 3-26. Comparison of Moon Illumination (%) against the logged sum of bat passes per night with a centered moving average in red (window = 50).

3.3.1.5.6 Barometric Pressure

There is a negative association between barometric pressure and bat activity (Figure 3-27), but this is likely to be just a seasonal effect, where the warmer summer and autumn periods are associated with lower barometric pressure. High barometric pressure has been associated with lower bat activity (Squires *et al.*, 2021), but no explanation was provided. While low pressures typically precede cooler rainfall events, which are associated with reduced bat activity, the seasonal signal is greater and overrides this effect, except at very low pressures where bat activity decreases slightly.

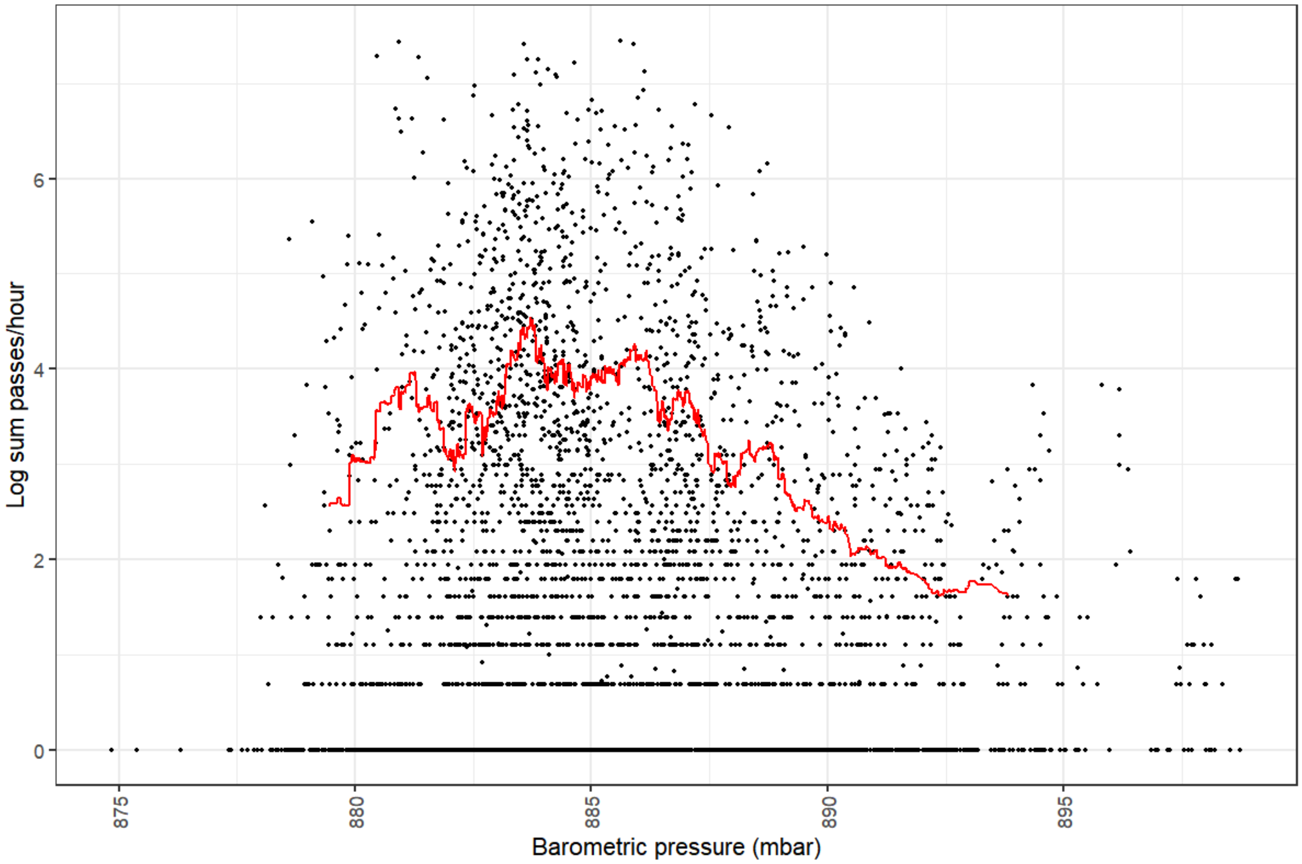


Figure 3-27. Comparison of logged average Barometric Pressure (mbar) against the logged sum of bat passes per hour with a centered moving average in red (window = 200).

3.3.1.5.7 Activity peaks

To better understand environmental cues for activity spikes, all nights with nightly median bat activity exceeding 20 bp/h were extracted, along with environmental data for the previous four nights (excluding the night immediately preceding the activity spike and any nights with an activity exceeding 20 bp/h). The average for each preceding period was calculated for each environmental variable and subtracted from that during the night of the peak activity. These are plotted below along with the overall averaged across all paired 'non-spike' and 'spike' data (Figure 3-28).

There were no consistent differences between the period preceding the activity spike and the conditions on the day of the spike for any of the environmental variables. Although, increased temperatures and more rainfall were slightly associated with spikes in activity, while reduced wind speed and moon illumination were moderately associated with activity spikes. Barometric pressure was slightly reduced on average during activity spikes. Activity spikes tended to occur when temperatures increase after rainfall with reduced moon illumination and wind speeds, but not to the extent that it can be easily predicted to allow for precise mitigation.

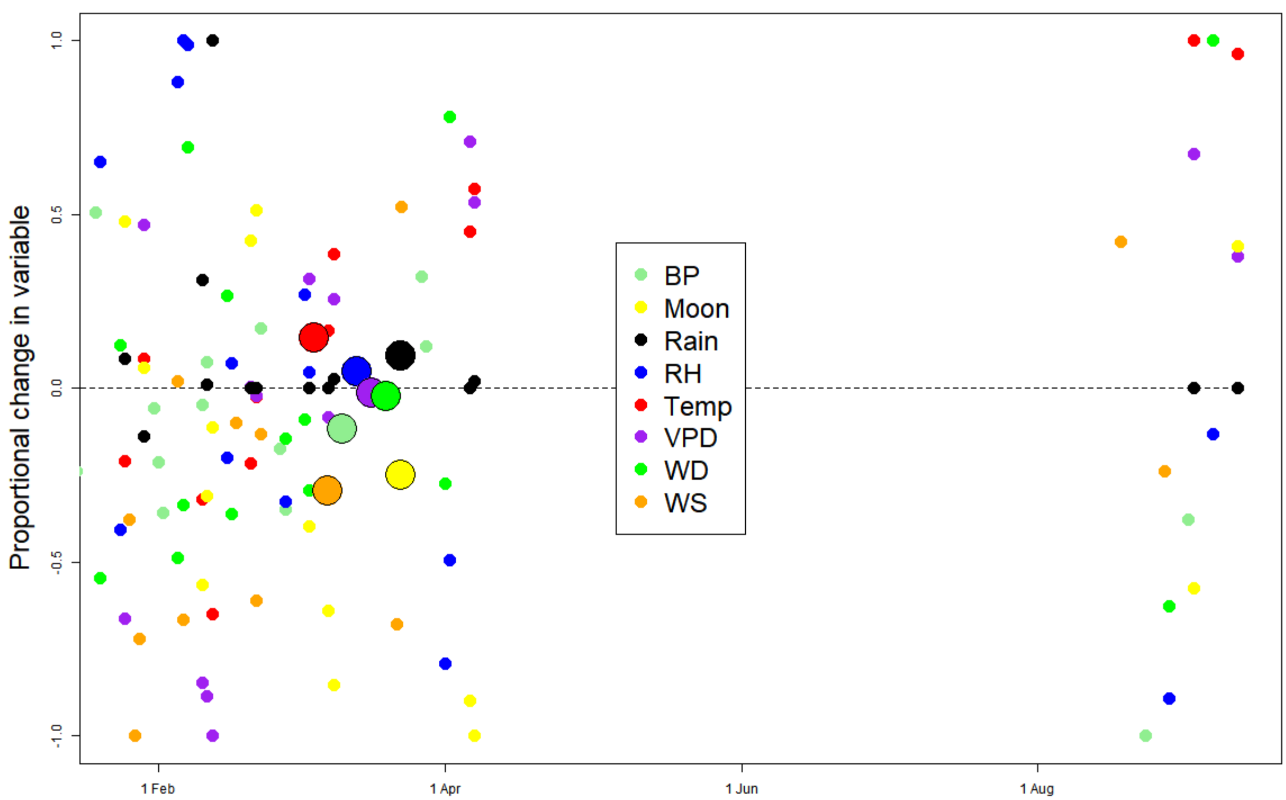


Figure 3-28. Comparison of the difference of paired 'spike' and 'non spike' activity levels for the available environmental variable (small hollow circles) and the overall average of these differences (large filled circles).

3.3.2 Active Acoustic Monitoring

A total of 665 bats vocalisation from only three species/group (*T. aegyptiaca* or *S. petrophilus; S. petrophilus* or *E. hottentotus;* and *M. natalensis*) were recorded during active monitoring (including calls duplicated where more than one bat was vocalising; Table 3-4, Figure 3-29). *Tadarida aegyptiaca* or *S. petrophilus* were by far the most dominant group detected during active acoustic monitoring, representing about 94% of all bat passes, similar to the passive acoustic monitoring. *Sauromys. petrophilus* or *E. hottentotus* appeared to be far less abundant, with a total of only 40 passes, 33 of which were detected during Summer. *Miniopterus natalensis* was only detected once during active surveys, which was during autumn. Seasonal activity was highest in summer, with less than half the activity in autumn and winter, and lowest activity in spring. In the static acoustic monitoring analysis, late summer and early autumn had the highest bat activity, and spring and winter had the lowest bat activity.

Table 3-4: Bat passes recording during driven transects per season[19].

Season	Month-Year	Total passes	Passes/hour	Total time recorded (HH:MM)	TADAEG or SAUPET		MINNAT		SAUPET or EPTHOT	
					Passes/ hour	Total Passes	Passes/ hour	Total Passes	Passes/ hour	Total Passes
Spring	Oct-21	53	7.08	07:29	6.28	47	0.00	0	0.80	6
Summer	Jan-22	342	43.57	07:51	39.36	309	0.00	0	4.20	33
Autumn	May-22	154	20.86	07:23	20.72	153	0.00	0	0.14	1
Winter	Aug-22	116	15.13	07:40	15.00	115	0.13	1	0.00	0
	Total	**665**	**86.64**	**30:23**		**624**		**1**		**40**

[19] Species acronyms: EPTHOT: *Eptesicus hottentotus*; MINNAT: *Miniopterus natalensis*; SAUPET: *Sauromys petrophilus*; TADAEG: *Tadarida aegyptiaca*

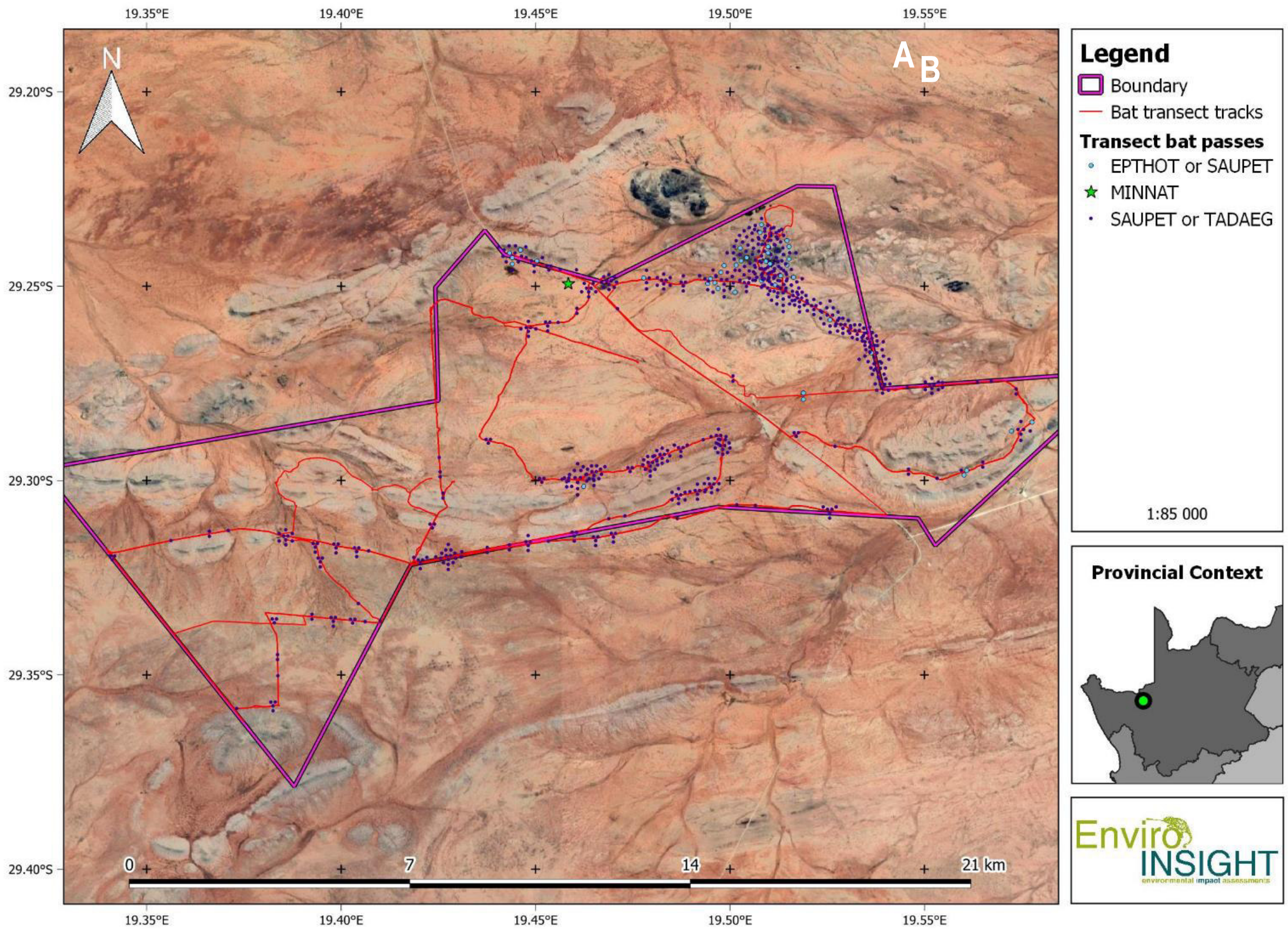


Figure 3-29: Detections of bat passes by species groups during active transect surveys. Bat passes are displayed in a spread-out fashion to enable better visualisation of point densities.

Seasonal and habitat specific activity are summarised in Table 3-5 and Figure 3-29 below.

Spring had the lowest activity, with lower than average activity around rocky areas and hills and greater activity in the vegetated watercourses. This may have been influenced by the delayed effect of rainfall that fell during and after this period, where bats favour vegetated watercourses for foraging where insect abundance is likely higher where some plant growth can persist. Activity was quite dispersed across the PA, but bats appeared to be absent from the western portions of the PA. **Summer** showed the greatest levels of activity, double that of any other season, and as for Spring, activity was absent from the western portions of the PA. Bat activity was highly concentrated around the dolerite outcrops intercepted by the transect surveys, and it is possible that these stacked dolerite koppies represent maternal roosts for *T. aegyptiaca*, *S. petrophilus* and/or *E. hottentotus*. **Autumn** activity decreased slightly from summer, but bat activity shifted away from the dolerite koppies (although the Autumn transect cut out a section through the dolerite habitat and may have missed some activity in this habitat) and became more widespread, with more activity around the brown rocks (with numerous temporary pools) and quartz hills and ridges, and less in the vegetated watercourses. **Winter** activity decreased from autumn, showing the most dispersed activity across the PA, especially in the west, with little activity in the east, except around the dolerite koppies which had higher than average activity. Across all seasons, brown bedrock had lower bat activity, dolerite koppies - exceptionally higher, quartz hills and ridges – comparable to, and vegetated watercourses - slightly higher compared to overall bat activity. The high activity levels at these dolerite koppies during summer could indicate social interaction or delayed maternal roosting.

It is important to note that the transect data alone may not provide accurate measures of spatial utilisation by bats and should be interpreted together with the passive acoustic monitoring data. The transect data is congruent with the general seasonal pattern of bat activity for the passive acoustic monitoring. The summer transects took place on two days of low and one day of moderate activity, and was too early in the season to capture one of the high activity spikes. Therefore, transect data should be interpreted with caution as day to day fluctuations can influence transect activity measures. This is discussed further in section 3.4.1 with regards to bat sensitive features and buffering.

Table 3-5: Bat passes per unit effort recorded during driven transects per season for different habitats. Green shades indicate increases above overall activity and red shades indicate decreases.

Season	Month-Year	Average passes per unit effort				
		Overall	Brown bedrock (200 m)	Dolerite koppies (200 m)	Quartz hills and ridges	Vegetated watercourses
Spring	Oct-21	1.23	0.89	0.00	0.95	1.84
Summer	Jan-22	4.98	0.99	73.40	0.84	5.98
Autumn	May-22	2.69	4.33	0.00	3.93	2.30
Winter	Aug-22	1.82	1.08	5.49	1.86	2.14
	Average	**2.68**	**1.82**	**19.72**	**1.89**	**3.07**

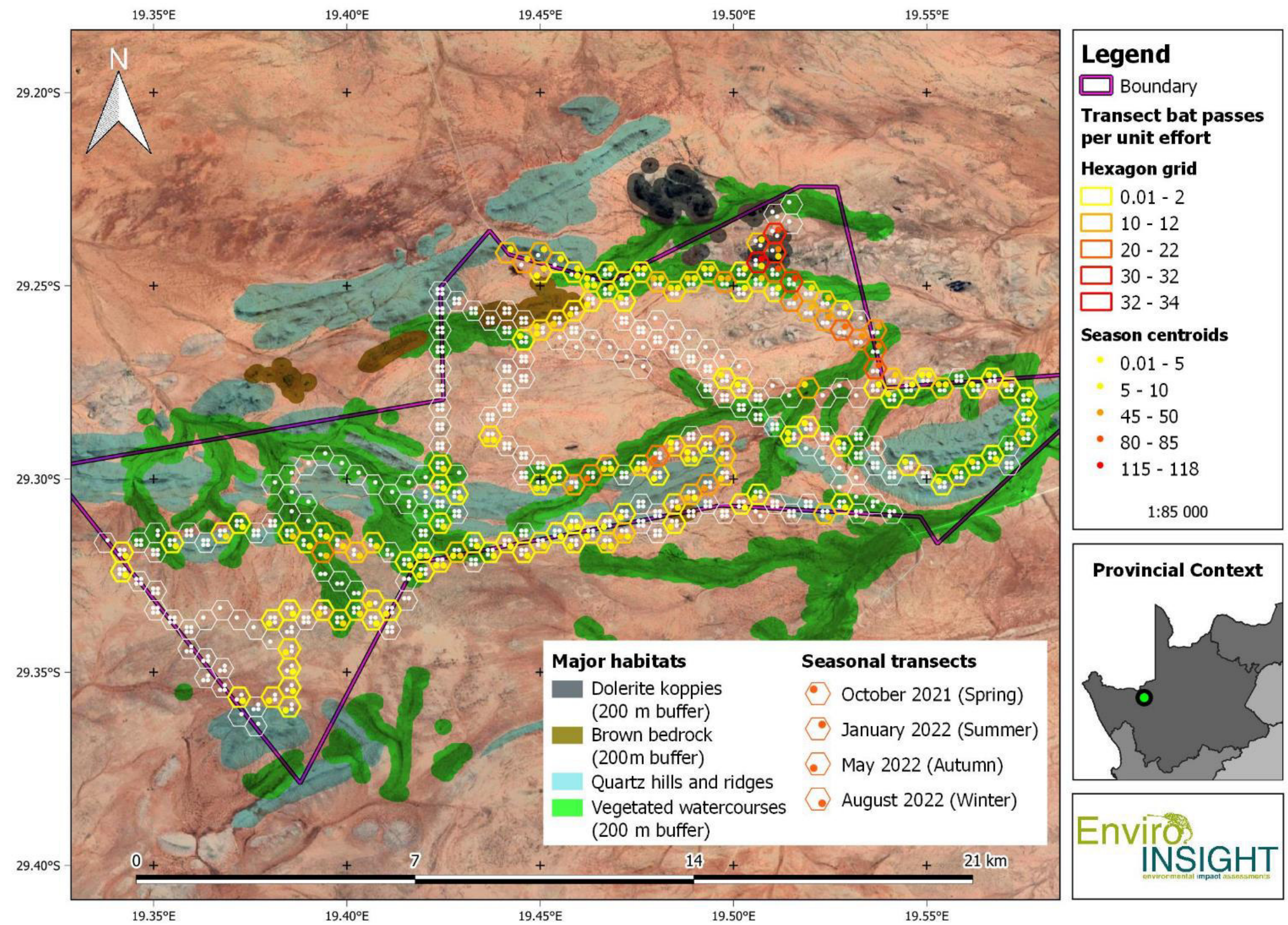


Figure 3-30: Bat transect abundance corrected for sampling effort for each season (dots) and across all seasons combined (hexagons) in relation to major habitats. White dots and grids indicate no recorded bats.

3.4 ROOSTING SITES

Twenty-nine potential roosting sites/habitats were investigated for the presence of bats during the survey period (Table 3-6, Figure 3-31). No cave systems were identified within or close to the PA during the desktop or site visits, but rocky outcrops were present in some parts of the PA and these are addressed below. These rocky outcrops are natural roosting sites, but man-made infrastructure is likely to offer the best roosting opportunities for bats in the PA. Storerooms and abandoned farm houses are ideal as they have many access points and refugia within. Inhabited farmhouses also have opportunities in the rooves and walls. Bats were confirmed to be roosting at an inhabited farmhouse (Figure 3-31; R4) and short-term acoustic monitoring suggests that bats are using rocky habitats as roosts, but no signs of bats were detected at any site during day inspections. The recording of only a single *Rhinolophus damarensis* (which is known to roost in rocky outcrops, not just caves) during roost inspections but no recordings from passive bat detectors or transects on the PA and very low numbers of *M. natalensis* further substantiates the conclusion that cave roosts are not present within or in close proximity to the PA.

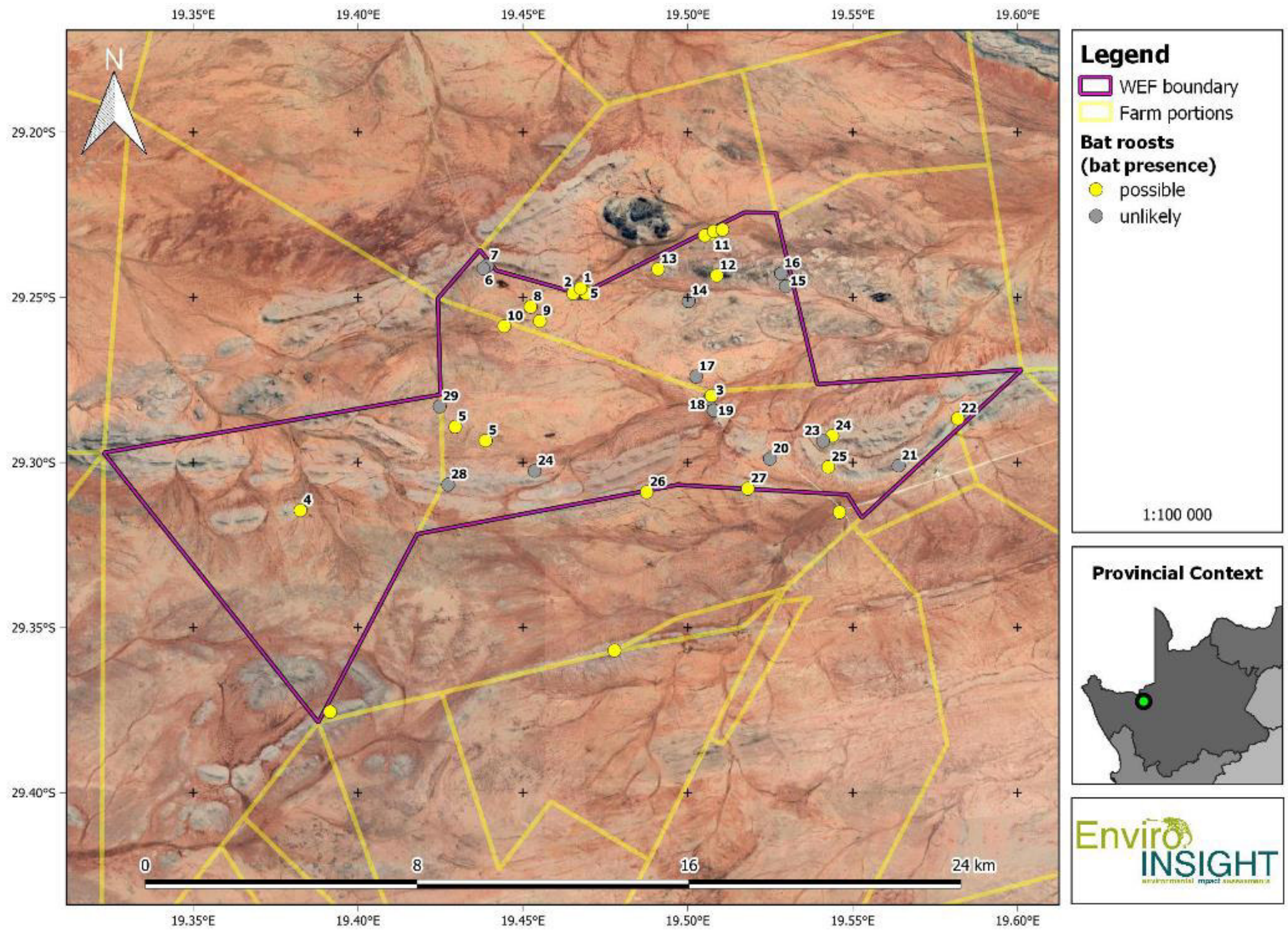
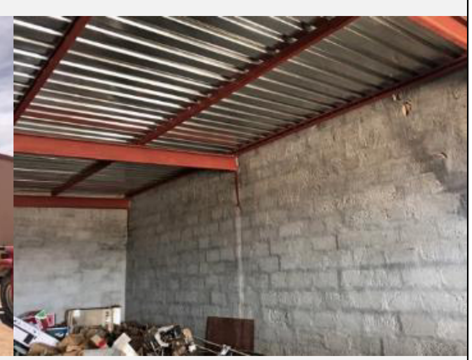


Figure 3-31. Location of bat roosts surveys and likelihood of roosting bats, showing roost identity (numbers in Table 3-6) as labels.

Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

Table 3-6: Details of sites inspected for roosting bats.

Site Name, location, dates inspected, bat evidence, habitat and likelihood of roosting bats.	**Site Photos and any evidence of bats**
R1 Latitude: -29.247262° Longitude: 19.467489° **Dates inspected, recordings & signs of bats:** 14/10/2021 – rec., no bat evidence **Habitat Description:** Oom Gert's resident house. Garage has tin roof with no ceiling, buildings are cleanly plastered with limited cracks and crevices in building material. Other structures around the house have openings and cracks. **Bat likelihood:** No evidence of bats was found during inspections and there are limited roost opportunities, but it is possible that a few bat individuals are roosting in some of the infrastructure.	   
R2 Latitude: -29.248835° Longitude: 19.465222° **Dates inspected, recordings & signs of bats:** 11/10/2021 – rec., no bat evidence 19/01/2022 – rec., no bat evidence	 

31/05/2022 – rec., bat dropping seen in garage **Habitat Description:** Main house (Thys). Storerooms have tin rooves with iron girders or wooden poles and no ceiling. Most walls are cleanly plastered but some walls are old bricks with spaces between. Storerooms are full of items that don't get moved often, with lots of refugia available. There are multiple other structures around the house and debris lying around. **Bat likelihood:** The are ample roosting opportunities for bats. Bat droppings were observed below the cracks of the iron girders in May 2022.	 
R3 Latitude: -29.279796° Longitude: 19.507154° **Dates inspected, recordings & signs of bats:** 11/10/2021 – rec., no bat evidence 19/01/2022 – rec., no bat evidence 31/05/2022 – rec., no bat evidence **Habitat Description:** Witkoppies farmhouse. The buildings have tin rooves, and the main house has a ceiling with degrading awnings while other structures do not. The walls are cleanly plastered. There are various other small structures with openings and stored items, and debris lying on the ground. **Bat likelihood:** No evidence of bats was found during	   

the inspection. However, there are ample roosting opportunities for bats, especially within the closed ceilings and awnings and bats are expected to roost at this site.	
R4 Latitude: -29.314524° Longitude: 19.382506° **Dates inspected, recordings & signs of bats:** 11/10/2021 – rec., no bat evidence 18/01/2022 – rec., no bat evidence 31/05/2022 – rec., no bat evidence **Habitat Description:** Western Farmhouse (Gert Kruger). Most buildings have tin rooves and wooden beams with no awnings or ceilings, but one structure does have a degraded awning. The walls are cleanly plastered or bricks without gaps, but some walls have cracks. There are various small structures with openings or cracks and stored equipment and debris lying on the ground.	   
Bat likelihood: No evidence of bats was found during the inspection. However, there are some roosting opportunities for bats, such as in cracks in the walls and between walls and wooden beams. The farmer reported and photographed bats (*N. thebaica*) roosting inside the store.	

Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

R5

Latitudes:

-29.289215°; -29.293389°

Longitudes:

19.429482°; 19.438685°

Dates inspected, recordings & signs of bats:

05/08/2022 – no signs of bats, no vocalisations detected.

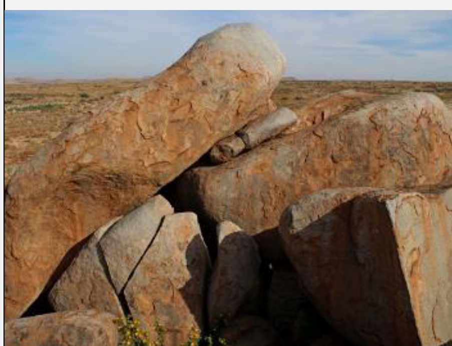
Habitat Description:

Two similar isolated koppies of large igneous boulders. The boulders are rounded and stacked, sometimes with large cracks and fissures. Cavities are formed between stacked boulders and appear to be relatively deep in places.

Bat likelihood:

Although no signs of bats were found, many spaces and cracks were inaccessible during inspection – being too confined and also one containing a beehive. It is likely that a few bats use these koppies as roosts for at least some time during the year, especially in deep crevices hidden in cavities between boulders.






R6

Latitude: -29.241246°

Longitude: 19.437968°

Dates inspected, recordings & signs of bats:

09/03/2021 – photographed from distance


Habitat Description: Large quartzite outcrop on top of hill, large angular boulders with various cracks and crevices. **Bat likelihood:** The site was not searched, only photographed from a distance. The rock is very broken and unlikely to be suitable for bat roosts.	 
R7 Latitude: -29.240434° Longitude: 19.439175° **Dates inspected, recordings & signs of bats:** 09/03/2021 – no bat evidence **Habitat Description:** Quartzite outcrop on top of hill, small rocks and boulders lying on or embedded in a stony soil matrix with few or only shallow cracks and crevices. **Bat likelihood:** No bats or evidence of bats were observed in or around any rock cracks and the habitat was not considered to be suitable for bat roosts, the few rock cracks present being too shallow and exposed.	   
R8 – 'Brown Bedrock' Latitude: -29.252859° Longitude: 19.452296° **Dates inspected, recordings & signs of bats:** 12/03/2021 – no bat evidence 16&17/08/2022 – roost recordings taken	 

Habitat Description:

Large expanse of exposed bedrock (brown and grainy texture). The larger exposed outcrops have small-medium sized cracks and crevices between rocks.

Bat likelihood: see R10.


R9 – 'Brown Bedrock'

Latitude: -29.257206°

Longitude: 19.455121°

Dates inspected, recordings & signs of bats:

11/03/2021 – no bat evidence

16&17/08/2022 – roost recordings taken

Habitat Description:

Large expanse of exposed bedrock (brown and grainy texture). The larger exposed outcrops have small-medium sized cracks and crevices between rocks.

Bat likelihood: see R10.




R10 – 'Brown Bedrock'

Latitude: -29.258717°

Longitude: 19.444309°

Dates inspected, recordings & signs of bats:

12/03/2021 – no bat evidence

16&17/08/2022 – roost recordings taken


Habitat Description:

Large expanse of exposed bedrock (brown and grainy texture). The larger exposed outcrops have small-medium sized cracks and crevices between rocks. Difficult to inspect visually.

Bat likelihood:

The entire bedrock area was surveyed in August 2022 to identify outcrops with suitable crevices for roosts. Short-time acoustic monitoring was conducted and the results indicate that some bats are using these features for roosting: **3.4.1.1.**

R11 – 'Dolerite Outcrops'

Latitude: -29.230838°

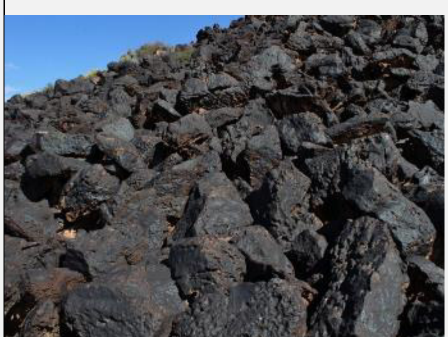
Longitude: 19.507059°

Dates inspected, recordings & signs of bats:

08/08/2022 – bat droppings found and roost recordings taken.

Habitat Description:

Group of large conical hills of exposed outcrops of black rounded dolerite boulders and rocks, embedded in sand on the edges but stacked boulders with many spaces and gaps in-between which appear to form deeper cavities in the centre of the outcrops go deep into the centre.



Bat likelihood:

Due to the small size of the gaps and cavities between the rounded boulders it is not possible to adequately visually assess whether any bats are roosting within these outcrops. However, these cavities appear to be some of the most suitable natural roosting habitats in landscape with limited alternative roosting habitats and it is likely that bats and possibly even small colonies are roosting in these outcrops. Bat droppings were found deep in some of the gaps between boulders.

See additional surveys confirming roosting bats: **3.4.1.2**

R12 – 'Dolerite Outcrops'

Latitude: -29.243394°

Longitude: 19.508776°

Dates inspected, recordings & signs of bats:

09/03/2021 – no bat evidence

Habitat Description:

Medium-sized exposed outcrops of black rounded dolerite boulders and rocks, embedded in sand on the edges but stacked boulders with many spaces and gaps in-between which appear to form deeper cavities in the center of the outcrops go deep into the centre.

Bat likelihood:

Due to the small size of the gaps and cavities between the rounded boulders it is not possible to adequately visually assess whether any bats are roosting within these outcrops. However, these cavities appear to be some of the most suitable natural roosting habitats in landscape with limited alternative roosting habitats and it is likely that bats and possibly even small colonies are

roosting in these outcrops.

R13 – Dolerite Koppies

Latitude: -29.241489°

Longitude: 19.490975°

Dates inspected, recordings & signs of bats:

07/08/2022 – no bat evidence

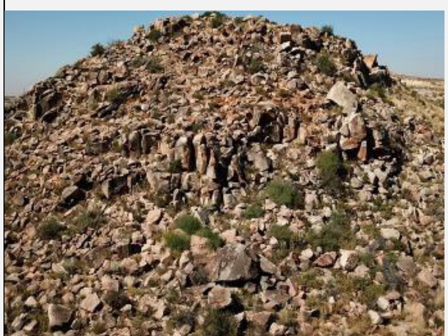
Habitat Description:

Group of medium conical hills of exposed outcrops of light brown dolerite boulders and rocks, embedded in sand on the edges but stacked in places and exposed bedrock near the crest with many deep cracks and crevices.

Bat likelihood:

Due to the extensive rocky habitat and difficulty in searching deep or internal cracks in the rock, the lack of bat evidence during visual surveys is not sufficient to rule out bat roosts. The habitat appears suitable for bat roosts and there is likely to be a few roosting bats in this habitat.





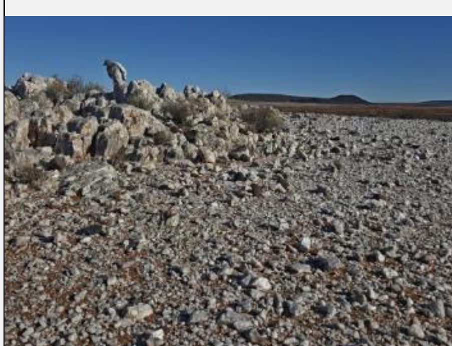

R14

Latitude: -29.251118°

Longitude: 19.500211°

Dates inspected, recordings & signs of bats:

12/03/2021 – no bat evidence




Habitat Description:

A small white quartz outcrop which is surrounded by small rocks and pebbles of quartz lying on a sandy matrix. The exposed outcrop is blocky and solid with few cracks or crevices. The few cracks present are often very shallow and narrow.

Bat likelihood:

No bats or evidence of bats were observed in or around the small outcrop and the habitat is unsuitable for bat roosts.


R15

Latitude: -29.246680°

Longitude: 19.529712°

Dates inspected, recordings & signs of bats:

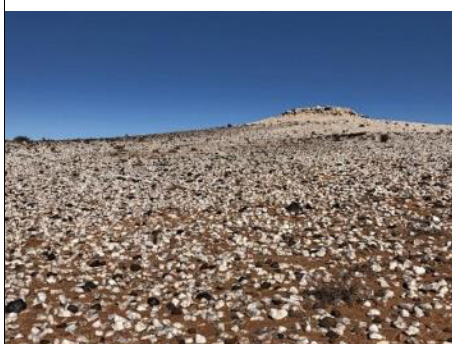
12/03/2021 – no bat evidence

Habitat Description:

Small hill with ridge of quartz outcrops, the scree slope and surroundings are covered in small rocks and pebbles of quartz lying on a sandy matrix. The exposed outcrops are blocky and solid with few cracks. Crevices between blocks in the outcrops are usually quite exposed and do not form consistent narrow widths.

Bat likelihood:

No bats or evidence of bats were observed in or around the small outcrop and the habitat is mostly unsuitable for bat roosts.




R16

Latitude: -29.242799°

Longitude: 19.528292°

Dates inspected, recordings & signs of bats:

12/03/2021 – no bat evidence

Habitat Description:

Slight hill with heavily eroded ridge of quartz outcrops, the surroundings are covered in small rocks and pebbles of quartz lying on a sandy matrix. The small, exposed outcrops are blocky and solid with few cracks and no notable crevices.

Bat likelihood:

No bats or evidence of bats were observed in or around the small outcrops and the habitat is unsuitable for bat roosts.




R17

Latitude: -29.273977°

Longitude: 19.502466°

Dates inspected, recordings & signs of bats:

10/03/2021 – no bat evidence

Habitat Description:

Small, eroded quartz ridge with bedrock quartz exposed above red sands and smaller quartz rocks and pebbles lying on the surface. The exposed boulders are blocky and have no small cracks or fissures and the gaps between them are exposed and not of consistent widths.

Bat likelihood:

No bats or evidence of bats were observed around the small outcrops and the habitat is unsuitable for bat roosts.




R18

Latitude: -29.280777°

Longitude: 19.506519°

Dates inspected, recordings & signs of bats:

10/03/2021 – no bat evidence

Habitat Description:

Small hill with a prominent quartz outcrop ridge with very large blocky boulders, the steep scree slope has large quartz boulders and rocks embedded in a very sandy matrix. The quartz outcrops have no cracks or fissures in the boulders, but some large crevices are formed where the boulders contact one another, but these crevices do not have consistent and narrow widths and are usually quite exposed. Most crevices at ground level have been filled by sand or other debris.

Bat likelihood:

No bats or evidence of bats were observed in or around the outcrop. The habitat is unsuitable for bat roosts.




R19

Latitude: -29. 284252°

Longitude: 19. 507798°

Dates inspected, recordings & signs of bats:

07/08/2022 – no bat evidence


Habitat Description:

Small hill with a prominent quartz outcrop ridge with very large blocky boulders, the steep scree slope has large quartz boulders and rocks embedded in a very sandy matrix. The quartz outcrops have few cracks or fissures in the boulders, but these are limited, usually very shallow, and quite exposed.


Bat likelihood:

No bats or evidence of bats were observed in or around the outcrop. The habitat is not considered to be suitable for bat roosts.

R20

Latitude: -29.298907°

Longitude: 19.524865°

Dates inspected, recordings & signs of bats:

11/03/2021 – no bat evidence


Habitat Description:

Series of small ridges with highly eroded quartz outcrops on the crest with slopes covered in small quartz rocks and pebbles on a sandy medium. The quarts crests have medium to small angular quarts rocks and some exposed bedrock. There are no cracks or fissures in the rocks and any crevices between rocks are very exposed and shallow.

Bat likelihood:

No bats or evidence of bats were observed around the ridges checked and the habitat is unsuitable for bat roosts.

R21

Latitude: -29.300985°

Longitude: 19.563907°

Dates inspected, recordings & signs of bats:

12/03/2021 – no bat evidence

Habitat Description:

A large quartzite hill/ridge with steep slopes and various strata of exposed quartz sills at different positions along the slope. The slope is covered in medium to small quartz rocks and pebbles with a small amount of sand in-between. The exposed quartz intrusions have intact bedrock and medium to large boulders with some cracks and crevices, but these are limited and often filled in with debris and quite shallow. In general the quartz are blocky and solid.

Bat likelihood:

No bats or evidence of bats were observed around the quartz outcrops and boulders checked and the habitat is unsuitable for bat roosts.



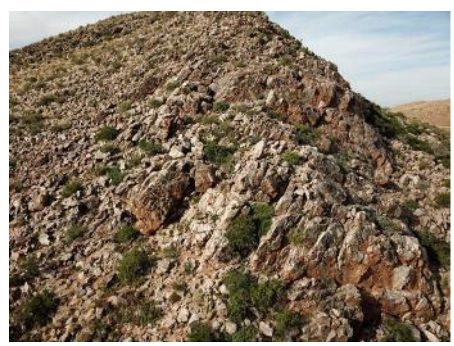

R22

Latitude: -29.286565°

Longitude: 19.582869°

Dates inspected, recordings & signs of bats:

06/08/2022 – only photographed.

Habitat Description:

A large quartzite hill/ridge with steep slopes and a particularly large outcrop exposed quartzite on the east side. The outcrop has partially consolidated bedrock. The slope is covered in medium to small quartz rocks and pebbles. The exposed quartz outcrops have large vertical cracks and crevices . These crevices have not been observed up close but they appear to be quite deep, the quartz rocks themselves are blocky and solid.

Bat likelihood:

The outcrop has not been searched for evidence of bats, but the photographs suggest that habitat is ideal for bats to utilise as roost sites. Therefore, the Precautionary Principal is followed and it is assumed that some bat individuals are roosting in this habitat.

R23

Latitude: -29.293515°

Longitude: 19.541002°

Dates inspected, recordings & signs of bats:

10/03/2021 – no bat evidence

Habitat Description:

A large quartzite hill/ridge with steep slopes and a crest of eroded quartz intrusion. The slope is covered in medium to small quartz rocks and pebbles with a small amount of sand in-between. The exposed quartz intrusions consist of broken rocks and boulders of small to medium size. While cracks and crevices are quite abundant, especially under rocks, they are quite small or shallow and relatively exposed. In general the quartz rocks are blocky and solid.

Bat likelihood:

No bats or evidence of bats were observed around the quartz outcrops checked and the habitat is unsuitable for bat roosts.

R24

Latitude: -29.29194°

Longitude: 19.54378°

Dates inspected, recordings & signs of bats:

10/03/2021 – no bat evidence

Habitat Description:

A large quartzite outcrop with intact bedrock and large rocks and boulders situated along the top of a quartzite hill/ridge. There are numerous crevices between boulders and formed by the way the exposed bedrock has weathered. The outcrops are solid rock and the crevices are not filled by sand and other debris

Bat likelihood:

No bats or evidence of bats were observed around the outcrop, but the deeper crevices cannot be easily checked and it is possible that a few bats utilised the outcrop for roosting.

R25

Latitude: -29.306712°

Longitude: 19.427250°

Dates inspected, recordings & signs of bats:

not inspected

Habitat Description:

A quartz outcrop at the top of a large hill/ridge. The exposed outcrop has large, stacked quartz boulders and some of the rocks appear to have deep crevices and probably cavities been the boulders.

Bat likelihood:

The habitat was not surveyed on the ground but appears to have suitable roosting habitat from drone photographs and the precautionary approach is taken assuming that bats do roost here.


R26

Latitude: -29.308984°

Longitude: 19.487507°

Dates inspected, recordings & signs of bats:

06/08/2022 – no bat evidence

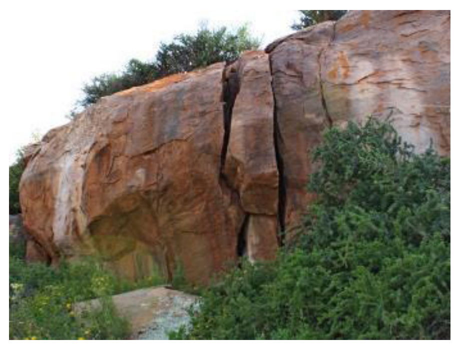
Habitat Description:

Large expanse of exposed igneous rock exposed on the side of a small hill, with a small quartz ridge above. The rock forms large boulders with varying degrees of weathering. Some parts have small hollow caverns, while some large boulders are solid with deep crevices and other boulder outcrops are extensively fissured with internal cracks.

Bat likelihood:

Due to the difficulty in searching deep or internal cracks in the rock, the lack of bat evidence during visual surveys is not sufficient to rule out bat roosts. The habitat appears suitable for bat roosts and there is likely to be a few roosting bats in this habitat.



R27 Latitude: -29.307938° Longitude: 19.518168° **Dates inspected, recordings & signs of bats:** 07/08/2022 – no bat evidence	 
Habitat Description: Large expanse of exposed igneous rock exposed on the side of a small hill. The rock forms large boulders with varying degrees of weathering. Large boulders are solid with deep crevices and other boulder outcrops are extensively fissured with internal cracks **Bat likelihood:** No bats or evidence of bats were observed around the outcrop, but the deeper crevices and cavities cannot be easily checked and it is possible that a few bats utilised the outcrop for roosting.	 
R28 Latitude: -29.306712° Longitude: 19.427250° **Dates inspected, recordings & signs of bats:** 09/03/2021 – no bat evidence	 

Habitat Description: A small quartzite hill/ridge with gentle slopes covered in medium to small quartz rocks and pebbles. The exposed quartz intrusions at the crest of the hill are small and have some cracks and crevices between rocks, but these are few and seem to be quite shallow. **Bat likelihood:** The cracks were not checked for evidence of bats as they were not considered to be suitable for bat roosts at the time they were photographed.	
R29 Latitude: -29.283057° Longitude: 19.424734° **Dates inspected, recordings & signs of bats:** 12/03/2021 – no bat evidence **Habitat Description:** Isolated patch of exposed doleritic bedrock with some larger boulders spaced widely apart from one another. The boulders have weathered in a round fashion, but a few have cracked forming deep crevices. **Bat likelihood:** No bats or evidence of bats were observed in cracks of the boulders and since all cracks could easily be checked it was confirmed that no bats appear to be using them as roost sites.	 

3.4.1 Short-term Passive Acoustic Monitoring

The exposed brown bedrock and dolerite outcrops were searched visually and no evidence of roosting bats were found. However, concealed cavities and crevices in the rocks could not be effectively searched using this method and bat detectors were deployed to provide a more robust assessment for roosting bats (Figure 3-32 & Figure 3-33). At the time sunset was 18:11 PM and sunrise and 07:26 AM.

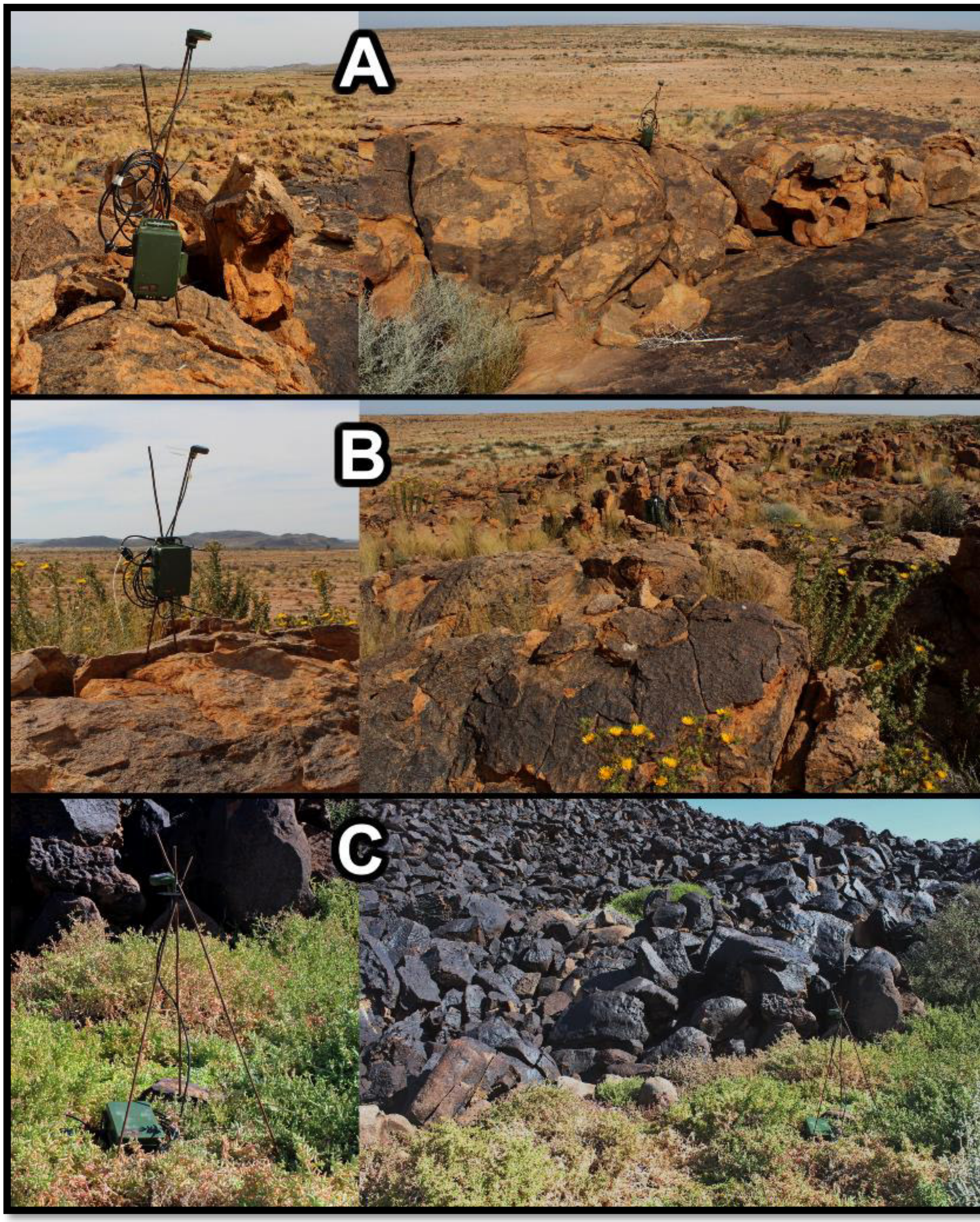


Figure 3-32. Short-term acoustic monitoring setups at potential bat roosting habitats[20].

[20] A: STAM1; B: STAM2; C: STAM3.

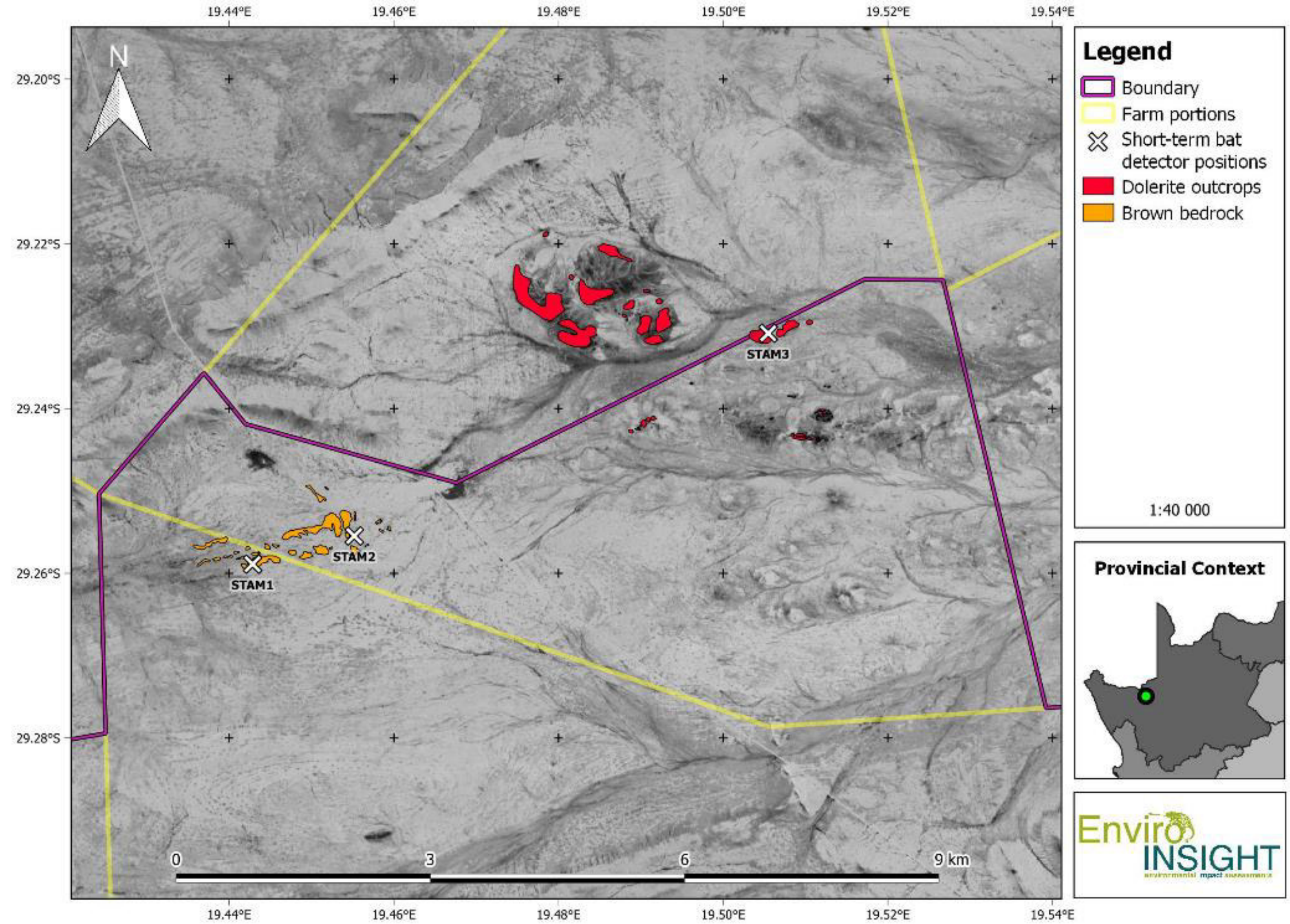


Figure 3-33. Locations for short-term acoustic monitoring setups within the northern part of the PA.

3.4.1.1 Brown bedrock (STAM1&2)

Two detectors were positioned at either end of the brown bedrock extent and recorded on the 5th and 6th August 2022. This was done to ensure that if bats were roosting in the nearby farmhouse to the east and immediately dispersing through the area, that they would be recorded at STAM2 first, and then at STAM1. The bat passes showed:

STAM1 recorded 43 bat passes and STAM2 recorded 17 bat passes over the two nights of recording. All bat passes were *T. aegyptiaca* and/or *S. petrophilus* with the exception of one pass of a *Rhinolophus damarensis* that was recorded at 06:09 AM by STAM2. it is possible that this one individual was foraging far from its roost (see below). Activity patterns at both detectors show a spike in activity in the evening during the sunset hour (18:00 PM), with activity declining and then some activity at STAM1 during the night and activity tailing off towards the morning (Figure 3-34). It is clear that bat activity did not originate in the east from the farmstead, with the western STAM1 detecting bat activity first. These activity patterns, early evening peak and lack of a clear directional movement, suggest that bats are roosting nearby - probably within the brown bedrock. Only a few bats were detected over the 2 nights recorded and thus this habitat probably only supports a small number of bat roosts, and areas supporting suitable roosting sites within this habitat should be buffered by 500 m.

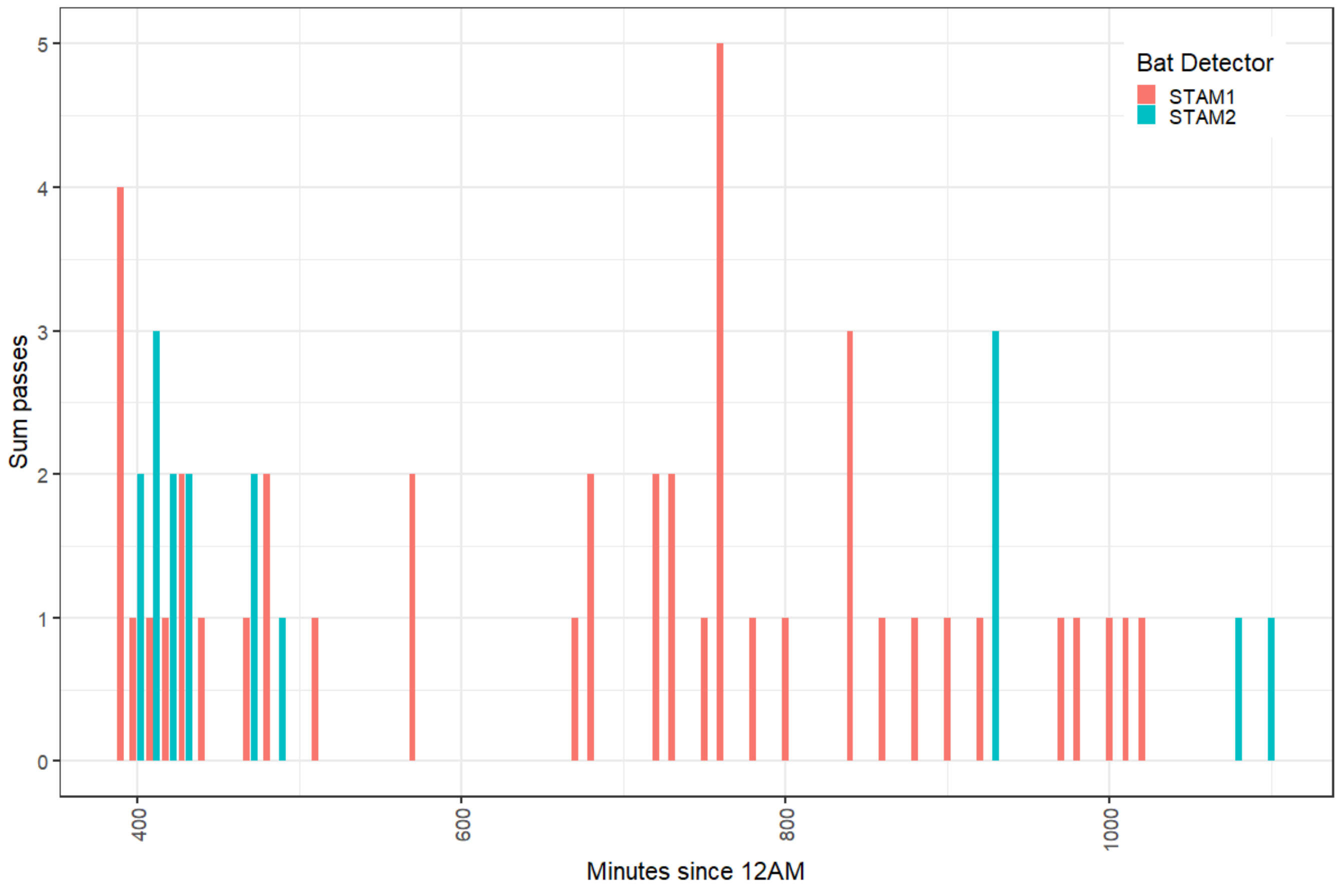


Figure 3-34. Bat activity for short-term acoustic monitoring setups STAM1&2 summed every 10 minutes. The initial time (400 minutes since 12:00 AM) is 18:00 PM.

3.4.1.2 Dolerite outcrop (STAM3)

A single detector was positioned adjacent to the large conical hill of dolerite boulders from the 7th August until the morning of the 13th August 2022. A particularly deep space beneath the boulders was identified close to this position and it looked promising for bat roosts. While other smaller rock outcrops to the south are unlikely to have as deep spaces between boulders, the habitat is expected to be homologous to some degree. The detector recorded 462 bat passes over the 6 nights, which is considerably high for the region. *Tadarida aegyptiaca* and/or *S. petrophilus* made up 389 of the passes, *R. damarensis* 46*, M. natalensis* 20 and *E. hottentotus* and/or *S. petrophilus* 7. The remarkably high abundance of clutter/clutter-edge foraging species either not encountered or in low densities elsewhere in the study area is noteworthy. The hourly activity indicates that *R. damarensis* is likely to roost in the cavities within the dolerite outcrops, with a large peak of activity in the early evening (18:00) and lower sustained activity thereafter (Figure 3-35). Other species do not show this pattern, instead their activity tends to increase later in the evening, indicating that these species are roosting elsewhere but are congregating in this area for foraging or social activities.

The static bat detector (B1) positioned within 230 of these dolerite outcrops did not support this, possibly because bats were only active close to the outcrops. These dolerite outcrops are clearly an important roosting site for *R. damarensis* as well as a major attractant for nightly bat activity and should be buffered accordingly.

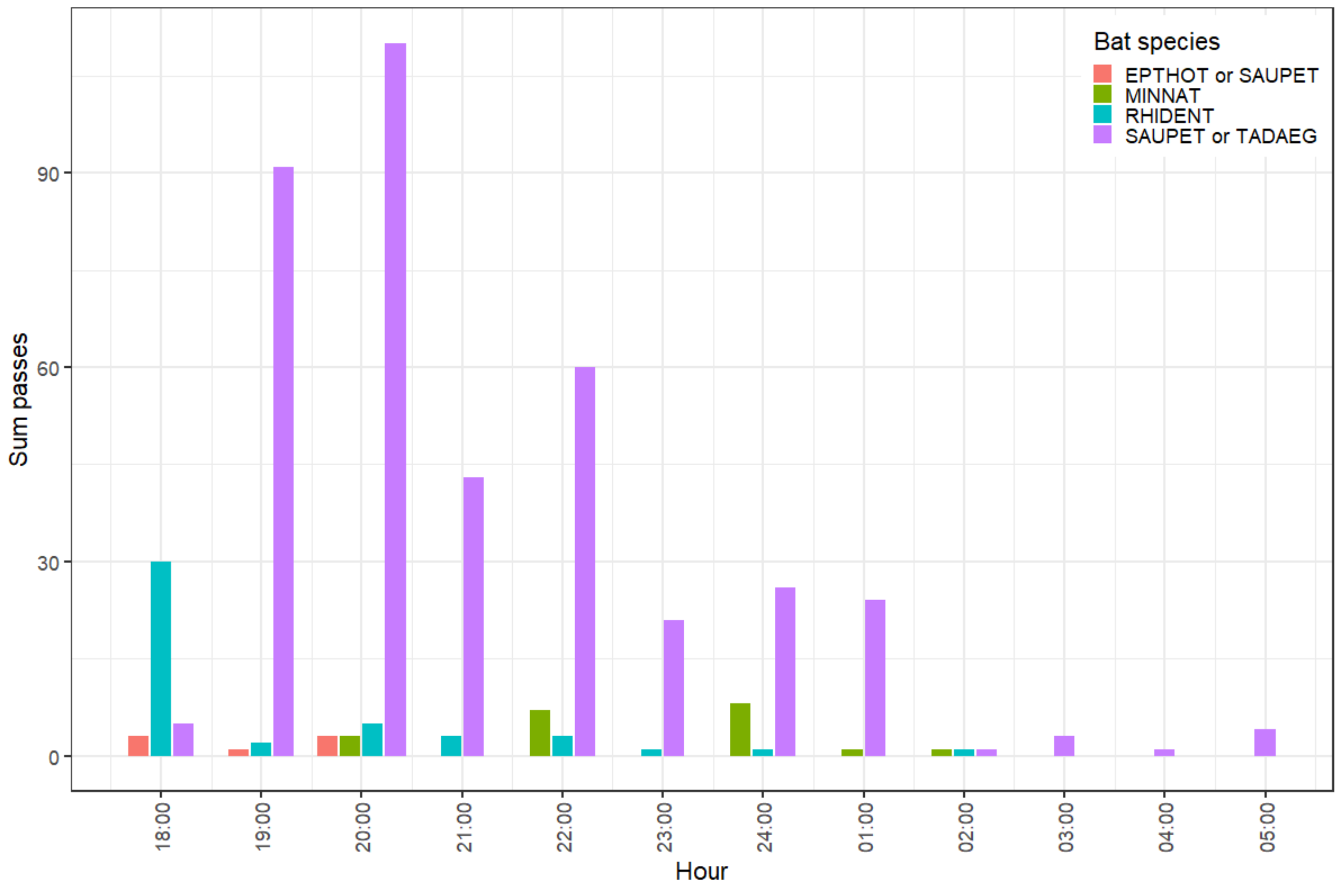


Figure 3-35. Bat activity per species for short-term acoustic monitoring setups STAM3 summed every hour.

3.6 BAT SENSITIVE FEATURES

The PA is very arid with ephemeral watercourses and one non-perennial dam, with a generally flat terrain with exposed dolerite koppies, bedrock and long chains of quartzite ridges, sometimes crested with quartz outcrops. Anthropogenic activities include sheep and some cattle ranching. Vegetation is limited, and when present is usually sparse and low to the ground, including grass clumps and low scrub bushes. Trees are very sparsely distributed, but occasionally *Vachellia* trees are present along dry watercourses, pans or dams and near to farmsteads and kraals, and larger bushes are often associated with the ephemeral watercourses. Bedrock pans are limited to the surface bedrock plains, but these are usually very small. The large dolerite outcrops that form conical stacks of large black rounded boulders are associated with species-specific bat roosts as well as general bat activity. Wetlands in arid areas are important foraging areas and drinking sites for bats and have higher activity levels than surrounding habitats (Loumassine *et al.*, 2020). This is also likely to be true for the pans/rock pools and dams present in the PA. Man-made infrastructure is sparse and scattered throughout the site, and farmsteads especially are likely to support small numbers of roosting bats.

Watercourses are ephemeral and generally have denser vegetation owing to the greater/prolonged availability of moisture in the soil. Bats are known to forage along watercourses, as a greater abundance of insect activity is generally associated with plant growth and open water, and watercourses are natural corridors of vegetation where bats can maximise their foraging success. Transect data indicated that bat activity was only slightly higher in vegetated watercourses (outside of autumn), while passive monitoring stations share no obvious activity patterns with the transect data or for the different nearby habitats (such as rocks and watercourses; Figure 3-36). None of the passive detectors where placed close enough to rocky habitats to effectively record associated bat activity. Transect data appear to be quite volatile between nights, even within the same season, which may explain some of the discrepancies. In addition, the La Niña event and associated rainfall leading to the uncharacteristic presence of a widespread abundance of plant growth may have reduced bat reliance on vegetated watercourses. Consequently, it is strongly recommended that the applied buffers are maintained as these habitats are expected to be used more frequently under normal (non-La Niña) conditions, these sensitive bat features, grouped by the type of feature, are shown in Figure 3-37.

Passive acoustic monitoring showed evidence for higher bat activity and large spikes in activity over summer and autumn, with these spikes also occurring at rotor-sweep heights and across all detectors. It is hypothesised that widespread insect eruptions cause these spikes in bat activity as there appears to be no particular habitat type where this phenomenon is confined. Avoiding bat mortality through strategic turbine placement is therefore challenging and additional minimisation mitigation measures are likely to be required.

Features identified as attractants for foraging bats have been buffered by 200 m, and features with confirmed or high likelihood of supporting bat roosts have been buffered by 500 m, as per the minimum requirements of the SABPG (MacEwan *et al.,* 2020b). These buffers should be considered as turbine-specific No-Go areas, where no part of the turbines should enter (including blade tips) (Figure 3-38; Figure 3-39). Turbines intersecting with these buffers will need to be relocated outside of the buffer zones. Of the current layouts (1 and 2), layout 1 (which consists of the North and South WEFs shown in Figure 3-38 and Figure 3-39) is the preferred layout with 6[21] turbines within the sensitive buffers (including turbine blades), while layout 2 has 44[22] turbines within the sensitive buffers. Consequently, layout 1 is preferred as there are fewer turbines which will need to be relocated outside of the bat sensitivity buffer shown in Figure 3-39. The other proposed infrastructure, including access roads, BESS, laydown areas, substations and other buildings (Figure 3-38) are outside of any sensitive roost habitat and are expected to have a negligible impact on bat roots or foraging habitat.

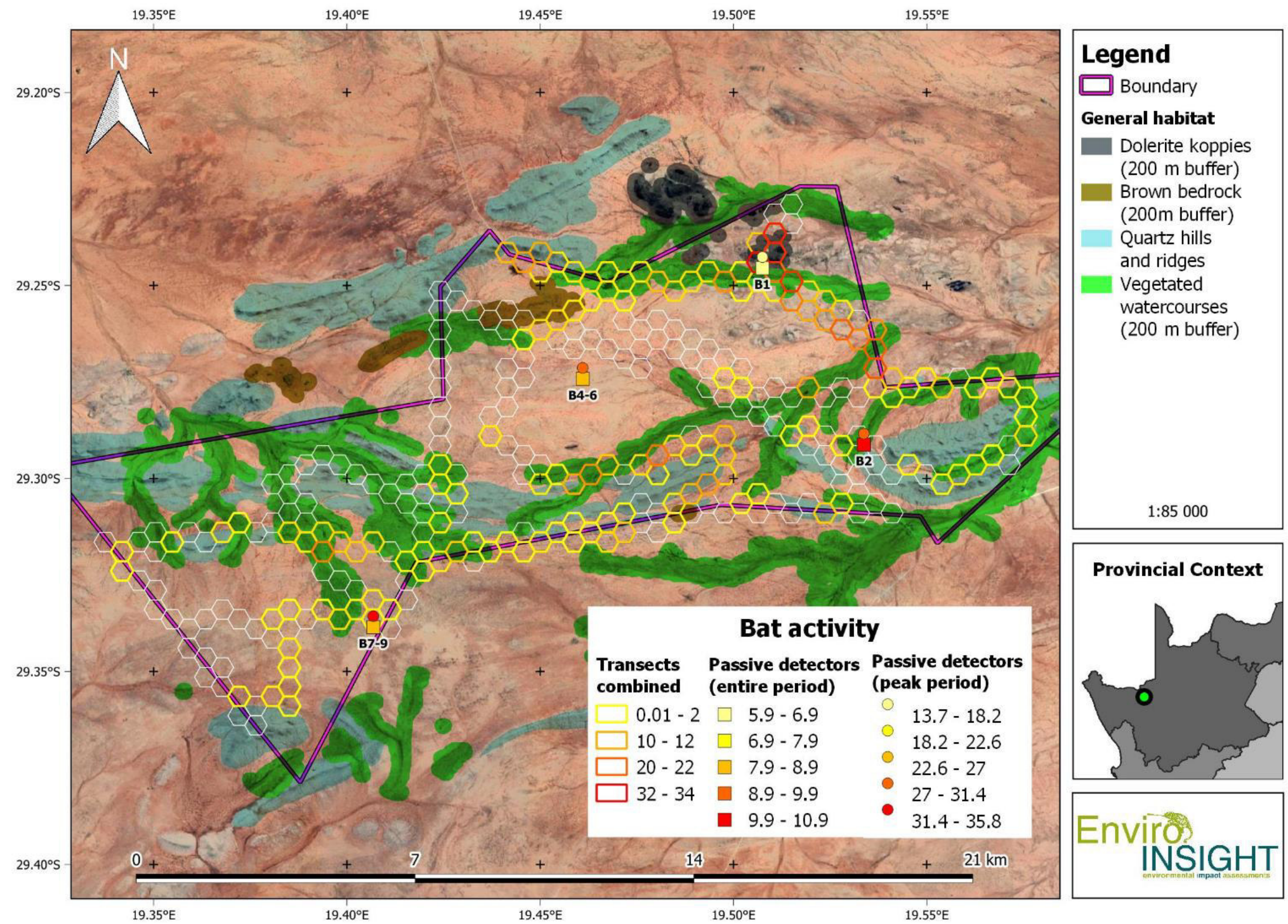


Figure 3-36: Passive and active acoustic monitoring results at ground level (average bat passes) in context of the major habitat types delineated. The peak bat activity refers to the high activity levels recorded at passive bat detectors between 1st and 26th February 2022.

[21] **North:** 15; 28; 34; 35; **South:** 29; 30.

[22] **#1:** 2; 3; 4; 5; 6; 7; 20; **#2:** 1; 3; 4; 5; 6; 7; 8; 9; 10; 13; 14; 16; 17; 18; 21; 22; 33; **#3:** 1; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 17; 19; 20; 21; 22; 23; 24; 26; 27.

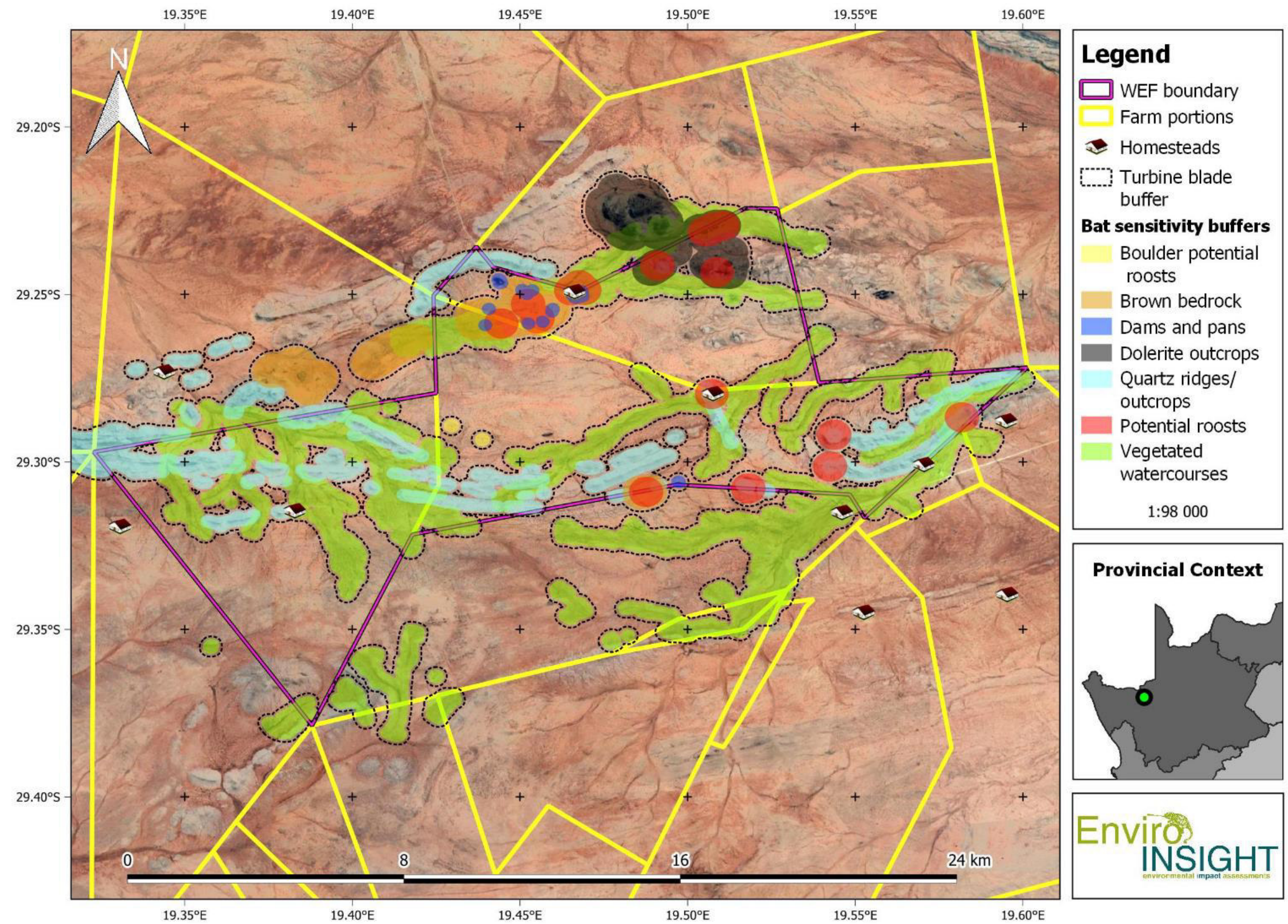


Figure 3-37: Sensitive bat features within the study area showing the appropriate buffers in relation to the alternative turbine layouts. No movement corridors were detected during transect surveys (requiring 500 m buffers), but confirmed or likely bat roosts were buffered by 500 m, while a 200 m buffer was implemented around areas potentially utilised by bats (such as vegetated drainage lines, dams, infrastructure, outcrops, pans and trees).

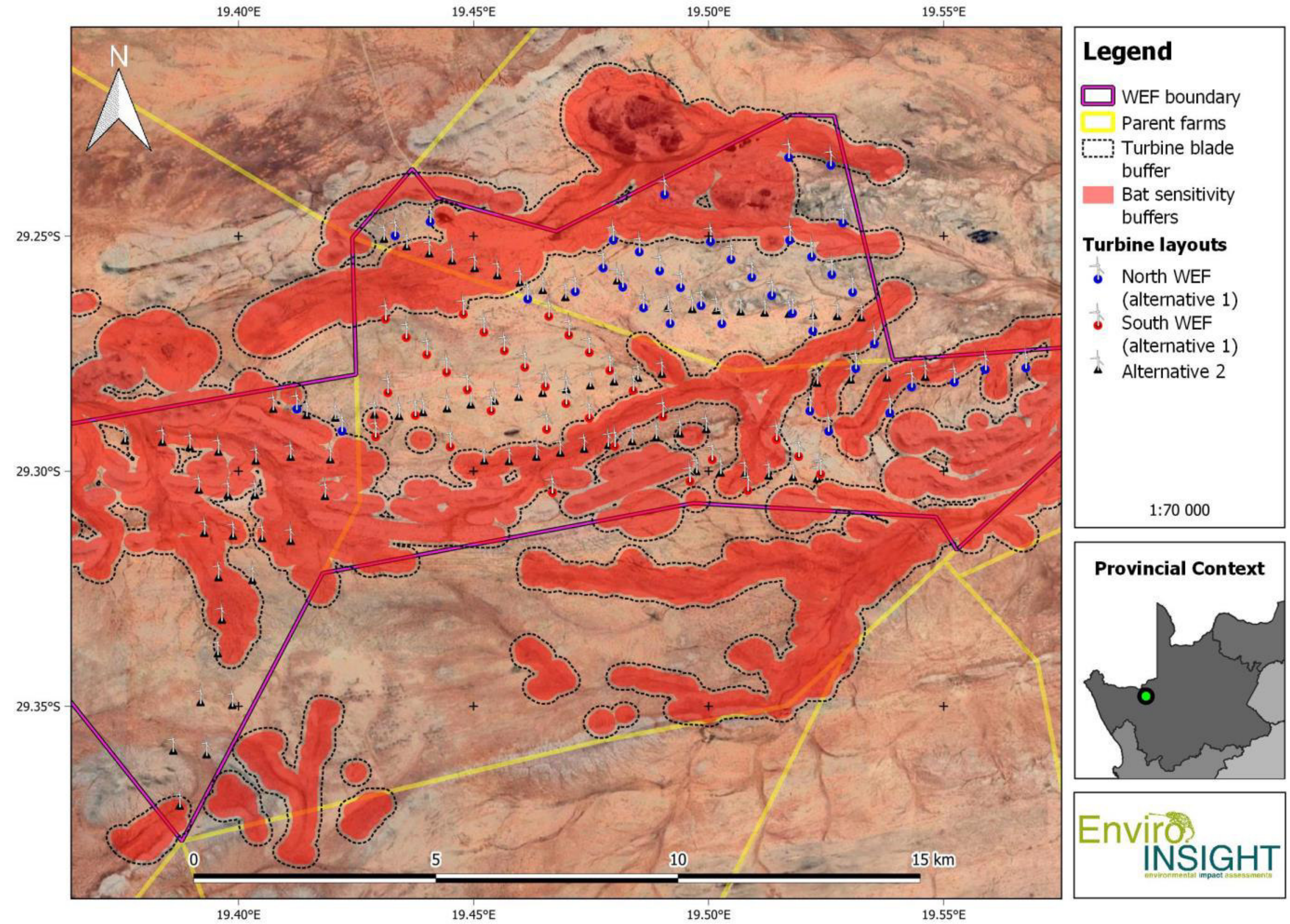


Figure 3-38: Sensitive bat features within the study area showing the appropriate buffers in relation to the turbine layouts. These are considered to be turbine specific No-Go areas.

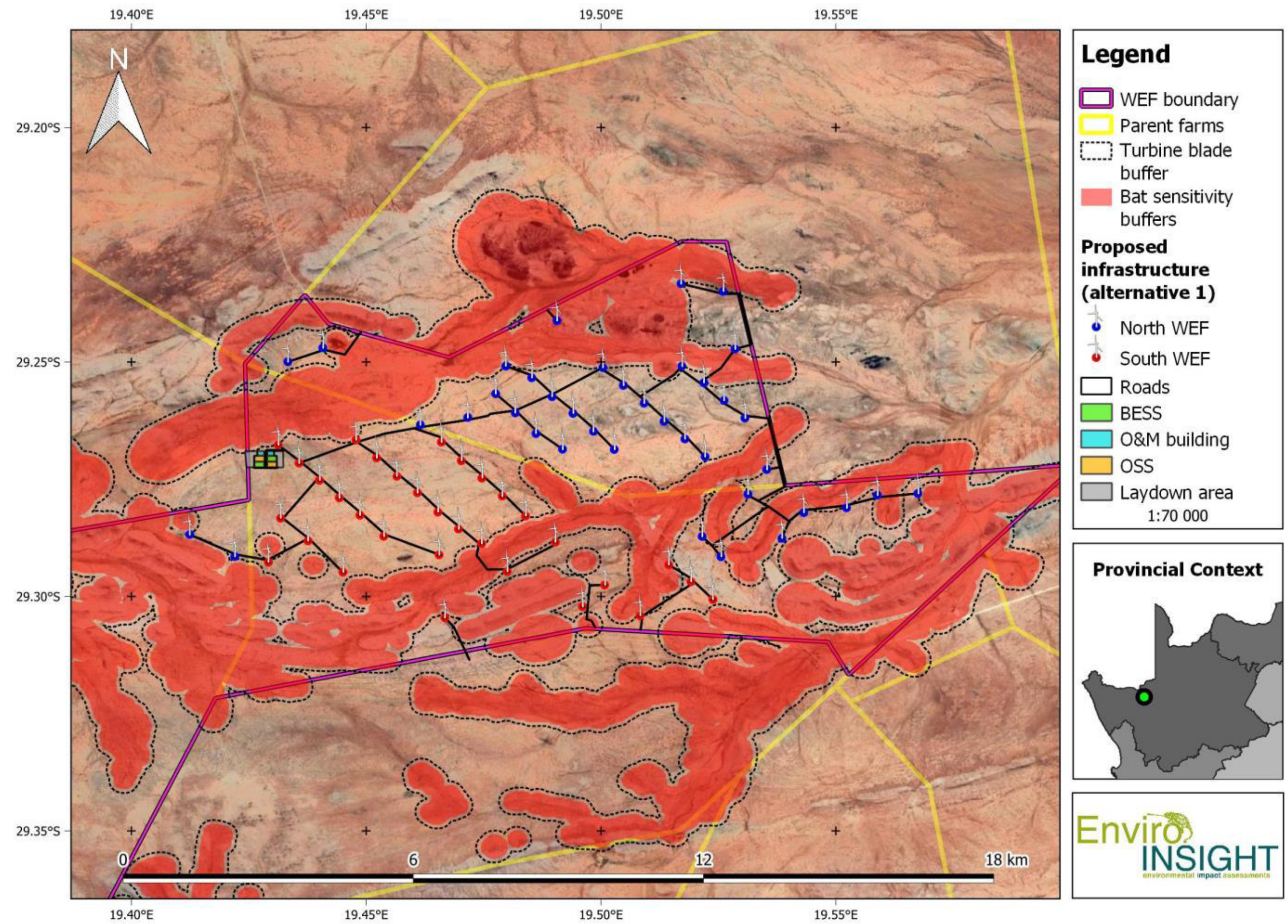


Figure 3-39: Sensitive bat features within the study area showing the appropriate buffers in relation to the full WEF infrastructure layout (preferred alternative). Note that the sensitive features are only pertinent to the placement of the turbines

4 POSSIBLE IMPACTS

4.1 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 habitat	Low - Medium	Low	High	No	No
Bat fatality	High	Medium-High	Low	Potentially	Unlikely
Artificial lighting	Medium - High	Low	Low	No	No

4.1.1 Loss or destruction of foraging and roosting habitat

Access roads and other infrastructure construction (e.g. laydown areas, turbine crane platforms, buildings, etc.) may necessitate the removal/disturbance of foraging or roost habitat (Table 4-2). Roost habitats include rocky outcrops and farmsteads, while sensitive foraging habitats include rocky ridges, water pools, pans and vegetated watercourse. The impact is expected to be definite (there will have to be vegetation clearing) and long-lasting, but if sensitive habitats (e.g. roost and foraging sites) are avoided then the severity will be low. If the turbine specific No-Go areas are avoided then the impact is expected to be minimal. As far as possible all roads must follow the existing farm roads to avoid further destruction of habitat. No off-road driving and no collection of building material (sand/rocks) within the WEF boundary that will result in destruction of natural habitats. Maintenance during the operational phase must use same laydown areas cleared for the construction phase. This impact is expected to be minimal following mitigation.

Table 4-2: Impacts on bats due to habitat loss from construction activities.

	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 year to ten years	3	Insignificant/non-harmful	1
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**

Without mitigation	Annually / Once-off	1	Definite	5
With mitigation	Annually / Once-off	1	Definite	5
	Significance Rating of Impacts		**Timing**	
Without mitigation	54 Low - Medium		Construction and Operational	
With mitigation	30 Low		Construction	

4.1.2 Bat fatalities due to collision or barotrauma

Turbines and their blades should be placed outside of the defined buffers for sensitive bat features where bat activity is expected to be higher. The number of fatalities is expected to increase with the number of active bats within the rotor-sweep area, during peak foraging bouts (especially in summer and autumn), movement of bats along flyways or migratory routes, or when bats enter and exit nearby roosting sites. The PA shows a High to Medium Risk for bat fatality within the rotor sweep zone based on activity levels, and the most abundant species, *T. aegyptiaca*, is at high risk of fatality being an open air forager and flying at rotor-sweep heights. However, bat activity vastly exceeds the high risk of fatality thresholds during peak periods, especially on certain nights where the activity spikes. Despite mitigation measures, it is likely that bat mortality will be high during these spikes in activity. Mitigation measures include increased cut-in speeds during periods of high bat activity/mortality (including targeted temporary turbine shutdown if necessary). No migratory behaviour was identified during the study, but operational and post-construction monitoring must continue to identify and mitigate such events. There are gaps in knowledge, the weather was “abnormal” (La Niña) during the monitoring period (above average rainfall) and it is not certain if bat activity was representative of normal conditions. Nevertheless, such “abnormal” (La Niña) events will re-occur during the operational lifetime of the WEF and need to be considered. Peaks in bat activity during summer and autumn appear to be sporadic and are not related to specific habitats. Therefore, temporal and adaptive strategies will be required to mitigate bat mortalities during these peaks activity times. Adaptive mitigation measures must be informed by near-real-time post-construction monitoring results (passive acoustic monitoring and carcass counts). Automated real-time bat monitoring and analysis systems with curtailment or peak activity blanket curtailment mitigation measures must be implemented following recommended cut-in speeds (see EMP below). More intense carcass searches must also take place during the peak activity time periods to ensure adaptive responses are effective. Operational monitoring should further investigate the cause of the activity spikes and potential spatial and temporal triggers to better inform more targeted mitigation measures. The impact can potentially be high and long-lasting, but if sensitive habitat buffers are considering during turbine placement, and suggested mitigation using real-time technologies as well as adaptive mitigation measures are applied, the impact should be medium to low.

Table 4-3: Impacts on bats due to collision or barotrauma.

	Spatial Scale	Rating	Duration	Rating	Severity	Rating

Without mitigation	Regional/neighbouring areas	4	Life of operation	4	Extremely harmful	5
With mitigation	Regional/neighbouring areas	4	Life of operation	4	Harmful	4
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	Weekly		4	Highly likely		5
With mitigation	Monthly		3	Likely		4
	Significance Rating of Impacts			**Timing**		
Without mitigation	117 High			Operation		
With mitigation	84 Medium-High			Operation		

4.1.3 Disruption and increase fatalities due to artificial lighting

Artificial lights can have a negative effect on bat behaviour by affecting foraging activity and flight paths used (Table 4-4). Artificial lights can attract insects which will entice bats to feed in the area leading to a higher likelihood of bat fatalities due to collision with infrastructure or barotrauma (if lighting is present at the turbines). This impact could be high, but is easily reduced if lighting is minimised, directed only to where it is required (not skyward) and low intensity, non-UV emitting lights are used. This should be applicable to all areas, but especially bat sensitive features used for foraging, such as any waterbodies, vegetated watercourses and rocky outcrops. In certain areas the use of artificial lights will be unavoidable, and these include areas where offices, substations or operational and maintenance buildings will be constructed. The exact location of all buildings is currently unknown, but it is recommended that these are constructed at least 200 m from turbines and their blades to minimise the potential for attracting bats to lights due to insects, as well as other attractants such as potential roosts and water associated with this infrastructure.

Table 4-4: Impacts on bats due to artificial lighting.

	Spatial Scale	Rating	Duration	Rating	Severity	Rating
Without mitigation	Area specific	2	Life of operation	4	Slightly harmful	3
With mitigation	Activity specific	1	Life of operation	4	Potentially harmful	2
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**

Without mitigation	Weekly	4	Possible	4
With mitigation	Monthly	3	Highly unlikely	2
	Significance Rating of Impacts		**Timing**	
Without mitigation	81 Medium – High		Operation	
With mitigation	49 Low		Operation	

4.2 CUMULATIVE IMPACTS

REEA Q3 (2022[23]) was used to assess the potential cumulative impacts. The De Rust WEF developments are surrounded by four other approved WEF projects within a 30 km radius, 'Paulputs' to the north, and 'Namies', 'Poortjies' and 'Korana' to the west. There are also two approved solar PV projects, 'Paulputs PV1&2' to the north and Khai-Ma to the west, in addition to the proposed Red Sands PV area. Only the latest versions of approved and unique technologies are thus considered in the calculations below.

The main cumulative impact anticipated from WEFs is the increased mortality of bats resulting from turbine strikes. Assuming that the total areas represented by the WEFs developments shown in Figure 4-1 will contain turbines, which is a deliberate over-estimation, Table 5 shows that the maximum transformed area from the WEF development boundaries (REEA Q3, 2022) within a 30 km radius of the proposed development cluster is expected to amount to 9.2% (46 675 ha) of the total land area. The proposed De Rust WEF cluster itself only represents 2.1% of the 30 km radius area, indicating a small proportion of transformation in the regional context. The combined transformed area for all renewable energy projects (including the proposed De Rust WEF cluster) is expected to represent 13.0% of the 30 km radius area.

Solar PV and CSP projects do not result in bat mortality (according to our current state of knowledge), but the removal of vegetation in the footprint of the panels, heliostat mirrors or infrastructure, is likely to reduce the foraging suitability for bats, where plants constitute food sources for insects, the prey of bats. It is difficult to assess the cumulative impact when regarding interactions between impacts, for example, the reduced prey availability may deter bats foraging in the region and result in a lower mortality of bats by the WEFs, but the overall reduction in food is also likely to negatively affect regional bat populations, which, in combination with prolonged WEF mortality may result in localised extirpation. Foraging areas are required to sustain bat populations in the region and the current proposed solar footprint (REEA Q3, 2022) amounts to potentially 4.6% (23 697 ha) of the total land area (calculated using farm portion boundaries), and the remaining habitat should provide ample foraging area for bats in the region. However, knowledge is lacking regarding the thresholds that bats can endure for reductions in foraging habitat and increased mortality rates over the lifespans of the renewable energy developments.

However, not all of these areas will be transformed by the proposed developments and mitigation recommendations made above and below will ensure that the most sensitive habitats will be avoided by turbine placement. Finally, with appropriate mitigation applied as suggested above, the anticipated cumulative impacts (sections 0 to 4.2.3) to bats are expected to be slightly higher than the anticipated impacts (sections 4.1.1 to 4.1.3), but still result in a Low or Low-Medium significance from the De Rust WEF cluster (Table 4-6).

No operational monitoring data could be obtained from the existing Kangnas WEF. Based on the finding in this report, as well as other bat reports in the region, the most abundant species are open-air foraging species with a high risk of turbine fatality. Furthermore, species of the most abundant genus (*Tadarida*) are known to undertake long nightly flights (Williams *et al.*, 1973) and some bats may forage in the PA but roost outside of the PA, during potential localised insect eruptions. If this is the case, then these populations are at high risk from cumulative impacts of multiple WEFs in the greater region, as they may fly far in

[23] https://egis.environment.gov.za/data_egis/data_download/current

search of sparse food resources and have a high likelihood of encountering wind turbines due to their habit of flying at height. Currently there are few existing WEFs in the region, but a number of new facilities have been proposed (Figure 4-1). Cumulative impacts are poorly understood in bats, but due to being long-lived and having a slow reproductive rate, it is likely that the effects of these impacts will only become known when it is very difficult to mitigate them. The current paradigm of monitoring data restriction (i.e. WEFs not disclosing monitoring data to the public) is significantly hampering our understanding and ability to counteract the negative effects of WEFs on bats, particularly so in the cumulative sense.

It is unlikely that any cumulative impact assessment will, under the current *status quo*, result in a fatal flaw for a proposed WEF. The best approach to address cumulative impacts is to consolidate available information and determine acceptable (predicted) fatalities for a given area and restrict the number of developments in that area, taking care to allow for unrestricted flyways between WEFs. In addition, a landscape scale approach should be taken, where large areas of bat sensitivity should be identified (perhaps by SABAA) and set aside as foraging and migration areas so that WEFs may not be constructed in these zones.

Mitigation measures, such as the application of new technologies enabling location-specific automated curtailment in real-time during periods of intense bat activity will further reduce bat mortalities. If all neighbouring WEFs practise effective bat mitigation measures then the cumulative impacts will be reduced. It is important for nearby WEFs to communicate with one another regarding bat activity and fatality levels, as one WEF may detect warning signs of peak bat activity, enabling other WEFs to implement adaptive mitigation before excessive fatalities occur. It is therefore crucial that operating WEFs make the post-construction monitoring data more available, to enable this approach. Combining monitoring datasets and analysis may also increase our understanding of bat activity across the region and assist in applying more strategically appropriate mitigation measures, especially in locations that become known as highly sensitive due to the ongoing data collection from post-construction monitoring.

Table 5: Spatial summary of approved renewable developments in the region.

Elements	Area (ha)	Proportion of total area
Total area of 30 km buffer surrounding (and including) the proposed De Rust WEF cluster.	507 807	100.0%
Total area of approved renewable energy projects within the 30 km buffer	65 960	13.0%
Solar CSP[24]	0	0.0%
Solar PV[24]	23 697	4.6%
Wind	56 774	11.2%

[24] Combined solar PV and wind areas calculated separately per technology

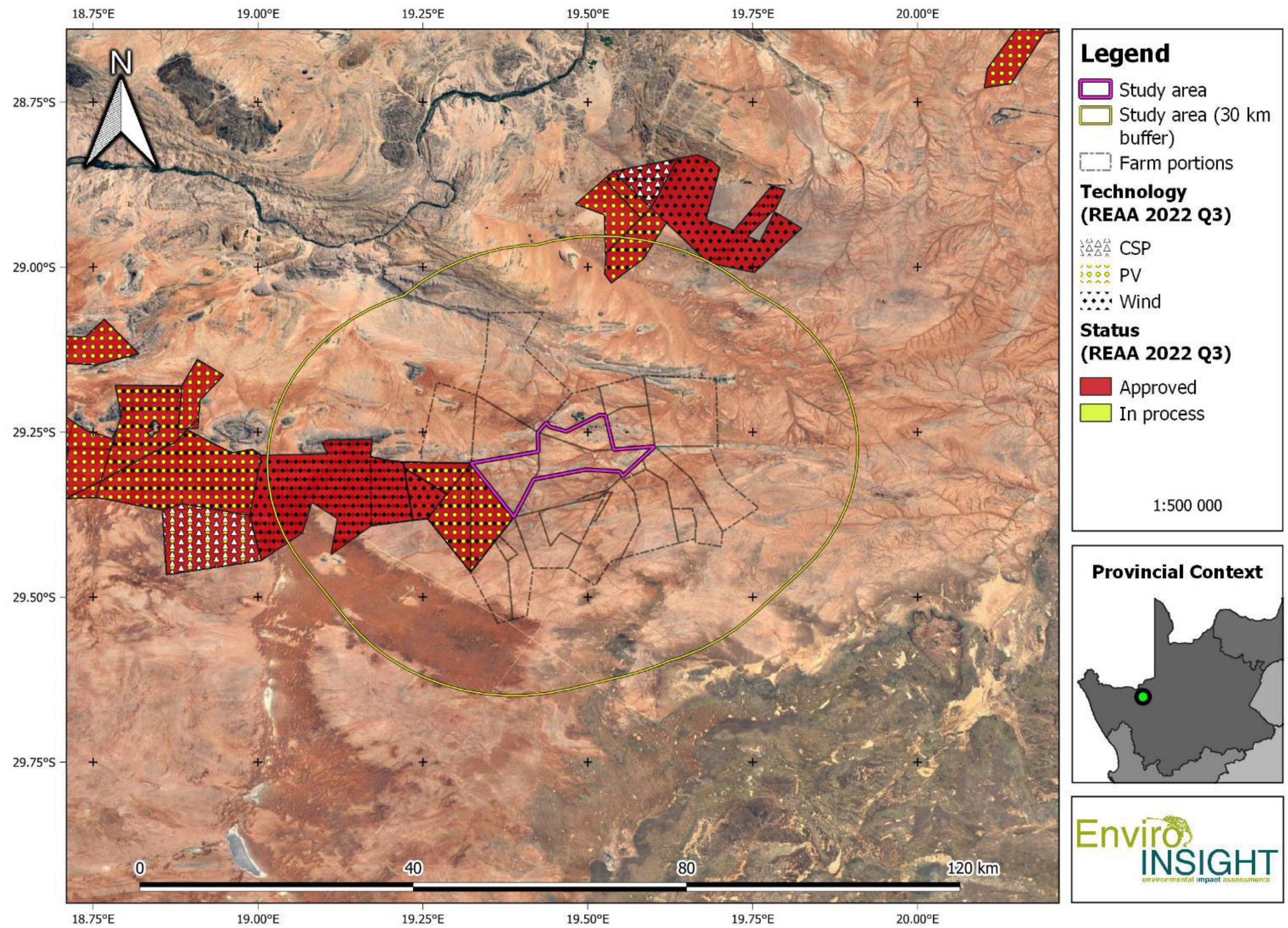


Figure 4-1. Renewable Energy EIA Applications surrounding the proposed De Rust WEF.

Table 4-6: Summary of potential negative cumulative 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 habitat	Low - Medium	Low	Moderate	No	No
Bat fatality	High	Medium-High	Low	Potentially	Unlikely
Artificial lighting	Medium - High	Low	Low	No	No

4.2.1 Loss or destruction of foraging and roosting habitat

See section 4.1 for a detailed impact description. Cumulative impact involves additional habitat loss due to construction of infrastructure for nearby renewable projects, in particular, the removal of habitat for heliostat mirrors and panels in solar plants.

Table 4-7: Impacts on bats due to habitat loss from construction activities.

	Spatial Scale	Rating	Duration	Rating	Severity	Rating
Without mitigation	Whole site	3	One year to ten years	3	Slightly harmful	3
With mitigation	Area specific	2	One year to ten years	3	Potentially harmful	2
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	Annually / Once-off		1	Definite		5
With mitigation	Annually / Once-off		1	Definite		5
	Significance Rating of Impacts			**Timing**		
Without mitigation	54 Low-Medium			Construction		
With mitigation	36 Low			Construction		

4.2.2 Bat fatalities due to collision or barotrauma

See section 4.1 for a detailed impact description. Cumulative impact involves additional bat mortality by other nearby WEFs.

Table 4-8: Impacts on bats due to collision or barotrauma

	Spatial Scale	Rating	Duration	Rating	Severity	Rating
Without mitigation	Regional/neighbouring areas	4	Life of operation	4	Extremely harmful	5
With mitigation	Regional/neighbouring areas	4	Life of operation	4	Harmful	4
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	Weekly		4	Highly likely		5
With mitigation	Weekly		4	Likely		5
	Significance Rating of Impacts			**Timing**		

Without mitigation	117 High	Operation
With mitigation	96 Medium-High	Operation

4.2.3 Disruption and increased fatalities due to artificial lighting

See section 4.1 for a detailed impact description. Cumulative impact involves additional light production by other nearby renewable facilities.

Table 4-9: Impacts on bats due to artificial lighting.

	Spatial Scale	Rating	Duration	Rating	Severity	Rating
Without mitigation	Whole site	3	Life of operation	4	Harmful	4
With mitigation	Area specific	2	Life of operation	4	Potentially harmful	2
	Frequency of Activity		**Rating**	**Probability of Impact**		**Rating**
Without mitigation	Weekly		4	Possible		4
With mitigation	Monthly		3	Highly unlikely		2
	Significance Rating of Impacts			**Timing**		
Without mitigation	88 Medium – High			Operation		
With mitigation	40 Low			Operation		

4.3 ENVIRONMENTAL MANAGEMENT PROGRAMME CONDITIONS

All turbine specific No-Go zone buffers must be adhered to, and the accepted placement of infrastructure must not be altered without consulting the bat specialists. The current turbine layout requires amendments to avoid the turbine specific No-Go zone buffers, and the total WEF development area must be constrained to the area limit of 20,000 ha pre-construction. 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.

Mitigation measures must be implemented, including the consideration of a reduction on the turbine blade lengths if possible. Two main mitigation options are presented below, at least one option must be implemented.

4.3.1 Automated peak period curtailment

Automated real-time bat monitoring and analysis systems have been shown to be successful in the USA, reducing bat fatalities by over 80% (Hayes et al., 2019). This option is available as the "Smart System" from Wildlife Acoustics (https://www.wildlifeacoustics.com/products/smart-system), and it is strongly recommended as the primary method for automated and near-real-time bat fatality mitigation. The deployment of 3-4 of these devices across the turbine area can control the curtailment of nearby turbines based on localised bat activity (instead of blanket curtailment) and thereby minimize total curtailment while maximising mitigation (Figure 4-2). However, the use of a single device across the entire WEF to regulate the curtailment of all turbines is also acceptable, because the predominant bats susceptible to turbine mortality are open-air foragers which are not tied to specific terrestrial habitat and because the hourly bat data collected at height by both meteorological masts were mostly correlated for peak activities. The microphones of these devices are attached to the turbines within the rotor sweep zone to monitor bat activity throughout the operational period, the system analyses the detections and the output can continuously feed back into the turbine control system to automatically initiate curtailment when the bat activity is high. The hardware for this option is expensive, but is expected to perform more effectively than a blanket curtailment and reduce turbine downtime. The recommended placement for the Smart System microphones is at 65 m on the turbine, which falls within the lower height of the rotor sweep area (62.5 - 237.5 m). This is because bat activity is expected to be greatest at this height and it is more likely that peak bat activity will be reliably detected. The recommended threshold value for bat activity to activate curtailment for Smart Systems with microphones at 65 m is 25 bat passes per hour, as this figure deviates from normal activity levels, capturing peak activity while still allowing the turbines to operate normally most of the time (Figure 4-3). From the data collected during this study, the threshold was only surpassed during 171 hours on average for the two 65 m bat detectors out of the total recording period (~8760 hours), representing only 2% of the time where curtailment is implemented. The curtailment should be implemented in the form of a cut-in speed, such that during periods of high bat activity turbines will only being rotating at wind speeds above 6.5 m/s, recommended initial cut-in speed.

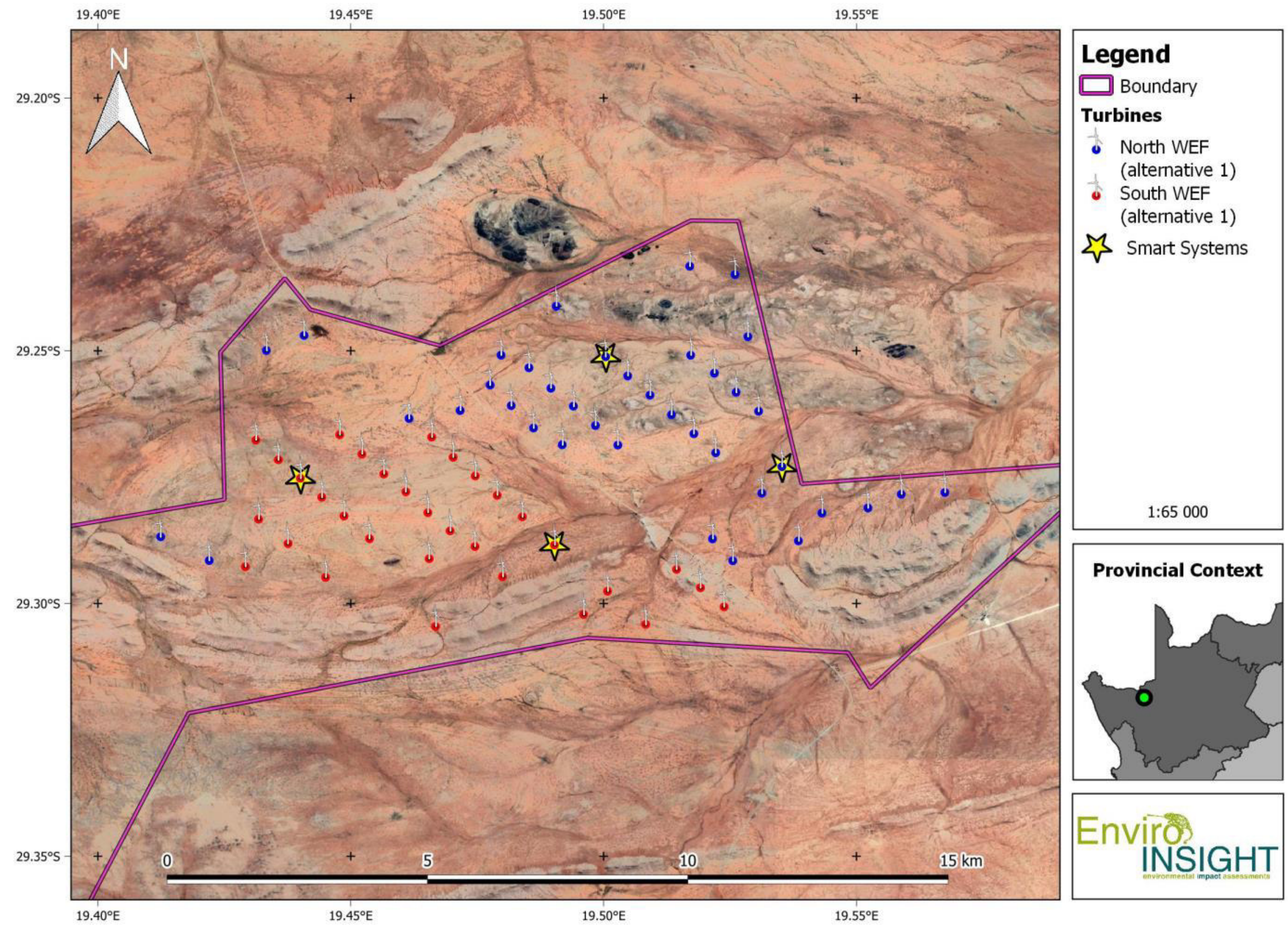


Figure 4-2. Potential placement of four Smart System (automated real-time bat detector) devices in relation to the De Rust WEF turbine layout. Smart Systems are placed to service the curtailment for an equal area of turbines.

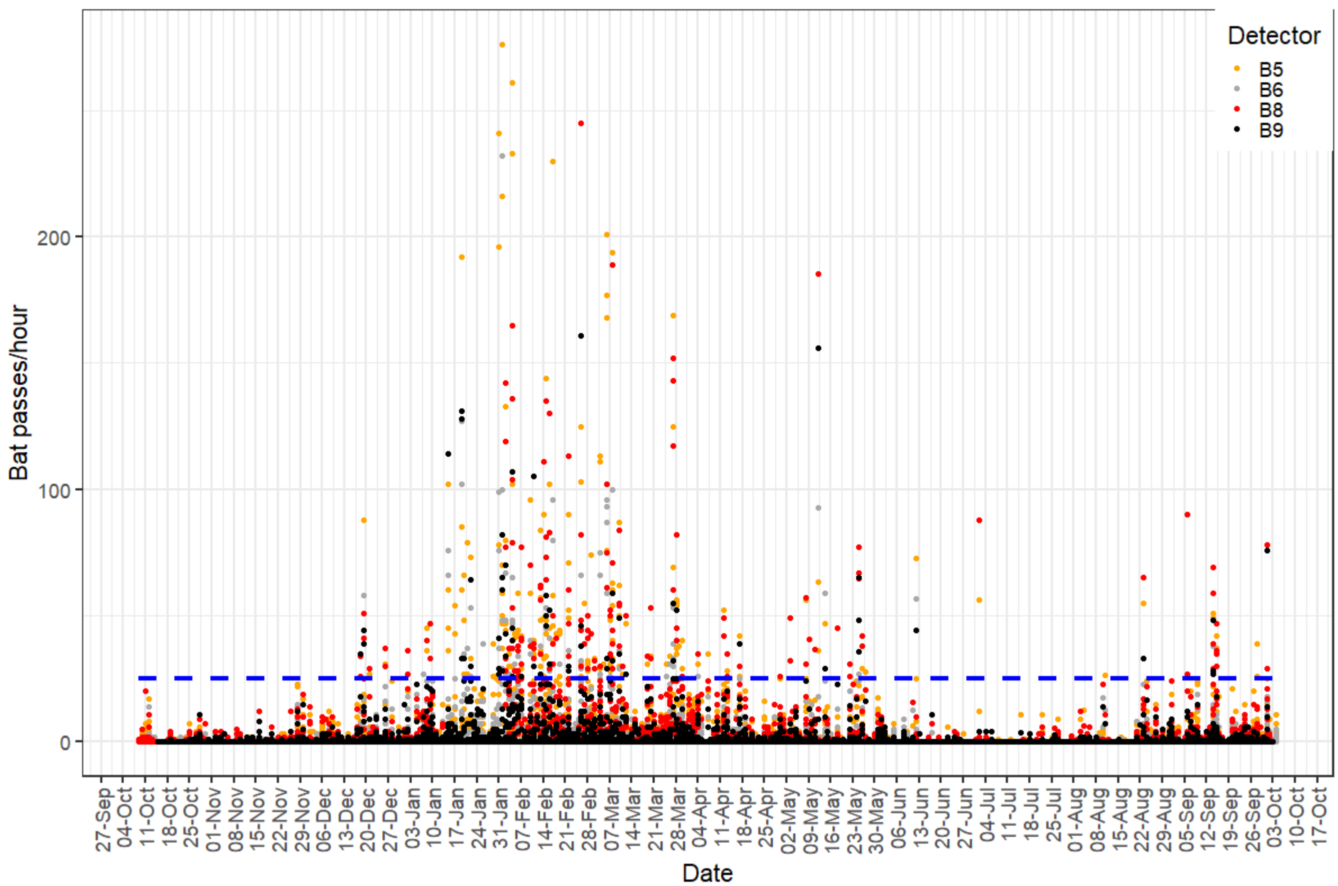


Figure 4-3. Hourly sum of bat passes for the entire monitoring period for the bat detectors placed at height. B5&8 at 65 m and B6&9 at 110 m. The horizontal blue dashed line indicates the recommended threshold value for bat activity (25 bp/hr), above which the Smart Systems will activate curtailment measures for surrounding turbines.

4.3.2 Blanket peak period curtailment

Implementing turbine cut-in wind speeds has been shown to significantly reduce bat fatalities (Arnett *et al.*, 2009). Previous research has shown that bat activity drops below 5% at wind speeds between 5-6 m/s (Wellig *et al.*, 2018), but the data from this study suggest that bat activity is affected far less drastically at these wind speeds, with a cut-in speed of 6.5 m/s expected to reduce bat mortality by roughly 50%. Therefore initial cut-in speed of 6.5 m/s is recommended as a starting point and should be implemented during the yearly peak activities (1 January to 14 April and 15 August to 1 October) and hourly activity peaks on these dates (21:00 to 03:59) for the first year of operation as a minimum, unless real-time bat detectors are implemented to automate this process (see above).

Whichever measure is implemented, it must be reassessed during the post-construction monitoring and be re-adjusted as necessary (relaxed or tightened). The specific mitigation measures and changes there-of need to be prescribed by the post-construction monitoring bat specialist, and will be informed by the data collected during the pre- and post-construction monitoring as per the post-construction monitoring guidelines (Aronson *et al.,* 2020). Continuous recording of environmental variables, such as temperature, wind speed and rainfall will be required for operational bat activity data analysis and implementation of adaptive mitigations measures. These data should be collected by the WEF and made available for this purpose. Greater carcass search effort will be required during periods of intense bat activity, at least until bat fatality patterns are well understood and it is no longer deemed necessary by the bat monitoring specialist.

The annual region-specific threshold for bat fatality is estimated at 0.011 bat deaths/hectare (MacEwan *et al.*, 2020a) per annum. Therefore, the total annual bat fatality threshold for the proposed De Rust WEF (8,469 ha) is estimated at 93 bats per annum. Fatality estimates must be corrected according to detection probabilities and scavenger removal as many fatalities will not be detected (see MacEwan *et al.*, 2020a). No priority species (where one fatality requires mitigation) are expected to occur at significant levels within the PA (the exception being *Rhinolophus* which was only recorded at the dolerite outcrops). Should the annual threshold be exceeded during operation, additional mitigation measures (such as those recommended above) will be required and must be prescribed by the bat specialist with inputs from SABAA. Adaptive mitigation is imperative, as rapid dissemination of the number of carcasses detected can reduce bat mortality during bat activity peaks through on-the-fly mitigation.

5 DISCUSSION AND CONCLUSION

This report presents the findings for the pre-construction bat monitoring which spanned the period from October 2021 to October 2022 wherein data were collected from two 10 m masts with single bat detectors and two meteorological masts each with 3 bat detectors.

A total of six bat species were detected during the survey period, namely *L. capensis*, *M. natalensis, E. hottentotus, R. damarensis, T. aegyptiaca* and *S. petrophilus*, but *N. thebaica* is also expected to occur based on sightings nearby. *Eptesicus hottentotus* and *S. petrophilus,* and some *T. aegyptiaca* and *S. petrophilus* were analysed as single groups due to similarities in their calls. The project area falls within the Nama Karoo biome, and, based on the SABPG (MacEwan *et al.*, 2020b), a median bat passes per hour greater than 1.01 bp/h at 'near ground' level is considered as a High Risk for bat fatalities, and above 0.18 as a Medium Risk. Different thresholds for fatality risk are applied to bat activity within the 'rotor sweep' height, with High Risk above 0.42 bp/h and a Medium Risk above 0.03 bp/h. This overall median for bat activity on the PA (at near-ground level only – 10 m) was 0.88 bp/h, classifying this PA as Medium Risk. For bat detectors recording within the rotor sweep zone, the median bat activity was 0.66 bp/h (65 m) and 0.36 bp/h (110 m), classifying the PA as High and Medium Risk for bat fatality, respectively.

Bat roosting sites are present and confirmed within the PA, such as rocky outcrops (especially dolerite outcrops) and farmsteads. The dolerite outcrops are unique in that they are confirmed to host *R. damarensis* roosts, a species that was not detected in any active or passive acoustic monitoring, indicating that they may restrict their foraging to the boulder fields and densely vegetated areas. In addition, there is some evidence that these outcrops may be used as maternal roosts by *T. aegyptiaca*. It is also likely that some bats are roosting outside of the PA but enter it during peak foraging activity. The most common species detected by far was *T. aegyptiaca*, a species known to forage widely and with activity patterns that peaked in the middle of the night, indicating that individuals may require some travel time before reaching the PA. This species was also shown to be active for an extended duration throughout the night, with peak activity occurring from 21:00 up to 03:59, and being an open-air forager – it is at High Risk of turbine fatality due it its habit of flying within rotor sweep zones. Bat activity surges between January to April, and to a lesser extent in August and September, with repeated spikes in activity over these periods which are picked up across multiple bat detectors. It is hypothesised that volant insect eruptions, triggered by preceding rainfall and rises in temperature, may be resulting in these isolated and sporadic peaks in bat activity where bats that typically foraging over a wide area converge on a small area. This same phenomenon was also observed at the nearby Red Sands WEF over a similar timeframe (Enviro-Insight 2023). No environmental variable was able to consistently predict these activity spikes, but they tended to occur in warmer conditions after rain and with reduced wind. Mitigation measures are thus best suited to cover the entire peak activity periods (seasonally and hourly) when these spikes are at their greatest, unless automated real-time bat detectors capable of controlling curtailment of turbines are applied as recommended above.

Bat activity was greater during and after warm temperatures, a few weeks following rain and during calmer wind conditions. Vegetated watercourses and dolerite koppies showed greater bat activity levels during active transects, although the latter was only true for two seasons, while bat activity was slightly reduced close to quartz ridges or brown bedrock. Although passive and active data were not always in agreement and active transect data are highly susceptible to nightly variations. Watercourses could be more important during drier years and the "abnormal" rainfall makes it impossible to know the regular activity patterns at this stage.

Due to the very high spikes in activity levels during certain times of the year, we recommend that a minimum cut-in speed of 6.5 m/s is implemented during the yearly peak activities (1 January to 14 April and 15 August to 1 October) and hourly activity peaks on these dates (21:00 to 03:59) for the first year of operation as a minimum, unless real-time bat detectors are implemented to automate this process. Post-construction monitoring will play a vital role in adjusting and implementing mitigation measures according to their effectiveness at reducing bat mortality to acceptable levels. Additional mitigation measures to consider include higher cut in speeds and temporary targeted turbine shutdowns if required. Sensitive bat features and their buffers have all been defined as turbine specific No-Go areas and turbine blades must not encroach within these buffers, which should assist in reducing bat mortality by roosting and foraging bats. The proposed placement of non-turbine infrastructure, including access roads, BESS, laydown areas, substations and other buildings are outside of any sensitive roost habitat and are expected to have a negligible impact on bat roots or foraging habitat.

In summary, the current location of the project area falls in a High Risk area for bat fatalities, and sporadic peaks of bat activity in late summer and early autumn require specific and targeted mitigation. It is recommended that the development may proceed on condition that:

- All mitigation measures stipulated above are adhered to and captured in an Environmental Management Plan (EMP);
- The EMP must include the necessity for post-construction bat monitoring as stipulated in Aronson *et al.* (2020).

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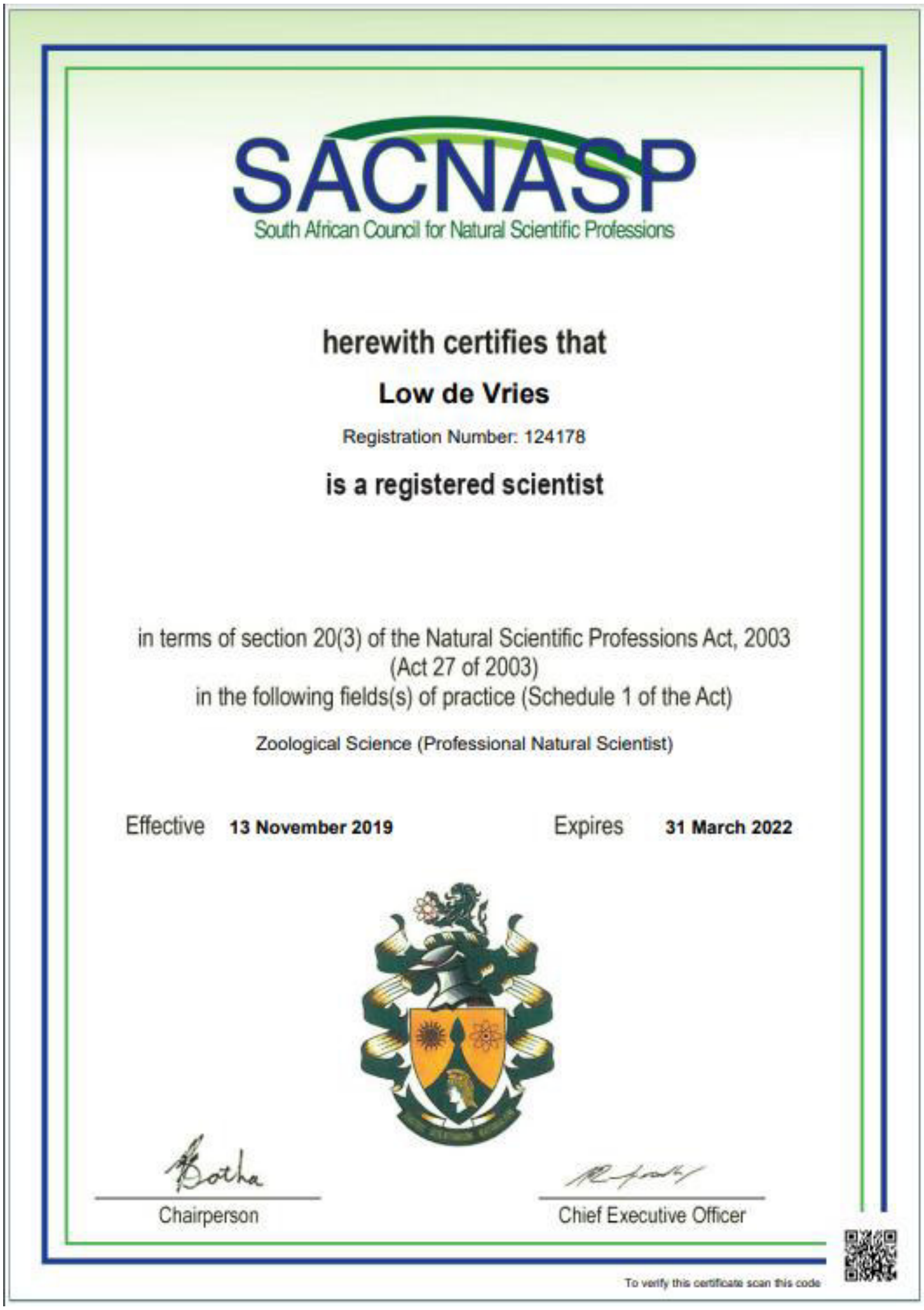
7 APPENDICES

7.1 SACNASP CERTIFICATION



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

Luke Verburgt

Registration Number: 400506/11

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 **2 November 2011** Expires **31 March 2023**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

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 2024**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

7.2 QUALIFICATIONS AND CV

7.2.1 Low de Vries

LOW DE VRIES

BAT SPECIALIST, ECOLOGIST, RESEARCHER
www.volantenvironmental.com

PROFESSIONAL PROFILE

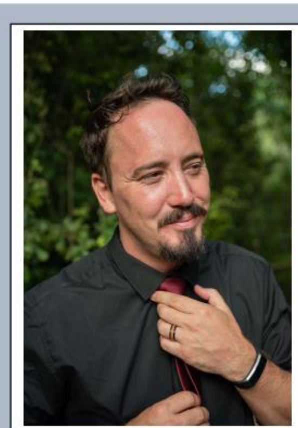
Research scientist with more than 10 years of experience in the field of bat ecology. This includes field work, report writing, team management, data presentation and supervision. Qualifications include BSc: Zoology, BSc. (Hons) Zoology and PhD: Zoology, completed through the University of Pretoria.
Professionally registered with SACNASP in Zoological Science (124178)
Registered Bat Assessment Specialist with SABAA

Key areas of expertise

- Bat and bird Specialist — Conducting surveys on bat and bird diversity and abundance and researh on bat ecology.
- Environmental Assessment Practitioner — Writing and collating Assessment reports for proposed Wind and Solar Energy Facilities

Focal Experience Relevant to Current Project

2023 - current Bat specialist for wind energy facility and associated grid connection near Aggeneys, Northern Cape Province, South Africa
2023 - current Bat specialist for wind energy facility and associated grid connection near Springbok, Northern Cape Province, South Africa
2023 – Bat specialist for a solar energy facility near Steelpoort in Limpopo, South Africa
2022 – Bat and Bird specialist for a Desktop Study of a wind energy facilities near George in the Eastern Cape, South Africa
2022 – Bat and Bird specialist for a Desktop Study of a wind energy facilities near Luckhof in Northern Cape, South Africa
2022 – Bat and Bird specialist for a Desktop Study of four wind energy facilities near Wakkerstroom in Mpumalanga, South Africa
2022 – Bat specialist for a Pre-Feasibly Study of a wind energy facility and associated grid connection near Petrusville in the Northern Cape, South Africa
2022 - current – Bird specialist for a solar energy facility near Port Elizabeth in the Eastern Cape, South Africa
2022 – Bat specialist for a Pre-Feasibly Study of a wind energy facility and associated grid connection near Philipstown in the Northern Cape, South Africa
2022 – Bird specialist for a solar energy facility near Port Elizabeth in the Eastern Cape, South Africa
2022 – current – Bat specialist for a wind energy facility and associated grid connection near Warden in the Free State, South Africa
2022-current – Bird specialist for a wind energy facility and associated grid connection near Ermelo in Mpumalanga South Africa
2022 -current – Bat specialist for a wind energy facility and associated grid connection near Doringbaai, Western Cape Province, South Africa
2022 – Bat Specialist conducting a walkthrough of a potential Wind Energy Facility near De Aar in the Northern Cape, South Africa
2021 -2022 – Bat specialist for three wind energy facilities and associated grid connection near Dordrecht, Eastern Cape Province, South Africa
2021-current – Bat specialist for two wind energy facilities and associated grid connection near Postmasburg, Northern Cape Province, South Africa
2021-2022 – Bat specialist for wind energy facility and associated grid connection near Belfast, Mpumalanga Province, South Africa
2020-2021– Bat specialist for wind energy facility and associated grid connection near Loeriesfontein, Northern Cape Province, South Africa
2020-2021 – Bat specialist for wind energy facility and associated grid connection near Gouda, Northern Cape Province, South Africa
2017 - Biodiversity survey of Bats in Gorongosa National Park, Mozambique



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EDUCATION

Matric Certificate
Hoerskool Jeugland
2002

BSc: Zoology
University of Pretoria
2006

BSc: (Hons) Zoology
University of Pretoria
2007
- Circadian Rhythms of Mole-rats

PhD: Zoology
University of Pretoria
2014
- Ecology of the Aardwolf

VOLANT ENVIRONMENTAL

7.2.2 Luke Verburgt

Luke Verburgt

Personal details

Full Name	Luke VERBURGT
DOB	31 March 1977
Nationality	South African
Marital Status	Married
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ID number	770331 5171084

Education

Completed	Degree and Institution
1994	Matric, Pietersburg Hoërskool, Polokwane, South Africa
1999	BSc in Zoology, University of Pretoria, Pretoria, South Africa
2002	BSc (Honours) in Zoology, University of Pretoria, Pretoria, South Africa
2006	MSc in Zoology (Evolutionary Biology, Behaviour, Bioacoustics), University of Pretoria, Pretoria, South Africa.

Bio-Sketch

Luke Verburgt is a consulting herpetologist living in South Africa with over 19 years of herpetofauna survey experience across 23 African countries (Angola, Botswana, Cameroon, DRC, Ghana, Ivory Coast, Kenya, Lesotho, Liberia, Namibia, Madagascar, Malawi, Mali, Morocco, Mozambique, Republic of Guinea, São Tomé and Príncipe, Sierra Leone, South Africa, Swaziland, Tanzania, Uganda and Zimbabwe). He is co-owner of Enviro-Insight, holds an MSc in Zoology from the University of Pretoria and is a registered scientific professional with the South African Council for Natural Scientific Professions (SACNASP). He has published more than 30 scientific articles, which include several descriptions of new African herpetofauna species and is co-author of the book titled "Snakes and other reptiles of Zambia and Malawi" (Struik Random House Publishers). He is also an extraordinary lecturer in the Department of Zoology & Entomology at the University of Pretoria.

Recent Relevant Project Experience

[Year - Nature of project – Specialist Capacity - Industry / - Client / Developer – Country]

- 2022 - Biodiversity studies for proposed PV Solar Facility - Namane - Project Management, Ecologist - Energy generation / Solar - Digby Wells and Associates (South Africa) (Pty) Ltd. - South Africa
- 2022 - Desktop herpetofauna study for proposed Wind Energy Facility – Loxton WEF - Herpetologist - Energy generation / Wind - Atlantic Renewable Energy Partners (Pty) Ltd - South Africa
- 2022 - Biodiversity studies for proposed PV Solar Facility - Apollo - Project Management, Ecologist - Energy generation / Solar - Terramanzi Group (Pty) Ltd / Alt-E Developments - South Africa
- 2022 - Wolseley Part 2 Application Ammendment: Specialist reporting on fauna - Specialist Ecologist - Energy generation / Solar - Terramanzi Group (Pty) Ltd - South Africa
- 2022 - Dominion PV Solar Cluster – scoping & EIA - Project Management, Ecologist - Energy generation / Solar - Terramanzi Group (Pty) Ltd / Red Rocket - South Africa
- 2022 - Biodiversity studies for proposed Wind Energy Facility - Hoeksplaas - Project Management, Ecologist - Energy generation / Wind - GAIA - South Africa
- 2022 - Bonnievale Part 2 Application Ammendment: Specialist reporting on fauna - Specialist Ecologist - Energy generation / Solar - Terramanzi Group (Pty) Ltd / Terramanzi Group (Pty) Ltd - South Africa
- 2022 - Honingklip Part 2 Application Ammendment: Specialist reporting on fauna - Specialist Ecologist - Energy generation / Solar - Terramanzi Group (Pty) Ltd - South Africa
- 2022 - Tsolwana Avifauna Pre-Assessment for a proposed Wind Energy Facility - Project Management, Ecologist - Energy generation / Wind - African Clean Energy Developments - South Africa
- 2022 - RUZIZI III Hydropower Plant, biodiversity risk assessment - GIS, Senior Herpetologist - Energy generation / Hydroelectricity - SLR Consulting (Africa) (Pty) Ltd - Democratic Republic of Congo (DRC)
- 2021 - Fraserburg Avifauna Pre-Assessment for a proposed Wind Energy Facility - Project Management, Ecologist - Energy generation / Wind - African Clean Energy Developments - South Africa
- 2021 - Biodiversity studies for proposed Wind Energy Facility - Pofadder - Project Management, Ecologist - Energy generation / Wind - Energy Team - South Africa
- 2021 - Copperton WEF Post-construction monitoring for bats and bird fatalities - Project Management, Ecologist - Energy generation / Wind - Terramanzi Group (Pty) Ltd - South Africa
- 2021 - Biodiversity studies for proposed Wind Energy Facility - Aggeneys - Project Management, Ecologist - Energy generation / Wind - Energy Team - South Africa
- 2021 - Biodiversity studies for proposed Wind Energy Facility - Gouda - Project Management, Ecologist - Energy generation / Wind - Calidris - South Africa
- 2021 - Biodiversity studies for proposed Wind Energy Facility - Loeriesfontein - Project Management, Ecologist - Energy generation / Wind - Calidris - South Africa
- 2021 - Development of the Mitigation Hierarchy Guidelines for South Africa - Project Management and Author - Law / Public communication - Endangered Wildlife Trust and BirdLife South Africa - South Africa
- 2020 - Development of the Species Environmental Assessment Guidelines for South Africa - Project Management, Lead Author and Herpetologist - Law / Public communication - South African National Biodiversity Institute and BirdLife South Africa - South Africa

Enviro INSIGHT

7.2.3 Alex Rebelo

Alexander Douglas Rebelo

Personal details

Full Name	Alexander Douglas Rebelo
DOB	14 April 1992
Nationality	South African
Marital Status	Single
Email	alex@enviro-insight.co.za
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ID number	920414 5067087

Education

Completed	Degree and Institution
2016	M.Sc. Zoology, Stellenbosch University, Stellenbosch, South Africa
2014	B.Sc. Hons in Zoology, University of Cape Town, Cape Town, South Africa
2013	B.Sc. Applied Biology and Ecology & Evolution, University of Cape Town, Cape Town, South Africa
2010	National Senior Certificate, Bergvleit High School, Cape Town, South Africa

Biosketch

Alex Rebelo is a herpetologist from South Africa with over 3 years of consulting experience and over 15 years of field herpetological experience across 10 African countries. He holds a MSc. in Zoology and is a registered candidate zoologist. He has published a couple scientific articles and short notes in the field. In addition, Alex is experienced with GIS, data managment / analysis and programming.

Recent Relevant Project Experience

[Year – Nature of project – Specialist Capacity – Industry / - Client / Developer – Country]

- 2021 – Red Sands Wind Energy Facility – Field technician and bat data analyst – Renewable Energy / Onshore Wind – Genesis Eco-Energy Developments (Pty) Ltd – South Africa (Northern Cape)
- 2020 – Botterblom Wind Energy Facility – Bat data analyst and Herpetologist – Renewable Energy / Onshore Wind – Genesis Eco-Energy Developments (Pty) Ltd – South Africa (Northern Cape)
- 2020 – Berg-river Wind Energy Facility – Bat acoustic data analyst – Renewable Energy / Onshore Wind – Genesis Eco-Energy Developments (Pty) Ltd – South Africa (Western Cape)