Bat Monitoring and Impact Assessment Report for the proposed Aberdeen Wind Facility 2, Eastern Cape

Compiled by:

Inkululeko WILDLIFE SERVICES

710 Penge Street, Faerie Glen, Pretoria, 0043
Mobile: +27 (0) 79 313 3479; Website: www.iws-sa.co.za

Compiled for:
Aberdeen Wind Facility 2 (Pty) Ltd

Mobile: + 27 (0) 21 418 2596
Website: www.atlanticep.com
Postal: 101, Block A, West Quay Building,
7 West Quay Road, V & A Waterfront,
Cape Town, Western Cape

IWS Ref No: 3131

Date: December 2022 – revised January and February 2023

Declaration of Independence

Inkululeko Wildlife Services (Pty) Ltd (IWS) is an independent consultancy. IWS has no legal or financial connection with the developer except for having fulfilled the tasks required for this assessment. Remuneration to IWS for conducting this assessment is not linked to the authorisation of the project by the competent authority. In addition, IWS has no interest or connection to any secondary or future development associated with the approval of this project. This report was compiled by Dr Caroline Lötter and reviewed by Kate MacEwan, who are both registered with the South African Council for Natural Scientific Professions (SACNASP).

Signed for Inkululeko Wildlife Services (Pty) Ltd by:

Dr Caroline Lötter, Pr. Nat. Sci.
(SACNASP Reg No. 400182/09)

Kate MacEwan, Pr. Nat. Sci
(SACNASP Reg No. 400123/05)

Copyright Warning

Executive Summary

Presented in this report is a Bat Monitoring and Impact Assessment for Aberdeen Wind Facility 2 (Pty)'s proposed Aberdeen Wind Facility 2 (AWF2) near the town of Aberdeen in the Eastern Cape. The Assessment was based on desktop review work, 12 months of passive acoustic bat activity monitoring in the AWF2 site (and on adjoining sites for two additional wind facilities proposed by Aberdeen Wind Facility 1 (Pty) Ltd and Aberdeen Wind Facility 3 (Pty) Ltd – cumulatively referred to as the Aberdeen Wind Facility Cluster), multiple site visits to the study area involving, inter alia, extensive ground-truthing of local potential bat important features, and knowledge from long-term bat monitoring conducted previously in the region by IWS team members.

The most salient findings from the monitoring are as follows:

- Four bat species were recorded on site, *viz*. the Egyptian Free-tailed Bat (*Tadarida aegyptiaca*), Cape Serotine (*Laephotis capensis*), Natal Long-fingered Bat (*Miniopterus natalensis*), and Mauritian Tomb Bat (*Taphozous mauritianus*), all of which have a High fatality risk of collision with turbines.
- The Egyptian Free-tailed Bat was the dominant species in the turbine rotor sweep height (between 80 and 130 m above ground level), suggesting that during operation of the WEF, this species will comprise most of the turbine-related bat fatalities.
- Near (at 10 m above) ground level, all four bat species were recorded, which will be at greater risk of fatality from turbines with blades that approach closer to ground level.
- The onsite levels of bat activity are slightly higher than the analogous average values of bat activity at other WEF sites in the Nama Karoo shrublands ecoregion. Above-average bat activity was previously recorded at a nearby study site by IWS team members (NSS 2014). In that study and this one, the above-average bat activity was potentially attributable to above-average rainfall and/or the presence of a large regional population. Given this, and that levels of bat activity in rotor sweep height can be positively related to numbers of operational bat fatalities, the predominant Egyptian Free-tailed Bat could face a slightly above-average risk of fatality from WEF development in the study area, at least during good rainfall years.
- Average bat activity at 130 m was highest during autumn, whereas average activity at 10 m was highest during summer. Appreciable bat activity was also recorded during spring. Therefore, during operation of the WEF, most bat fatalities will likely occur during autumn, summer, and spring (possibly in descending order). Where bat fatality mitigation may become necessary, turbine curtailment and/or other measures would likely need to be applied during autumn, summer, and spring.
- The recorded low levels of Natal Long-fingered Bat activity are not indicative of migration of this species through the site.
- On nights when Egyptian Free-tailed bat activity can be more or less 20 times higher than the average number of bat passes per night, fatalities will be inevitable. Pre-emptive, predictive, or smart curtailment could be most effective at mitigating fatalities during such peaks, with the least impact on the WEF.
- From sunset there was a progressive increase in Egyptian Free-tailed bat activity until ca. 19:30-20:30. From then, an overall high level of activity was recorded until ca. 02:00/03:00, whereafter activity declined by sunrise. These bats will, therefore, be at risk of fatality from turbines throughout the night whenever favourable weather and other conditions prevail.
- Half of the time, bats were active in the study area during wind speeds stronger than 6 m/s. Consequently, if the WEF's bat fatality threshold is exceeded during operation and turbine curtailment becomes necessary, only 50% of bat activity would be protected below a cut-in wind speed of 6 m/s.

Within the WEF site:

- High (no-go) bat sensitive areas include:
  - A nearby small roost, and a 500 m buffer around this.
  - Rivers, streams, wetlands, farms dams, and reservoirs, and a 500 m buffer around these.
- Medium-High bat sensitive areas include:
  - Potential onsite bat roosts, and a 500 m buffer around these.
  - Secondary drainage lines, and a 200 m buffer around these.

- Medium bat sensitive areas include:
    - Areas with dolerite (which may be associated with karst formations).
    - Floodplain zones.
- Remaining areas were rated with Medium-Low sensitivity.

All High sensitive areas must be avoided. There must be no development of turbines (including all blades plus a 2 m pressure buffer around these), substations, buildings, battery energy storage systems, quarries, construction camps, or laydown areas in High sensitive areas. In Medium-High sensitive areas, the construction of infrastructure and other disturbances should be avoided where possible. In Medium Bat Sensitive Areas, disturbances should be minimized. The Final layout of the WEF infrastructure should be planned to coincide with Medium-Low Bat Sensitive Areas so far as possible.

Under the current proposed layout of the Aberdeen Wind Facility 2, there is no encroachment into any High sensitive area from any of the turbines, or the battery energy storage system, operation and maintenance buildings, warehouse, construction camp, or laydown area. Most (66%) of the proposed turbine positions coincide with Medium-Low and/or Medium sensitive areas.

Without mitigation, the proposed Aberdeen Wind Facility 2 is expected to have a Medium significant potential impact on bat roosts, and bat foraging habitat, a High significant potential impact in terms of turbine bat fatalities, and a Medium significant potential impact on bat ecosystem services.

With diligent, effective mitigation as recommended in this report, the WEF’s potential impact on bat roosts, and bat foraging habitat could be reduced to Low, the potential impact in terms of bat turbine fatalities could be reduced to Medium, and the potential impact on bat ecosystem services could be reduced to Low.

The overall cumulative impact of the proposed project when considered in isolation was rated with Medium significance. When considered in combination with other proposed WEFs (and solar farms) in and around the Beaufort West Renewable Energy Development Zone, the overall cumulative impact of these was rated with High significance.

Recommended bat impact mitigation measures for the WEF include the following:

- Avoid High sensitive areas. Currently, no proposed WEF infrastructure except certain road sections encroach on High sensitive areas.
- Avoid blasting within 2 km of a confirmed roost. There are no confirmed roosts in this site.
- Minimize disturbance of Medium-High sensitive areas. Currently, most (66%) of the proposed turbine positions coincide with Medium-Low and/or Medium sensitive areas.
- Minimize the length and breadth of proposed roads to thus minimize the clearing and disturbance of natural areas. Currently, the road network is minimal.
- Minimize degradation of terrestrial habitat by implementing and maintaining effective invasive alien plant, stormwater, erosion, sediment, and dust control measures.
- Minimize artificial lighting on site.
- Rehabilitate disturbed terrestrial habitat and water resources (bat foraging habitat) based on consultation with an appropriate experienced specialist(s).
- Monitor bat fatalities (and ideally also live bat activity) as soon as the first turbine is operational - as per the latest SABAA guideline for this (Aronson *et al.* 2020 or later) - during the WEF's first two years of operation, and then every fifth year thereafter. The monitoring and data analysis are to be conducted to a high standard so that there is confidence in the estimated numbers of actual bat fatalities.
- Mitigate bat fatalities adaptively by consulting the latest SABAA guideline for this (Aronson *et al*. 2020 or later), and the best available relevant scientific information. Adequate financial provision should be made to permit effective monitoring, management, and mitigation of bat fatalities throughout the life of the WEF.
- If the monitoring and data analysis are poorly performed, and/or if fatalities exceed the WEF's bat fatality threshold (to be calculated as per MacEwan *et al*. 2018 or later), and unless reliable and comprehensive operational monitoring data and a suitably experienced bat specialist indicate otherwise: Reduce fatalities

by implementing curtailment of all problematic turbines below an initial cut-in speed of 6 m/s during temperatures of 12 °C or warmer from sunset to sunrise in February, March, April, and September. The 6 m/s turbine cut-in wind speed represents the wind speed associated with approximately 50% of bat activity recorded at 130 m above ground level in 2021/2022 by IWS.

- Report the annual operational bat monitoring results to the South African Bat Assessment Association, the Endangered Wildlife Trust, and the national Department of Forestry, Fisheries, and the Environment.
- Forward all (live and fatality) bat monitoring data to the database recommended by SABAA to expand the scientific knowledge base for more informed decision making and mitigation.

IWS does not object to approval of the Aberdeen Wind Facility 2 as it is currently proposed, provided that the bat impact mitigation measures prescribed herein are diligently implemented during the relevant project phases.

Going forward it is suggested that the feasibility of the prescribed turbine curtailment should be tested prior to finalization of the project - for in case bat fatalities at some point exceed the calculated bat fatality threshold for the WEF. The impact of the prescribed curtailment on the financial feasibility of the wind farm could be explored by using the available weather data from site to obtain estimates of the number of turbine night hours per annum during which curtailment would need to be implemented and, consequently, how much turbine energy production could potentially be lost. The results should be used to ensure that there is adequate financial provision to accommodate curtailment during operation.

Table of Contents

List of Figures

List of Tables

1. Introduction

Aberdeen Wind Facility 2 (Pty) Ltd proposes to develop a cluster of three wind energy facilities (WEFs), comprising up to 123 turbines within an area of collectively ~22 896 ha, near the town of Aberdeen in the Eastern Cape (**Figure 2**). For the proposed WEF cluster, Aberdeen Wind Facility 2 (Pty) Ltd appointed Inkululeko Wildlife Services (Pty) Ltd (IWS) to undertake 12 months of pre-construction bat monitoring and impact assessment as per the current South African guidelines on bat monitoring for proposed wind farms (MacEwan *et al*. 2020a). The pre-construction bat assessment was based on desktop review work, 12 months of passive acoustic bat activity monitoring for the WEF cluster, multiple site visits to the study area involving, inter alia, extensive ground-truthing of local potential bat important features, and knowledge from long-term bat monitoring conducted previously in the region by IWS team members. Presented in this report is the pre-construction bat assessment for the proposed Aberdeen Wind Facility 2 (AWF2). This report includes the 12-month monitoring results, a final bat sensitivity map, and a final bat impact assessment with recommended impact mitigation measures for the proposed AWF2.

2. Project Description

Within the ~6 500 ha AWF2 site, up to 41 turbines, a substation, battery energy storage system (BESS), operation and maintenance buildings (OMB), road network, warehouse, construction camp, and laydown area are proposed. There will also be a ~12 km 132 kV S/C Twin Tern overhead line (OHL) from the onsite substation to the planned offsite Aberdeen Main Transmission Substation (MTS)[1] (**Figure 2**). However, the final WEF infrastructure layout and the proposed turbine dimensions are to be confirmed by Aberdeen Wind Facility 2 (Pty) Ltd.

3. IWS Team

IWS has conducted bat (and bird) monitoring and impact assessments for over 60 (pre-construction and operational) wind farm developments in South Africa, Zambia, Namibia, and Malawi. IWS team members were involved with the bat sensitivity analysis of the Strategic Environmental Assessment for South Africa's Renewable Energy Development Zones (REDZs), and have performed numerous specialist bat assessments for mines, power lines, the Square Kilometre Array, and other developments, as well as for caves, and protected areas.

Key IWS personnel are as follows.

Dr Caroline Lötter

Caroline, the Managing Director at IWS, has worked on multiple long-term bat monitoring and impact assessment studies for wind energy developments in South Africa. Caroline has also performed numerous impact assessments on vertebrate and invertebrate fauna, as well as bat cave surveys for a broad spectrum of other developments throughout South Africa. Caroline is SACNASP-accredited as a Professional Natural Scientist in the field of Zoology and obtained a PhD in Zoology on the conservation biology of the rare Giant Bullfrog (*Pyxicephalus adspersus*). Caroline currently sits on the Panel of the South African Bat Assessment Association (SABAA) and the Executive Committee of the Gauteng and Northern Regions Bat Interest Group (GNORBIG). Caroline is a co-author of the current South African best practice guidelines for pre-construction bat monitoring studies at wind farm developments (MacEwan *et al*. 2020), and a recent peer-reviewed article on bat activity and its implications for wind farm development in South Africa (MacEwan *et al.* 2020b). She is a member also of the Zoological Society of Southern Africa and the Herpetological Association of Africa.

[1] The connection infrastructure associated with this grid solution (i.e. between the facility substation and the MTS) will be assessed as part of a separate Environmental Application.

Trevor Morgan

Trevor has worked with Kate and Caroline for 10 years as the Senior Technical Specialist on all the various bat monitoring projects. He has served as an active member on the Executive Committee of the GNorBIG for several years. He is very knowledgeable on South African bats and has extensive experience with bat detectors, their related software, mist-netting, and harp-trapping. By trade, Trevor is an electrician and an inventor, and has constructed his own harp trap and heterodyne bat detector. Trevor's considerable field-based involvement in all long-term bat monitoring and several bird monitoring studies has been invaluable. Trevor is also a co-author on the MacEwan *et al*. (2020b) article on bat activity and its implications for wind farm development in South Africa.

Dominique Greeff

Dominique is a Junior Zoological Consultant at IWS. Dominique holds a MSc in Ecology and Environmental Conservation from the University of the Witwatersrand. She has extensive terrestrial field work experience working with various animal species within South Africa, including African elephants, sungazer lizards, and edible bullfrogs, and is certified in snake handling, working at heights, and basic first aid. In addition to her work within the country, Dominique has spent nearly 2 years focused on bat research and conservation in Malawi, and has extensive experience with mist-netting, harp-trapping, radiotracking, hand-netting, and identification of many African bat species.

Kate MacEwan

Kate, the Founding Director of IWS, now uses her over 23 years of zoological and practical bat conservation experience, in an advisory capacity at IWS. Kate is full-time employed by Western EcoSystems Technology (WEST, Inc.) in the United States as a consulting biologist and to broaden their international footprint. Kate was also the founding chairperson of the South African Bat Assessment Association (SABAA) for seven years and is the lead author / co-author of the current South African best practice guidelines regarding bat monitoring studies at proposed and operational wind farms (MacEwan et al. 2020 and Aronson et al. 2020, respectively), and regarding bat fatality thresholds (MacEwan *et al.* 2018). She has published several peer-reviewed articles on bats at wind farms in Africa, including a recent paper on bat activity and its implications for wind farm development in South Africa (MacEwan *et al*. 2020b).

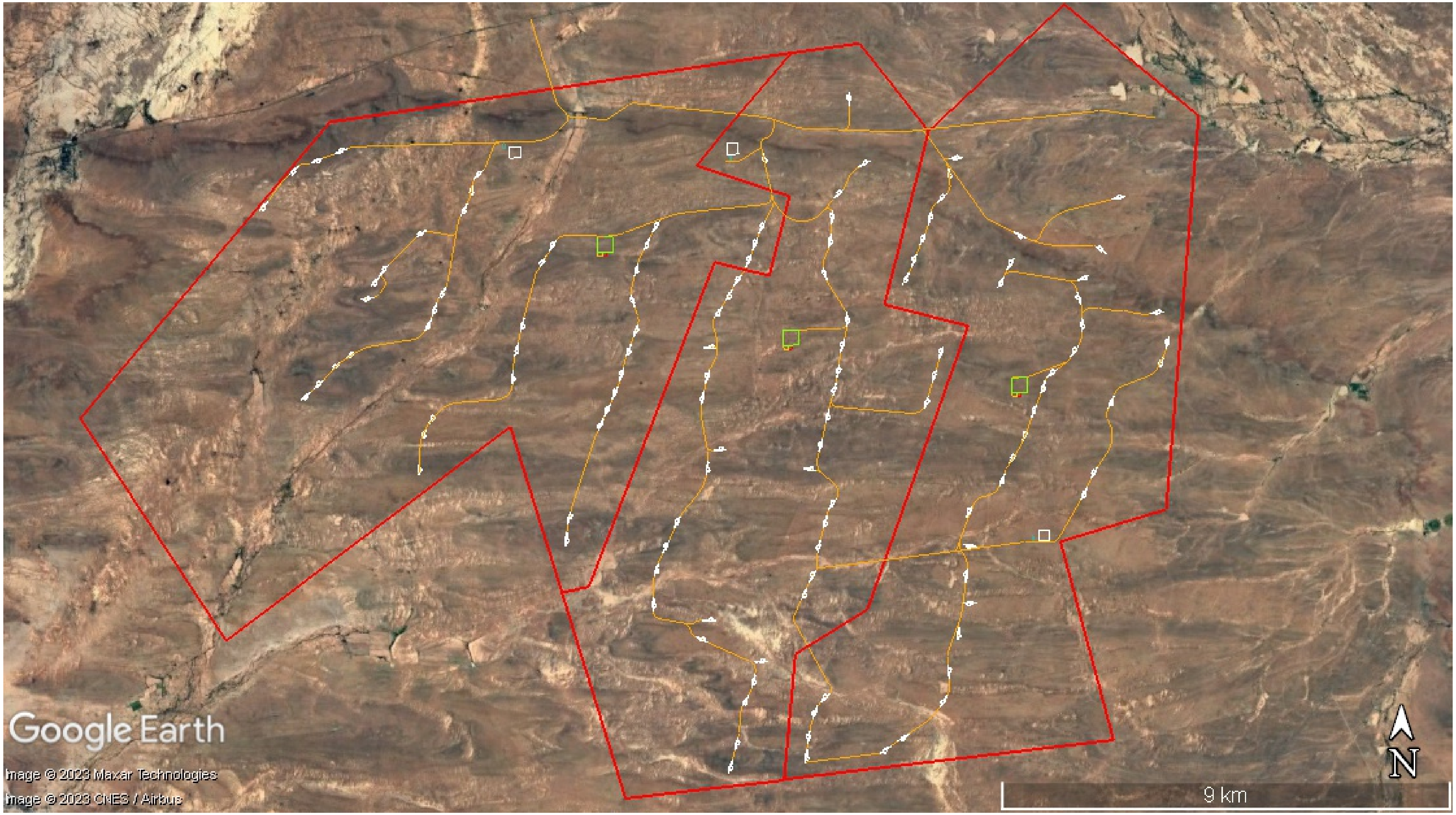


Figure 1 The currently planned infrastructure layout of the proposed cluster of three WEFs near Aberdeen

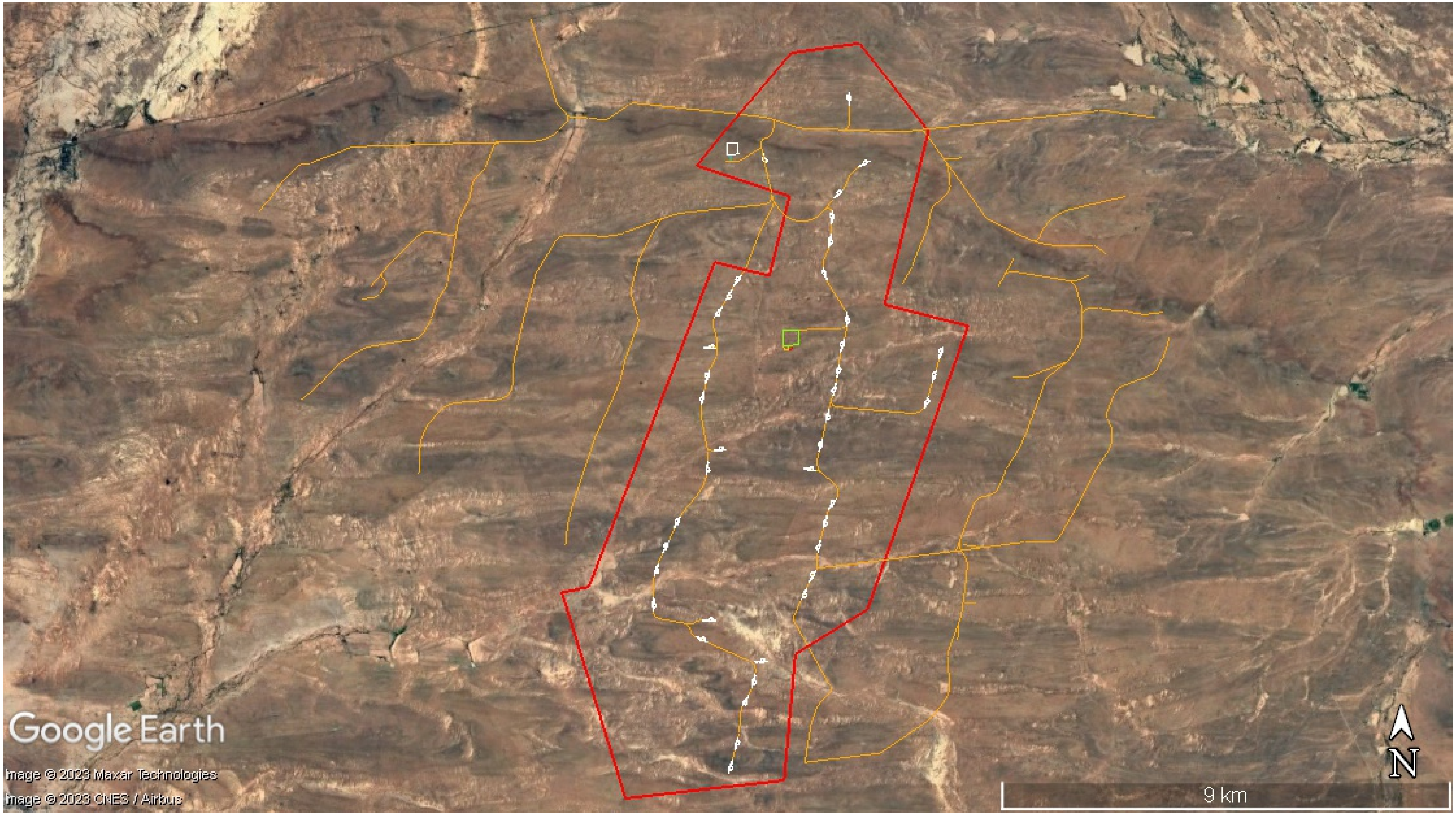


Figure 2 The currently planned infrastructure layout of the proposed Aberdeen Wind Facility 2

4. Methodology

4.1 Desktop review

A desktop review involved (but was not limited to) consultation and consideration of: long-term bat monitoring information obtained previously from the region by IWS team members (NSS 2014); the current proposed layout of turbines for the AWF2; the bat species records and distribution maps for the region provided by the African Chiroptera Report (2020), Monadjem *et al.* (2020), MammalMAP (FAIO 2021), and iNaturalist (2021); and the current South African and global Red List status of the listed bat species (Child *et al.* 2016; IUCN 2021-2).

4.2 Fieldwork

The passive acoustic monitoring of local bat activity commenced during 20-24 September 2021, and ended during 3-7 October 2022. During the 12-month monitoring period, the study area was visited by IWS on seven occasions to firstly install the monitoring equipment on each of the four met. masts in the cluster, secondly to check the equipment, download data, and to perform seasonal driven night-time transects and ground-truthing of potential bat important features, and finally to decommission the monitoring equipment.

On each met. mast two SM3BAT detectors were installed in connection with three omni-directional SMM-U2 microphones, positioned at approximately 10 m, 80 m, and 130 m above ground level to monitor bat activity at near ground level and in turbine rotor sweep. Day-time ground-truthing of potential bat important features (which included active searching for possible bat roosts) involved visual inspection and logging (with a GPS and camera) of all local buildings, ruins, farm dams, reservoirs, (wind and solar) water pumps, and more. The locations of the four bat monitoring stations ABN1 – 4, and IWS' ground-truthing tracks and waypoints are shown in **Figure 3**. During seasonal night-time driven transects, an EchoMeter 3 (EM3) and omni-directional microphone were used for snap-shot sampling of bat activity in areas not sampled by the met. masts. No live bat catching was performed as this was not considered necessary.

4.3 Sensitivity mapping

Sensitivity mapping was based on the desktop review work, the extensive ground-truthing of potential bat important features, and 12-month passive acoustic bat activity monitoring results, and took into consideration:

- Known and potential bat roosts (NSS 2014).
- Natural and artificial permanent, seasonal, and ephemeral surface water resources (CDNGI 2020).
- Geological layers, such as dolerite, which may be associated with karst formations (CDNGI 2020).
- Riparian and other woody vegetation and tree clumps (Mucina & Rutherford 2018; CDNGI 2020).
- Local buildings, including ruins (CDNGI 2020).

Buffering of identified bat important features was based on recommendations in the South African guidelines on bat monitoring for proposed wind farms (MacEwan *et al*. 2020a), and our professsional judgement.

4.4 Impact assessment and mitigation

Potential direct, indirect, and cumulative impacts on bats (including species, habitats, and ecosystem services) were assessed for the different project phases using the methodology of Savannah (Pty) Ltd, the Environmental Assessment Practitioner for the project.

4.5 Assumptions and Limitations

- Information on bats in South Africa is limited relative to more popular taxa such as birds and large mammals. For example, not all signficant bat cave roosts in South Africa may be known, and information on bat migration in South Africa is limited.

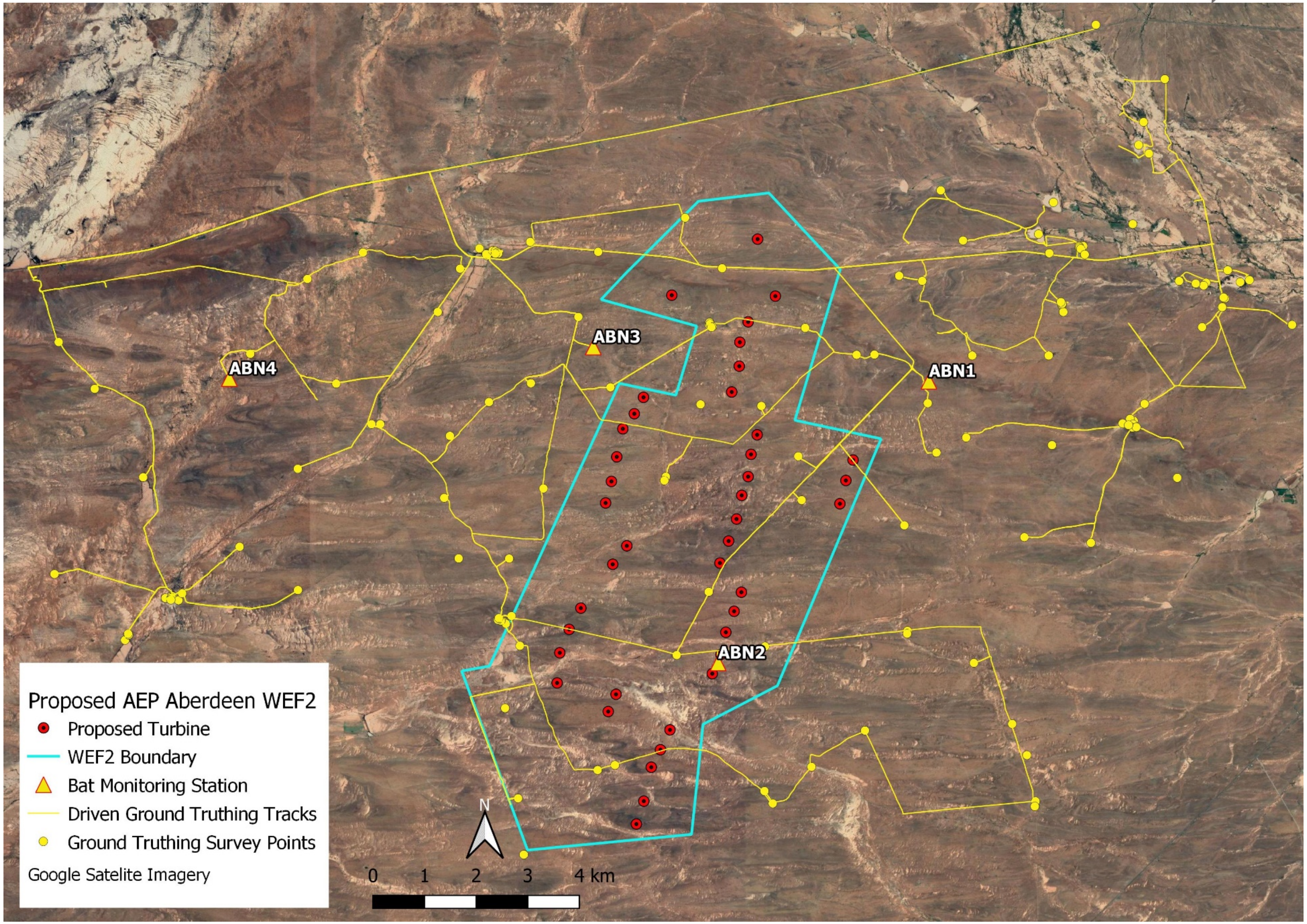


Figure 3 **The locations of bat monitoring stations ABN1 – 4, and the extent of IWS' ground-truthing of potential bat important features in the study area**

5. Results & Discussion

5.1 Recording success

The recording success of bat monitoring stations ABN1-4 is shown in **Figure 4**. Within the AWF2 site, recording at station ABN2 was 100% successful for the top microphone (ABN2-1 130 m), but a few nights of data from the middle and bottom microphones (ABN2-2 80 m and 10 m) were lost in October 2021 due to a detector software problem. Installation of the (offsite) ABN1 station was delayed by strong winds but recording through the three microphones at (offsite) station ABN3 was 100% successful. At the (offsite) station ABN4, recording was 100% successful for the lower microphone (ABN4-2 10 m) and middle microphone (ABN4-2 80 m), but no data from the top microphone (ABN4-1 130 m) were recorded from 27 December 2021 to 5 May 2022 after the detector was damaged by lightning, and from 25 September 2022 for the last week of monitoring, when the microphone failed (possibly as a result of the previous lightning damage to the station) (see **Figure 4**). IWS believes that the gaps in recording did not impact the pre-construction bat monitoring in a significant way since at any given time of year, data on bat activity were obtained at each height from at least three other locations within the WEF cluster site, and bat activity at the four bat monitoring stations was similar.

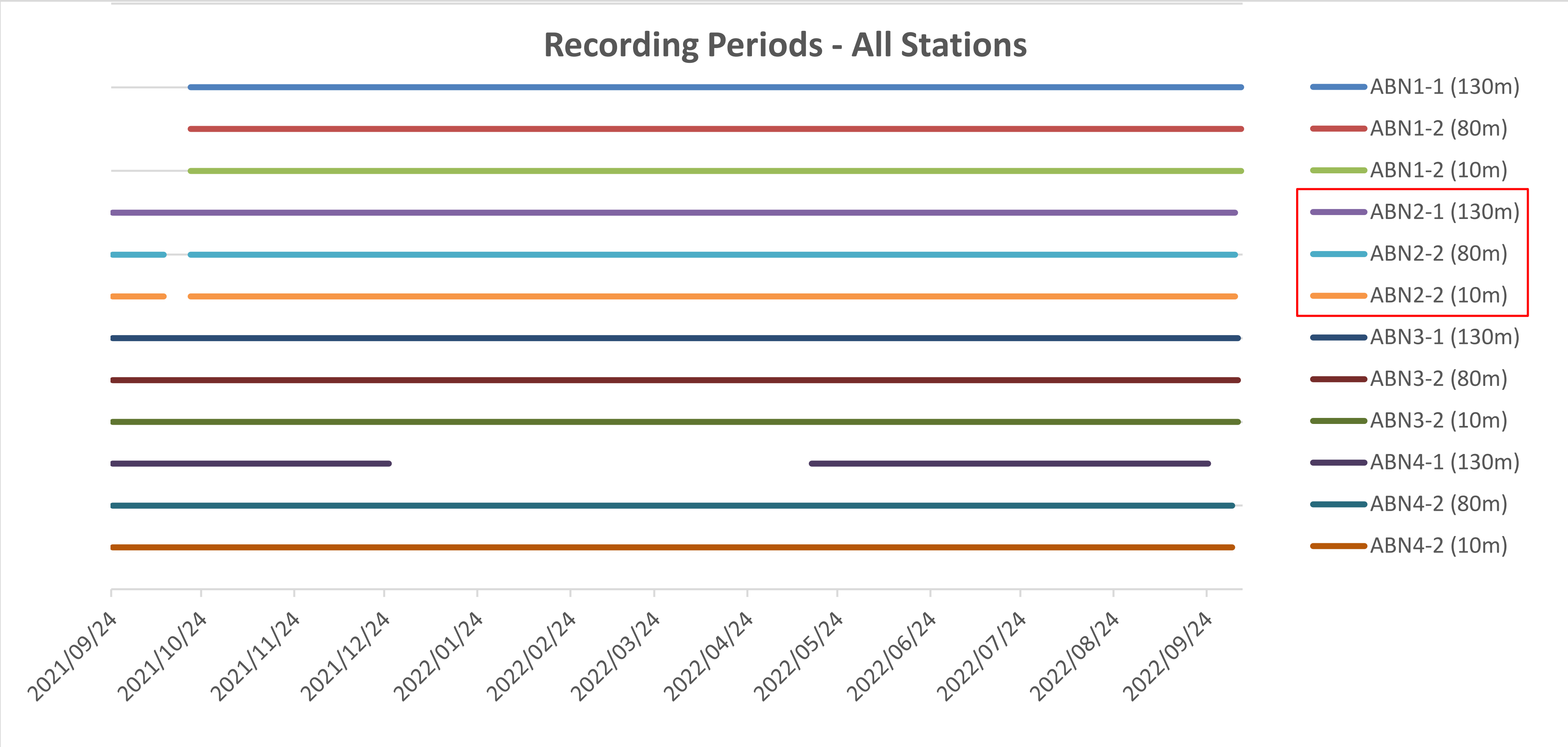


Figure 4 Recording success at bat monitoring stations ABN 1-4. ABN2 in the AWF2 site is outlined in red

5.2 Detected and potentially occurring bat species

Based on available species records and published distribution maps, potentially 10 bat species occur in the study area (hereafter referred to as “potentially occurring species”; **Table 1**). Of these, four bat species were recorded by IWS onsite during the 12-month monitoring campaign (“onsite detected species”) and three have been recorded offsite in the study region during separate studies (“offsite detected species”):

Onsite detected species:

- Egyptian Free-tailed Bat (*Tadarida aegyptiaca*)
- Cape Serotine (*Laeophotis capensis*)
- Natal Long-fingered Bat (*Miniopterus natalensis*)
- Mauritian Tomb Bat (*Taphozous mauritianus*)

Offsite detected species:

- Long-tailed Serotine (*Eptesicus hottentotus*)
- Geoffroy’s Horseshoe Bat (*Rhinolophus clivosis*)
- Cape Horseshoe Bat (*Rhinolophus capensis*)

Some recorded Molossid calls which could not be reliably identified may represent calls of the Egyptian Free-tailed Bat and/or the Long-tailed Serotine.

Of the detected species (onsite and offsite), four (*viz.* the Egyptian Free-tailed Bat, Cape Serotine, Natal Long-fingered Bat, and Mauritian Tomb Bat) have a High fatality risk of collision with turbines and one (*viz.* the Long-tailed Serotine) has a Medium fatality risk. Of the potentially occurring species, one (*viz.* Temminck’s Myotis) has a Medium-High fatality risk (MacEwan *et al*. 2020a).

The following three listed bat species are regarded by IWS as having the highest conservation priority:

- Cape Horseshoe Bat (*Rhinolophus capensis*): Endemic to the southern edge of South Africa and possibly Namibia (Monadjem *et al.* 2020).
- Lesueur's Hairy Bat (*Cistugo lesueuri*): Endemic in South Africa, especially the Cape Fold and Drakensberg mountains (Monadjem *et al*. 2020; IUCN 2021-1).
- Natal Long-fingered Bat (*M. natalensis*): known to roost in large numbers (sometimes hundreds or thousands) and to migrate hundreds of kilometres (Miller-Butterworth *et al*. 2003; MacEwan *et al*. 2016).

Of the three priority bat species, the onsite detected Natal Long-fingered Bat is considered most likely to be potentially impacted by the proposed WEF. The offsite detected Cape Horseshoe Bat, and Lesueur’s Hairy Bat, which has a High potential occurrence, both have a Low Risk of collision with turbines.

5.3 Bat species composition at different heights and localities

The calls of four bat species, namely the Egyptian Free-tailed Bat, Cape Serotine, Natal Long-fingered Bat, and Mauritian Tomb Bat were recorded at ABN2 (**Figure 5**, **Figure 6**).

The Egyptian Free-tailed Bat was the dominant species in turbine rotor sweep height, with >98% of recorded calls made by this species between 80 and 130 m a.g.l. The Cape Serotine, Natal Long-fingered Bat, and Mauritian Tomb Bat each contributed less than 1% to the calls recorded in rotor sweep height during any given season. These findings suggest that **during operation of the WEF, Egyptian Free-tailed Bats will comprise most of the turbine-related bat fatalities.** This aligns with the general finding that Egyptian Free-tailed Bat accounted for most of the bat carcasses found at operational WEFs in South Africa (Aronson *et al*. 2022).

The Egyptian Free-tailed Bat was also the dominant species near (at approximately 10 m above) ground level. However, near ground level, a greater relative (call) abundance of the other three species was recorded, which is a typical occurrence across most of South Africa (MacEwan *et al.* 2020b). The Cape Serotine contributed only ~1% of the calls recorded near ground level, while the Natal Long-fingered Bat contributed up to 19% of the calls recorded in winter at ABN2. These findings suggest that **a greater diversity (species richness and abundance) of bats will be at risk of fatality from turbines with blades that approach close to ground level.**

The species composition of the recorded bat call data was not surprising. The Egyptian Free-tailed Bat, Cape Serotine, and Natal Long-fingered are widespread across South Africa (Monadjem et al. 2020), and the open-air foraging Egyptian Free-tailed Bat is typically more prevalent above the vegetation canopy, whereas calls of the clutter-edge foraging Cape Serotine and Natal Long-fingered Bat are more frequently recorded closer to ground level.

Table 1 Detected and potentially occurring bat species in the study area

FAMILY	SPECIES	COMMON NAME	LIKELIHOOD OF OCCURRENCE[1,2,3,4]	RED LIST STATUS		SPECIES OF CONSERVATION CONCERN[2,5]	TURBINE FATATLITY RISK[7]
				Global[5]	National[6]		
MOLOSSIDAE	*Tadarida aegyptiaca*	Egyptian Free-tailed Bat	**Recorded onsite**	LC (U)	LC		**High**
VESPERTILIONIDAE	*Laeophotis capensis*	Cape Serotine Bat	**Recorded onsite**	LC (S)	LC		**High**
RHINOLOPHIDAE	*Rhinolophus clivosus*	Geoffroy's Horseshoe Bat	**Previously recorded offsite**	LC (U)	LC		Low
MINIOPTERIDAE	*Miniopterus natalensis*	Natal Long-fingered Bat	**Recorded onsite**	LC (U)	LC	**Migratory**	**High**
RHINOLOPHIDAE	*Rhinolophus capensis*	Cape Horseshoe Bat	**Previously recorded offsite**	LC (S)	LC	**SA endemic**	Low
VESPERTILIONIDAE	*Eptesicus hottentotus*	Long-tailed Serotine Bat	**Previously recorded onsite**	LC (U)	LC		**Medium**
EMBALLONURIDAE	*Taphozous mauritianus*	Mauritian Tomb Bat	**Recorded onsite**	LC (U)	LC		**High**
NYCTERIDAE	*Nycteris thebaica*	Egyptian Slit-faced Bat	High	LC (U)	LC		Low
CISTUGIDAE	*Cistugo lesueuri*	Leseur's Wing-gland Bat	High	LC (D)	LC	**SA endemic**	Low
VESPERTILIONIDAE	*Myotis tricolor*	Temminck's Myotis	Low	LC (U)	LC		**Medium-High**

Status: D: Decreasing; LC: Least Concern; S: Stable; U: Unknown.

Source: [1]African Chiroptera Report (2020); [2]Monadjem *et al.* (2020); [3]FIAO (2021); [4]iNaturalist (2021); [5]IUCN (2021-1); [6]Child *et al.* (2016); [7]MacEwan *et al.* (2020a)

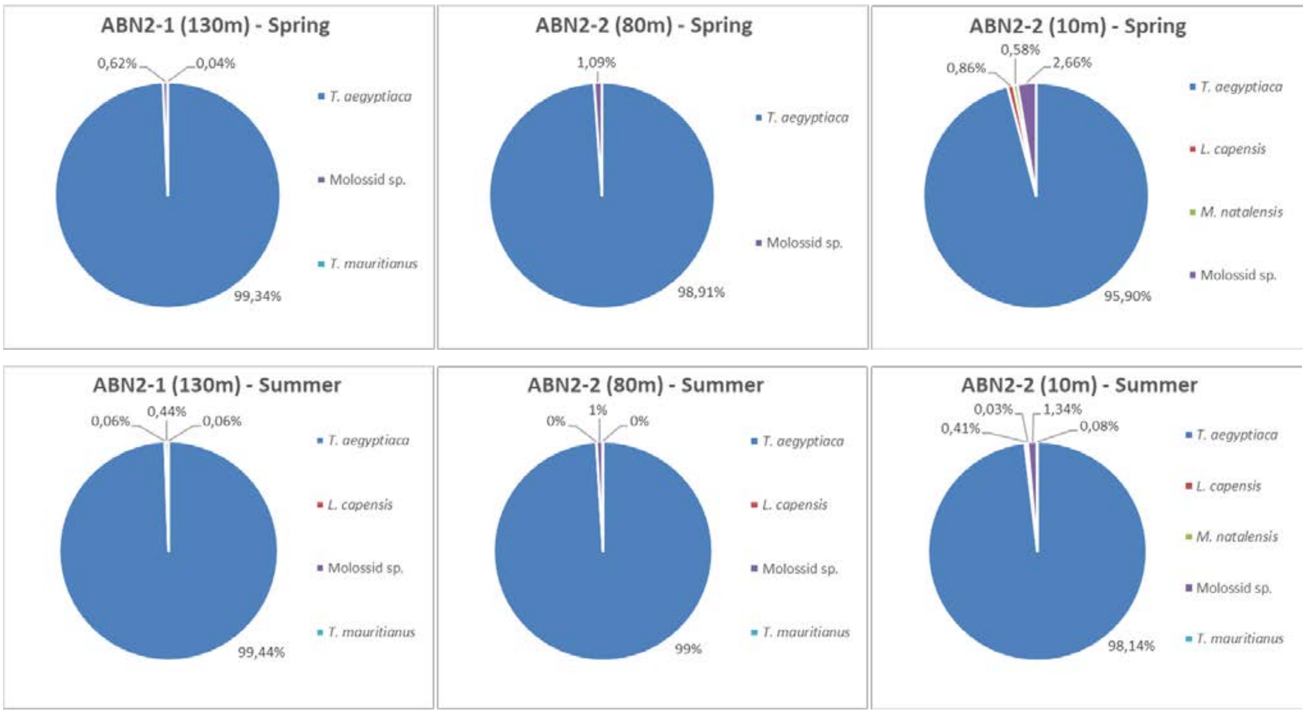


Figure 5 **Species composition of bat calls recorded in spring and summer at ABN2**

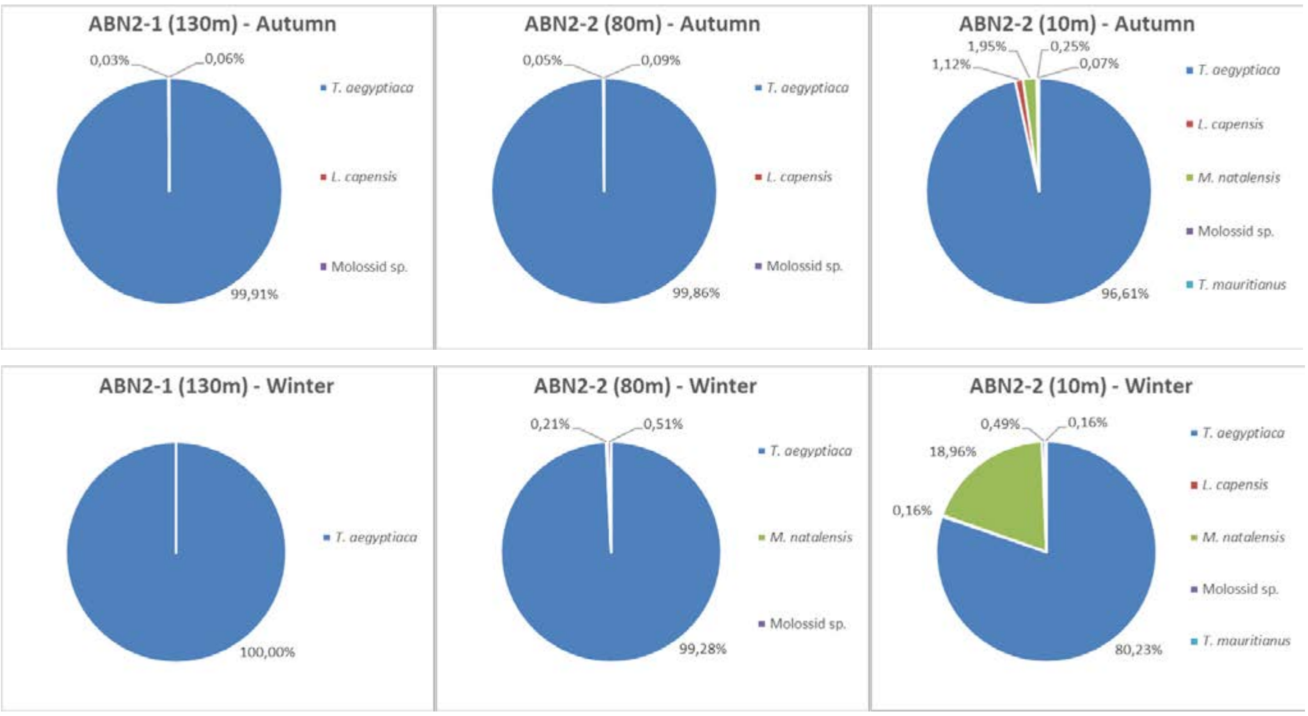


Figure 6 **Species composition of bat calls recorded in autumn and winter at ABN2**

5.4 Bat activity at different heights and locations

An overall average of 32 bat passes (bp) per night (or 3 bp per hour) at 130 m, 59 bp per night (5 bp per hour) at 80 m, and 54 bat passes (bp) per night (5 bp per hour) near ground level was recorded on site (**Figure 7**). The onsite levels of bat activity are slightly higher than the analogous average values of bat activity at other WEF sites in the Nama Karoo shrublands ecoregion (Dinerstein *et al*. 2017), where IWS recorded on average 1 bp per hour (range: 0-4 bp per hour) in rotor sweep (60 m), and 2 bp per hour (range: 1-7 bp per hour) near ground level (MacEwan *et al.* 2020b). Above-average bat activity was previously recorded at a nearby study site by IWS team members (NSS 2014). In that study and this one, the above-average bat activity was potentially attributable to above-average rainfall and/or the presence of a large regional population.

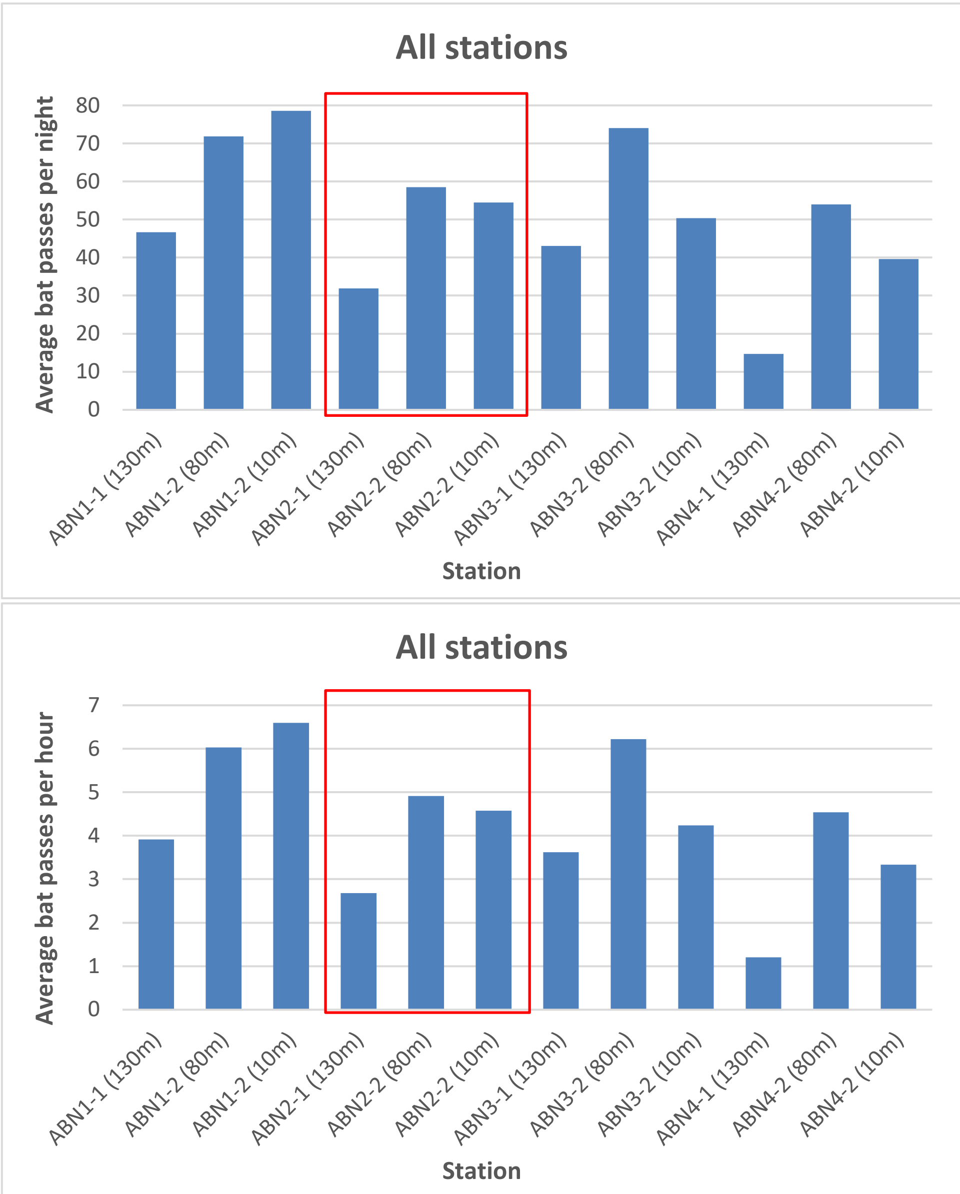


Figure 7 **Average bat activity measured in passes per night (above) or per hour (below) recorded in the cluster site. ABN2 in the AWF2 site is outlined in red**

At ABN2, it appears that higher activity was recorded on average at 80 m a.g.l. compared to at 10 m and 130 m a.g.l. This same elevational pattern in bat activity was recorded at ABN3 and ABN4. The higher activity at 80 m a.g.l. was, however, likely due to some overlap in the detection range of the microphones at 80 m, and those at 130 m and 10 m with, consequently, some duplication of recorded calls between these. At other WEF sites in South Africa where IWS performed long-term pre-construction monitoring, bat activity was on average, typically higher near ground level than in rotor sweep height (i.e. ±60 m a.g.l.; MacEwan *et al.* 2020b).

Given the slightly above-average levels of recorded onsite bat activity, and that levels of bat activity in rotor sweep height can be positively related to numbers of operational bat fatalities (IWS unpubl. data), the predominant Egyptian Free-tailed Bat could face a slightly above-average risk of fatality from WEF development in the study area.

Slightly less activity at each of the three monitoring heights was recorded at ABN2 compared to ABN1 (**Figure 7**). This may be because ABN2 is situated slightly further (~22 km) than ABN1 (which is ~15 km) to the prominent mountains located north and north-east of the site, where possibly a large proportion of the recorded Egyptian Free-tailed Bats may roost. If this is the case, during operation of the WEF, fatalities of the Egyptian Free-tailed Bat might accumulate at the most northerly proposed turbines. This possibility should be checked during operational bat fatality monitoring and mitigated if necessary (by installing bat deterrents on these turbines, for example).

5.5 Bat activity during different seasons

At ABN2, average bat activity at 130 m was highest during autumn, whereas average activity at 10 m was highest during summer (**Figure 8**). At 80 m, average activity was also highest during summer, which likely reflects some duplication of calls that were also recorded at 10 m. Appreciable bat activity was also recorded during spring. These findings suggest that **during operation of the WEF, most bat fatalities will likely occur during autumn, summer, and spring (possibly in descending order of priority)**, based on the assumption that the levels of bat activity in rotor sweep height may be positively related to the numbers of operational bat fatalities (IWS unpubl. data). Indeed, most recorded bat fatalities at operational WEFs in South Africa have occurred between February (late summer) and April (autumn) (Aronson *et al*. 2022). In contrast, less than 5% of recorded bat fatalities at WEFs in South Africa have occurred during winter (Aronson *et al*. 2022). Similarly, during operation of the proposed WEF, **the lowest numbers of bat fatalities are likely to occur during winter**, when the lowest levels of activity were recorded at virtually all monitoring locations and heights.

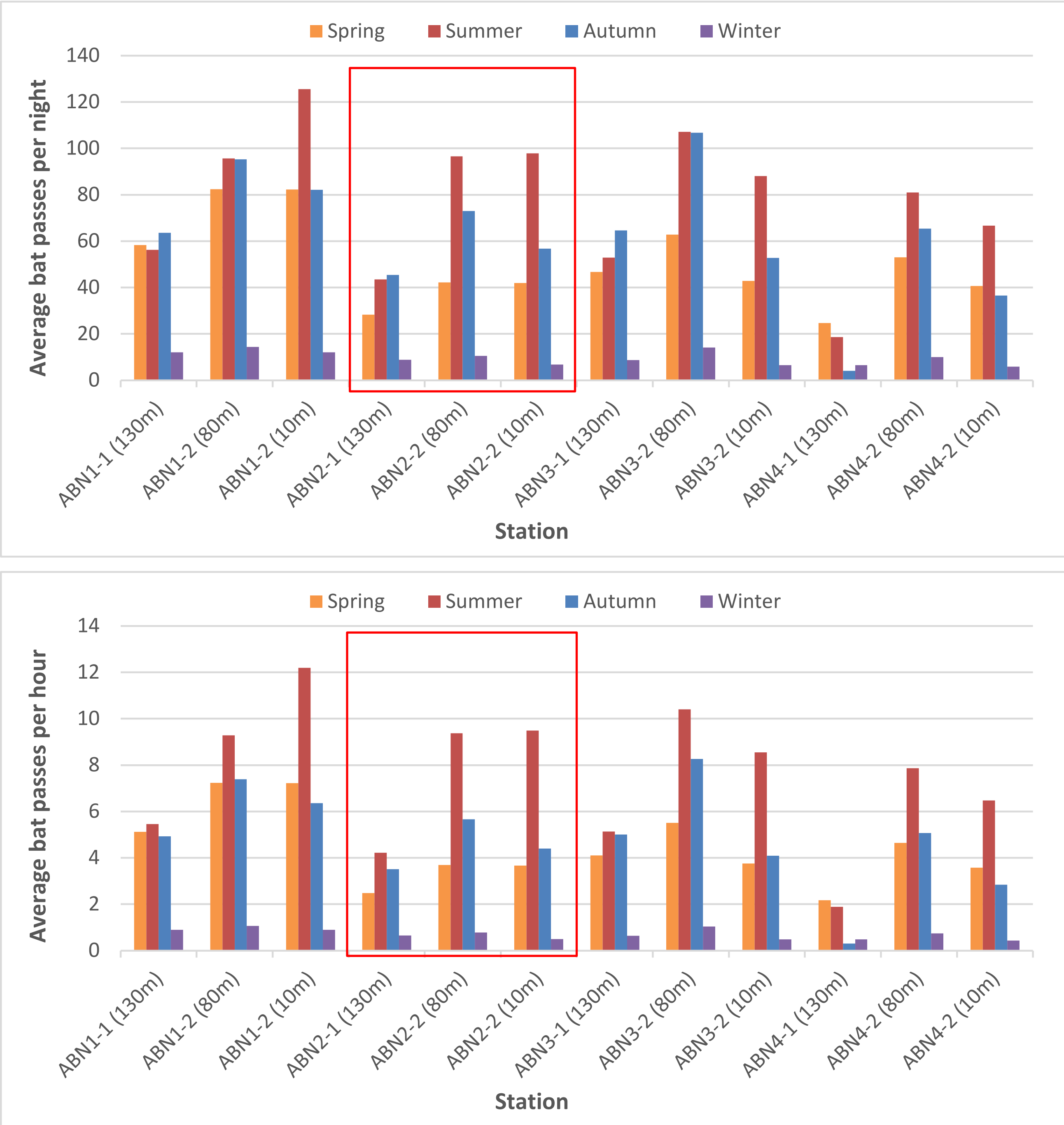
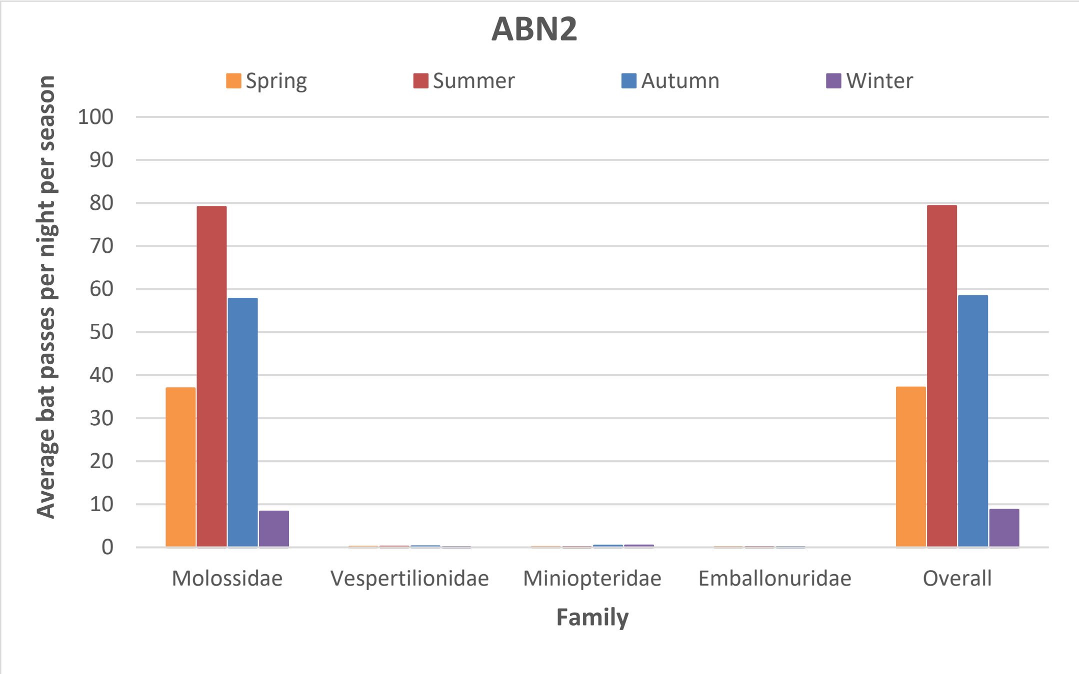


Figure 8 **Average bat activity (measured in passes per night or per hour) recorded in the cluster site during each season. ABN2 in the AWF2 site is outlined in red**

5.6 Activity of different bat families and species

Onsite bat activity was essentially a reflection of the activity of the predominant Egyptian Free-tailed Bat (the only listed species belonging to the Molossidae family), which exhibited high activity during spring, and especially summer and autumn (**Figure 9**). The Cape Serotine (the only recorded species belonging to the family Vespertilionidae) did not show appreciable variation in activity between spring, summer, and autumn. The Natal Long-fingered Bat (the only recorded species belonging to the family Miniopteridae) was most active during winter, autumn, and spring (in descending order). **The recorded low levels of Natal Long-fingered Bat activity (mostly below 10 bp/night) are not indicative of migration through the site, which would be revealed by high seasonal peaks in the activity peaks of this species.** However, since bat migration in South Africa is poorly understood, the possibility of this happening locally in future cannot be ruled out. The Mauritian Tomb Bat (the only recorded species belonging to the family Emballonuridae) was most active during summer. These results suggest that **where bat fatality mitigation may become necessary, turbine curtailment and/or other measures would likely need to be applied during autumn, summer, and spring.**



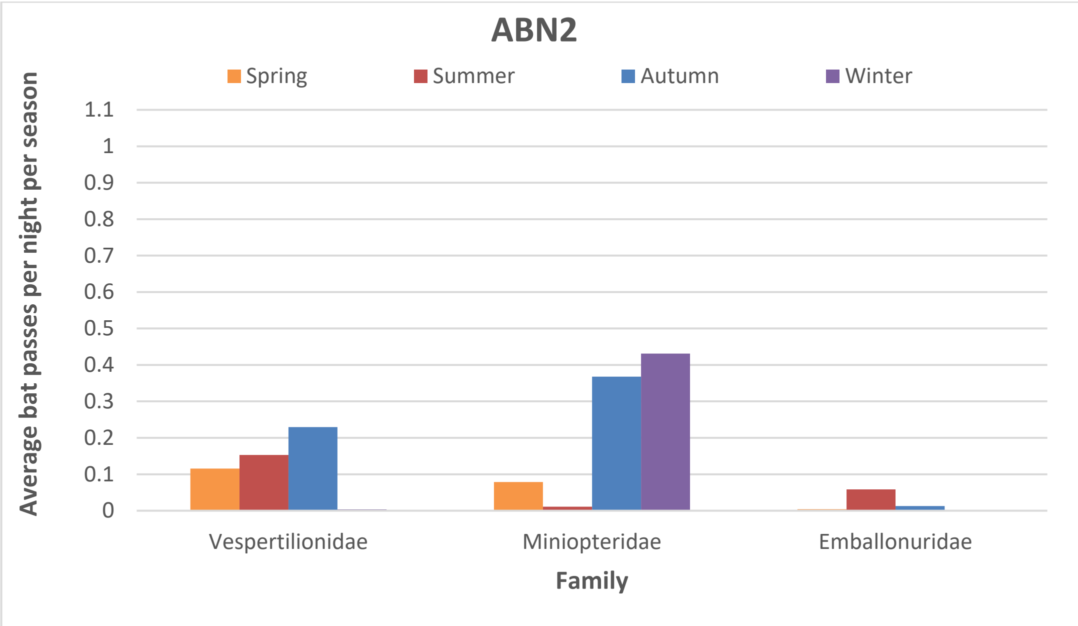


Figure 9 Average activity (in passes per night) of the different bat families recorded onsite during each season (above), with the activity levels of the Vesper, Miniopterid, and Emballonurid bats visible in the graph below.

5.7 Nights when bat activity peaked

Nights when the highest total numbers of bat passes were recorded on site at ABN2 occurred in summer, autumn, and spring. High numbers of passes during a night are indicative of an increase in bat activity and possibly also bat abundance. Across the three monitoring heights, Egyptian Free-tailed Bat activity reached totals of 669-993 bp on 16 September 2021 (spring), 624-1 326 bp on 31 January 2022 (summer), and 403-1 116 bp on 6 March (autumn) (**Figure 10**).

The comparatively low nightly activity of the other bats species (included but not visible in **Figure 10**) is shown in **Figure 11**. Near ground level, Cape Serotine activity peaked by no more than 30 bp on nights mainly in March-April (autumn). Natal Long-fingered Bat activity peaked by no more than 20 bp on nights from March to September (autumn and winter).

On nights when the levels of Egyptian Free-tailed bat activity can be almost 21 times higher than the average level of 32 bp per night at 130 m, fatalities will be inevitable without effective mitigation. Pre-emptive, predictive, or smart curtailment could be most effective at mitigating fatalities during peaks in bat activity, with the least impact on the WEF.

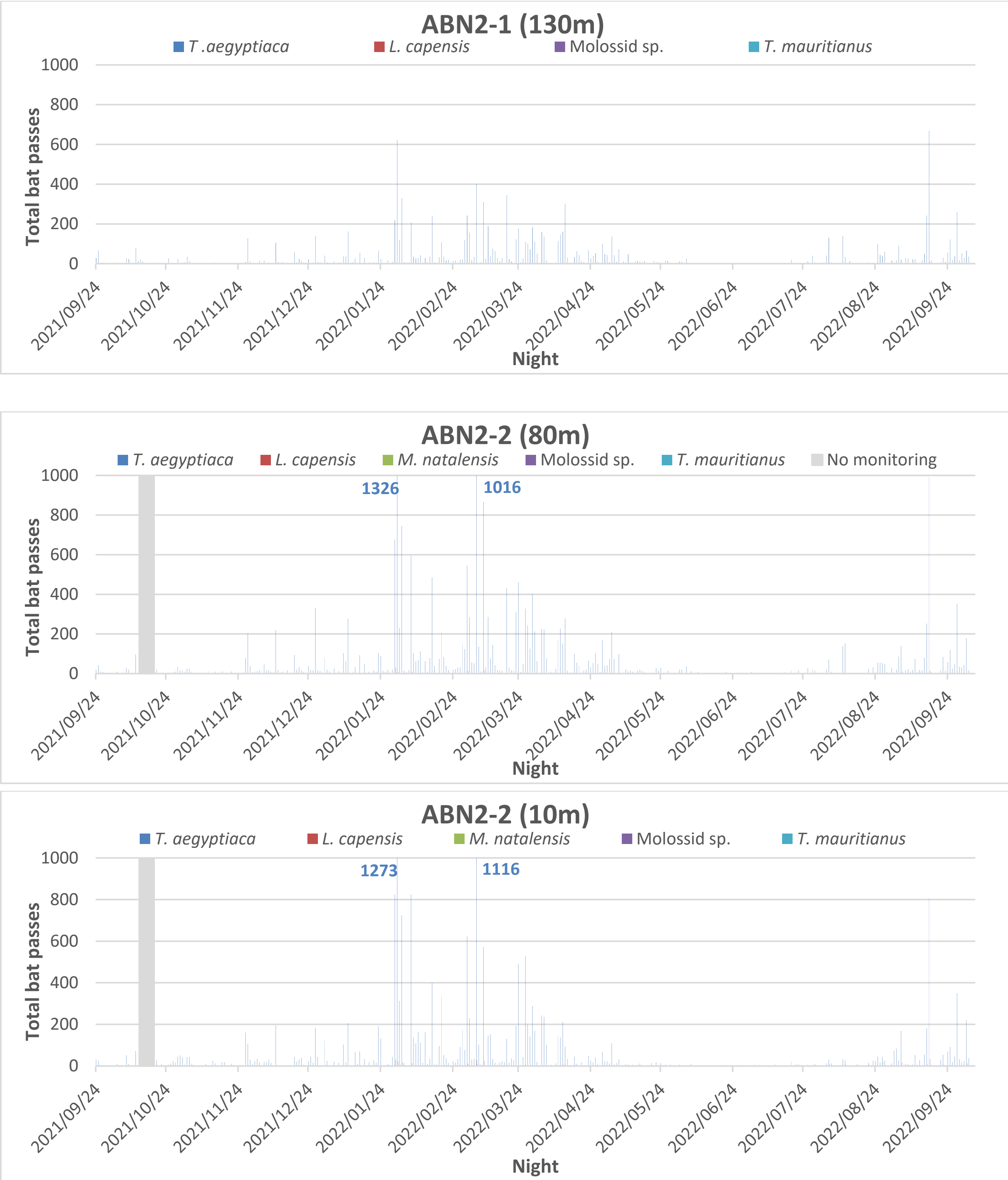


Figure 10 Total bat passes recorded nightly at different heights at the ABN2 bat monitoring station

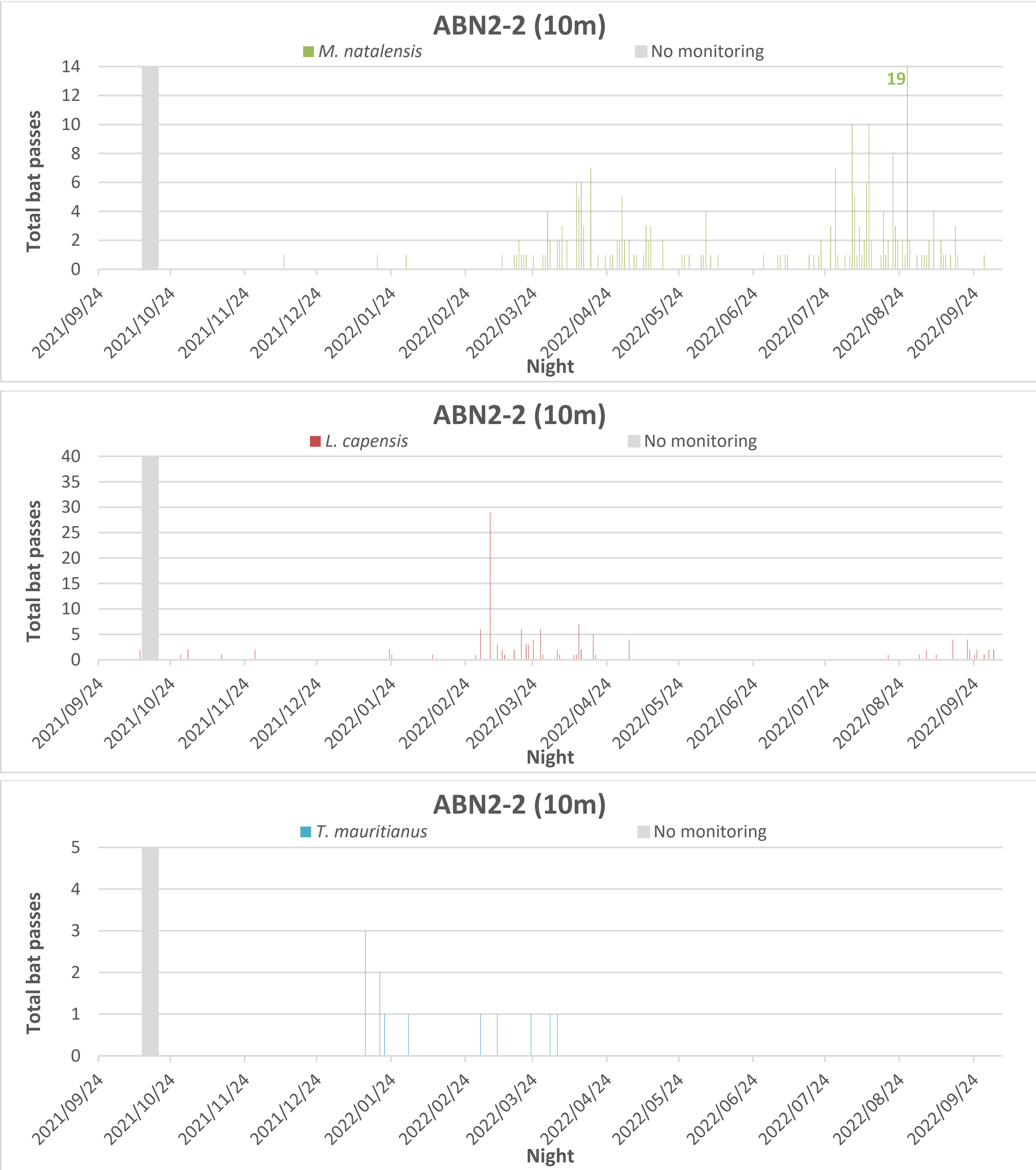


Figure 11 **Total bat passes (excluding Egyptian Free-tailed) bat passes recorded nightly at 10 m at the ABN2 bat monitoring station**

5.8 Key bat activity times

A very similar pattern of Egyptian Free-tailed bat activity between sunset and sunrise was recorded at the two on site monitoring locations and three monitoring heights (not considering the compromised data for ABN2-1 130 m; **Figure 12**). Basically, from sunset there was a progressive increase in Egyptian Free-tailed Bat activity until ca. 19:30/20:30. From then, an overall high level of activity was recorded until ca. 02:00/03:00, whereafter activity declined by sunrise. IWS suspects that this may be due to regular foraging over the study area by Egyptian Free-tailed Bats which commute from/to the mountains in the surrounding region. If most of these bats roost locally, their emergence at sunset, and retreat at sunrise, would probably create separate distinctive activity peaks at these times. **Due to their protracted night-time activity on site, Egyptian Free-tailed Bats will be at risk of fatality from turbines throughout the night whenever favourable weather, insect, and possible other (e.g. lunar) conditions prevail.**

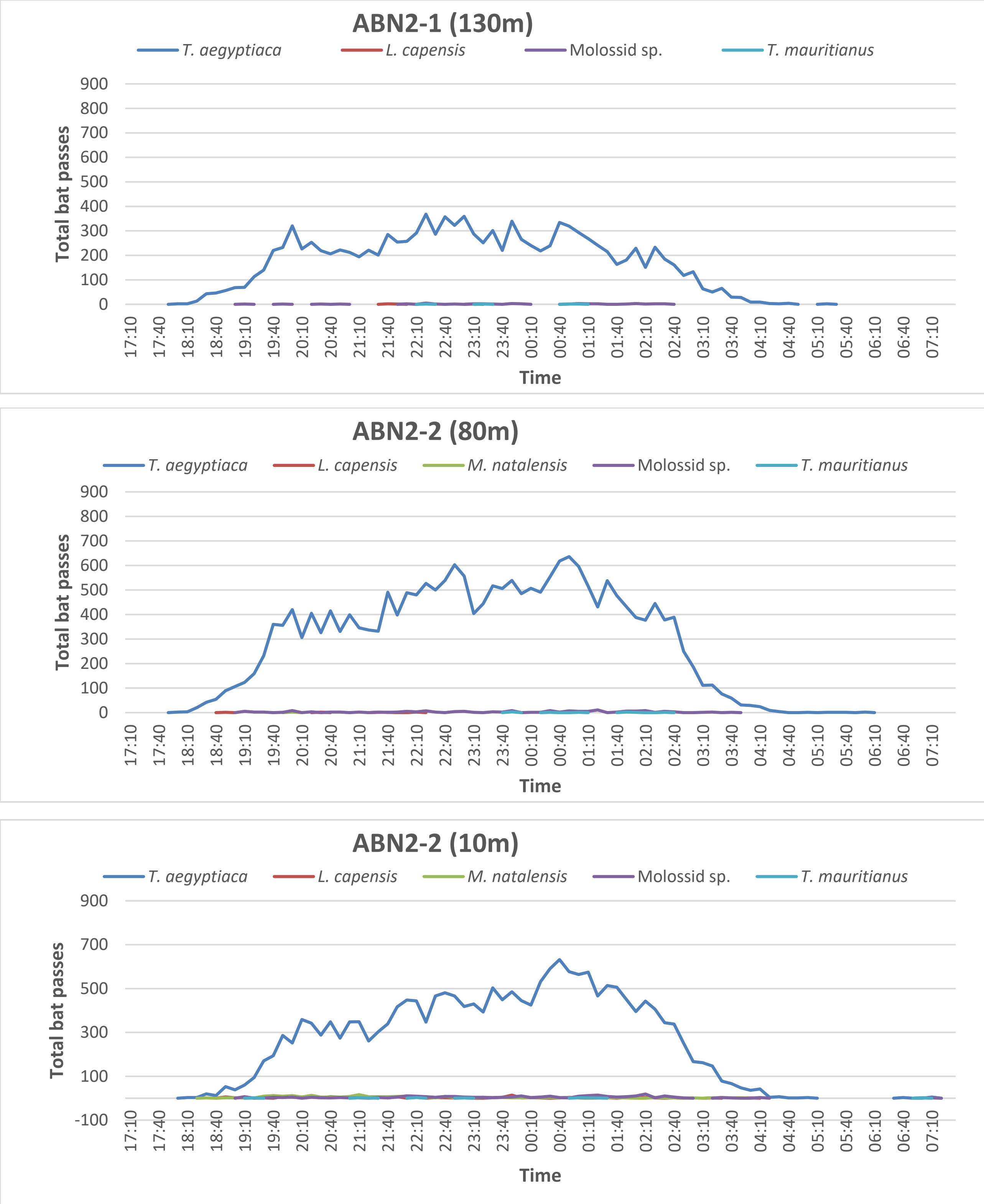


Figure 12 **Overall night-time activity of bat species recorded at ABN2**

5.9 Bat activity in relation to weather

The cumulative and percentage bat passes recorded during different wind speeds and atmospheric temperatures in rotor sweep height at ABN2 is shown in **Figure 13** and

Figure 14.

Most (90% of) bat activity was recorded at 130 m during temperatures warmer than 12 °C. Approximately:

- 50% of bat activity was recorded during wind speeds below 6 m/s.
- 75% of bat activity was recorded during wind speeds below 8.5 m/s.
- 80% of bat activity was recorded during wind speeds below 9 m/s.
- 90% of bat activity was recorded during wind speeds below 10.5 m/s.
- 95% of bat activity was recorded during wind speeds below 11.5 m/s.

Evidently, bats in the study area have adapted to flying in quite windy conditions – compared to populations at certain other sites where IWS has performed long-term monitoring. **Half of the time, bats were active in the study area during wind speeds stronger than 6 m/s. Consequently, if the WEF's bat fatality threshold is exceeded during operation and turbine curtailment becomes necessary, only 50% of bat activity would be protected below a cut-in wind speed of 6 m/s.**

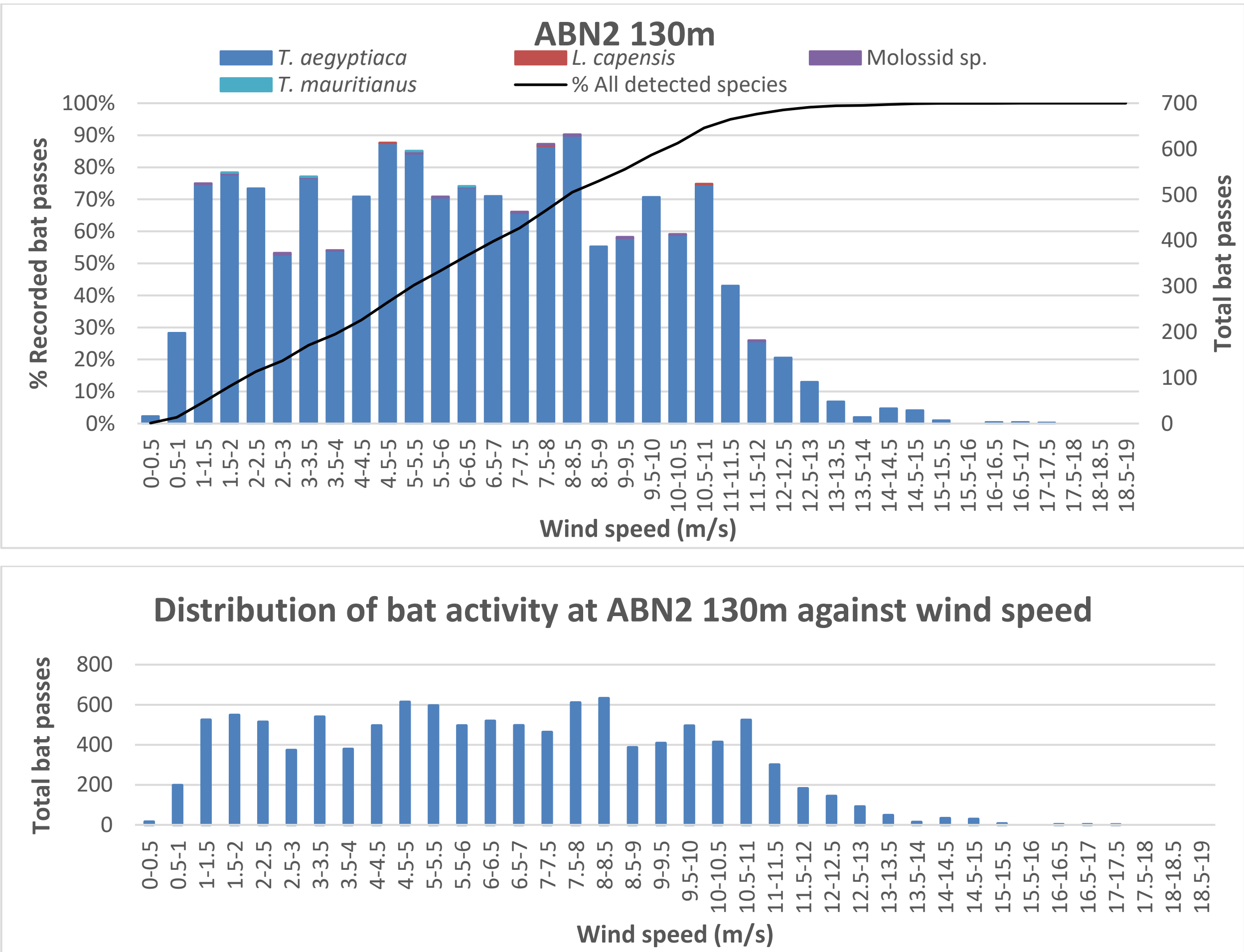


Figure 13 **Relationship between bat activity and wind speed in rotor sweep at ABN2**

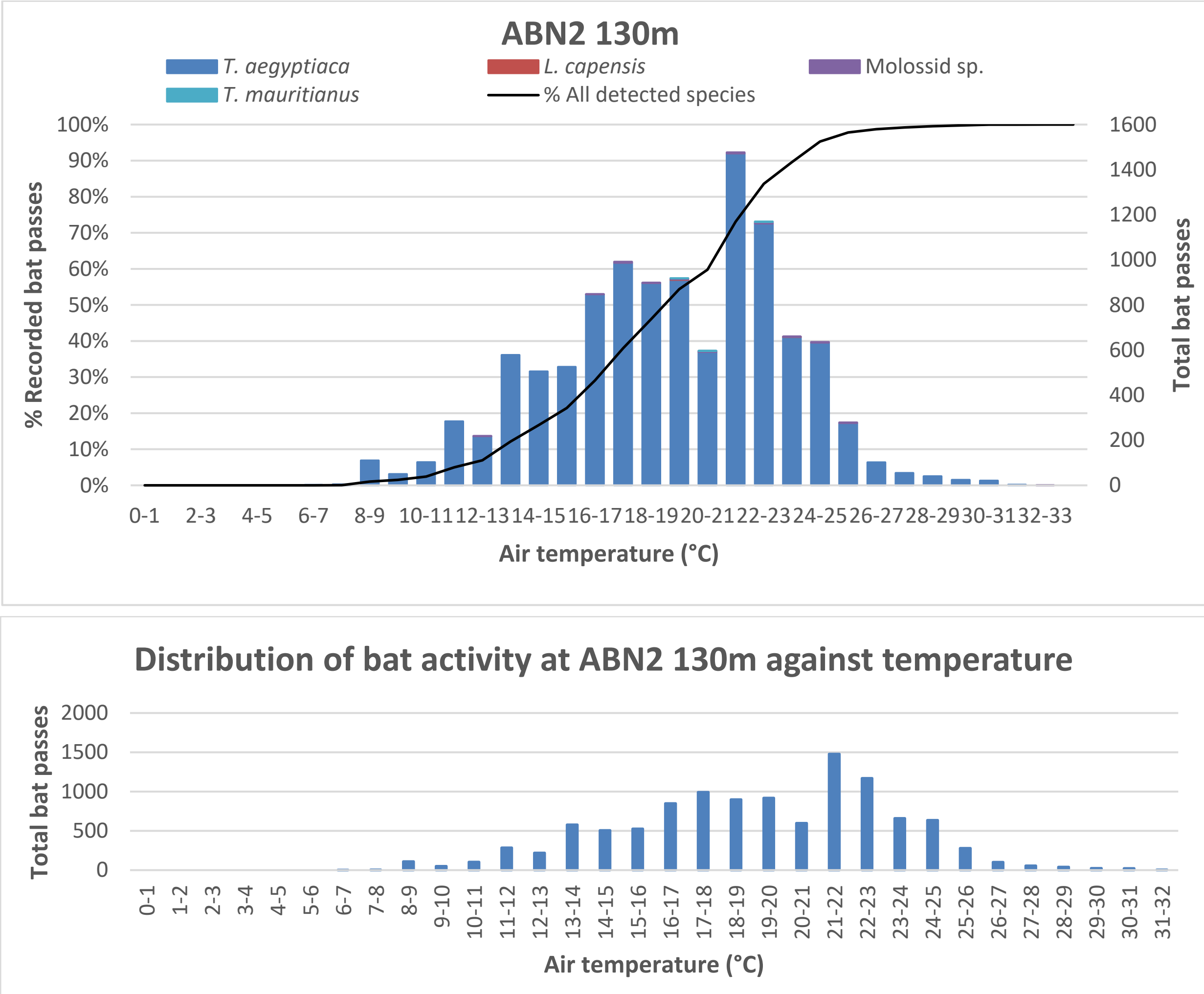


Figure 14 **Relationship between bat activity and atmospheric temperature in rotor sweep at ABN2**

6. Bat Sensitivity Map

Described in **Table 2** and shown in **Figure 15**, is the relative sensitivity (i.e. the conservation importance for bats) of different local natural and artificial habitats, and the recommended buffers around these as stipulated in the South African guidelines on bat monitoring for proposed wind farms (MacEwan *et al.* 2020a) and based on our professional judgement.

Table 2 Relative sensitivity of different bat habitats and buffers in and around the proposed AWF2 site

Sensitivity	Description
High	• Confirmed bat roosts, and a 1 km buffer around these. • All rivers, streams, and wetlands, and a 500 m buffer around these. • All farm dams and reservoirs, and a 500 m buffer around these.
Medium-High	• Potential bat roosts, and a 500 m buffer around these. • Secondary drainage lines, and a 200 m buffer around these.
Medium	• Dolerite and a 200 m buffer around this. • Floodplain zones.
Low-Medium	• All remaining areas

High Bat Sensitive Areas include:

- A small roost (of Cape Serotines and possibly some Egyptian Free-tailed Bats) near the south-western corner of the AFW2 site, and a 500 m buffer around this, based on the minimum 500 m buffer recommendation in the MacEwan *et al*. (2020a) guidelines for a small roost of (<50) bats of Least Concern.
- Rivers, streams, wetlands, farms dams, and reservoirs, and a 500 m buffer around these, based on: i) the minimum 200 m buffer recommendation in the best practice guidelines by MacEwan *et al*. (2020a) for known and potential bat important features; and additionally ii) the known importance of surface water resources for drinking, foraging, navigation, and movement of bats – especially in arid areas (Serra-Cobo *et al.* 2000; Salata 2012; Sirami *et al.* 2013; Blakey *et al.* 2018); and iii) the recorded onsite levels of bat activity which are slightly higher than the analogous average values of bat activity at other WEF sites in the Nama Karoo shrublands ecoregion (MacEwan *et al.* 2020b).

Medium-High Bat Sensitive Areas include:

- Potential onsite bat roosts (in buildings, and woody vegetation), and a 500 m buffer around these, based on the minimum 500 m buffer recommendation in the MacEwan *et al*. (2020a) guidelines for a small roost of (<50) bats of Least Concern.
- Secondary drainage lines, and a 200 m buffer around these, based on: i) the possibility that these may be utilized by bats (at certain times at least) for drinking, foraging, navigation, and movement; and ii) the minimum 200 m buffer recommendation in the best practice guidelines by MacEwan *et al*. (2020a) for known and potential bat important features.

Medium Bat Sensitive Areas include:

- Areas with dolerite which may be associated with karst formations (although no obvious cavities suitable for bat roosting were observed), and a 200 m buffer around these, based on the minimum 200 m buffer recommendation in the best practice guidelines by MacEwan *et al*. (2020a) for known and potential bat important features.
- Floodplain zones, based on the possibility that these may be utilized by bats at certain times for drinking, foraging, navigation, and movement.

Remaining areas were rated with Low-Medium (not Low) sensitivity owing to the above-average levels of Egyptian Free-tailed Bat activity recorded on site, and previously in the region by IWS.

The locations and species identity of all bat calls recorded during the seasonal driven transects are shown in **Figure 16**. Most of the calls were recorded in High sensitive areas, which included the buffers around the main onsite river, certain farm dams, and a reservoir with surrounding woody vegetation.

The sensitivity mapping should be interpreted as follows:

- **High** Bat Sensitive Areas represent **No-Go** areas for the construction of WEF infrastructure especially turbines (including all blades plus a 2 m pressure buffer around these), substations, offices, battery energy storage systems, quarries, construction camps, or laydown areas (to avoid disturbing key bat roosting, foraging, and/or commuting habitat, and to avoid high bat fatalities in these areas where high bat activity is anticipated).
- **Medium-High** Bat Sensitive Areas represent areas where the construction of infrastructure and other disturbances should be avoided *where possible* (to avoid areas where bat roosting, foraging, commuting, and/or migration may be concentrated).
- In **Medium** Bat Sensitive Areas, disturbances should be minimized.
- The layout of the WEF infrastructure should be planned to coincide with **Medium-Low** Bat Sensitive Areas so far as possible.

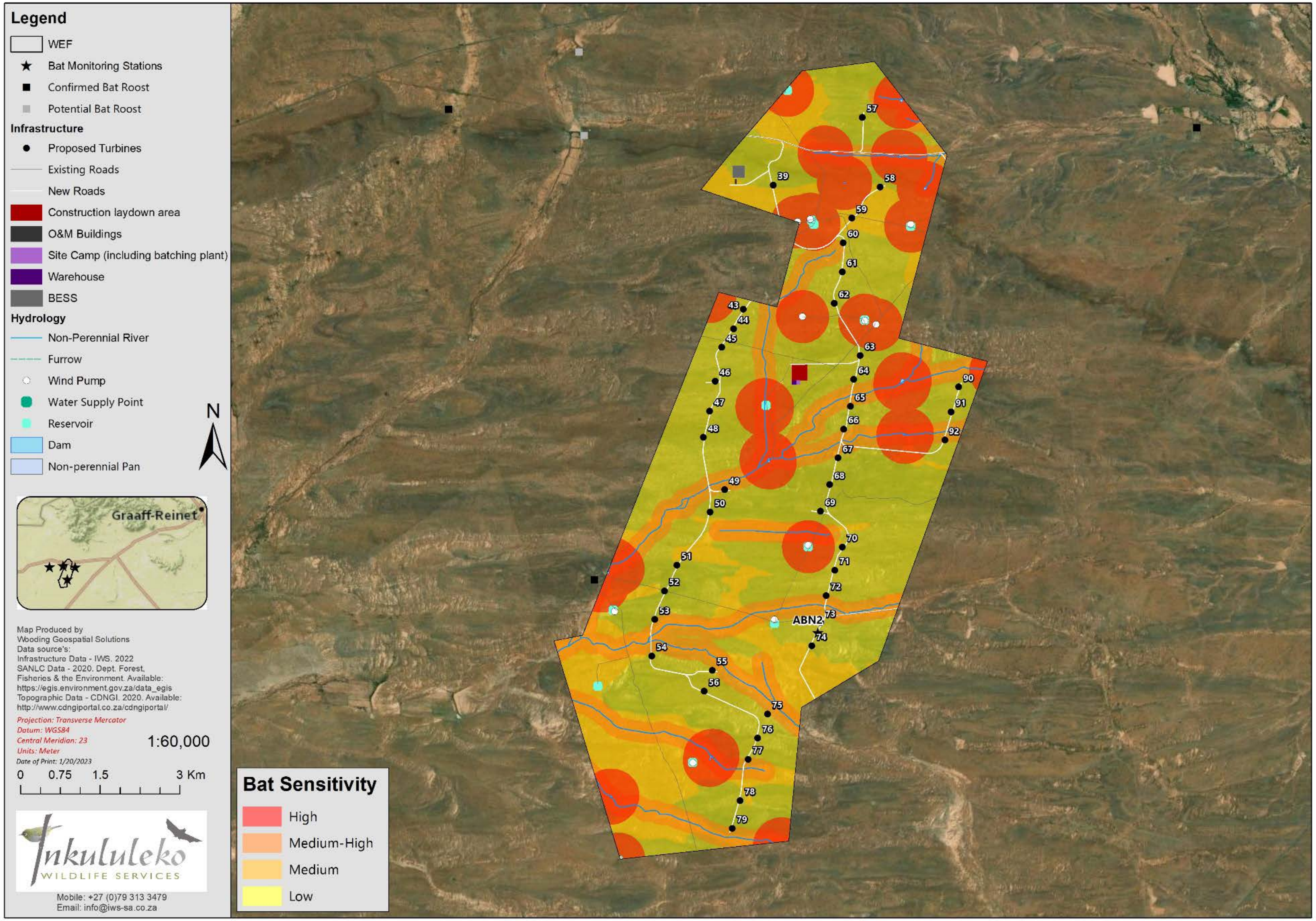

Legend
WEF
Bat Monitoring Stations
Confirmed Bat Roost
Potential Bat Roost
Infrastructure
Proposed Turbines
Existing Roads
New Roads
Construction laydown area
O&M Buildings
Site Camp (including batching plant)
Warehouse
BESS
Hydrology
Non-Perennial River
Furrow
Wind Pump
Water Supply Point
Reservoir
Dam
Non-perennial Pan
N
Graaff-Reinet
Map Produced by
Wooding Geospatial Solutions
Data source's:
Infrastructure Data - IWS. 2022
SANLC Data - 2020. Dept. Forest, Fisheries & the Environment. Available: https://egis.environment.gov.za/data_egis
Topographic Data - CDNGI. 2020. Available: http://www.cdngiportal.co.za/cdngiportal/
Projection: Transverse Mercator
Datum: WGS84
Central Meridian: 23
Units: Meter
Date of Print: 1/20/2023
1:60,000
0 0.75 1.5 3 Km
Inkululeko WILDLIFE SERVICES
Mobile: +27 (0)79 313 3479
Email: info@iws-sa.co.za
Bat Sensitivity
High
Medium-High
Medium
Low
ABN2

Figure 15 Bat sensitivity map for the proposed Aberdeen Wind Facility 2

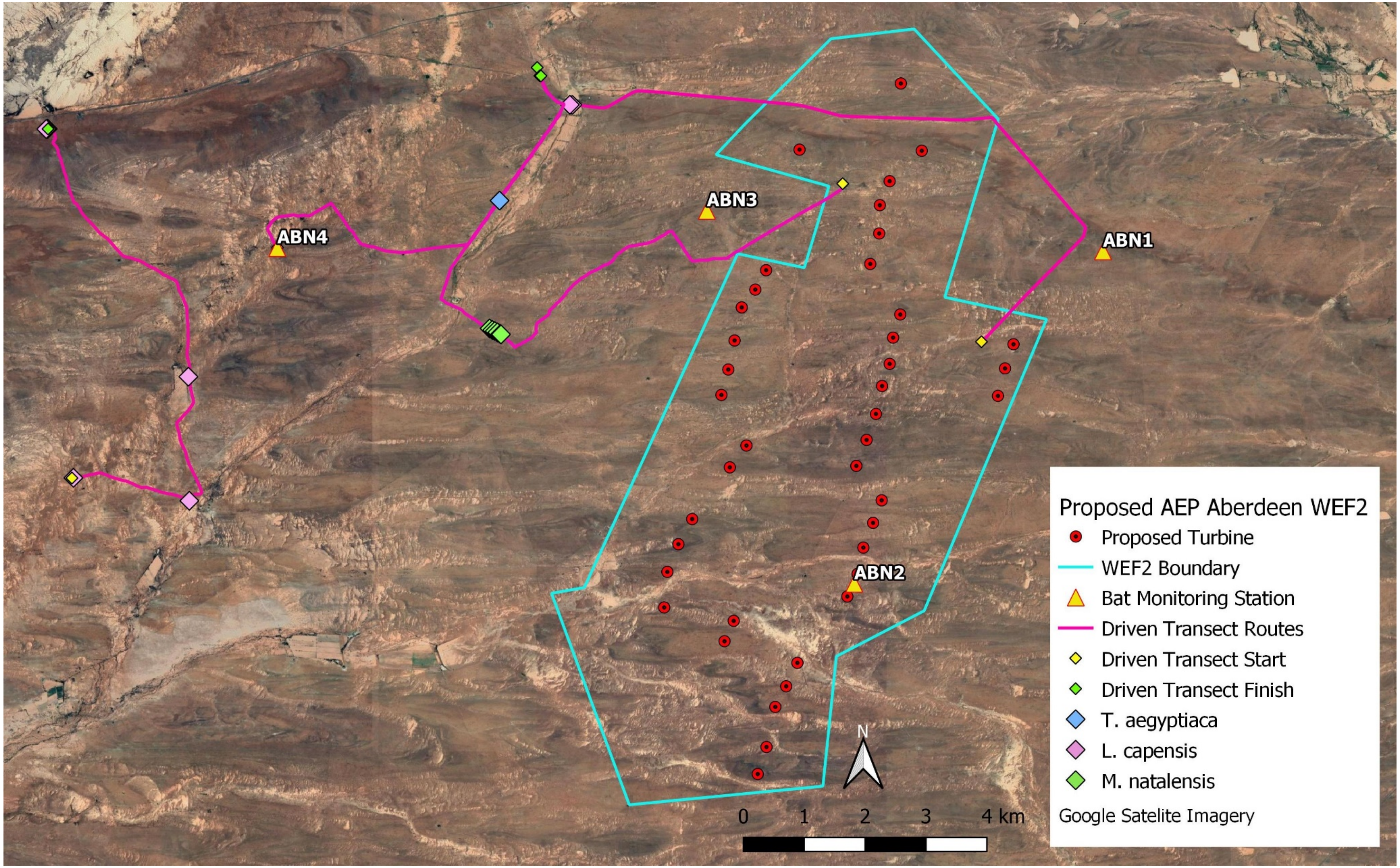


Figure 16 Driven transect routes in the study area, showing the locations and species identity of recorded bat calls

7. Bat Impact Assessment and Recommended Mitigation

7.1 Current impacts

Currently, bats might be negatively impacted to some degree by disturbance of natural habitat from especially livestock overgrazing and possibly other agricultural activities, built infrastructure (such as roads), and light pollution from scattered dwellings and Aberdeen town. At the same time, developments such as certain buildings, dams, and reservoirs are positively benefitting bats by providing them with favourable roosting habitat and more permanent water supplies. Therefore, onsite anthropogenic disturbances currently do not appear to exert an appreciable negative impact on bats.

7.2 Potential impacts without and with mitigation

Provided in **Table 3** is the assessment of potential direct, indirect, and cumulative impacts on bats from the proposed project, without and with mitigation. Presented in **Table 4** is an assessment of the overall cumulative impact of the proposed project when considered in isolation, or when considered in combination with other proposed WEFs (and solar farms) in and around the Beaufort West Renewable Energy Development Zone (https://egis.environment.gov.za/renewable_energy; **Figure 17**).

Table 3 Assessment of potential impacts on bats from the proposed project, without and with mitigation

Nature: Roost disturbance or destruction					
Impact description: During construction of infrastructure for the WEF, potential bat roosts (roosting bats and/or roost sites) in trees, buildings, or elsewhere could be disturbed or destroyed (during possible tree felling, demolishment of old buildings, blasting, etc.) if overlooked and/or not adequately avoided.					
	Rating		**Motivation**	**Significance**	
Prior to Mitigation					
Duration	**Permanent**	**5**	**Roosts could be permanently lost from site if/where buildings are disturbed, large trees are felled, blasting is performed, etc.**	**42**	**Medium Negative**
Extent	**On-site**	**1**	**Construction activities are likely to impact only onsite roosts.**		
Magnitude	**High**	**8**	**Roost destruction or disturbance could impact many common bats and/or a small but significant roost of a priority species.**		
Probability	**Probable**	**3**	**Construction activities could result in disturbance of buildings, and is likely to involve clearing of vegetation, and excavation works.**		
Mitigation/Enhancement Measures					

Mitigation: • Avoid High sensitive areas (especially confirmed roosts, and the prescribed buffers around these). • Avoid blasting within 2 km of a confirmed roost. • Minimize disturbance of Medium-High sensitive areas (especially potential roosts, and the prescribed buffers around these). • Minimize the length and breadth of proposed roads to thus minimize the clearing and disturbance of natural areas (including potential bat roosting habitat). • Minimize degradation of terrestrial habitat (potential bat roosting habitat) by implementing and maintaining effective invasive alien plant, stormwater, erosion, sediment, and dust control measures. • Minimize artificial lighting on site (excluding compulsory civil aviation lighting) - especially high-intensity, steady-burning, sodium vapour, quartz, halogen, and other bright lights at substations, offices, and turbines (to avoid disturbing roosts of certain sensitive bat species). All non-aviation lights should be hooded downward and directed to minimise horizontal and skyward illumination. Where possible, solar-powered motion-sensitive lights should be used.					
Post Mitigation/Enhancement Measures					
Duration	Short-term	2	If buildings remain undisturbed, mainly tree-roosting bats will be liable to disturbance/displacement during construction.	15	Low Negative
Extent	On-site	1	Construction activities are likely to impact only onsite roosts.		
Magnitude	Minor	2	If buildings remain undisturbed, diffuse numbers of mainly tree-roosting bats will be liable to disturbance/displacement.		
Probability	Probable	3	Even if buildings remain undisturbed, construction activities could disturb tree-roosting bats.		
Cumulative impacts: Bat roosts in buildings, trees, and elsewhere (e.g. in rocky terrain and caves) are likely to be increasingly impacted by ongoing agriculture (including possible further overgrazing), urban settlement (involving e.g. possible persecution of bats in rooves, and light pollution), and especially the development of multiple approved and proposed WEFs and solar farms in and around the Beaufort West Renewable Energy Development Zone or REDZ (https://egis.environment.gov.za/renewable_energy).					
Residual Risks: Some roosting bats could be impacted wherever trees are cleared for construction of the wind farm. Since trees are scattered throughout the study area, it is presumed that impacted bats should find alternative trees for roosting.					

Nature: Destruction, degradation, and fragmentation of and displacement from foraging habitat			
Impact description: Construction of the WEF will cause destruction, degradation, and fragmentation of natural shrubland and trees where, respectively, aerial-foraging, and clutter and clutter-edge foraging bat species are likely to forage. Without careful planning, there could during construction also be destruction or disturbance of dams, reservoirs, drainage lines, and flood plains which provide bats (permanently, seasonally, or occasionally) with essential drinking water, concentrated insect prey, and/or which may represent important beacons or pathways for bat navigation and commuting. Furthermore, during operation, certain bats may be displaced from suitable foraging areas if they avoid the WEF (e.g. due to light pollution or obstruction to movement) or suffer fatality from collision with turbines.			
	Rating	Motivation	Significance
Prior to Mitigation			

Duration	Permanent	5	Natural terrestrial habitat will be permanently lost wherever WEF infrastructure is developed.	55	Medium Negative
Extent	On-site	1	Construction activities are likely to impact only onsite terrestrial habitat.		
Magnitude	Moderate	5	There will be loss and fragmentation of terrestrial habitat wherever WEF infrastructure is developed. 34% of turbines are proposed in Medium-High sensitive areas.		
Probability	Definite	5	Construction activities will definitely involve destruction, degradation, and fragmentation of terrestrial habitat.		
Mitigation/Enhancement Measures					
Mitigation: • Avoid High sensitive areas (especially dams, functional reservoirs, and major drainage lines, and the prescribed buffers around these). • Minimize disturbance of Medium-High sensitive areas (secondary drainage lines, and the prescribed buffers around these). • Minimize the length and breadth of proposed roads to thus minimize the clearing and disturbance of natural areas (including potential bat foraging habitat). • Minimize degradation of terrestrial habitat (potential bat foraging habitat) by implementing and maintaining effective invasive alien plant, stormwater, erosion, sediment, and dust control measures. • Minimize artificial lighting on site (excluding compulsory civil aviation lighting) - especially high-intensity, steady-burning, sodium vapour, quartz, halogen, and other bright lights at substations, offices, and turbines (to avoid disturbing certain sensitive bat species). All non-aviation lights should be hooded downward and directed to minimise horizontal and skyward illumination. Where possible, solar-powered motion-sensitive lights should be used. • Rehabilitate disturbed terrestrial habitat and water resources (bat foraging habitat) based on consultation with an appropriate experienced specialist(s).					
Post Mitigation/Enhancement Measures					
Duration	Long-term	4	Terrestrial habitat may partially re-establish where disturbed areas are rehabilitated after construction and decommissioning.	28	Low Negative
Extent	On-site	1	Natural terrestrial habitat will likely only be lost on site.		
Magnitude	Minor	2	If loss and fragmentation of terrestrial habitat are minimized, the magnitude of this impact will be reduced.		
Probability	Highly Probable	4	It is highly probable that natural terrestrial habitat will be lost, even where disturbed areas are subject to rehabilitation.		
Cumulative impacts: Hydrological features, trees, shrubland, and other natural terrestrial habitat (e.g. rocky terrain) are likely to be increasingly impacted by ongoing livestock, crop farming, and other agricultural activities, urban settlement, and especially the development of multiple approved and proposed WEFs and solar farms in and around the Beaufort West REDZ.					
Residual Risks: Terrestrial habitat will be permanently lost wherever WEF infrastructure is developed. Even if all the infrastructure is decommissioned, it is unlikely that the footprint will be rehabilitated to allow natural habitat to fully recover.					

Nature: Bat fatalities from collision with turbines, and potential population declines					
Impact description: During operation of the WEF, there will be inevitable fatality of bats from their collision with turbines, and possible barotrauma.					
	Rating		Motivation	Significance	
Prior to Mitigation					
Duration	Long-term	4	Bat fatalities will occur throughout the life of the WEF, especially without mitigation.	75	High Negative
Extent	Regional	3	Certain bat species cover large distances, and if the WEF causes fatalities of bats from near and far afield, onsite, local, and possibly even regional bat populations could be impacted.		
Magnitude	High	8	Appreciable bat fatalities are anticipated considering that: i) the most prevalent onsite species all have a High Risk of fatality from turbines; and ii) a slightly above-average levels of bat activity were recorded onsite compared to other sites in the Nama Karoo ecoregion.		
Probability	Definite	5	Bat fatalities at a WEF are inevitable without mitigation.		
Mitigation/Enhancement Measures					
Mitigation: • Avoid High sensitive areas (including all confirmed roosts, dams, functional reservoirs, and major drainage lines, and the prescribed buffers around these). • Minimize disturbance of Medium-High sensitive areas (including all potential roosts, secondary drainage lines, and the prescribed buffers around these). • Minimize artificial lighting on site (excluding compulsory civil aviation lighting) - especially high-intensity, steady-burning, sodium vapour, quartz, halogen, and other bright lights at substations, offices, and turbines (to avoid attracting certain insects and bats into the WEF site). All non-aviation lights should be hooded downward and directed to minimise horizontal and skyward illumination. Where possible, solar-powered motion-sensitive lights should be used. • Monitor bat fatalities (and ideally also live bat activity) as soon as the first turbine is operational - as per the latest SABAA guideline for this (Aronson *et al*. 2020 or later) - during the WEF's first two years of operation, and then every fifth year thereafter. The monitoring and data analysis are to be conducted to a high standard so that there is confidence in the estimated numbers of actual bat fatalities. • Mitigate bat fatalities adaptively by consulting the latest SABAA guideline for this (Aronson *et al.* 2020 or later), and the best available relevant scientific information. Adequate financial provision should be made to permit effective monitoring, management, and mitigation of bat fatalities throughout the life of the WEF. If the monitoring and data analysis are poorly performed, and/or if fatalities exceed the WEF's bat fatality threshold (to be calculated as per MacEwan *et al*. 2018 or later), and unless reliable and comprehensive operational monitoring data and a suitably experienced bat specialist indicate otherwise: • Reduce fatalities by implementing curtailment of all problematic turbines below an initial cut-in speed of 6 m/s during temperatures of 12 °C or warmer from sunset to sunrise in February, March, and September. The 6 m/s turbine cut-in wind speed represents the wind speed associated with approximately 50% of bat activity recorded at 130 m above ground level in 2021/2022 by IWS. • Report the annual operational bat monitoring results to SABAA (the South African Bat Assessment Association), EWT (the Endangered Wildlife Trust), and DFFE (the national Department of Forestry, Fisheries, and the Environment). • Forward all (live and fatality) bat monitoring data to the database recommended by SABAA to expand the scientific knowledge base for more informed decision making and mitigation.					

Post Mitigation/Enhancement Measures					
Duration	Long-term	4	Bat fatalities may occur throughout the life of the WEF despite mitigation.	30	Medium Negative
Extent	Local	2	If bat fatalities are largely mitigated, it is assumed that most fatalities will represent bats from local populations.		
Magnitude	Low	4	Effective mitigation should ensure that fatalities do not exceed the calculated bat fatality threshold for the WEF.		
Probability	Probable	3	Even with mitigation, bat fatalities at a WEF are probable.		
Cumulative impacts: Bat fatalities will escalate, and bat population declines will thus become probable with continued urban settlement (involving e.g. possible eviction and persecution of bats in rooves), and especially the development of multiple approved and proposed WEFs in and around the Beaufort West REDZ.					
Residual Risks: Bat fatalities will occur unless bat fatality mitigation measures are 100% effective.					

Nature: Decline or loss of bat ecosystem services					
Impact description: If high bat fatalities lead to declines in certain species populations, the ecosystem services that these populations provide will be compromised. As locally occurring bat species are insectivorous, their eco-services relate to insect (including pest) species predation and population regulation.					
	Rating		Motivation	Significance	
Prior to Mitigation					
Duration	Long-term	4	Bat fatalities will occur throughout the life of the WEF, especially without mitigation.	36	Medium Negative
Extent	Local	2	Local bat eco-services are most likely to be impacted by potential disturbance of onsite roosts, displacement of bats from onsite foraging habitat, and onsite bat fatalities.		
Magnitude	Moderate	6	Local bat ecoservices are not well understood, but it is assumed that the services could be compromised by unsustainable bat fatalities.		
Probability	Probable	3	Bat fatalities at a WEF are inevitable without mitigation.		
Mitigation/Enhancement Measures					
Mitigation: Implement all measures that have been prescribed to mitigate bat roost disturbance/destruction, bat habitat loss, and bat fatalities.					

Post Mitigation/Enhancement Measures					
Duration	Short-term	1	Although bat fatalities may occur throughout the life of the WEF even with mitigation, bat ecoservices might only be compromised in the short-term, for example, after unanticipated mass mortality events following high rainfall and insect activity.	14	Low Negative
Extent	Local	2	If bat fatalities are largely mitigated, it is assumed that most fatalities will represent bats from local populations and therefore, ecoservices of local bats will mainly be impacted.		
Magnitude	Low	4	Effective mitigation should ensure that fatalities do not exceed the calculated bat fatality threshold for the WEF and, presumably, the impact on bat ecoservices will be minor.		
Probability	Improbable	2	So long as bat fatalities remain below the fatality threshold, it is presumably unlikely that local bat eco-services would be impacted.		
Cumulative impacts: Bat ecoservices could be increasingly compromised if bat fatalities escalate and bat population declines occur with development of multiple approved and proposed WEFs in and around the Beaufort West REDZ.					
Residual Risks: This is difficult to predict since bat ecosystem services are poorly understood.					

Table 4 Cumulative impact of the proposed project in isolation, and in combination with other projects in the area

Nature: Impact on bat species, bat habitats, and bat ecosystem services		
	Overall impact of the proposed project if considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (2)	Regional (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (7)	Very High (10)
Probability	Probable (3)	Highly Probable (4)
Significance	Medium (39)	High (68)
Status (positive or negative)	Negative	Negative
Reversibility	High	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: Each and every WEF should: • Avoid High sensitive areas. • Avoid blasting within 2 km of a confirmed roost. • Minimize and rehabilitate disturbed natural areas. • Minimize artificial lighting. • Monitor bat fatalities as per the latest SABAA guideline for this (Aronson *et al*. 2020 or later). • Mitigate bat fatalities adaptively by consulting the latest SABAA guideline for this (Aronson *et al*. 2020 or later), and the best available relevant scientific information. • Report annual operational bat monitoring results to SABAA, EWT, and DFFE. • Forward all bat monitoring data to the database recommended by SABAA.		
Residual impacts: Terrestrial habitat will be permanently lost wherever WEF infrastructure is developed. Bat fatalities will occur at every WEF unless fatality mitigation measures are 100% effective.		

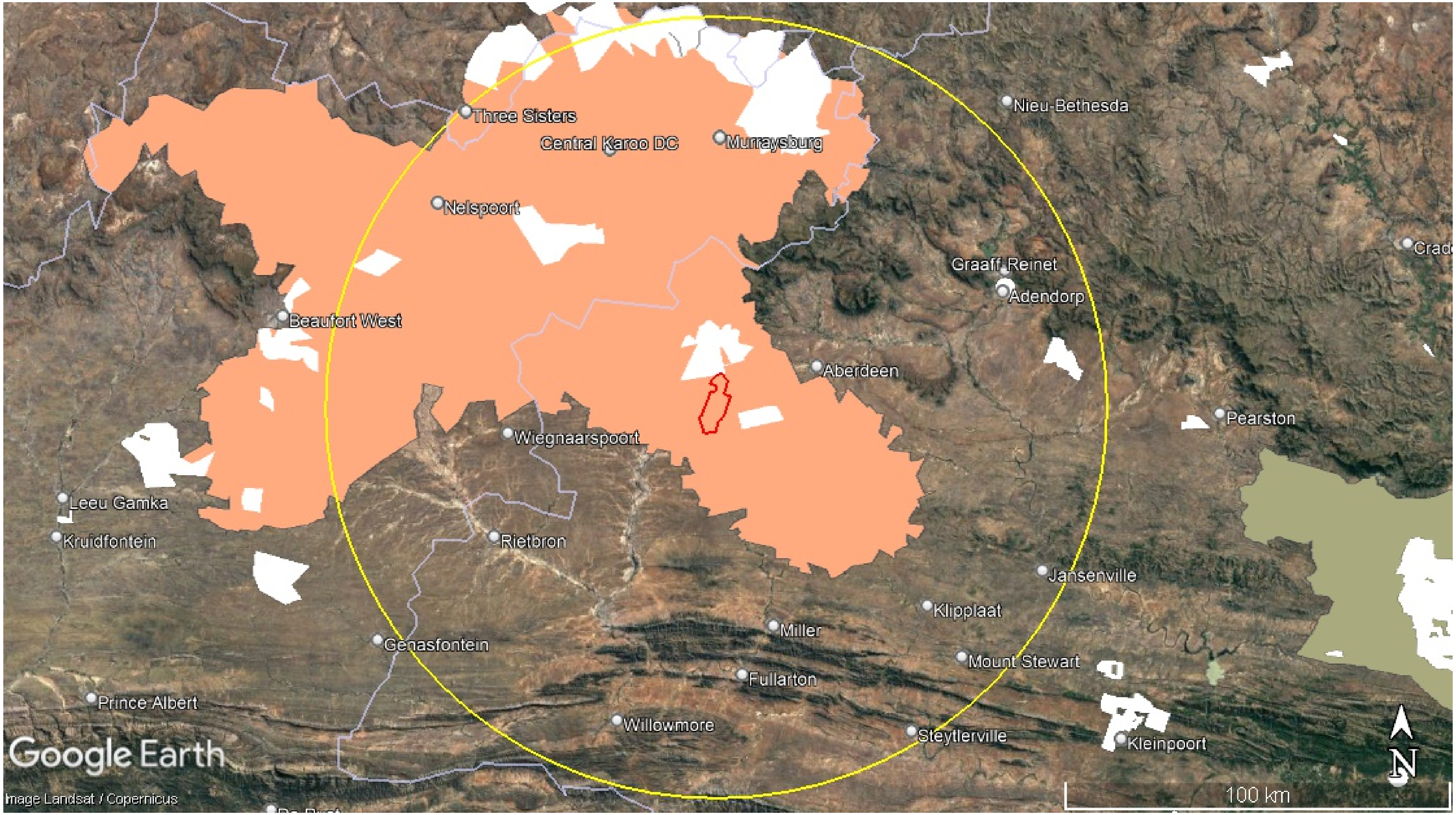


Figure 17 Renewable energy EIA applications (white) in and around a 100 km radius (yellow) of the proposed AWF2 site (red). Applications are concentrated within the Beaufort West (orange) and Cookhouse (olive) REDZs

7.3 Recommended mitigation

Recommended bat impact mitigation measures for the WEF include the following:

- Avoid High sensitive areas. Currently, no proposed WEF infrastructure except certain road sections encroach on High sensitive areas. This is acceptable from a bat impact perspective.
- Avoid blasting within 2 km of a confirmed roost. There are no confirmed roosts in this site.
- Minimize disturbance of Medium-High sensitive areas. Currently, most (66%) of the proposed turbine positions coincide with Medium-Low and/or Medium sensitive areas.
- Minimize the length and breadth of proposed roads to thus minimize the clearing and disturbance of natural areas. Currently, the road network is minimal.
- Minimize degradation of terrestrial habitat by implementing and maintaining effective invasive alien plant, stormwater, erosion, sediment, and dust control measures.
- Minimize artificial lighting on site.

  Rehabilitate disturbed terrestrial habitat and water resources (bat foraging habitat) based on consultation with an appropriate experienced specialist(s).
- Monitor bat fatalities (and ideally also live bat activity) as soon as the first turbine is operational - as per the latest SABAA guideline for this (Aronson *et al.* 2020 or later) - during the WEF's first two years of operation, and then every fifth year thereafter. The monitoring and data analysis are to be conducted to a high standard so that there is confidence in the estimated numbers of actual bat fatalities.
- Mitigate bat fatalities adaptively by consulting the latest SABAA guideline for this (Aronson *et al*. 2020 or later), and the best available relevant scientific information. Adequate financial provision should be made to permit effective monitoring, management, and mitigation of bat fatalities throughout the life of the WEF.
- If the monitoring and data analysis are poorly performed, and/or if fatalities exceed the WEF's bat fatality threshold (to be calculated as per MacEwan *et al*. 2018 or later), and unless reliable and comprehensive operational monitoring data and a suitably experienced bat specialist indicate otherwise: Reduce fatalities by implementing curtailment of all problematic turbines below an initial cut-in speed of 6 m/s during temperatures of 12 °C or warmer from sunset to sunrise in February, March, April, and September. The 6 m/s turbine cut-in wind speed represents the wind speed associated with approximately 50% of bat activity recorded at 130 m above ground level in 2021/2022 by IWS.
- Report the annual operational bat monitoring results to the South African Bat Assessment Association, the Endangered Wildlife Trust, and the national Department of Forestry, Fisheries, and the Environment.
- Forward all (live and fatality) bat monitoring data to the database recommended by SABAA to expand the scientific knowledge base for more informed decision making and mitigation.

The above bat impact mitigation measures must be included in the WEF's authorized Environmental Management Programme (EMPr), as indicated in **Table 5**.

Table 5 Bat monitoring and mitigation requirements to be included in the EMPr for the Aberdeen Wind Facility 2

OBJECTIVE: Avoid bat roost disturbance or destruction		
Project component/s	WEF construction, operation, and decommissioning	
Potential Impact	Roost disturbance or destruction	
Activity/risk source	Blasting, vegetation clearing, excavation works, decommissioning of infrastructure, noise, light, and dust	
Mitigation: Target/ Objective	No confirmed or potential bat roost should be disturbed	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Avoid High sensitive areas (especially confirmed roosts, and the prescribed buffers around these). • Avoid blasting within 2 km of a confirmed roost. • Minimize disturbance of Medium-High sensitive areas (especially potential roosts, and the prescribed buffers around these). • Minimize and rehabilitate disturbed natural areas. • Minimize artificial lighting.	Design team; construction team; contractors; operational staff; Environmental Control Officer (ECO)and team; decommissioning team.	Throughout the life of the WEF.
Performance Indicator	1) Confirmed roosts remain undisturbed. 2) Potential roosts remain undisturbed where possible. 3) Artificial lighting is effectively minimized throughout the life of the WEF.	
Monitoring	Confirmed and potential roosts should be checked during operation and decommissioning.	

OBJECTIVE: Minimize unnecessary disturbance or destruction of natural habitat		
Project component/s	WEF construction, operation, and decommissioning	
Potential Impact	Destruction, degradation, and fragmentation of, and displacement of bats from, foraging habitat	

Activity/risk source	Traffic, laydown of materials, blasting, vegetation clearing, excavation works, construction of infrastructure, operational activities, proliferation of invasive alien flora, erosion, sedimentation, light, other forms of pollution, and decommissioning of infrastructure	
Mitigation: Target/ Objective	No unnecessary disturbance or destruction of natural habitat	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Avoid High sensitive areas. • Minimize disturbance of Medium-High sensitive areas. • Minimize the length and breadth of proposed roads. • Minimize artificial lighting. • Minimize degradation of terrestrial habitat by implementing and maintaining effective invasive alien plant, stormwater, erosion, sediment, and dust control measures. • Rehabilitate disturbed terrestrial habitat and water resources based on consultation with an appropriate experienced specialist(s).	Design team; construction team; contractors; operational staff; ECO and team; decommissioning team.	Throughout the life of the WEF.
Performance Indicator	1) High sensitive areas remain undisturbed. 2) Medium-High sensitive areas remain undisturbed where possible. 3) Remaining areas are minimally disturbed. 3) Existing roads are used to the fullest extent possible to minimize the extent of new roads. 4) Artificial lighting is effectively minimized throughout the life of the WEF. 5) Invasive alien plants, erosion, sedimentation, and dust are effectively controlled throughout the life of the WEF. 6) Disturbed areas are effectively rehabilitated.	
Monitoring	Dust, invasive alien plants, erosion, sedimentation, and rehabilitated areas should be effectively monitored and managed.	

OBJECTIVE: Mitigate bat fatalities from collision with turbines, and potential population declines		
Project component/s	WEF operation	
Potential Impact	Bat fatalities from collision with turbines, and potential population declines	

Activity/risk source	Operation of turbines between sunset and sunrise	
Mitigation: Target/ Objective	The annual estimated number of actual bat fatalities must not exceed the WEF's bat fatality threshold calculated as per MacEwan *et al*. 2018 (or later)	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Monitor bat fatalities as soon as the first turbine is operational - as per Aronson *et al*. 2020 (or later) - during the WEF's first two years of operation, and then every fifth year thereafter. • Mitigate bat fatalities adaptively by consulting Aronson *et al.* 2020 (or later), and the best available relevant scientific information. If the monitoring and data analysis are poorly performed, and/or if fatalities exceed the WEF's bat fatality threshold: • Reduce fatalities by implementing curtailment of all problematic turbines below an initial cut-in speed of 6 m/s during temperatures of 12 °C or warmer from sunset to sunrise in February, March, and September. • Report the annual monitoring results to SABAA, EWT and DFFE. • Forward all bat monitoring data to the database recommended by SABAA.	WEF owner; ECO; appointed bat specialist and carcass searchers; operational staff.	Throughout the life of the WEF.
Performance Indicator	1) Operational bat monitoring is performed as per Aronson *et al*. 2020 (or later). 2) Bat fatalities remain below the WEF's bat fatality threshold, calculated as per MacEwan *et al*. 2018 (or later). 3) If/When the bat fatality threshold is exceeded, this is promptly mitigated by implementing turbine curtailment (as described herein) *or better*. 4) The WEF's operational bat monitoring reports are submitted to SABAA, EWT, and DFFE.	

Monitoring	Bat fatality monitoring should be diligently performed from when the first turbine is operational, through the first two years of operation, and at least every fifth year thereafter throughout the life of the WEF.

8. Conclusion

IWS does not object to approval of the Aberdeen Wind Facility 2 as it is currently proposed, provided that the bat impact mitigation measures prescribed herein are diligently implemented during the relevant project phases.

Going forward it is suggested that the feasibility of the prescribed turbine curtailment should be tested prior to finalization of the project - for in case bat fatalities at some point exceed the calculated bat fatality threshold for the WEF. The impact of the prescribed curtailment on the financial feasibility of the wind farm could be explored by using the available weather data from site to obtain estimates of the number of turbine night hours per annum during which curtailment would need to be implemented and, consequently, how much turbine energy production could potentially be lost. The results should be used to ensure that there is adequate financial provision to accommodate curtailment during operation.

9. References

African Chiroptera Report (2020). Website: https://africanbats.org/publications/african-chiroptera-report/. Accessed in July 2021.

Aronson, J. (2022). Current state of knowledge of wind energy impacts on bats in South Africa. *Acta Chiropterologica* 24: 221-238.

Aronson, J., Richardson, E., MacEwan, K., Jacobs, D., Marais, W., Taylor, P., Sowler, S., Hein. C. and Richards, L. (2020). *South African Good Practice Guidelines for Operational Monitoring for Bats at Wind Energy Facilities.* Edition 2. South African Bat Assessment Association, South Africa.

Blakey, R.V., Law, B.S., Straka, T.M., Kingsford, R.T. and Milne, D.J. (2018). Importance of wetlands to bats on a dry continent: a review and meta-analysis. *Hystrix*.

CDNGI. (2020). Northern Cape Geodatabase. Website: cdngiportal.co.za/cdngiportal. Accessed in 2020.

Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D., and Davies-Mostert, H.T. (2016). *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

FIAO (FitzPatrick Institute of African Ornithology) (2021). Virtual Museum. Website: http://vmus.adu.org.za/. Visited in July 2021.

iNaturalist (2021). Website: https://www.inaturalist.org/. Accessed in July 2021.

IUCN (2021-1). IUCN Red List of Threatened Species. Version 2020-1. Website: www.iucnredlist.org. Visited in July 2021.

MacEwan, K.L. (2016). Fruit bats and wind turbine fatalities in South Africa. *African Bat Conservation News*, 42, 3-5.

MacEwan, K., Richards, L.R., Cohen, L., Jacobs, D., Monadjem, A., Schoeman, C., Sethusa, T., Taylor, P.J. (2016). A conservation assessment of *Miniopterus natalensis*. In Child, M.F., Roxburgh, L., DoLinh San, E., Raimondo, D., Davies-Mostert, H.T., editors. *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

MacEwan, K., Aronson, J., Richardson, E., Taylor, P., Coverdale, B., Jacobs, D., Leeuwner, L., Marais, W., Richards, L. (2018). *South African Bat Fatality Threshold Guidelines*. Edition 2. South African Bat Assessment Association, South Africa.

MacEwan, K., Sowler, S., Aronson, J. and Lötter, C. (2020a). South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities. Edition 5. South African Bat Assessment Association. South Africa.

MacEwan, K.L., Morgan, T.W., Lötter, C.A. and Tredennick, A.T. (2020b). Bat activity across South Africa: implications for wind energy development. *African Journal of Wildlife Research,* 50, 212–222.

Miller-Butterworth, C.M., Jacobs, D. and Harley, E.H. (2003). Strong population substructure is correlated with morphology and ecology in a migratory bat. *Nature*, 424: 187-191.

Monadjem, A., Taylor, P.J., Cotterill, F.P.D. and Schoeman M.C. (2020). B*ats of southern and central Africa – A biogeographic and taxonomic synthesis*. Wits University Press, Johannesburg.

Pretorius, M., Broders, H. and Keith, M. (2020). Threat analysis of modelled potential migratory routes for Miniopterus natalensis in South Africa. *Austral Ecology*, 45, 1110- 1122.

Salata, H.A.B. (2012). *Environmental factors influencing the distribution of bats (Chiroptera) in South Africa*. PhD thesis. University of Cape Town, South Africa.

Serra-Cobo J., López-Roig M., Marquès-Lopez T., and Lahuerta E. (2000). Rivers as possible landmarks in the orientation flight of *Miniopterus schreibersii*. *Acta Theriologica,* 45, 347-352.

Sirami, C., Jacobs, D.S. and Cumming, G.S. (2013). Artificial wetlands and surrounding habitats provide important foraging habitat for bats in agricultural landscapes in the Western Cape, South Africa. *Biological Conservation,* 164, 30-38.

10. Appendix: CV of Dr Caroline Lötter

Name:	**DR CAROLINE ANGELA LöTTER (NEÉ YETMAN)**
Name of Firm:	Inkululeko Wildlife Services (Pty) Ltd
Position:	Managing Director
Date of Birth:	6 November 1979
Nationality:	South African
Languages:	English, Afrikaans

QUALIFICATIONS & PROFESSIONAL REGISTRATION

- PhD – Zoology (University of Pretoria: 2003-2011)
- MSc – African Mammalogy (University of Pretoria: 2002)
- BSc Hons – Zoology (University of Pretoria: 2001)
- BSc – Ecology (University of Pretoria: 1998-2000)
- Registered with SACNASP (no. 400182/09) as a Professional Natural Scientist in the field of Zoology

KEY EXPERIENCE

- **Specialist Assessments:**
  - Long-term bat monitoring at more than 30 wind farm sites in southern Africa, including field work, desktop research, report writing, and project management.
  - Surveys and impact assessments for the Square Kilometre Array project and several bat caves.
  - Baseline and impact assessments for fauna in general at over 100 sites in South Africa.
  - Biodiversity Management Plans for large South African mining complexes.
  - Specialist Giant Bullfrog assessments for more than 50 proposed development sites.

EMPLOYMENT EXPERIENCE

- **Inkululeko Wildlife Services, Johannesburg (June 2019 – present)**
  Position Title: Managing Director
  - Bat project management
  - Proposals
  - Desktop research
  - Field work
  - Reporting and report reviews
  - Analysis and reporting of data for peer-review publication
  - Co-author of South African pre-construction bat monitoring guidelines (MacEwan *et al*. 2020a)
  - Co-author of article on bat activity in South Africa and its implications for wind farm development (MacEwan *et al.* 2020b)
- **Natural Scientific Services, Johannesburg (November 2011 – April 2019)**
  Position Title: Senior Zoologist
  - Bat, faunal, and general biodiversity (i.e. faunal, flora, wetland and aquatic) project management
  - Proposals
  - Desktop research
  - Field work
  - Reporting and report reviews
  - Analysis and reporting of data for peer-review publication