Pre-construction Bat Monitoring and Comparative Impact Assessment for the Richtersveld Wind Energy Facility

Compiled By:

Inkululeko Wildlife Services

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

Mobile: +27 (0) 82 321 3914
Website: www.rina.org
Postal: 20 Kloof Street, Gardens
2nd Floor, Rozenhof Office Court
8001, Cape Town

IWS Ref No: 3157

Date: July 2022

Declaration of Independence

Inkululeko Wildlife Services (Pty) Ltd (IWS) is an independent consultancy. IWS has no legal or financial connection with the developer or the environmental assessment practitioner (EAP), except for fulfilling 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 Dominique Greeff and Dr Caroline Lötter and reviewed by Kate MacEwan. Caroline and Kate were the senior specialists on this project, and both are 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.	Kate MacEwan, Pr. Nat. Sci.	Dominique Greeff

Copyright Warning

Executive Summary

Richtersveld Wind Farm (Pty) Ltd intends to develop the Richtersveld Wind Energy Facility (WEF) near Alexander Bay in the Northern Cape. Pre-construction bat monitoring and impact assessment for the Richtersveld WEF was performed by Natural Scientific Services (NSS 2013), and an Environmental Authorization for the WEF was granted.

Richtersveld Wind Farm (Pty) Ltd now intends to request a reduction in the overall number of turbines, and an increase in turbine height and rotor diameter for all remaining turbines. The layout of the WEF turbines, road network, onsite substation, construction laydown areas, buildings, internal power lines and fencing has also been revised.

As the five-year validity of the NSS (2013) bat study has expired, Inkululeko Wildlife Services (Pty) Ltd (IWS) was appointed to undertake six additional months of pre-construction bat monitoring to inform a comparative bat impact assessment for the project amendment. Presented in this report are the six-month monitoring results, an updated bat sensitivity map, and a comparative bat impact assessment with recommended impact mitigation measures for the proposed Richtersveld WEF.

The additional six-month bat data were collected from three onsite passive acoustic monitoring stations between 16 November 2021 and 24 May 2022. Where possible, the six-month IWS monitoring results were compared to applicable data from the NSS (2013) monitoring study for the periods 19 April - 24 May 2012 and 16 November 2012 - 18 April 2013.

The most salient findings from the monitoring are as follows:

- A few calls resembling those of the endemic and regionally Near Threatened Angolan Hairy Bat (*Cistugo seabrae*) were recorded for the first time onsite. A few calls of the endemic Cape Horseshoe Bat (*Rhinolophus capensis*) were also recorded onsite, as was the case in 2012/2013. Although these priority conservation bat species both have a Low risk of fatality from turbines (MacEwan *et al*. 2020a), one fatality per annum of either species will trigger mitigation as stipulated in the South African bat fatality threshold guidelines (MacEwan *et al.* 2018).
- The Egyptian Free-tailed Bat remained the dominant species in the turbine rotor sweep zone, suggesting that during operation, this species will comprise most turbine-related bat fatalities.
- Near ground level a greater diversity of six bat species was recorded, which will be at greater risk of fatality from turbines with blades that approach closer to ground level - especially in autumn, when the call proportion of Natal Long-fingered Bats was greatest at all stations.
- The higher levels of bat activity recorded near ground level (and extrapolated for rotor sweep height) during 2021/2022, relative to 2013/2014, were at least partly due to the more sensitive bat recording technology used, and the higher (100%) recording success in 2021/2022.
- During 2012/2013 and 2021/2022, in both rotor sweep height and near ground level, nights with high activity of Egyptian Free-tailed, Cape Serotine, and Natal Long-fingered bats were most common in autumn. The 12-month NSS (2013) study revealed that there was also elevated activity of these species during spring (which was not sampled in 2021/2022). To mitigate bat fatalities, turbine curtailment should be applied at the very least during February and March, when peaks in the activity of Egyptian Free-tailed Bats were most common.
- To mitigate fatalities of the three bat species most prevalent onsite, curtailment should be implemented, at the very least between 21:30 and 04:00, but preferably throughout the night (from sunset to sunrise).

Within the amended Richtersveld WEF site:

- High bat sensitive areas include:
  - Two rocky outcrops, and a 500 m buffer around these.
  - An onsite building, and a 200 m buffer around this.
  - Dry pans, and a 200 m buffer around these.
- Remaining areas were rated with Medium sensitivity.

There must be no development of turbines, quarries, construction camps, laydown areas, buildings, substations, or battery energy storage systems in High sensitive areas.

Infrastructure amendments, which are expected to reduce potential impacts on bats include the:

- Fewer number of (32, not 70) turbines and, therefore, 38 fewer turbine towers, and fewer turbine lights – which otherwise might attract bats.
- Slightly higher reach of the lowest blade tip (42,5 m, not 41,5 m above ground level [a.g.l.]) – which is expected to very slightly reduce the fatality risk of low-flying bat species.
- 111 416 m^2 (55%) smaller total turbine terrestrial disturbance footprint of 91 584 m^2 – not 203 000 m^2.
- Potentially smaller total terrestrial disturbance footprint of the WEF road network - depending on the width and total length of all proposed new roads, and existing roads to be upgraded, under authorization, and for amendment.

Infrastructure amendments, which are expected to increase potential impacts on bats include the:

- 2.27% Larger total rotor swept area (769 696 m^2, not 752 570 m^2).

Layout amendments, which are expected to reduce potential impacts on bats include the:

- Positioning of all turbines (including their full rotor diameter, plus a 2 m pressure buffer) outside of all High sensitive areas - except for Turbine 17, which will encroach by approximately 20 m into the 500 m buffer around a rocky outcrop if fitted with 87.5 m blades. Under the authorized layout, eight turbines (*viz.* Turbines 7, 10, 20, 25, 29, 55, 58 and 59) are proposed in or will encroach into High sensitive areas.

- >50% smaller turbine "area of influence" (the minimum convex polygon around all turbines and their blades) of the amended project, compared to that of the authorized project.

No layout amendment is expected to increase potential impacts on bats, relative to the authorized layout.

Without mitigation the amended WEF is expected to have a Moderate significant potential impact on bat roosts, bat foraging, and bat ecosystem services, and a potential Major significant impact in terms of turbine bat fatalities, and potential bat population species declines.

With diligent, effective mitigation as recommended in this report, the amended WEF's potential impact on bat foraging, fatalities, populations, and ecosystem services could be reduced to Minor significance, and the potential impact on bat roosts could be reduced to Negligible significance.

An important consideration is the potential cumulative impact on bats from the proposed Richtersveld WEF and various other proposed WEFs in the surrounding region. Existing wind farms in the region include, but may not be limited to, the Kangnas, Kohbab, and Loeriesfontein facilities. The potential added impact of the Richtersveld WEF to the cumulative impact of existing WEFs in the region was rated with Moderate significance in the absence of any mitigation. With effective mitigation, the contribution of the proposed Richtersveld WEF to the cumulative impact of existing operational wind farms in the region, was rated as Minor.

Key recommended bat impact mitigation measures for the project include the following:

- Avoid High sensitive areas. Where necessary, the WEF layout must be adjusted to ensure that turbines, quarries, construction camps, and laydown areas avoid all High sensitive areas. Under the amended WEF layout there is no encroachment into High sensitive areas from the onsite substation complex, nor any turbine (with 87.5 m blades plus a 2 m pressure buffer) – except for Turbine 17, which should be shifted by at least 20 m to avoid the 500 m buffer around a rocky outcrop.
- Minimize the road network to minimize the clearing and disturbance of natural areas.
- Minimize artificial lighting on site.
- Minimize degradation of terrestrial habitat by implementing and maintaining effective erosion, stormwater, and potential invasive alien plant control measures.
- Implement curtailment of all turbines in February and March (when major peaks in the activity of Egyptian Free-tailed Bats were most common), between sunset and sunrise, below a cut-in wind speed of 6.9 m/s, when atmospheric temperature is ≥8.5 °C. Wind speeds below 7 m/s (measured at 80 m above ground level) were associated with approximately 93% of all bat activity recorded at 10 m above ground level in 2012/2013 (NSS 2013), and the 6.9 m/s cut-in wind speed is a US Fish and Wildlife Service recommended cut-in speed for avoiding fatality impacts on priority species (Maclaurin *et al.* 2022).
- Perform operational bat monitoring as soon as the first turbine is operational - as per the latest South African guidance for this (Aronson *et al*. 2020 or later). The quality of the operational monitoring and data analysis are to be conducted to a high standard so that there is confidence in the data and the fatality estimate results. If the operational monitoring and data analysis are not conducted properly as per Aronson *et al*. 2020 (or later), more rigorous turbine curtailment must be implemented.
- Adaptively manage and mitigate bat fatalities by consulting the South African bat monitoring guidelines for operational wind farms (Aronson *et al*. 2020 or later), the South African bat fatality threshold guidelines (MacEwan *et al*. 2018 or later), and the best available relevant scientific information. The specialist conducting the Year 1 and Year 2 operational monitoring should provide recommendations for adaptive management and mitigation of bat fatalities on a six- and 12-month basis at the very most. Allowance should be made in the financial provision for adaptive management and mitigation of bat fatalities. If one or more fatalities of a conservation priority bat species is recorded, and/or if the overall bat fatality threshold is exceeded (determined as per MacEwan *et al*. 2018 or later), further adaptive management and mitigation (possibly including greater curtailment) must be implemented without delay.

Considering that: i) the amended WEF infrastructure and layout are expected to markedly reduce potential impacts on bats (relative to the authorized project); and ii) potential direct residual impacts of the amended project were rated with Minor or Negligible significance, IWS does not object to authorization of the amended Richtersveld WEF project provided that all turbines, quarries, construction camps, and laydown areas avoid all High sensitive areas, and that the conditions of authorization include all the bat impact mitigation measures recommended herein by IWS.

Table of Contents

List of Figures

List of Tables

1. Introduction

Richtersveld Wind Farm (Pty) Ltd intends to develop the Richtersveld Wind Energy Facility (WEF) situated approximately 22 km south-east of Alexander Bay in the Northern Cape. Pre-construction bat monitoring and impact assessment for the Richtersveld WEF was performed by Natural Scientific Services (NSS 2013), and an Environmental Authorization (EA) for the WEF was granted.

Richtersveld Wind Farm (Pty) Ltd now intends to request a reduction in the overall number of turbines, and an increase in turbine height and rotor diameter for all remaining turbines. Turbine foundation areas will be smaller, and turbine laydown areas will remain as authorized. The layout of the WEF turbines, road network, onsite substation, construction laydown areas, buildings, internal power lines and fencing has also been revised.

Provided in **Table 1** is a summary of the authorized, versus the amended infrastructure details, which are most applicable to this assessment, and which were supplied to IWS. The authorized and amended infrastructure layouts are shown in **Figure 1**.

Table 1 Summary of relevant details for the Richtersveld WEF under authorization vs. for the EA amendment

Component / Specification	Authorised	Proposed change
Site access	New roads will be created in addition to some existing roads that will be upgraded. The length and breadth of the authorized road network was uncertain.	New roads will be created in addition to some existing roads that will be upgraded. The length and breadth of the amended road network was uncertain.
Generation capacity	225 MW generation	224 MW generation
Number of turbines	70	32
Turbine generation capacity	Between 2 and 3 MW	Approximately 7 MW
Hub height from ground level	100 m	130 m
Rotor diameter	117 m	175 m
Blade length	Up to 58.5 m – not specified in EA	Up to 87.5 m – not specified in EA
Blade tip height	Up to 158.5 m	Up to 217.5 m
Turbine foundation area	400 m^2	362 m^2
Turbine laydown area	2 500 m^2	2 500 m^2
Area occupied by substation	Uncertain	Uncertain
Capacity of substation	Uncertain	Uncertain
Area occupied by construction laydown areas	Uncertain	Uncertain
Location of construction camps / laydown areas	Uncertain	Uncertain
Area occupied by buildings	Uncertain	Uncertain
Internal power line/cables	All power lines linking wind turbines to each other and to the internal substation will be buried.	Condition remains applicable. No amendment required.

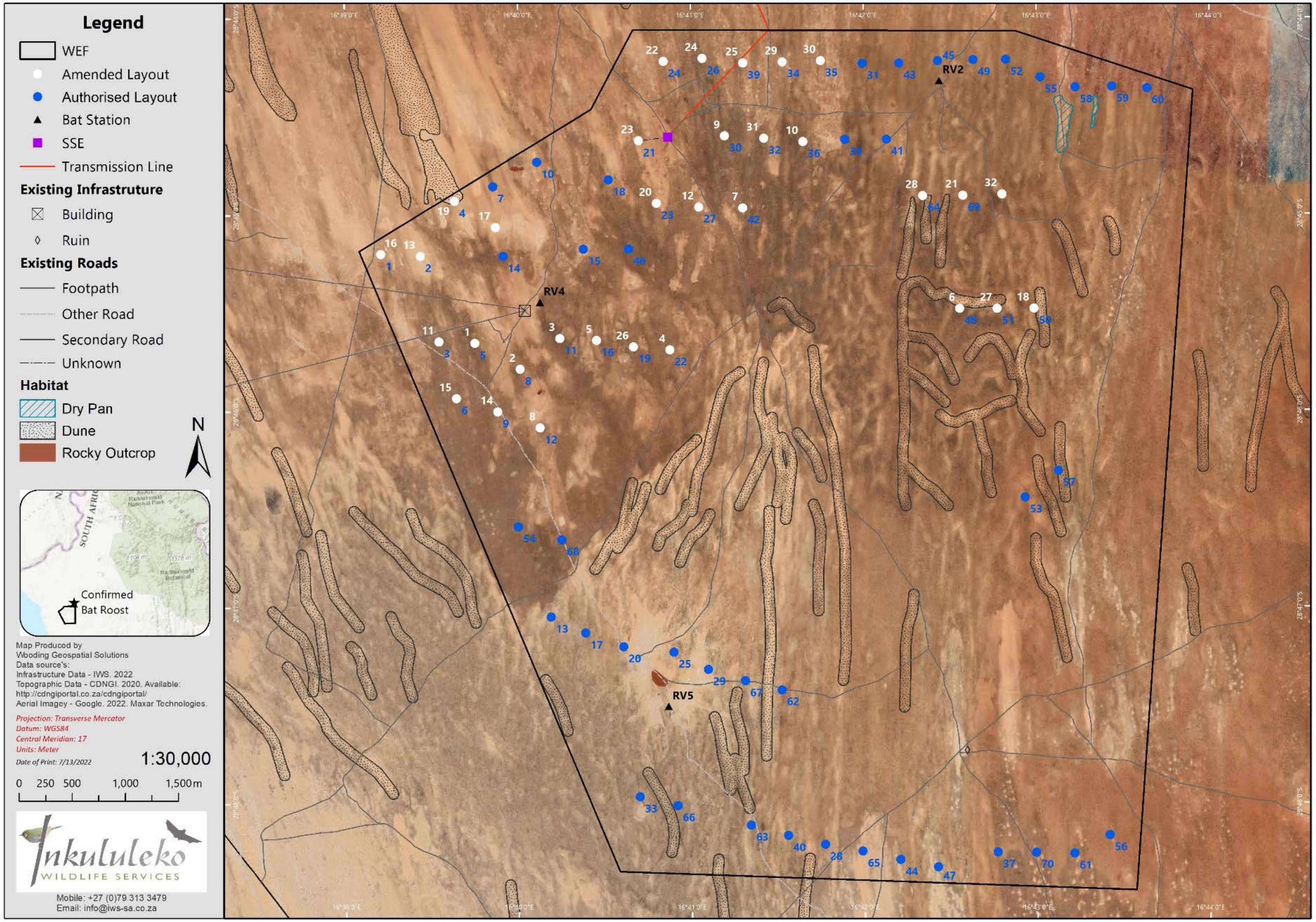


Figure 1 **Richtersveld WEF authorised (blue) and currently proposed (white) turbine layout**

As the five-year validity of the NSS (2013) bat study has expired, Inkululeko Wildlife Services (Pty) Ltd (IWS; **Appendix 1**) was appointed to undertake six additional months of pre-construction bat monitoring to inform a comparative bat impact assessment for the project amendment.

The specific objectives of IWS's bat specialist scope of work were to determine:

- Whether there is any appreciable difference between the six-month and the 2012/2013 monitoring periods for:
  - site species richness i.e. the number of recorded (especially conservation priority) bat species;
  - bat species composition recorded in turbine rotor sweep height and near ground level;
  - overall and species-specific activity levels of bats at the different monitoring heights;
  - overall and species-specific spatial pattern of recorded bat activity.
  - seasonal pattern of overall and species-specific bat activity (especially in terms of possible migration).
  - season-specific nightly (sunset to sunrise) pattern of overall and species-specific bat activity.
- The relative importance/sensitivity of different features/habitats in the study area for bats based on the six month and the 2012/2013 monitoring results.
- The overall importance/sensitivity of the site based on e.g. the proximity of protected areas and regionally important cave roosts, and the average level of recorded in situ bat activity relative to that recorded at other previous IWS bat monitoring sites in the same, or similar ecoregion (MacEwan *et al.* 2020b).
- The significance of potential direct, indirect, and cumulative impacts on bat habitats and taxa during construction, operation, and decommissioning of the amended, versus the authorized, WEF project.
- Effective project-/site- and habitat-specific bat impact mitigation measures.

Presented in this report are the six-month monitoring results, an updated bat sensitivity map, and a comparative bat impact assessment with recommended impact mitigation measures for the proposed Richtersveld WEF amendment. Where possible, the six-month IWS monitoring results were compared to analogous results of NSS (2013).

2. Terms of reference

The IWS bat specialist input was based on the following agreed scope of work:

1. Desktop review
   - A desktop review of pertinent information.
2. Monitoring
   - Six months of pre-construction bat monitoring, which will be analogous to the 2012/2013 monitoring so far as this is technically and logistically possible, and acceptable under the current guidelines.
3. Assessment and Reporting
   - Comprehensive analysis of the six-month data - in relation to applicable 2012/2013 data, which may require "correction" due to improvements in technology and data analysis.
   - Compilation of a Comparative Bat Impact Assessment (IA) Report, including recommended bat impact mitigation measures.
   - Compilation of a Report Addendum containing the results from the additional monitoring in relation to applicable data from the 2012/2013 monitoring.

However, due to the specific reporting requirements of RINA Consulting Ltd (RINA), the six-month monitoring results and comparative impact assessment were combined in this report (i.e. the monitoring results are not provided in a separate addendum).

3. Bat monitoring

3.1 Methodology

During the NSS (2013) monitoring study, passive acoustic recording of bat call activity was performed using Wildlife Acoustics SongMeter 2 bat (SM2BAT) detectors and SMX-US microphones installed at approximately 9.5 m above ground level (a.g.l.) on 10 m telescopic aluminium poles at three locations referred to as RV1, RV3, and RV5, and at 10 m and 79 m a.g.l. on 80 m meteorological (met.) masts at two locations referred to as RV2 and RV4.

For the additional six months of monitoring, bat call activity was monitored using SM2BAT detectors and SMX-U1 microphones installed at approximately 9.5 m on 10 m aluminium poles at the three previous monitoring locations RV2, RV4, and RV5 (**Figure 1**). For the purposes of the comparative impact assessment, the six-month monitoring data were compared with that obtained at RV2, RV4, and RV5 during the same periods in 2012/2013.

The data were processed and analyzed using Wildlife Acoustic's Kaleidoscope, Titley Scientific's Analook, and MicroSoft's Excel software programmes. For the NSS (2013) report, the data were only analysed in terms of bat groups or guilds. Due to subsequent improvements in computing power, the 2021/2022 data were analysed, and the 2012/2013 data were re-analysed, in terms of bat species.

In 2012/2013, the detectors were set to record intermittently (every alternate 10 or 30 minutes through the night). In 2021/2022, the detectors recorded continuously through the night. The 2012/2013 data were corrected to account for the intermittent recording during those years. The 2012/2013 data were further corrected to account for differences in the sensitivity of the microphones that were used between the two monitoring periods. The corrective factors that were applied were derived from an experiment performed by IWS.

Most importantly, an extrapolation of the available near ground data was performed to *estimate* the levels of bat activity data that occurred in rotor sweep height during the six-month monitoring period. The extrapolation was necessary because onsite met. masts were no longer available in 2021 for installation of bat monitoring equipment in rotor sweep height. **IWS agreed to undertake the six-month monitoring, and the South African Bat Assessment Association approved the extrapolation (pers. comm. with SABAA in October 2021), ON CONDITION that:**

- The Client tries to obtain pre-construction and operational bat data from nearby WEFs, so far as the latter are willing to oblige, and so far as the Client's finances permit. To this end IWS: i) compared the latest monitoring results with confidential pre-construction bat monitoring data obtained by IWS Team members from two other proposed WEF sites within 150 km of the proposed Richtersveld WEF site; and ii) consulted bat activity and fatality data received by IWS from the operational Kangnas, Khobab, and Loeriesfontein wind farms situated up to ca. 250 km to the south-east.
- **The Client agrees to strictly adhere to operational bat monitoring at the Richtersveld WEF.**
- **The Client accepts that mitigation measures might have to be implemented at the Richtersveld WEF if bat fatalities exceed threshold levels** (determined as per the current or subsequent versions of the guidelines by MacEwan *et al*. 2018).

3.2 Results and discussion

3.2.1 Recording success

In 2012/2013, gaps in the passive acoustic recording of bat activity in rotor sweep height (i.e. at 79 m a.g.l.) at both RV2 and RV4 were caused by faults with microphones and/or batteries (**Figure 2**). Consequently, very few bat calls were recorded in rotor sweep height in 2012/2013 and, therefore, **the extrapolated levels of bat activity in rotor sweep during 2021/2022 may be lower than they were in reality.** In 2012/2013 there was also a gap in recording at RV5 between 27 November 2012 and 20 February 2013 due to water damage to the detector. Between 16 November 2021 and 24 May 2022, recording was 100% successful (**Figure 2**).

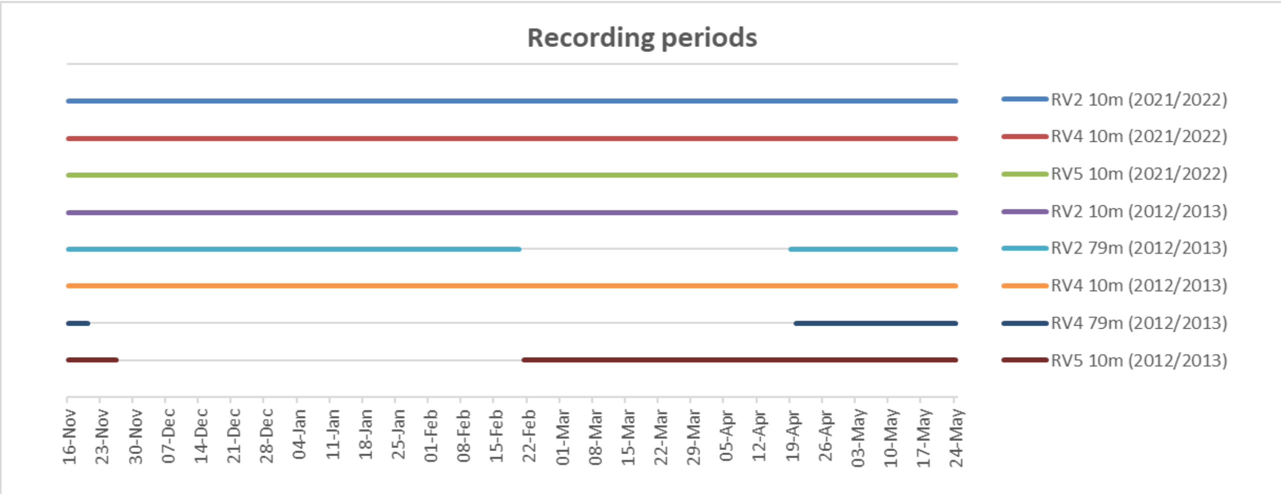


Figure 2 Recording success at bat monitoring stations between 16 November and 24 May in 2021/2022 and 2012/2013

3.2.2 Bat species composition at different heights and localities

During both the 2012/2013 and 2021/2022 monitoring periods, the three most prevalent bat species recorded on site were the Egyptian Free-tailed Bat (*Tadarida aegyptiaca*), Cape Serotine (*Laephotis capensis*), and Natal Long-fingered Bat (*Miniopterus natalensis*). Some calls of Robert's Flat-headed Bat (*Sauromys petrophilus*) and the endemic Cape horseshoe Bat (*Rhinolophus capensis*) were also recorded both in 2021/2022 and 2012/2013, but not at all localities. **For the first time onsite (near ground level) at RV2 in autumn 2022, a few calls were recorded, which resembled those of the Angolan Hairy Bat (*Cistugo seabrae*), which is endemic and regionally Near Threatened (Child *et al.* 2016).** This elevated the number of confirmed bat species at the Richtersveld WEF site from five to six.

The six recorded bat species are all Protected in the Northern Cape (Northern Cape Nature Conservation Act 9 or 2009), and all have a High risk of fatality from collision with turbines except for the priority conservation Angolan Hairy Bat and Cape Horseshoe Bat, which both have a Low fatality risk (MacEwan *et al.* 2022a). However, one fatality per annum of either species will trigger mitigation as stipulated in the South African bat fatality threshold guidelines (MacEwan *et al.* 2018).

In 2012/2013 at 79 m a.g.l. 100% of the recorded calls were made by the Egyptian Free-tailed Bat, and the extrapolated data suggest that this species remained dominant in turbine rotor sweep height in 2021/2022 (**Figure 3**). The dominance of the Egyptian Free-tailed Bat in rotor sweep height appeared to be consistent between monitoring localities RV2 and RV4, and showed no appreciable change between summer and autumn. No calls of the Natal Long-fingered Bat or any other species were recorded at 79 m in 2012/2013. These results suggest that **during operation of the Richtersveld WEF, Egyptian Free-tailed Bats will comprise the majority of turbine-related bat fatalities.** At the Khobab and Loeriesfontein WEFs, this species has comprised most of the turbine-related bat fatalities known to IWS.

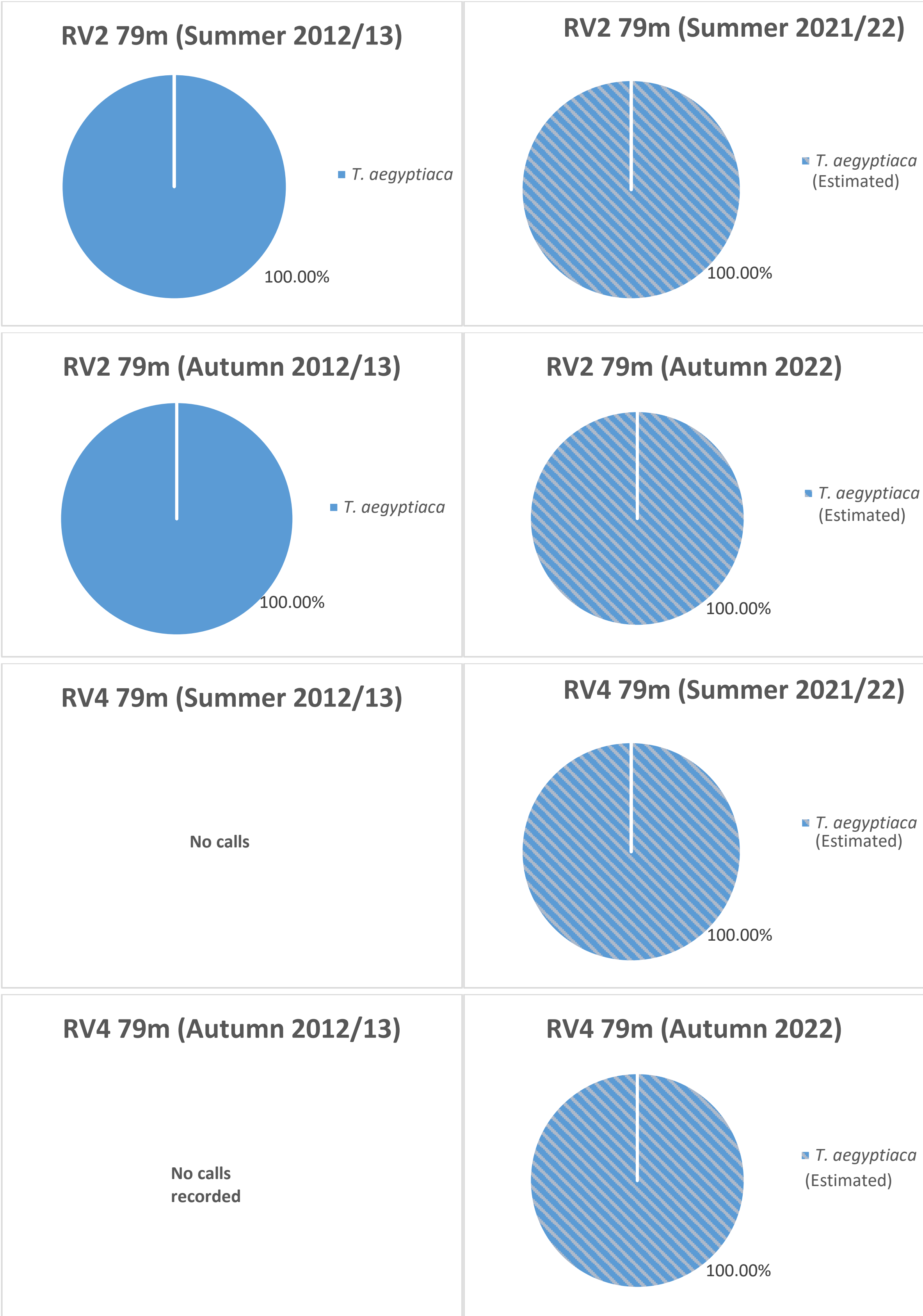


Figure 3 Species composition of bat calls in rotor sweep height in 2012/2013 and 2021/2022

Near (at approximately 10 m above) ground level, the Egyptian Free-tailed Bat, Cape Serotine, and Natal Long-fingered Bat were recorded at all monitoring locations in autumn during both 2012/2013 and 2022. The percentage or proportional contribution of each species to the total calls recorded varied notably, however, between the two monitoring periods (**Figure 4**). The call proportions of Natal Long-fingered Bats were greatest in autumn (at all monitoring locations) but were significantly lower (by ~40 to 70 %) in 2022 than what they were in 2012/2013.

During autumn of 2022, very limited activity of the Natal Long-fingered Bat was also recorded by IWS at a very similar site roughly 150 km away. The dramatic difference in the activity of Natal Long-fingered Bats recorded in autumn between 2012/2013 and 2022 was potentially due to dispersal or disappearance of this species from the region before the summer of 2021/2022. Of the bat carcasses found at the Khobab and Loeriesfontein wind farms, which are known to IWS, none represented the Natal Long-fingered Bat. Since the Natal Long-fingered Bat can occur in large colonies and travel over large (up to 150 km) distances (Monadjem *et al.* 2020), pronounced inter-annual variation in the prevalence of this species can be expected.

More species were recorded near ground level in 2021/2022 than in 2012/2013 (except in summer at RV2) potentially because: i) the SMX-U1 microphones used in 2021/2022 were more sensitive than the SMM-US microphones that were used in 2012/2013; ii) monitoring was performed continuously through the night in 2021/2022, and not intermittently as in 2012/2013; and/or iii) environmental (weather and/or insect) conditions were different between the two monitoring periods. **These results suggest that for turbine blades that approach closer to ground level, turbine-related bat fatalities will comprise a greater diversity (richness and abundance) of species - especially in autumn, when the call proportion of Natal Long-fingered Bats was greatest at all stations.**

3.2.3 Bat activity at different heights and locations

Across the different monitoring years and locations, significantly less bat activity was recorded in turbine rotor sweep height compared to near ground level (**Figure 5**). For the combined summer and autumn seasons in 2021/2022, an average of approximately 0.87 bat passes (bp) per night (or 0.08 bp per hour) was estimated at RV2 79 m, and an average of ca. 3.14 bp per night (0.28 bp per hour) was estimated at RV4 79 m. For RV2 79 m and RV4 79 m combined, an average of 2.00 bp per night (0.12 bp per hour) was estimated. This level of bat activity in rotor sweep height is within the typical range of bat activity for the Namaqualand-Richtersveld steppe ecoregion (MacEwan *et al.* 2020b).

The average of 8.8 bp per night (or roughly 0.78 bp per hour) recorded near ground level at RV2 and RV4 was more than four times the average level of bat activity estimated in rotor sweep height during 2021/2022 (**Figure 5**). This is a typical observation in many parts of South Africa (MacEwan *et al.* 2020b). If spring and winter levels of bat activity had been monitored in 2021/2022, the overall annual level of near ground bat activity in 2021/2022 would likely be similar to that reported for the Namaqualand-Richtersveld steppe ecoregion (MacEwan *et al*. 2020b). **Due to the concentration of bat activity near ground level, greater turbine-related bat fatalities are anticipated for turbine blades that approach closer to ground level.**

The average of > 6 bp per night (or roughly 1 bp per hour) recorded near ground level at RV2, RV4, and RV5 in 2021/2022 was, however, roughly 1 to 5 times the average of number of bat passes per night recorded near ground level at these respective stations during 2012/2013. **The higher levels of bat activity recorded near ground level (and extrapolated for rotor sweep height) during 2021/2022, relative to 2013/2014, were at least partly due to the more sensitive bat recording technology used, and the higher (100%) recording success in 2021/2022.**

There was no consistent pattern in bat activity among monitoring locations/areas that were repeatedly sampled (**Figure 5**). During 2012/2013, bat activity was on average, lowest at RV4 and highest at RV2. In contrast, during 2021/2022, bat activity was on average, highest at RV4 and lowest at RV2. **This finding highlights how dramatically bat activity may vary at a given location between years, and why adaptive management of bat fatalities during WEF operation is crucial.**

Figure 4 **Species composition of bat calls recorded near ground level in 2012/2013 and 2021/2022**

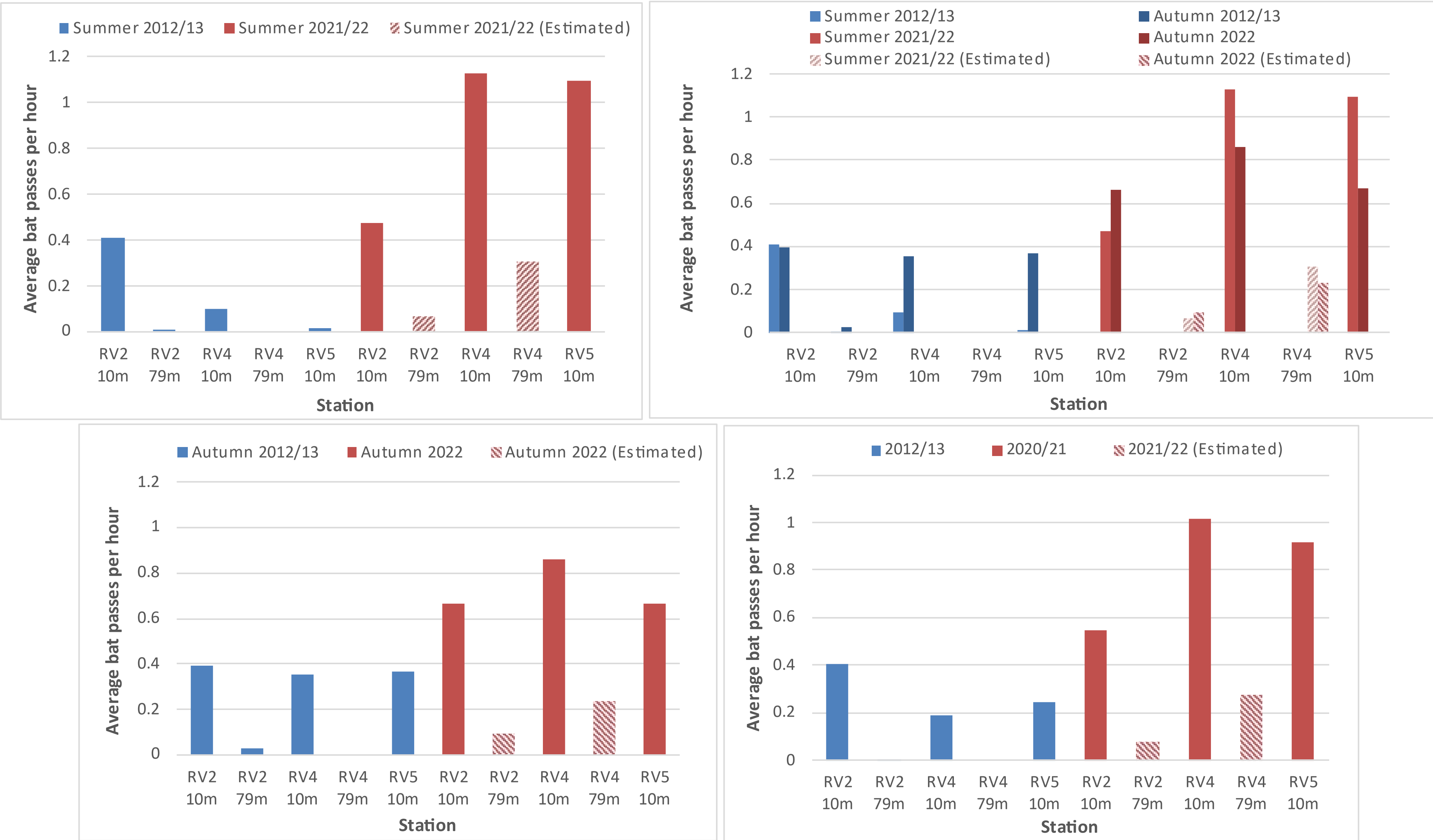


Figure 5 **Average nightly bat activity (measured in passes per hour) recorded in 2012/2013 and 2021/2022**

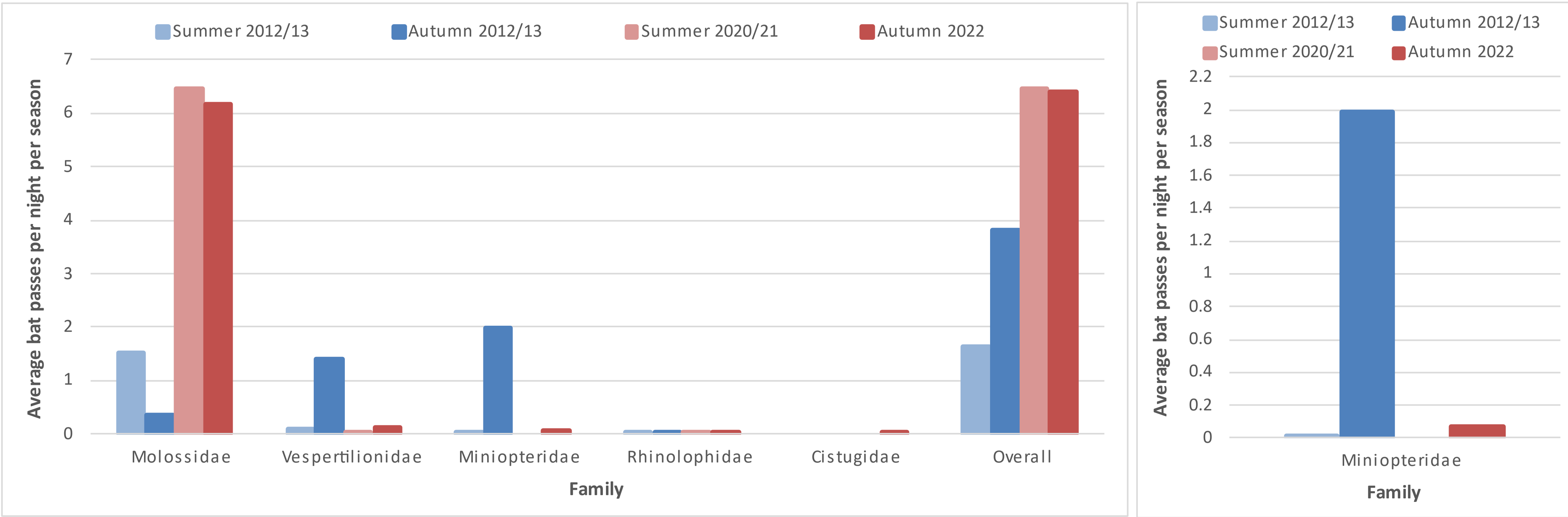


Figure 6 **Seasonal differences in the average nightly activity of different bat families (measured in passes per night per season) in 2012/2013 and 2021/2022**

3.2.4 Seasonal variation in bat activity

During 2012/2013, bat activity at the different monitoring stations was generally higher in autumn both near ground level and in rotor sweep height (**Figure 5**). In contrast, during 2021/2022, bat activity in rotor sweep height and near ground level was generally higher during summer.

When the bat activity data from all years and stations are presented in terms of bat families (**Figure 6**), it is evident that Molossids (represented mainly by the Egyptian Free-tailed Bat) exhibited high activity during the summer of 2012/2013 and the autumn of 2022.

Bats in the family Miniopteridae (represented by the Natal Long-fingered Bat) were most active during autumn, but very few calls for this species were recorded in 2022 compared to 2012/2013. As previously explained, the dramatic difference in the activity of Natal Long-fingered Bats recorded in autumn between 2012/2013 and 2022 was potentially due to dispersal or disappearance of this species from the region before the summer of 2021/2022.

Vesper bats (represented by the Cape Serotine) exhibited higher activity levels in autumn compared to summer. Bats in the family Rhinolophidae (represented by the Cape Horseshoe Bat) exhibited a similar level of activity in summer and autumn. Calls of the Angolan Hairy Bat (in the family Cistugidae) were only recorded in the autumn of 2022.

The high near ground activity, especially in 2021/2022 comprised high activity of Egyptian Free-tailed and Cape Serotine bats during both summer and autumn, and high Natal Long-fingered Bat activity during autumn (**Figure 7**). In the autumn of 2012/2013, the high near ground activity at RV2, RV4, and RV5 was mostly attributable to high activity of Cape Serotines and Natal Long-fingered Bats (**Figure 7**).

In rotor sweep height, nights with high Egyptian Free-tailed Bat activity were most common in autumn – especially February and March during both 2012/2013 and 2022 (**Figure 8**). Near ground level, nights with very high Egyptian Free-tailed and Cape Serotine bat activity were also more common in autumn – specifically February and March, and April and May, respectively, during both 2012/2013 and 2022 (**Figure 9**). Nights with high Natal Long-fingered Bat activity were also most common during autumn i.e. in March, April, and May – especially in 2012/2013 (**Figure 10**). The 12-month NSS (2013) study revealed that there was also elevated activity of these species during spring (which was not sampled in 2021/2022). Based on these findings, **to mitigate bat fatalities, turbine curtailment should be applied at the very least during February and March, when peaks in the activity of Egyptian Free-tailed Bats were most common.**

3.2.5 Key bat activity times

In rotor sweep height, and near ground level, Egyptian Free-tailed Bats were active throughout the night, and particularly between 21:30 and 04:00 (**Figure 11; Figure 12**). Near ground level, Cape Serotines and Natal Long-fingered Bats also exhibited activity throughout the night, and particularly after sunset. Therefore, **to mitigate fatalities of these species, curtailment should be implemented, at the very least between 21:30 and 04:00, but preferably throughout the night (from sunset to sunrise).**

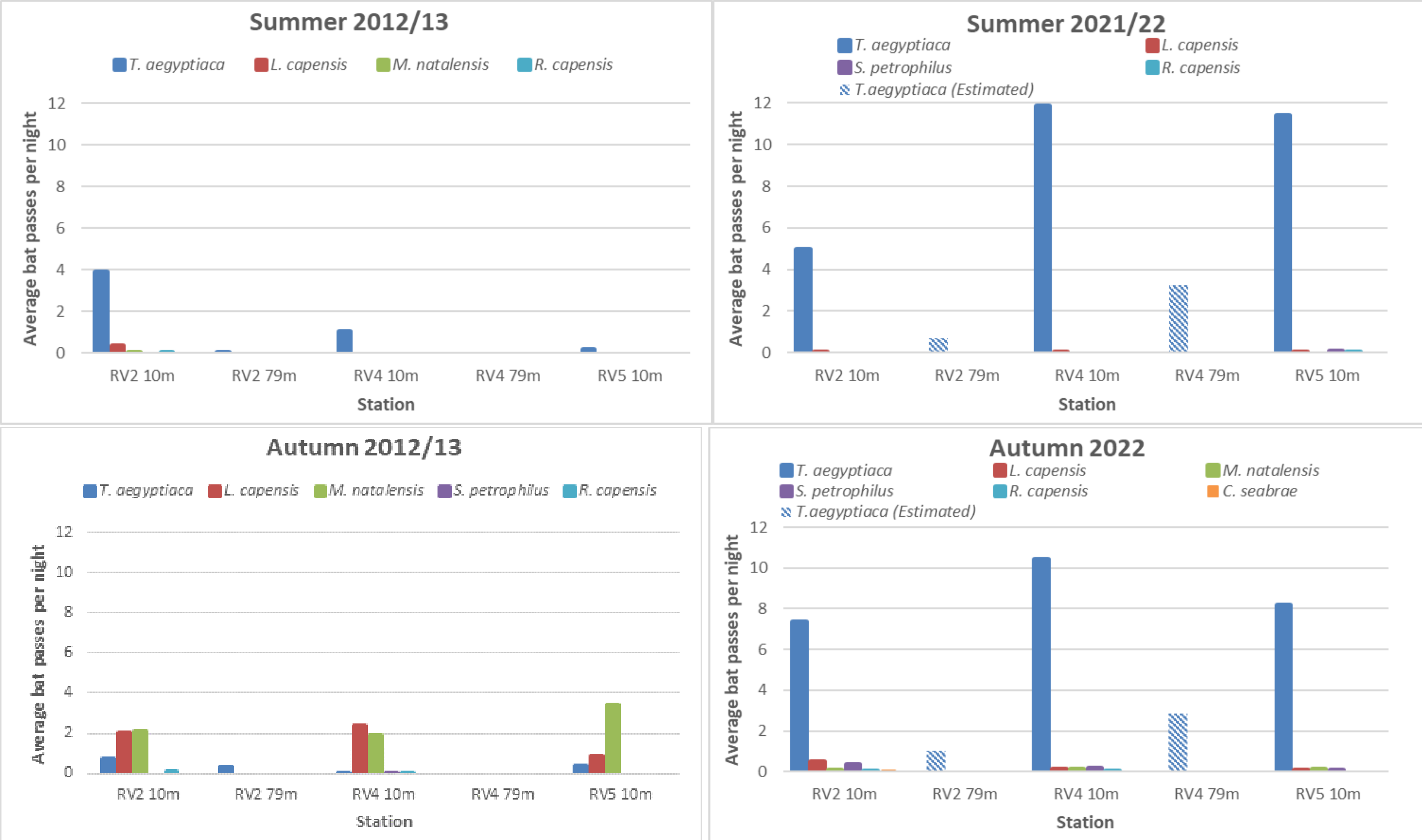


Figure 7 **Average nightly bat species activity (measured in passes per night) recorded in summer and autumn at selected stations in 2012/2013 and 2021/2022**

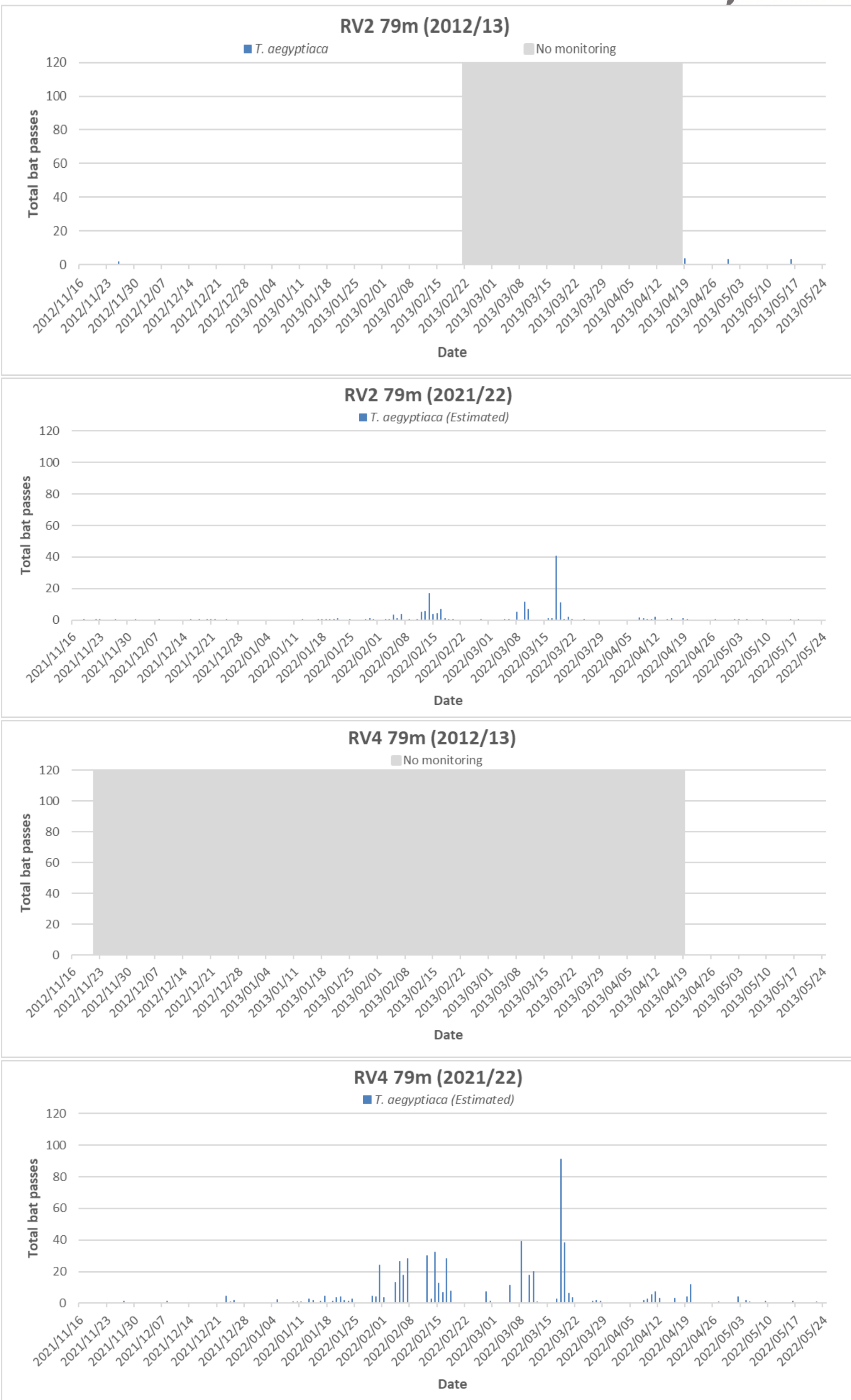
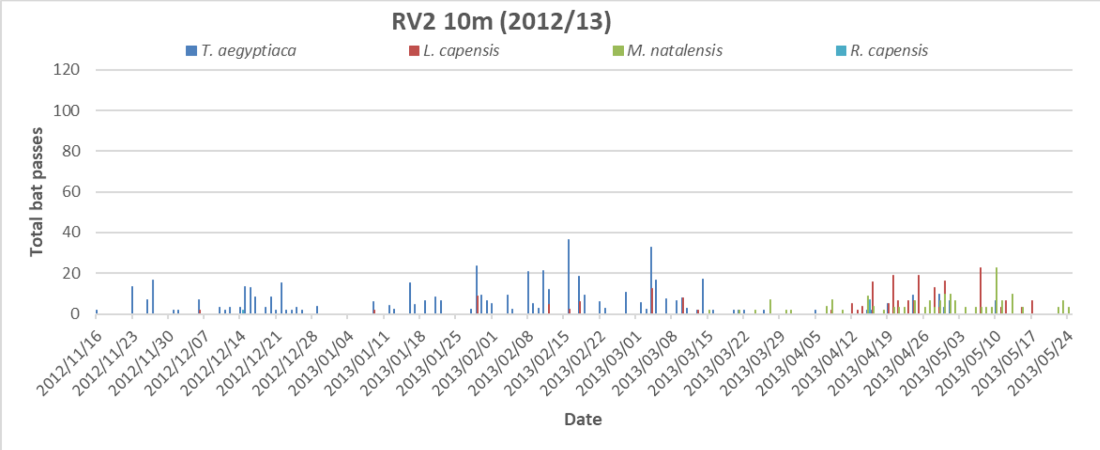
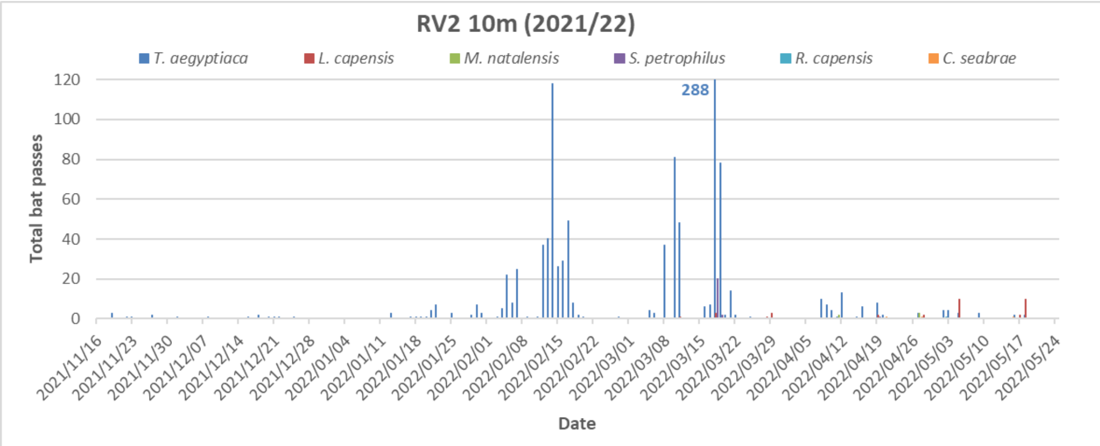
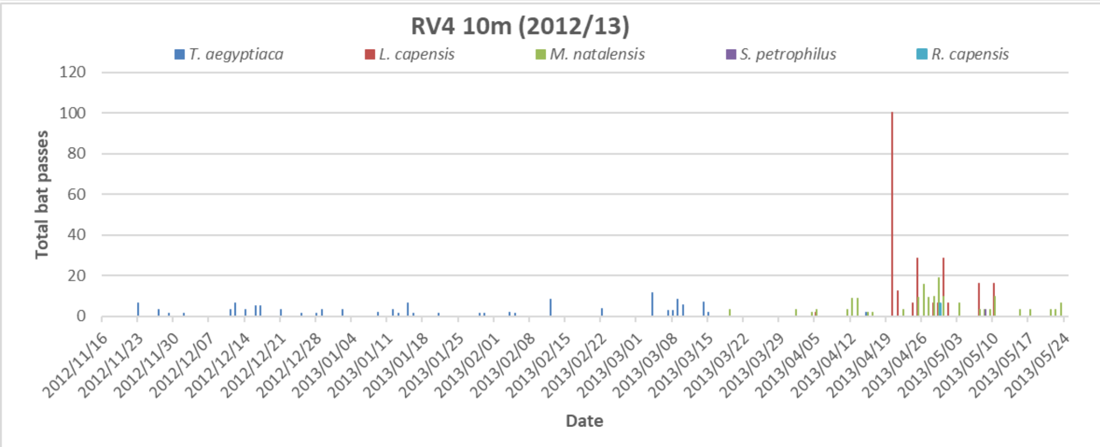
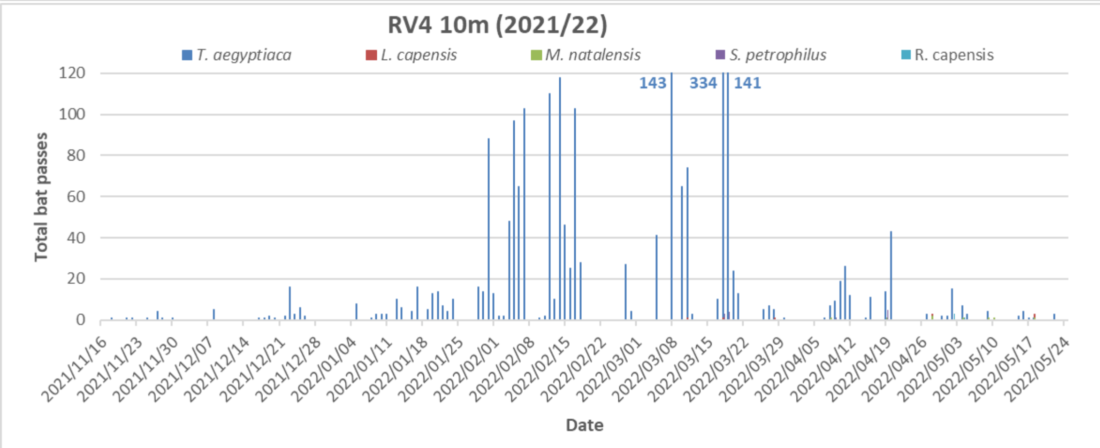


Figure 8 Total bat passes recorded nightly in rotor sweep height between mid-November and mid-May in 2012/2013 and 2021/2022


RV2 10m (2012/13)
T. aegyptiaca
L. capensis
M. natalensis
R. capensis
Total bat passes
120
100
80
60
40
20
0
Date


RV2 10m (2021/22)
T. aegyptiaca
L. capensis
M. natalensis
S. petrophilus
R. capensis
C. seabrae
288
Total bat passes
120
100
80
60
40
20
0
Date


RV4 10m (2012/13)
T. aegyptiaca
L. capensis
M. natalensis
S. petrophilus
R. capensis
Total bat passes
120
100
80
60
40
20
0
Date


RV4 10m (2021/22)
T. aegyptiaca
L. capensis
M. natalensis
S. petrophilus
R. capensis
143
334
141
Total bat passes
120
100
80
60
40
20
0
Date

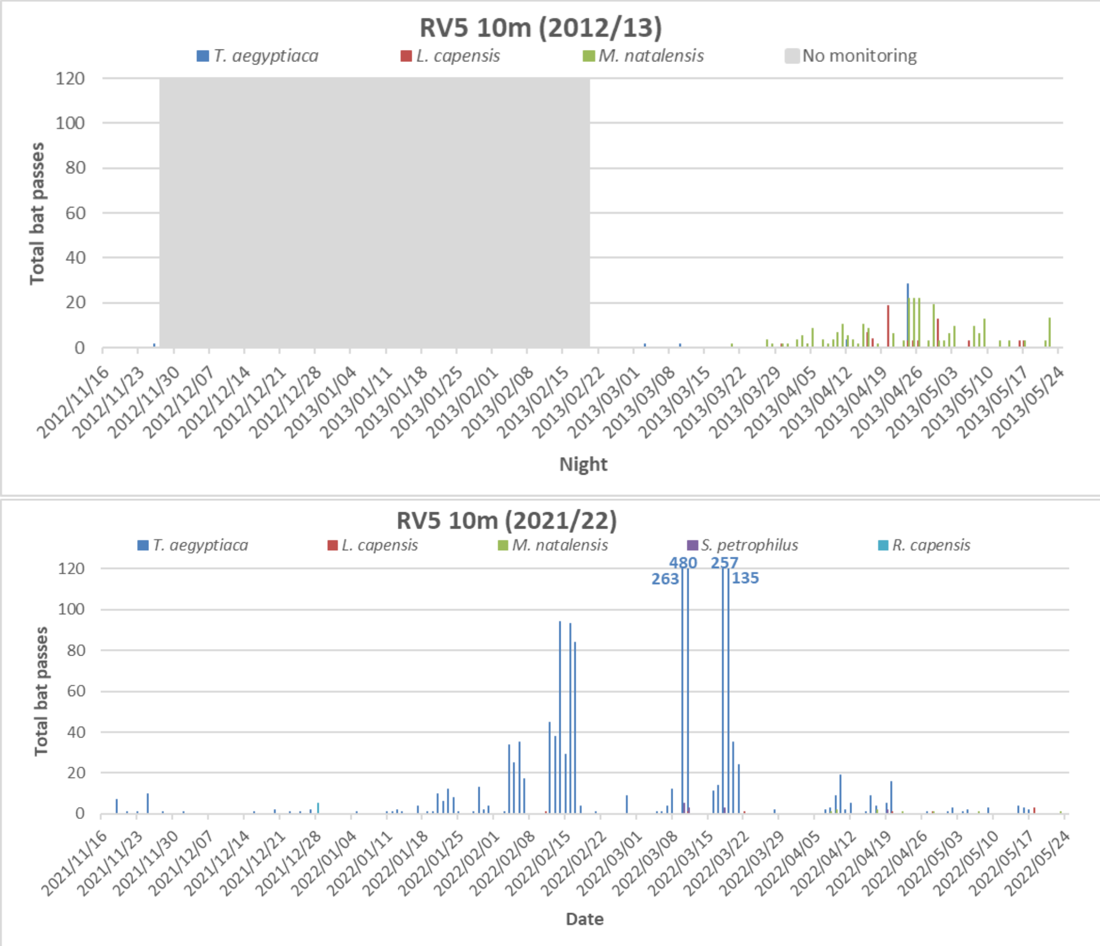
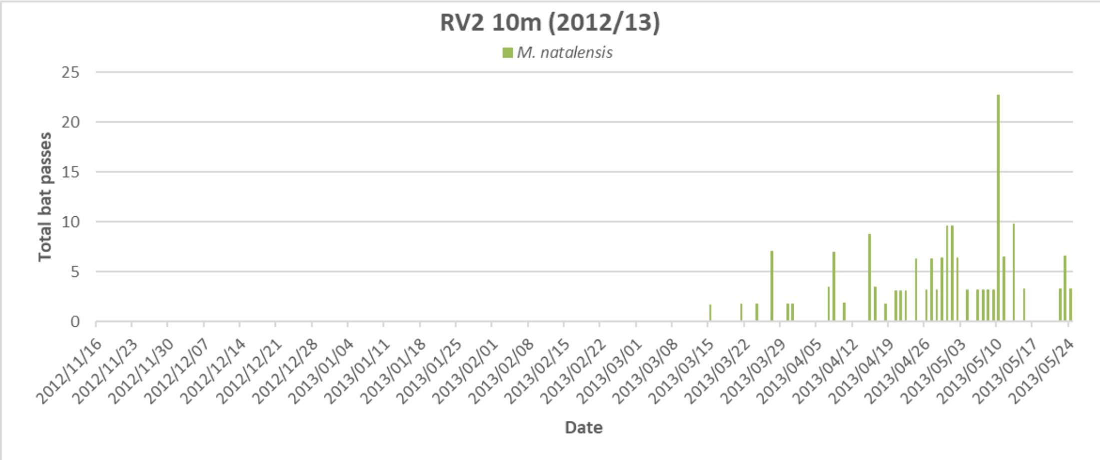
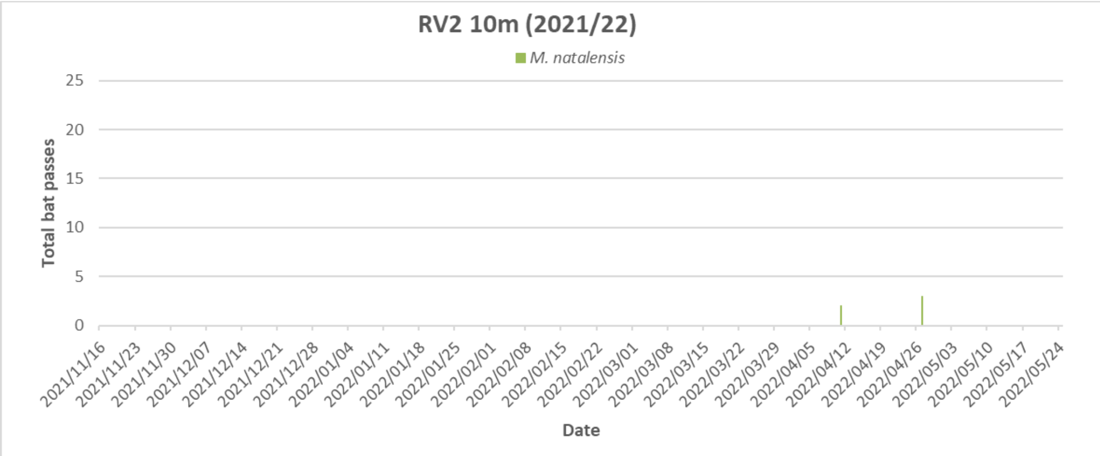
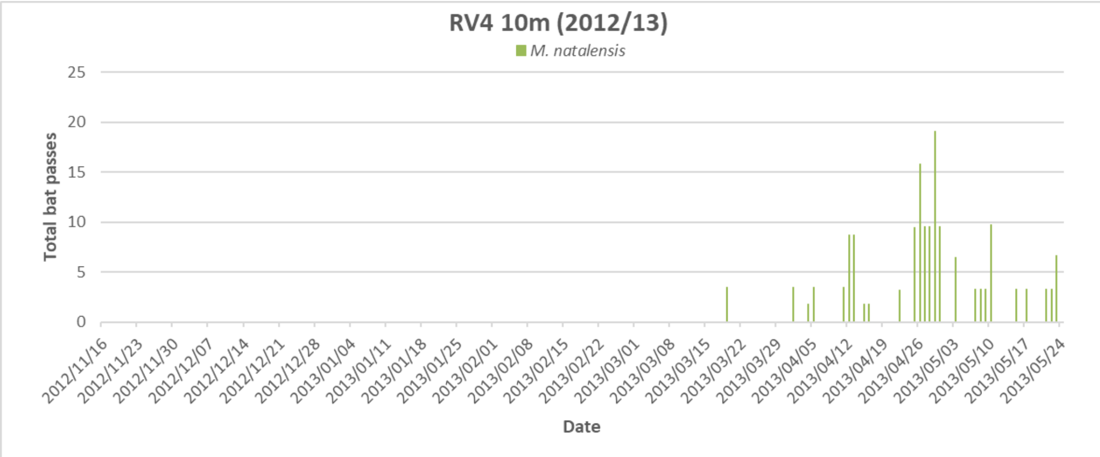
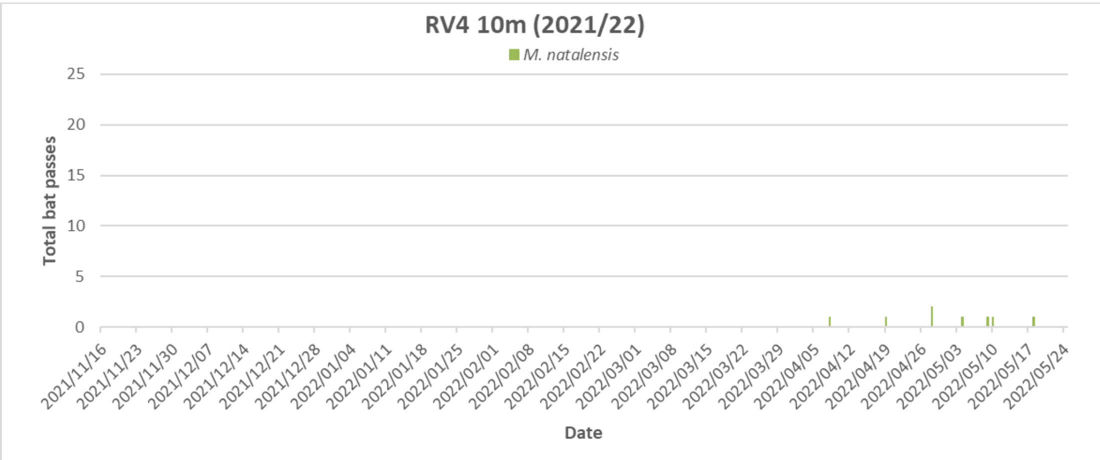


Figure 9 Total bat passes recorded nightly near ground level between mid-November and mid-May in 2012/2013 and 2021/2022


RV2 10m (2012/13)
M. natalensis
Total bat passes
0
5
10
15
20
25
Date


RV2 10m (2021/22)
M. natalensis
Total bat passes
0
5
10
15
20
25
Date


RV4 10m (2012/13)
M. natalensis
Total bat passes
0
5
10
15
20
25
Date


RV4 10m (2021/22)
M. natalensis
Total bat passes
0
5
10
15
20
25
Date

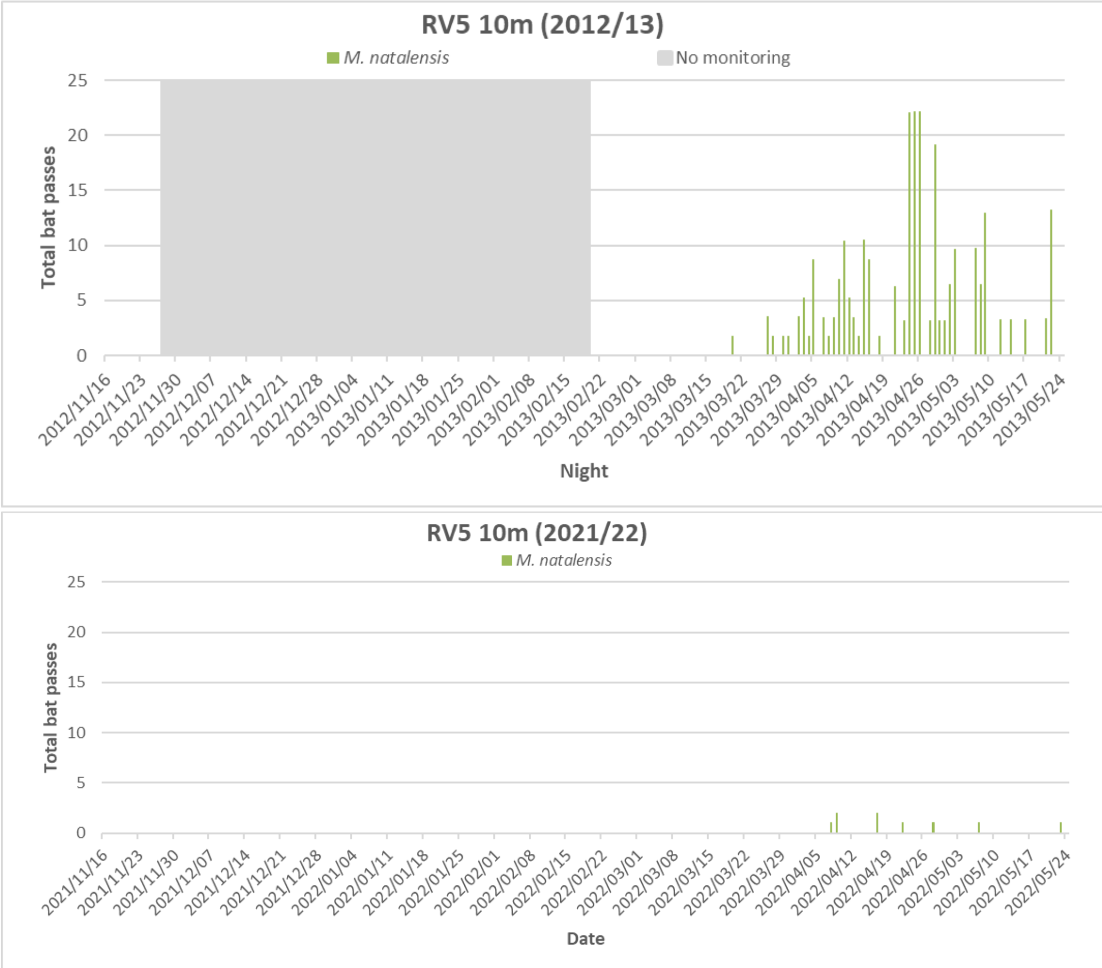


Figure 10 Total Natal Long-fingered Bat passes recorded nightly near ground level between mid-November mid-May in 2012/2013 and 2021/2022

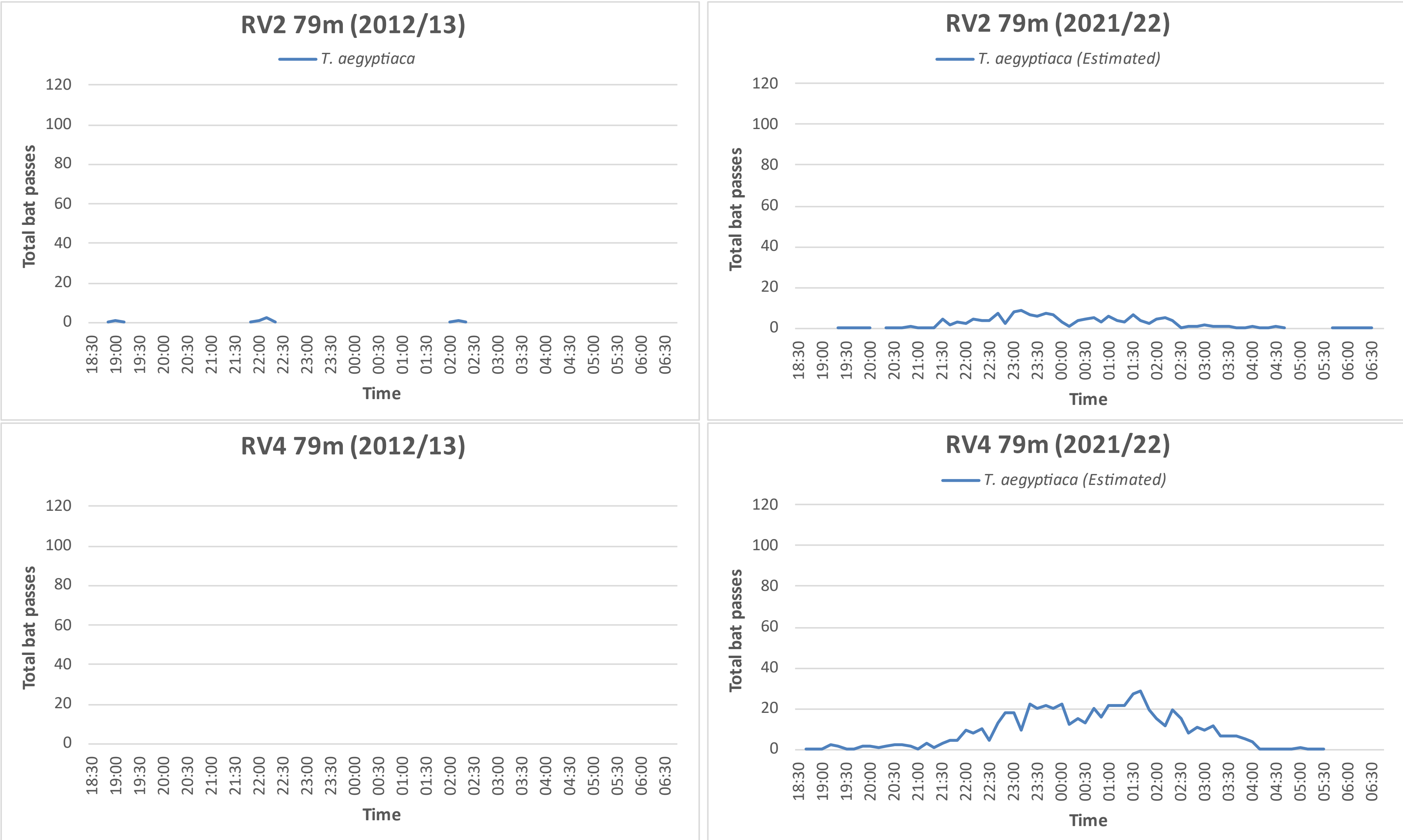


Figure 11 **Night-time activity of bat species at rotor sweep height between mid-November and mid-May in 2012/2013 and 2021/2022**

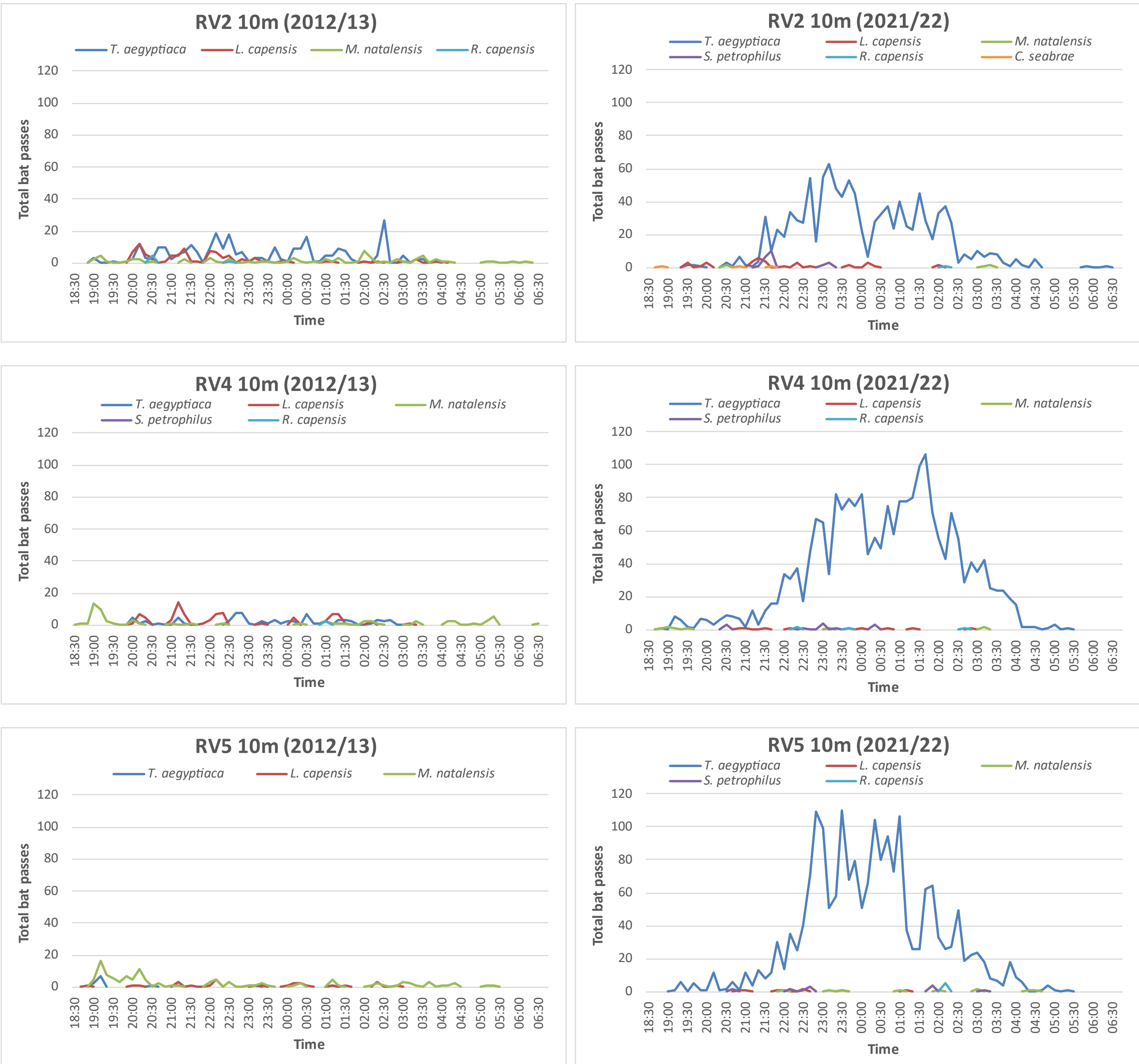


Figure 12 Night-time activity of bat species near ground level between mid-November and mid-May 2012/2013 and 2021/2022

4. Comparative bat impact assessment

4.1 Infrastructure amendments

The dimensions and footprints of the different infrastructure components as authorised, versus, as presently proposed, are provided in **Table 2**. The total length of all proposed new roads, and existing roads to be upgraded, under authorization, and for amendment, was not certain. **Impacts of the presently proposed Richtersveld WEF were assessed according to the values in Table 2**.

Table 2 Size of different infrastructure components as authorised vs. as presently proposed

Component	Authorised		Proposed amendment	
	No. and/or dimensions	Footprint (m^2)	No. and/or dimensions	Footprint (m^2)
Turbine rotor swept area	70 x (10 751 m^2)	752 570	32 x (24 053 m^2)	769 696
AERIAL DISTURBANCE		**752 570**		**769 696**
Turbine foundations	70 x 400 m^2	28 000	32 x 362 m^2	11 584
Turbine laydown areas	70 x 2 500 m^2	175 000	32 x 2 500 m^2	80 000
Construction laydown areas	Uncertain	Uncertain	Uncertain	Uncertain
New roads	Uncertain	Uncertain	Uncertain	Uncertain
Upgraded existing roads	Uncertain	Uncertain	Uncertain	Uncertain
Substation compound	Uncertain	Uncertain	Uncertain	Uncertain
TERRESTRIAL DISTURBANCE		**At least 203 000**		**At least 91 584**

Infrastructure amendments, which are expected to reduce potential impacts on bats include the:

- Fewer number of (32, not 70) turbines and, therefore, 38 fewer turbine towers, and fewer turbine lights – which otherwise might attract bats.
- Slightly higher reach of the lowest blade tip (42,5 m, not 41,5 m above ground level [a.g.l.]) – which is expected to very slightly reduce the fatality risk of low-flying bat species.
- 111 416 m^2 (55%) smaller total turbine terrestrial disturbance footprint of 91 584 m^2 – not 203 000 m^2.
- Potentially smaller total terrestrial disturbance footprint of the WEF road network - depending on the width and total length of all proposed new roads, and existing roads to be upgraded, under authorization, and for amendment.

Infrastructure amendments, which are expected to increase potential impacts on bats include the:

- 2.27% Larger total rotor swept area (769 696 m^2, not 752 570 m^2).

4.2 Layout amendments

Shown in **Figure 13** is the layout of the Richtersveld WEF, as presently proposed for the EA amendment, in the context of the updated relative sensitivity of different habitats and buffers for bats as described in **Table 3.**

Table 3 Relative sensitivity of different habitats and buffers for bats in and around the Richtersveld WEF

Sensitivity	Description
High	• Two rocky outcrops, and a 500 m buffer around these. • An onsite building, and a 200m buffer around this. • Dry pans, and a 200 m buffer around these.
Medium	Remaining areas

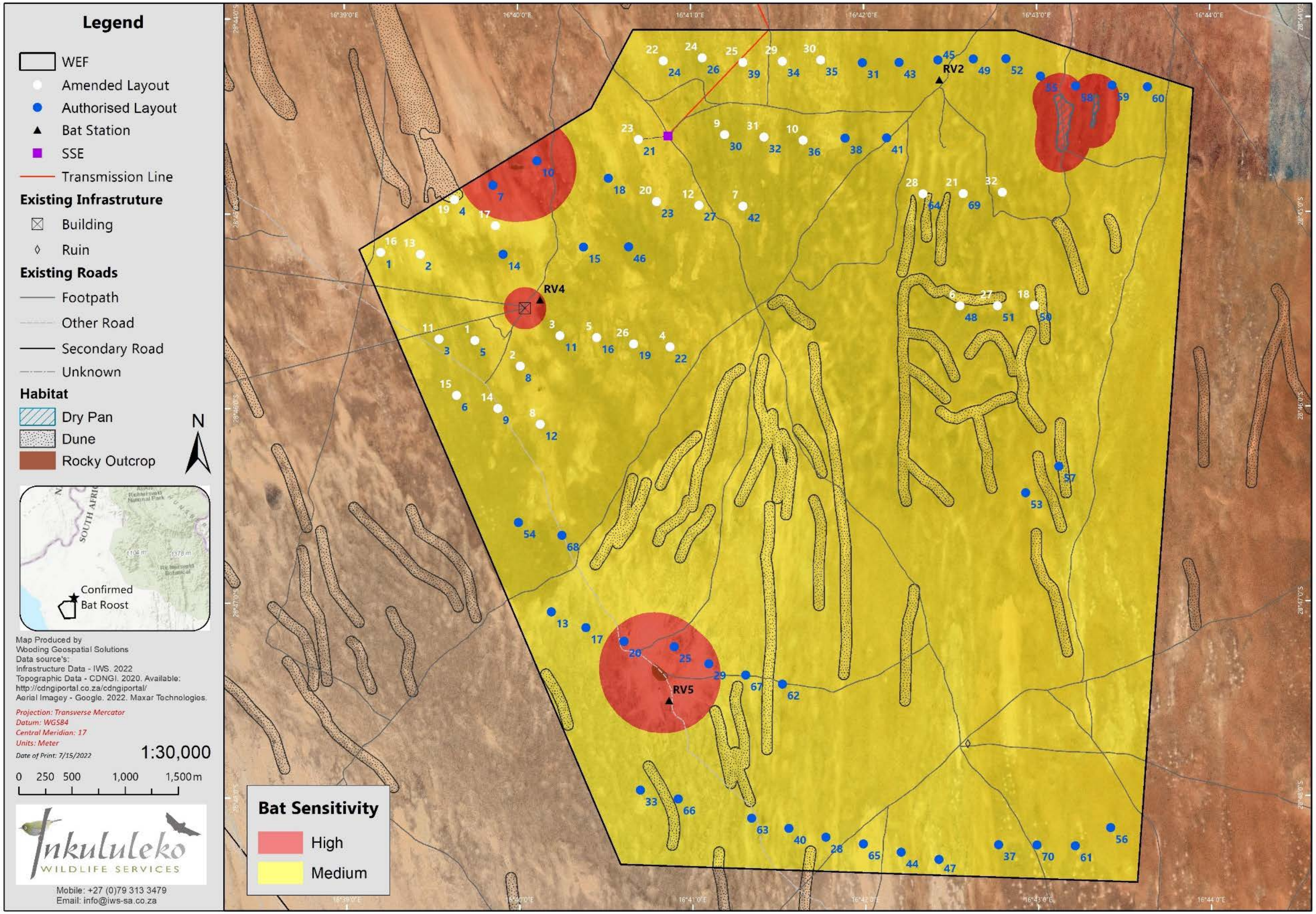


Figure 13 **Authorized and presently proposed layout of the Richtersveld WEF in relation to sensitive areas for bats**

The features and buffers in **Table 3** represent an updated and refined version of the habitat and buffer sensitivity ratings which were previously reported by NSS (2013). **There must be no development of turbines, quarries, construction camps, laydown areas, buildings, substations, or battery energy storage systems in High sensitive areas.**

Layout amendments, which are expected to reduce potential impacts on bats include the:

- Positioning of all turbines (including their full rotor diameter, plus a 2 m pressure buffer) outside of all High sensitive areas - except for Turbine 17, which will encroach by approximately 20 m into the 500 m buffer around a rocky outcrop if fitted with 87.5 m blades. Under the authorized layout, eight turbines (*viz.* Turbines 7, 10, 20, 25, 29, 55, 58 and 59) are proposed in or will encroach into High sensitive areas.
- >50% smaller turbine "area of influence" (the minimum convex polygon around all turbines and their blades) of the amended project, compared to that of the authorized project.

No layout amendment is expected to increase potential impacts on bats, relative to the authorized layout.

4.3 Potential impacts

The rating and significance of potential impacts on bats from the authorized, versus the amended Richtersveld WEF project, without and with mitigation, is detailed in **Table 4**. The impact assessment methodology was stipulated by RINA and is described in **Appendix 2. The comparative bat impact assessment in this report represents an updated, consolidated, and refined version of the impact assessment provided by NSS (2013), and the ratings and significance of potential impacts for the amended project replace those that were provided by NSS (2013) for the authorized project.**

4.3.1 Direct impacts

Roost disturbance or destruction (all project phases)

During all project phases, bat roost features and roosting bats may be disturbed or destroyed by vegetation clearing, excavation and building activities, built and operating turbines and other infrastructure, decommissioning activities, and associated human activity, traffic, dust, noise, light, and vibrations. Since turbines occur in the northern section of the site where some potential bat roost (rocky outcrop and building) features have been buffered, there is no difference in the **Moderate** significance rating of the potential impact on bat roosts (without mitigation) between the authorised, versus the amended WEF project. With diligent implementation of the prescribed mitigation measures, especially ensuring that there is no development of turbines, quarries, construction camps, or laydown areas in High sensitive areas, the potential impact of the project on bat roosts was rated with **Negligible** significance**.**

Terrestrial and aerial habitat loss and associated displacement of bats (all project phases)

Terrestrial bat foraging habitat will be destroyed and disturbed by vegetation clearing, and excavation and building activities; and foraging, commuting, and/or migrating bats may be displaced or avoid terrestrial areas and aerial space with built and operating turbines and other infrastructure, and associated danger, noise, light, and vibrations. Compared to the authorized project (**Table 2**), the amended project will have a slightly (~2 ha) larger aerial turbine footprint, but: i) 38 fewer built turbines (and therefore, fewer blades, towers, and lights that might disturb foraging bats); ii) a (~11 ha) smaller terrestrial turbine footprint; iii) a potentially smaller terrestrial road disturbance footprint; and iv) a >50% smaller turbine area of influence. Therefore, the impact of the amended project on terrestrial and aerial habitat loss and associated displacement of bats was rated with **Moderate** significance (without mitigation), and not Major (or High) significance as rated by NSS (2013) for the authorized project. With diligent implementation of the prescribed mitigation measures, especially ensuring that there is no development of turbines, quarries, construction camps, or laydown areas in High sensitive areas, the potential impact of the project on bat terrestrial and aerial habitat loss and displacement was rated with **Minor** significance.

Bat fatalities (operational phase)

Bat fatalities caused by their collision with (and possible barotrauma from) turbines, were rated with **Major** significance (without mitigation) for the authorized and the amended project. This is because the amended project will have a slightly (~2 ha) larger aerial turbine footprint despite comprising fewer turbines, and despite having a smaller turbine area of influence. With diligent implementation of the prescribed mitigation measures, especially ensuring that there is no development of turbines in High sensitive areas, that turbine curtailment is implemented (as prescribed in Section **5 Recommended mitigation**), and that operational bat fatality monitoring and adaptive management and mitigation of bat fatalities are performed in accordance with best practice standards, the potential impact of the project in terms of bat fatalities was rated with **Minor** significance.

4.3.2 Indirect impacts

Direct impacts of the Richtersveld WEF on bat roosting, foraging and fatalities will have certain indirect impacts on bats, which are expected to be similar for the authorized versus the amended project because these have the same potential Major significant impact (without mitigation) in terms of bat fatalities. Indirect impacts are, however, difficult to rate with confidence and accuracy.

Bat species population declines or loss (operational phase)

Decline or loss of (conservation priority and common) bat species populations (due to reductions in their size, social structure, genetic diversity, resilience, and persistence) was rated with **Major** significance without mitigation. This is because potential bat fatalities were rated with Major significance without mitigation, and consideration was given to the presence of the endemic Cape Horseshoe Bat, and the previous potential and now confirmed presence of the endemic and Near Threatened Angolan Hairy Bat. With effective mitigation (as described for the afore-mentioned direct impacts on bats) potential decline or loss of bat species populations was rated with **Minor** significance.

Bat eco-service declines or loss (operational phase)

Decline or loss of bat ecosystem services (due to decline or loss of bat species populations) was rated with **Moderate** significance without mitigation. This is because fruit bats are not expected to occur in the study area (NSS 2013) and, therefore, bat ecosystem services likely mainly relate to insect population control. With effective mitigation (as described for the afore-mentioned direct impacts on bats) potential decline or loss of bat eco-services was rated with **Minor** significance.

4.3.3 Cumulative impacts (operational phase)

An important consideration is the potential cumulative impact on bats from multiple proposed WEF developments along the South African (and Namibian) west coast and nearby interior. Shown in **Figure 14**, within a 100 km radius of the proposed Richtersveld WEF site, is one of South Africa's largest clusters of renewable energy projects for which environmental impact assessment applications have been received by the Department of Forestry, Fisheries and the Environment (Renewable Energy EIA Application Map, February 2022). Existing wind farms in the region include, but may not be limited to, the Kangnas, Kohbab, and Loeriesfontein facilities. The potential added impact of the proposed Richtersveld WEF to the cumulative impact of the existing WEFs in the region was rated with **Moderate** significance in the absence of any mitigation. With effective mitigation the contribution of the proposed Richtersveld WEF to the cumulative impact of existing operational wind farms in the region was rated as **Minor**.

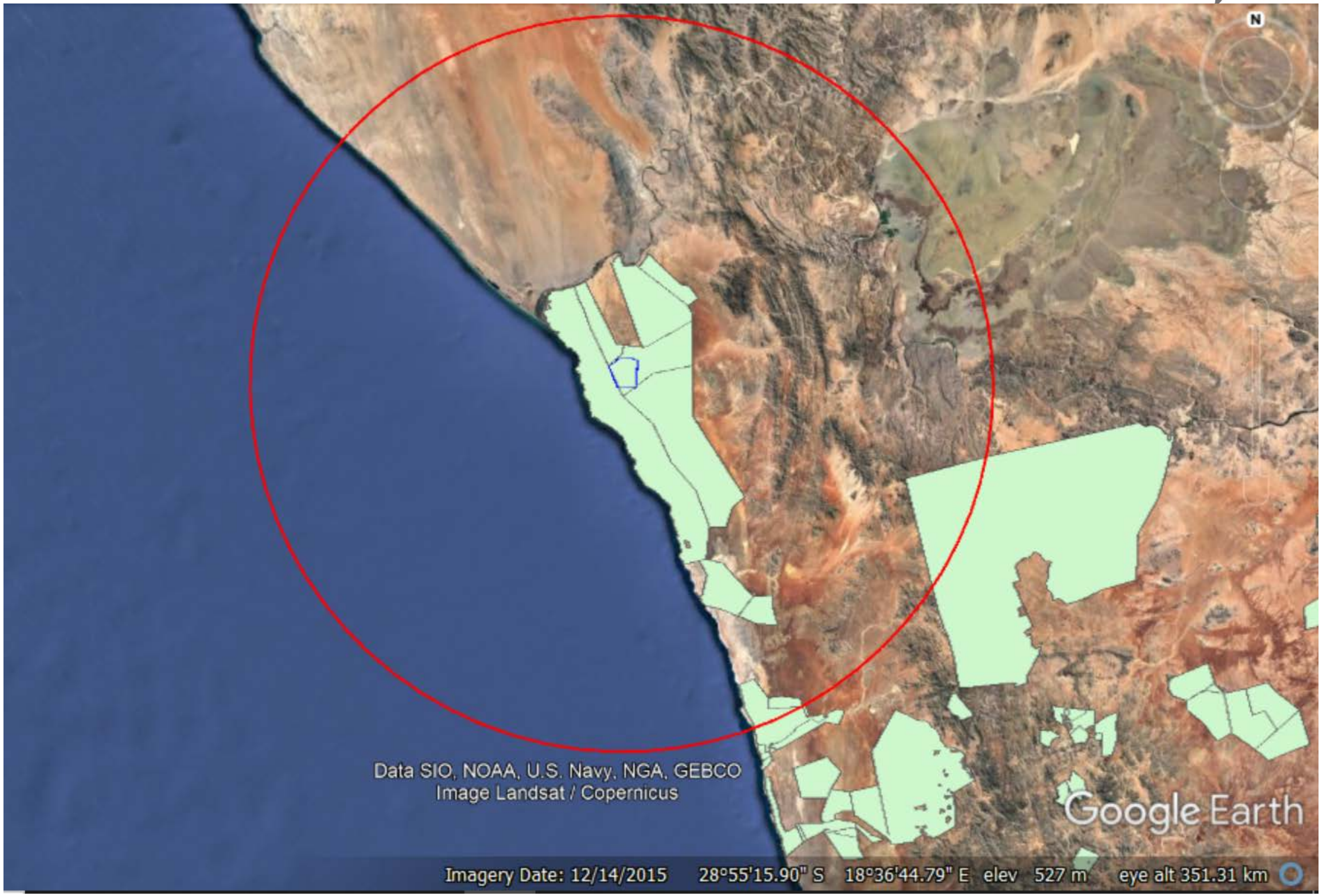


Figure 14 **Renewable energy project applications within a 100 km radius of the proposed Richtersveld WEF (blue boundary)**

Table 4 Comparative bat impact assessment ratings (without and with mitigation) for the authorized versus the amended Richtersveld WEF project

DIRECT IMPACT: Roost disturbance or destruction (all project phases)										
WITHOUT MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	On-site	Long-term	Medium	Regular	Likely	Medium	Medium	MODERATE	– ve	High
	1	3	2	4	3	13	3			
Proposed	On-site	Long-term	Medium	Regular	Likely	Medium	Medium	MODERATE	– ve	High
	1	3	2	4	3	13	3			
WITH MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	On-site	Temporary	Low	Seldom	Possible	Negligible	Medium	NEGLIGIBLE	– ve	High
	1	1	1	2	2	7	3			
Proposed	On-site	Temporary	Low	Seldom	Possible	Negligible	Medium	NEGLIGIBLE	– ve	High
	1	1	1	2	2	7	3			
DIRECT IMPACT: Terrestrial and aerial habitat loss and associated displacement of bats (all project phases)										
WITHOUT MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Local	Long-term	Very High	Always	Likely	High	Medium	MAJOR	– ve	Moderate
	2	3	4	5	3	17	3			
Proposed	On-site	Long-term	High	Regular	Possible	Medium	Medium	MODERATE	– ve	Moderate
	1	3	3	4	2	13	3			
WITH MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Local	Long-term	High	Occasional	Unlikely	Low	Medium	MINOR	– ve	Moderate
	2	3	3	3	1	12	3			
Proposed	On-site	Long-term	Medium	Occasional	Unlikely	Low	Medium	MINOR	– ve	Moderate
	1	3	2	3	1	10	3			
DIRECT IMPACT: Bat fatalities from collision or barotrauma (operational phase)										
WITHOUT MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Regional	Long-term	Very High	Regular	Likely	High	Medium	MAJOR	– ve	High
	3	3	4	4	3	17	3			
Proposed	Regional	Long-term	Very High	Regular	Likely	High	Medium	MAJOR	– ve	High
	3	3	4	4	3	17	3			
WITH MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Local	Long-term	Low	Occasional	Likely	Low	Medium	MINOR	– ve	High
	2	3	1	3	3	12	3			
Proposed	Local	Long-term	Low	Occasional	Likely	Low	Medium	MINOR	– ve	High
	2	3	1	3	3	12	3			

INDIRECT IMPACT: Decline or loss of bat populations (operational phase)										
WITHOUT MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Regional	Long-term	Very High	Regular	Likely	High	High	MAJOR	– ve	Moderate
	3	3	4	4	3	17	4			
Proposed	Regional	Long-term	Very High	Regular	Likely	High	High	MAJOR	– ve	Moderate
	3	3	4	4	3	17	4			
WITH MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Local	Short-term	Low	Seldom	Possible	Low	Medium	MINOR	– ve	Moderate
	2	2	1	2	2	9	3			
Proposed	Local	Short-term	Low	Seldom	Possible	Low	Medium	MINOR	– ve	Moderate
	2	2	1	2	2	9	3			
INDIRECT IMPACT: Decline or loss of bat ecosystem services (operational phase)										
WITHOUT MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Regional	Long-term	High	Regular	Likely	Medium	Medium	MODERATE	– ve	Moderate
	3	3	3	4	3	16	3			
Proposed	Regional	Long-term	High	Regular	Likely	Medium	Medium	MODERATE	– ve	Moderate
	3	3	3	4	3	16	3			
WITH MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Local	Short-term	Low	Seldom	Possible	Low	Medium	MINOR	– ve	Moderate
	2	2	1	2	2	9	3			
Proposed	Local	Short-term	Low	Seldom	Possible	Low	Medium	MINOR	– ve	Moderate
	2	2	1	2	2	9	3			
CUMULATIVE IMPACT (operational phase)										
WITHOUT MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Regional	Long-term	High	Regular	Likely	Medium	Medium	MODERATE	– ve	Moderate
	3	3	3	4	3	16	3			
Proposed	Regional	Long-term	Medium	Regular	Possible	Medium	Medium	MODERATE	– ve	Moderate
	3	3	2	4	2	14	3			
WITH MITIGATION	Extent	Duration	Scale	Frequency	Likelihood	Magnitude	Receptor sensitivity	Significance	Status	Confidence
Authorized	Local	Short-term	Medium	Occasional	Likely	Low	Medium	MINOR	– ve	Moderate
	2	2	2	3	2	11	3			
Proposed	Local	Short-term	Low	Occasional	Possible	Low	Medium	MINOR	– ve	Moderate
	2	2	1	3	2	10	3			

5. Recommended mitigation

For the afore-mentioned potential impacts on bats, their habitats, and ecosystem services, the following mitigation measures are recommended:

- **Avoid High sensitive areas**. Where necessary, the WEF layout must be adjusted to ensure that turbines, quarries, construction camps, and construction laydown areas avoid all High sensitive areas. Under the amended WEF layout there is no encroachment into High sensitive areas from the onsite substation complex, nor any turbine (with 87.5 m blades plus a 2 m pressure buffer) – except that **Turbine 17 should be shifted by at least 20 m to avoid the 500 m buffer around a rocky outcrop.**
- **Minimize the road network** to minimize the clearing and disturbance of natural areas. Obtain a water use licence for any watercourse crossing.
- **Minimize artificial lighting** on site. Apart from compulsory civil aviation lighting, minimize artificial lighting - especially high-intensity, steady-burning, sodium vapour, quartz, halogen, and other bright lights at sub-stations, offices, and turbines. 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.
- **Ensure that turbines can be fitted with bat detectors and deterrent devices**. Turbine engineers must consult with bat specialists to incorporate the necessary turbine adaptations for this during the design phase, so there are no unexpected surprises or concerns after the turbines are built.
- **Minimize degradation of terrestrial habitat** by implementing and maintaining effective erosion, stormwater, and potential invasive alien plant control measures. Rehabilitate disturbed areas based on consultation with an appropriate experienced specialist(s).
- **Implement curtailment of all turbines in February and March** (when major peaks in the activity of Egyptian Free-tailed Bats were most common), between sunset and sunrise, below a cut-in wind speed of 6.9 m/s, when atmospheric temperature is ≥8.5 °C. Wind speeds below 7 m/s (measured at 80 m above ground level) were associated with approximately 93% of all bat activity recorded at 10 m above ground level in 2012/2013 (NSS 2013), and the 6.9 m/s cut-in wind speed is a US Fish and Wildlife Service recommended cut-in speed for avoiding fatality impacts on priority species (Maclaurin *et al.* 2022).

  This recommended curtailment represents an updated and refined version of the curtailment previously prescribed by NSS (2013), based on consideration of: i) the South African bat fatality threshold guidelines (MacEwan *et al.* 2018), which were published after the NSS (2013) study was reported; ii) the full 18 months of pre-construction bat monitoring and the comparative impact assessment presented in this report for the amended versus the authorized project; and iii) the comparatively higher levels of bat activity recorded in other South African ecoregions as reported by MacEwan *et al.* (2020b).
- **Perform operational bat monitoring as soon as the first turbine is operational** - as per the latest South African guideline for this (Aronson *et al*. 2020 or later). The quality of the operational monitoring and data analysis are to be conducted to a high standard so that there is confidence in the data and the fatality estimate results. **If the operational monitoring and data analysis are not conducted properly as per Aronson *et al*. 2020 (or later), more rigorous turbine curtailment must be implemented.**
- **Adaptively manage and mitigate bat fatalities** by consulting the South African bat monitoring guidelines for operational wind farms (Aronson *et al.* 2020 or later), the South African bat fatality threshold guidelines (MacEwan *et al*. 2018 or later), and the best available relevant scientific

information. The specialist conducting the Year 1 and Year 2 operational monitoring should provide recommendations for adaptive management and mitigation of bat fatalities on a six- and 12-month basis at the very most. **Allowance should be made in the financial provision for adaptive management and mitigation of bat fatalities. If one or more fatalities of a conservation priority bat species is recorded, and/or if the overall bat fatality threshold is exceeded (determined as per MacEwan *et al*. 2018 or later), further adaptive management and mitigation (possibly including greater curtailment) must be implemented without delay.**

- **Submit quarterly progress and annual bat fatality monitoring reports to SABAAP** (the South African Bat Assessment Association Panel), EWT (the Endangered Wildlife Trust), and the DEFF (the national Department of Environment, Forestry and Fisheries).
- **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.

5.1 Conclusion

Considering that: i) the amended WEF infrastructure and layout are expected to markedly reduce potential impacts on bats (relative to the authorized project); and ii) potential direct residual impacts of the amended project were rated with Minor or Negligible significance, **IWS does not object to authorization of the amended Richtersveld WEF project provided that all turbines, quarries, construction camps, and laydown areas avoid all High sensitive areas, and that the conditions of authorization include all the bat impact mitigation measures recommended herein by IWS.**

6. Limitations

- An extrapolation of the available near ground data was performed to *estimate* the levels of bat activity data that occurred in rotor sweep height during the six-month monitoring period. The extrapolation was necessary because onsite met. masts were no longer available in 2021 for installation of bat monitoring equipment in rotor sweep height. IWS agreed to undertake the six-month monitoring, and the South African Bat Assessment Association approved the extrapolation (pers. comm. with SABAA in October 2021), ON CONDITION that:
  - The Client tries to obtain pre-construction and operational bat data from nearby WEFs, so far as the latter are willing to oblige, and so far as the Client's finances permit. To this end IWS: i) compared the latest monitoring results with confidential pre-construction bat monitoring data obtained by IWS Team members from two other proposed WEF sites within 150 km of the proposed Richtersveld WEF site; and ii) consulted bat activity and fatality data received by IWS from the operational Kangnas, Khobab, and Loeriesfontein wind farms situated up to ca. 250 km to the south-east.
  - The Client agrees to strictly adhere to operational bat monitoring at the Richtersveld WEF.
  - The Client accepts that mitigation measures might have to be implemented at the Richtersveld WEF if bat fatalities exceed threshold levels (determined as per the current or subsequent versions of the guidelines by MacEwan *et al*. 2018).
- In 2012/2013, gaps in the passive acoustic recording of bat activity in rotor sweep height (i.e. at 79 m a.g.l.) at both RV2 and RV4 were caused by faults with microphones and/or batteries (**Figure 2**). Consequently, very few bat calls were recorded in rotor sweep height in 2012/2013 and, therefore, the extrapolated levels of bat activity in rotor sweep during 2021/2022 may be lower than they were in reality. In 2012/2013 there was also a gap in recording at RV5 between 27 November 2012 and 20 February 2013 due to water damage to the detector.

- Certain infrastructure details, such the exact extent (length x breadth) of the authorized and the amended road networks, was uncertain – as indicated in **Table 1** and **Table 2.**
- The potential indirect impacts on bats were difficult to rate with confidence and accuracy.
- Information on bats in South Africa is limited relative to more popular taxa such as birds and large mammals. For example, not all significant bat cave roosts in South Africa are probably known.

7. References

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.

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.

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.

Maclaurin, G., Hein, C., Williams, T., Roberts, O., Lantz, E., Buster, G., and Lopez, A. 2022. National-scale impacts on wind energy production under curtailment scenarios to reduce bat fatalities. *Wind Energy 2022*: 1-16.

Monadjem, A., Taylor, P.J., Cotterill, F.P.D. and Schoeman, M.C. 2020. *Bats of Southern and Central Africa. A biogeographic and taxonomic synthesis*. Edition 2. Wits University Press, Johannesburg, South Africa.

NSS. 2013. *Pre-Construction Bat Monitoring and Impact Assessment Report for the Proposed Richtersveld Wind Energy Facility*. Natural Scientific Services, Johannesburg, South Africa.

Sowler, S. and Stoffberg, S. 2011. *The South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments.* Edition 1. Endangered Wildlife Trust, Johannesburg, South Africa.

Sowler, S. and Stoffberg, S. 2012. *The South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments.* Edition 2. Endangered Wildlife Trust, Johannesburg, South Africa.

8. Appendices

8.1 Appendix 1: IWS Team

IWS team members have conducted over 50 pre-construction, and 10 operational long-term bat monitoring studies for WEFs in southern Africa. IWS team members were also 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 in southern Africa, for various developments (mines, power lines, the Square Kilometre Array, etc.) as well as for caves, and protected areas. IWS core personnel include:

Dr Caroline Lötter

Caroline, the Managing Director at IWS, has worked on multiple long-term bat monitoring studies for proposed WEFs. She currently sits on the South African Bat Assessment Association (SABAA) Panel and is a co-author of the current South African best practice guidelines for pre-construction bat monitoring studies at WEF developments (MacEwan *et al*. 2020a), and a recently published paper on bat activity and its implications for wind farm development in South Africa (MacEwan *et al*. 2020b). 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 has also performed numerous impact assessments on vertebrate and invertebrate fauna throughout South Africa. Caroline has produced several peer-reviewed zoological articles and is a member of the Gauteng and Northern Regions Bat Interest Group (GNorBIG) and the Zoological Society of Southern Africa.

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 Masters degree 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 bullfrogs. In addition to her work within the country, Dominique 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, is a SACNASP registered zoologist and environmental scientist with a BSc Honours in Zoology from Wits University. She has over 22 years of zoological and practical bat conservation experience, and a wide diversity of contacts with bat academics and biologists in Africa. She was Chairperson of SABAA for seven years and is the lead author / co-author of the current South African best practice guidelines regarding bat monitoring studies at WEF developments during pre-construction (MacEwan *et al*. 2020) and operation (Aronson *et al*. 2020), and regarding bat fatality thresholds (MacEwan *et al*. 2018). Kate is also employed by Western EcoSystems Technology, Inc. in the United States to broaden their international footprint and to partner with IWS to offer a comprehensive and world-class service to Africa and other emerging markets. She has published several peer-reviewed articles on bats at WEFs, including a recent paper on bat activity and its implications for wind farm development in South Africa (MacEwan *et al*. 2020b).

8.2 Appendix 2: RINA impact assessment methodology

An 'impact' is any change to a resource or receptor caused by the presence of a project component or by a project- related activity. Impacts can be negative or positive and are described in terms of their characteristics, including the impact's type and the impact's spatial and temporal features (namely extent, duration, scale and frequency). Impact characteristics are defined in the subsections below.

Type of Impact

- ✓ Direct: applies to an impact which can be clearly and directly attributed to a particular environmental or social parameter (e.g. dust generation directly affects air quality)
- ✓ Indirect: applies to impacts which may be associated with or subsequent to a particular impact on a certain environmental or social parameter (e.g. high levels of dust could entail nuisance and health effects to workers on site).
- ✓ Induced: applies to impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project.
- ✓ Cumulative: applies to impacts that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect.

Duration of Impact

- ✓ Temporary - applies to impacts whose effects are limited to a period of less than 3 years, or only associated with Project pre-construction or construction phases.
- ✓ Short-term: applies to impacts whose effects are limited to a five-year period.
- ✓ Long-term: applies to impacts whose effects last longer than a period of five years, but limited to within the project lifetime.
- ✓ Permanent: applies to impacts whose effects last longer than the life of project – i.e. irreversible.

Extent of Impact

- ✓ On-site: impacts that are limited to the Project site.
- ✓ Local: impacts that are limited to the Project site and adjacent properties.
- ✓ Regional: impacts that are experienced at a regional scale.
- ✓ National: impacts that are experienced at a national scale.
- ✓ Trans-boundary/International: impacts that are experienced outside of Ghana.

Scale of Impacts

The scale of an impact is a quantitative measure, such as the size of the area damaged / impacted or the fraction of a resource that is lost / affected, etc. It is generally described using numerical values and units rather than assigned fixed designations.

Frequency of Impacts

The frequency of an impact the measure of the constancy or periodicity of an impact, described using numerical values or a qualitative description.

Likelihood

Likelihood is a measure of the degree to which the unplanned event (e.g. incidents, spills) is expected to occur. The likelihood of an unplanned event occurring is determined qualitatively, or when data is available, semi-quantitatively. Definitions of likelihood as applied in the ESIA are provided as follows:

- ✓ Unlikely: The event is unlikely but may occur at some time during normal operating conditions
- ✓ Possible: The event is likely to occur at some time during normal operating conditions.
- ✓ Likely: The event will occur during normal operating conditions (i.e. it is essentially inevitable).

A consistent approach to the assessment of impacts will be followed to enable E&S impacts to be broadly compared across the ESIA. A set of generic criteria are used to determine significance and are applied across the various environmental and social parameters.

Assessment of Impact Significance

As far as possible, E&S impacts will be quantified. Where it is not possible to quantify impacts, a qualitative assessment will be conducted using professional judgement, experience and available knowledge, and including the consideration of stakeholder views. Where there are limitations to the data, and/or uncertainties, these will be recorded in the relevant chapters, along with any assumptions made during the assessment.

In order to determine the significance of each impact, two overall factors are considered:

- ✓ magnitude and nature of impacts;
- ✓ the importance and/or sensitivity of the environmental and social receiving parameter, as determined during the assessment of baseline conditions.

Magnitude of Impact

Once impacts are characterised (see section above) they are assigned a 'magnitude'. Magnitude is typically a function of some combination (depending on the resource / receptor in question) of the following impact characteristics:

- ✓ extent;
- ✓ duration;
- ✓ scale;
- ✓ frequency.

Magnitude (from small to large) is a continuum. Evaluation along the continuum requires professional judgement and experience. Each impact is evaluated on a case-by-case basis and the rationale for each determination is noted. Magnitude designations for negative effects are: negligible, small, medium and large. The magnitude designations themselves are universally consistent, but the definition for the designations varies by issue. In the case of a positive impact, no magnitude designation is assigned as it is considered sufficient for the purpose of the impact assessment to indicate that the Project is expected to result in a positive impact.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is used. The likelihood factor is also considered, together with the other impact characteristics, when assigning a magnitude designation.

Sensitivity of Receiving Parameter

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity of the receptor. There are a range of factors to be taken into account when defining the sensitivity of the receptor, which may be physical, biological, cultural or human. As in the case of magnitude, the sensitivity designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity of receptor is set as either negligible, low, medium or high.

For ecological impacts, sensitivity is assigned as low, medium or high based on the conservation importance of habitats and species. For socio-economic impacts, the degree of sensitivity of a receptor is defined as the level of resilience (or capacity to cope) with sudden social and economic changes. Criteria for deciding on the value or sensitivity of biological and socioeconomic receptors are presented as follows.

Assessing the Significance of Impacts

In order to assess the significance of an impact, the sensitivity of the receiving environmental or social parameter is considered in association with the magnitude of the impact, according to the matrix shown in Table A.

Table A Matrix for Assessing Impacts Significance

Magnitude of Impact	Sensitivity of Receiving Receptor		
	Low	Medium	High
Negligible	Negligible	Negligible	Negligible
Low	Negligible	Minor	Moderate
Medium	Minor	Moderate	Major
High	Moderate	Major	Major

While the above matrix provides a framework for the determination of significance and enables comparison across environmental and social parameters, a degree of professional judgement must be used and some parameter- specific factors considered in making a determination of impact significance. The ESIA will provide additional guidance to the degrees of significance.

Note that positive impacts are defined, but not rated for significance.

Mitigation Measures and Residual Impacts

A key objective of an ESIA is to identify and define socially, environmentally and technically acceptable and cost effective measures to manage and mitigate potential impacts. Mitigation measures are developed to avoid, reduce, remedy or compensate for potential negative impacts, and to enhance potential environmental and social benefits. The approach taken to define mitigation measures is based on a typical hierarchy of decisions and measures, as described in the table below.

The priority is to first apply mitigation measures to the source of the impact (i.e. to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e. to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

Once mitigation measures are applied, the next step in the impact assessment process is to assign residual impact significance.

This means a repetition of the impact assessment steps reported above.

Table B Mitigation Hierarchy

Avoid / reduce at source: avoiding or reducing at source through the design of the Project (e.g. avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity).
Abate on Site: add something to the design to abate the impact (e.g. pollution control equipment).
Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site (e.g. traffic measures)
Repair or Remedy: some impacts involve unavoidable damage to a resource (e.g. material storage areas) and these impacts require repair, restoration and reinstatement measures
Compensate in Kind/Compensate Through Other Means where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g. financial compensation for degrading agricultural land and impacting crop yields)

Provided in Table C are the values that IWS assigned to RINA's stipulated impact assessment criteria. Impact magnitude was calculated as the sum of impact extent, duration, scale, frequency, and likelihood. Impact magnitude and receptor sensitivity were used to determine impact significance as indicated in Table B.

Table C Impact Assessment Criteria Values

Extent		Duration		Scale		Frequency		Likelihood		Magnitude		Receptor Sensitivity	
On-site	1	Temporary	1	Low	1	Never	1	Unlikely	1	Negligible	5-8	Negligible	1
Local	2	Short-term	2	Medium	2	Seldom	2	Possible	2	Low	9-12	Low	2
Regional	3	Long-term	3	High	3	Occasional	3	Likely	3	Medium	13-16	Medium	3
National	4	Permanent	4	Very high	4	Regular	4			High	17-21	High	4
International	5					Always	5						