# *Final Avian Re-Assessment for turbines proposed for the KARREEBOSCH WIND ENERGY DEVELOPMENT AREA, ROGGEVELD*


**Produced for:**

G7 renewable ENERGIES

**Produced by:**

BIRDS & BATS UNLIMITED

# CONTENTS

# 1 SUMMARY

This study contains a re-appraisal of the impacts and mitigations suggested for the proposed Karreebosch Wind Energy Facility (WEF) by Karreebosch Wind Farm (RF) (Pty) Limited. The avian component was previously surveyed in 2016 by African Insights (Williams 2016), and Birds & Bats Unlimited were asked to undertake a short re-assessment of the priority raptors in May 2021. The primary aim was to determine if the receiving environment has changed from the original assessment and subsequent granting of the EA, and to summarise the avian impacts of the previous avian assessment report.

The number of turbines was originally 71 (of 100-m hub height), in 2015. The authorised number of turbines was set at 65 (of hub height maximum 125-m) in 2016. The new proposal that this amendment considers is for up to 40 turbines of up to 140m hub height (HH) and up to 170m rotor diameter (RD) each generating up to 7.5MW. The original pre-construction avian monitoring by African Insights (2016) for Karreebosch covered a total 20 days in the development site itself, across four seasons, in the period March 2013 to September 2014. This started with good rains in 2013 and developed into drought in 2014.

The impact zone of the originally proposed facility lies in a small area in the Nama/Succulent Karoo biomes – in mountainous Roggeveld terrain. The area held few birds at the time, but eight priority species were recorded, of which three are *Endangered* species: Black Harrier *Circus maurus,* Martial Eagle *Polemaetus bellicosus,* Ludwig's Bustard *Neotis ludwigii,* and the *Vulnerable* Verreaux's Eagle *Aquila Verreauxii*. Raptors made up the remainder of the Priority species.

The increase in hub height necessitates a re-appraisal of the number of avian fatalities because taller turbines are expected to cause exponentially more deaths per turbine than shorter ones. The forecast for fatalities at the authorised hub height (125-m) was 1170 for the 65 shorter turbines, but 1120 birds for the 40 taller (140-m HH) turbines. This is a 4% decrease in fatalities over the larger number of shorter turbines. Thus, the revised number of turbines (from 65 to up to 40) is expected to decrease overall impacts on birds.

African Insights' report did not report Passage Rates or flight heights but recorded Priority bird flights and observation hours (n = 430-hours). We could, thus, reconstruct Passage Rates to quantitatively compare their 2016 findings with our 2014 (n = 38-hours) and 2021 (n= 15-hours) surveys.

- In 2016, Verreaux's Eagle Passage Rate were very low at 0.03 eagles per hour (~ 0.3 flight/day), and all Priority Species had a Passage Rate of 0.04 birds per hour.
- In 2014, our brief survey here (Birds & Bats Unlimited 2014) recorded 0.10 eagles per hour (~1 flights/day) and all Priority species had a Passage Rate of 0.29 birds per hour.
- In May 2021, our short survey revealed Verreaux's Eagle Passage Rates of 0.2 eagles per hour (~2 flights/day) and all Priority species had a Passage Rate of 0.20 birds per hour.
- There was no activity at the Verreaux's Eagle nest (No. 1, Beacon Hill) just south of Karreebosch in 2021 that had been reported active by African Insights (2016). However, a pair was in attendance around this nest in the Roggeveld construction phase assessment in September 2020 with a Passage Rate of 0.57 eagles per hour (~ 6 eagles per day). This nest is expected to become active in winter 2022.

The presence of the Verreaux's Eagle nest on Beacon Hill prompted a recommendation of a 1.5-km buffer for the nest (African Insights 2016), and that was given environmental authorisation. Subsequently, the guidelines for this species (Ralston Paton 2017) recommend a 3-km buffer around active eagle nests. This would influence the placement of seven turbines (WTG 27, 28, 36, 37, 38, 39, 40). Given the 3-km buffer recommendation the developers subsequently (July 2022) re-positioned all turbines falling within the 3-km outside this buffer and indeed only two turbines (WTG5 and 22) fall within the newly recommended buffer of 3.7-km.

As discussed with the developer, those turbines close to the nest were re-located 3km or more from the known Verreaux's Eagle nest complying with recommendations. We additionally recommend that if possible all turbines

within the 5.2km Verreaux's Eagle precautionary buffer are erected with a single, coloured blade to increase blade visibility and reduce risks to the eagles. This recommendation is subject to South African Civil Aviation Authority (CAA) approval of blade painting and colouring and the selected turbine supplier accepting the warranties of blades being painted. This must include the turbines T5 and T22 (closest to the eagle nest). We have done so to accommodate the revised Verreaux's Eagle guidelines that recommend a 5.2km precautionary buffer for areas with known eagle flights. Given that SDOD and retrospective blade painting are both expensive we recommend blade painting at the construction phase as the most cost effective mitigation at source, with no operational phase costs.

An additional form of mitigation, for any turbine across the farm that kills more than one *Endangered* or *Vulnerable* species per year, would be – in conjunction with the Avian Specialist – adopting adaptive mitigation measures in the form of automated shut-down on demand (SDOD) on the problem turbines. This can be Bioseco, or DT-bird or a suitable alternative.

Operational-phase monitoring is essential to determine the actual impacts on birds and will inform the required mitigation measures and thresholds. This plan must allow for:

(i) Any changes recommended by the specialist and agreed by the Holder of the EA to be implemented within a maximum timeframe of two months;
(ii) the Wind Farm must agree to follow the mitigation measures that may result from the operational monitoring and Adaptive Management Plan; and
(ii) in accordance with the Adaptive Management Plan, appropriate mitigation measures are implemented, such as curtailment, during specific environmental conditions, or during high-risk periods such as breeding seasons.
(iii) If fatalities persist at certain turbines, then SDOD must be implemented as longer-term measure.

With the number and layout of the 40 turbines as discussed above and the appropriate mitigations in place we see no reason why this amendment cannot be approved from an avian perspective.

## 1.1 Qualifications of Specialist Consultant

Dr Rob Simmons, Director of Birds & Bats Unlimited is an ecologist, ornithologist, and environmental consultant, with three decades research experience in North America, Africa, Europe, and Asia. He is a Permanent Resident in South Africa. Currently a Research Associate of the FitzPatrick Institute's Centre of Excellence, University of Cape Town. Formerly employed in Namibia's Ministry of Environment & Tourism as the state ornithologist, specialising in wetland, avian and montane biodiversity. Schooled in London (Honours: Astrophysics), Canada (MSc: Biology) and South Africa (PhD: Zoology).

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### SURVEY EXPERIENCE:

- **Sandwich Harbour avifauna** - A 30-year project assessing fluctuations in wetland avifauna relative to Walvis Bay and revealing long term declines in palearctic migrant shorebirds - published *Conservation Biology* (2015)
- **Arid species diversity across a steep rainfall gradient -** a 3-year project at 5 sites across a 270 km gradient, in the wet and dry seasons, assessing avian richness and functional diversity in 3 habitats in Namibia. Dry rivers found to be critical refugia as biodiversity declined with increasing aridity. Published *Ecosystems* (2015).
- **Population monitoring of Namibian endemics**–Determined densities and overall population numbers of all 16 Namibian endemic birds with Edinburgh University, published *Biological Conservation* Robertson et al (1996);
- **Damara Tern status** –Stratified random survey of the 1470-km Namibian coast, to determine the global population of this tern. Published *Ibis* 1998. Angolan breeding colonies published *Af J Mar Sci, Ostrich*
- **Black Harrier status** – 18-year study of *Endangered* Black Harriers in South Africa, followed by satellite tags to determine ecology and migration with FitzPatrick students. *PlosOne* Garcia-Heras et al. (2019).

### Research on new avian mitigation measures for the wind and power industry:

- **testing use of vulture restaurants** to draw vultures away from wind farms in Lesotho.
- proposing and **testing coloured-blade mitigation** to reduce raptor fatalities in SA.
- **Implementing staggered pylons on parallel lines** as first effective mitigation for high bustard deaths.

### Environmental Impact Assessments (renewable energy, power lines, mining, airports)

- birds impacted by a proposed Haib **copper mine** near the Orange River (1994);
- siting of proposed Lüderitz **wind farm** prior to formal assessments for NamPower (1997);
- impact of **water abstraction** from Karst System wetland birds Tsumeb (2003) (J Hughes);
- impact of **uranium mine** at Valencia, Khan River, Namibia (Aug 2007, Feb 2008)
- Impact on birds by a proposed **airport** in Caledon, Western Cape (2009)
- **Biodiversity surveys** in Namib Desert, Angola, (SANBI–Angola joint surveys- Dr B. Huntley)
- **Wind farm** assessments on the west coast at Kleinsee and Koingnaas (Savannah – 2011)
- EIA report on avian impacts at Namaqualand + Karreebosch **wind farms** (Mulilo –2015, 2017)
- Pre-construction avian impacts at the Witteberg (Karoo) **wind farm** site – (Anchor Environmental 2011-2012) and Verreaux's Eagles (G7/Building Energy 2014-2015, 2019);
- Pre-construction avian impacts at Happy Valley (E Cape) **wind farm** (EDP Renewables 2014)
- Pre-construction avian monitoring Karoshoek CSP-trough **CSP-tower** Solar Park (Upington) (Savannah Environmental for Emvelo Eco Projects, 2015-2016)
- Pre-construction avian impacts at a Tankwa Karoo **wind farm** (Genesis Eco-Energy 2016-17)
- Pre-construction avian impacts at **Juno WEF,** Strandfontein (AMDA Pty Ltd, 2016-2017)
- Specialist studies of Red Data raptors at Jeffreys Bay **wind farm** (Globeleq, 2016-2019)
- Pre-construction avian impacts: Namas+Zonnequa **wind farms**, Kleinsee (Atlantic Energy + Genesis 2016/17);
- Pre-construction avian impacts and mitigation test at Lesotho **wind farm**, IFC compliant (eGEN+AGR 2017-18);
- Walvis Bay **waterfront development** impacts on Walvis Bay lagoon avifauna (ECC) 2017
- Avian-**power line** EIA study of 450 km-long, 400 kV line (Lithon-Nampower 2017-2018);
- Pre-construction avian impacts of Kappa 1 and 2 and 3 **wind farms** in Tankwa (Eco-Genesis 2018-2020);
- Pre-construction avian impacts of Nama Karoo **wind farms** Komas + Komas (Enertrag) 2019;
- Avian impacts along Kruisvallei **Hydro-project power line** Free State and IFC compliance(Building Energy 2019)
- Amendments to avian impact (hub heights) Karreebosch (Nama-Karoo) **wind farm** site (Mulilo 2019) and the Namas and Zonnequa **wind farms** (Enertrag) 2019
- Specialist studies of Black Harriers at **Elands Bay** wind farm and aquaculture site (Planet Capital 2019/20)
- Pre-construction avian impacts at Kotulo-Tsatsi **solar and wind farm** (Savannah 2021)
- Avian impact assessment at the Euronotus and Roggeveld **wind farm** cluster **(x4)** Karoo (Red Rocket 2021)

Consultancy work at: http://www.birds-and-bats-unlimited.com

Papers and academic background at: www.fitzpatrick.uct.ac.za/fitz/staff/research/simmons

# 2 SPECIALIST DECLARATION

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

| | (For official use only) |
|---|---|
| File Reference Number: | |
| NEAS Reference Number: | DEA/EIA/ |
| Date Received: | |

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

**PROJECT TITLE**

| |
|---|
| **EA AMENDMENT: KARREEBOSCH WIND ENERGY FACILITY, NORTHERN CAPE PROVINCE - AVIAN SPECIALIST REPORT – 2022** |

**Kindly note the following:**

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

**Departmental Details**

**Postal address:**
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447, Pretoria 0001

**Physical address**:
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Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road, Arcadia
Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

**Specialist Details**

| | | | | |
|---|---|---|---|---|
| Specialist Company Name: | Birds & Bats Unlimited | | | |
| B-BBEE | Contribution level (indicate 1 to 8 or non-compliant) | 4 | Percentage Procurement recognition | 100 |
| Specialist name: | Dr Robert E Simmons | | | |
| Specialist Qualifications: | PhD (Wits), MSc (Acadian Univ, Canada), BSc Hons (London) | | | |
| Professional affiliation/registration: | Birdlife South Africa, Honourary Research Associate University of Cape Town | | | |
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| Postal code: | 7975 | Cell: | 0827 800 133 | |
| Telephone: | As above | Fax: | | |
| E-mail: | Rob.Simmons@uct.ac.za | | | |

## 2.1 DECLARATION of INDEPENDENCE by the SPECIALIST

I, _____Dr Rob Simmons_____, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

**Birds & Bats Unlimited**

Name of Company:

**14 August 2022**

Date

## 2.2 UNDERTAKING UNDER OATH/AFFIRMATION

I, ____Dr Rob Simmons____, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

**Birds & Bats Unlimited**

Name of Company

**14 August 2022**

Date

Signature of the Commissioner of Oaths

Date

# 3 INTRODUCTION and TERMS of REFERENCE

The Terms of Reference for the avian impact amendment assessment are to compile an addendum to the 2016 specialist' avian reports addressing the following:

- Re-survey the study site to determine if the receiving environment has changed.
- Survey the priority species to determine if they occur with the same frequency as before.
- Survey the site to assess if any changes to the breeding species have occurred since 2016.
- The implications of the proposed amendments in terms of the potential impact(s).
- A detailed description of measures to ensure avoidance, management and mitigation of impacts associated with the proposed changes.
- The re-assessment must take into account and address public comments once completed and if any avifaunal questions are raised.
- The re-assessment must consider the findings of the 12-month pre-construction monitoring and inform the construction and post-construction phases.

## 3.1 LEGISLATION: LEGAL REQUIREMENTS

Impact Assessment reports are required to follow guidelines laid out by the Department of Fisheries, Forestry, and the Environment (DFFE). They provide the following guidelines:

On the 7th of April 2017, the Minister of Environmental Affairs promulgated amendments to the EIA Regulations (2014), as amended (GNR 982) in terms of Chapter 5 of the National Environmental Management Act (No. 107 of 1998), as amended (NEMA). Regulations 31 and 32 of the EIA Regulations (2014), as amended, details the process for a Part 2 (substantive) amendment of an environmental authorisation where a change of scope occurs, but a listed activity is not triggered.

The proposed amendments detailed below do not trigger any new listed activities in terms of the EIA Regulations (2014), as amended. Furthermore, no additional properties will be affected by the amendments that were not originally assessed. However, the proposed amendments will result in a change in scope of the valid EA. As such, a Regulation 31 Amendment Process in terms the EIA Regulations (GNR 326) of the EIA Regulations, 2014 as amended is applicable.

Because this development already has Environmental Authorization (from the DFFE), the Screening Tool requirements fall away. However, the EA stipulates (point 47) that "*a pre-construction walk-through on … the turbine positions must be undertaken by a … avifaunal specialist …. to ensure that the micro-sighting of the turbines is optimal."*

We have also undertaken this amendment under the guidance of Birdlife South Africa's wind farm guidelines (Jenkins et al. 2015).

## 3.2 STUDY AREA

The proposed Karreebosch Wind Energy Facility (WEF) lies in the Roggeveldberg a north-south lying mountain range rising to about 1500-m asl.

The habitat in the study area is described as *Central Mountain Shale Renosterveld* (Mucina & Rutherford 2006, p178). The vegetation comprises components of both the Nama and Succulent Karoo biomes, but mainly with Karoo bushes. The habitat is described *as Least Threatened*, with none conserved in formal protected areas.

This region just north of Matjiesfontein lies in the winter rainfall region but with summer rains also evident. Mean Annual Rainfall varies between 180- and 410-mm with a mean of 290-mm/year. Temperatures vary from

a mean of 29.9°C in summer to 0.9°C in winter. Winds sweep across the open and undulating landscape, reducing temperatures to low levels. Frost days are common.

Land use is mainly low-level sheep farming, with large and small farm reservoirs attracting wetland birds (African Insights 2016). Indigenous wildlife comprises Baboon, Klipspringer, Red Rock Hare, Mountain Rhebok and a raptor component reported on below.

### 3.3 BACKGROUND

The following report is a revision and re-assessment of the avian impacts EIA Report (African Insights 2016) for the proposed Karreebosch WEF. This is required to re-examine possible impacts arising from:

(i) possible changes in the receiving environment
(ii) changes in turbine numbers and dimensions as tabulated below (Table 1)

The possible environmental changes are important given the intense drought apparent in 2016 (African Insights 2016) and the steady return to typical rainfall in 2021.

**Table 1**: Changes in dimensions and numbers of turbines and other major features of the Karreebosch WEF between authorised and amendment

| ASPECT TO BE AMENDED | AUTHORISED | PROPOSED AMENDMENT |
|---|---|---|
| Number of Turbines | Up to 65 with a foundation of 25m in diameter and 4m in depth | Up to 40 turbines with a foundation of 30m in diameter and 5m in depth |
| Turbine generating capacity | Up to 5.5 MW | up to 7.5 MW in capacity each |
| Turbine Hub Height | A range up to and including 125m | All turbines up to 140m |
| Rotor Diameter | A range up to and including 160m | All turbines up to 170m |
| Blade length | ~80m | ~85m |
| Area occupied by transformer stations/ substation | • Two 33/132kV Substation 100m x 200m<br>• Extension of the existing 400kV substation at Komsberg<br>• Transformer art each turbine: total area <1500m² (2 m² per turbine up to 10m² at some locations) | • one 33/132kV substation 150m x 200m (3ha)<br>• Extension of the existing 400kV substation at Komsberg<br>• Transformer at each turbine: 6m x 3m= 720m² total area <0.4ha (up to 10mX10m at some locations) |
| Length of (new) internal access roads | ~40 km | ~77 km of new internal access roads and up to ~14 km of 4x4 access tracks . ~30km of existing access roads of 4m width will be widened by up to 9m. |

# 4 METHODS

- This report compares data from 2016 when monitoring was undertaken (March 2013, May, July, September, November 2013, and September 2014: African Insights 2016) with avian surveys in May 2021 and September 2020).
- The total number of hours spent surveying the site from vantage points (VPs) on Karreebosch in 2016 was 430-hours from 12 VPs (African Insights 2016).
- We estimated Passage Rates from the number of flights depicted in Figures 6 to 11 of the African Insights report (2016) and reproduced below (Figures 2 and 3).
- In September 2014 and May 2021, Birds & Bats Unlimited undertook site visits covering 38.4- and 18.8-hours respectively observing from eleven VPs (as close as possible to those used by African Insights).
- May is the start of the breeding season for Verreaux's Eagles (Simmons 2005), and September when nestlings are being fed. Thus, the visits were timed to coincide with maximum flight activity of the main priority species here.
- We define 'Priority Species' as the top 100 most collision-prone species for wind farms (Ralston Paton et al. 2017).

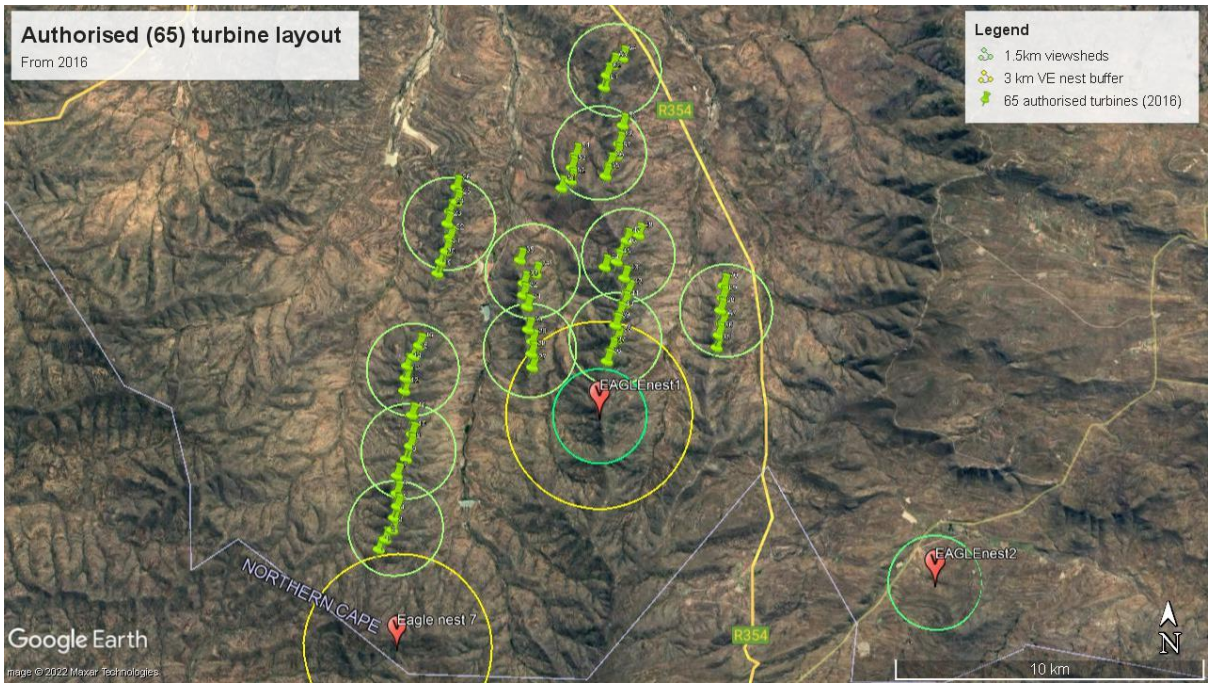



**Figure 1**: The 2016 layout of the (65) authorised turbine positions (green pins) in the Karreebosch WEF in the Roggeveld mountains. The turbine positions are shown with our 1.5-km viewsheds (= green circles) overlooking all turbines. The three known Verreaux's Eagle nests are shown as red pins.

# 5 SUMMARY of FINDINGS of ORIGINAL (2016) EIA REPORT

The main findings of the original avian assessment for Karreebosch (African Insights 2016) can be summarised as follows:

- Six site visits, spanning all four seasons, were undertaken in 2013/2014. Spring was covered twice: in September 2013 and September 2014.
- From 12 Vantage Points, 430-hours of observation were undertaken to record priority species.
- Only four priority species were recorded in that time (Table 1).
- *Endangered* Black Harrier and Martial Eagle, and *Vulnerable* Verreaux's Eagle, were recorded on site.

- A Verreaux's Eagle nest was found at the southern end of the wind farm and a very low Passage Rate (0.03 eagles/hour) for the species was recorded in 2013/14.
- The Passage Rate for the remaining Priority species (Black Harrier, Martial Eagle, Jackal Buzzard, excluding the Rock Kestrel) was estimated at a very low 0.04 birds/hour.
- The EIA included a short site visit by Birds & Bats Unlimited (BBU) in September 2014 (n = 38.4 h) to assess raptor activity. We recorded 6 priority species (Verreaux's, Martial, Pale Chanting Goshawk, Black Sparrowhawk, African Fish Eagle, Black stork) with a Passage rate of 0.29 birds/hour.
- Verreaux's Eagle flights recorded by BBU with a Passage rate of 0.1 eagles/hour, were about three-fold higher than simultaneously recorded results from African Insights (2016).

**Table 1:** Four priority species identified in the avian EIA report for Karreebosch in 2013/14 (African Insights 2016). Those in green are the six priority species recorded by BBU in September 2014 in our single site visit.

| Common name | Conservation status | Relative importance of local population[1] | Susceptibility to collision | Susceptibility to electrocution | Susceptibility to disturbance | Likelihood of occurrence |
|---|---|---|---|---|---|---|
| **Black Harrier** | **Endangered** | Moderate | Very High | low | High | Not reported |
| **Martial Eagle** | **Endangered** | Low | Very High | High | High | Not reported |
| **Verreaux's Eagle** | **Vulnerable** | Moderate | Very High | Low | Medium | Not reported |
| **Jackal Buzzard** | Least Concern | Low? | Very high | High | Moderate | Not reported |
| **Verreaux's Eagle** | **Vulnerable** | Moderate | High | Low | Medium | Not reported |
| **Martial Eagle** | **Endangered** | Low | High | High | High | Not reported |
| **Black Stork** | **Vulnerable** | Moderate | Very High | Medium | High | Not reported |
| **Black Sparrowhawk** | Least Concern | Low | Medium | Low | Low | Not reported |
| **African Fish Eagle** | **Least Concern** | Low | High | Medium | Low | Not reported |
| **Pale Chanting Goshawk** | Least Concern | Low | Medium | High | Low | Not reported |

**Photo 1:** A juvenile Martial Eagle photographed in our short site visit in September 2014 to assess raptors on the original Karreebosch WEF site.

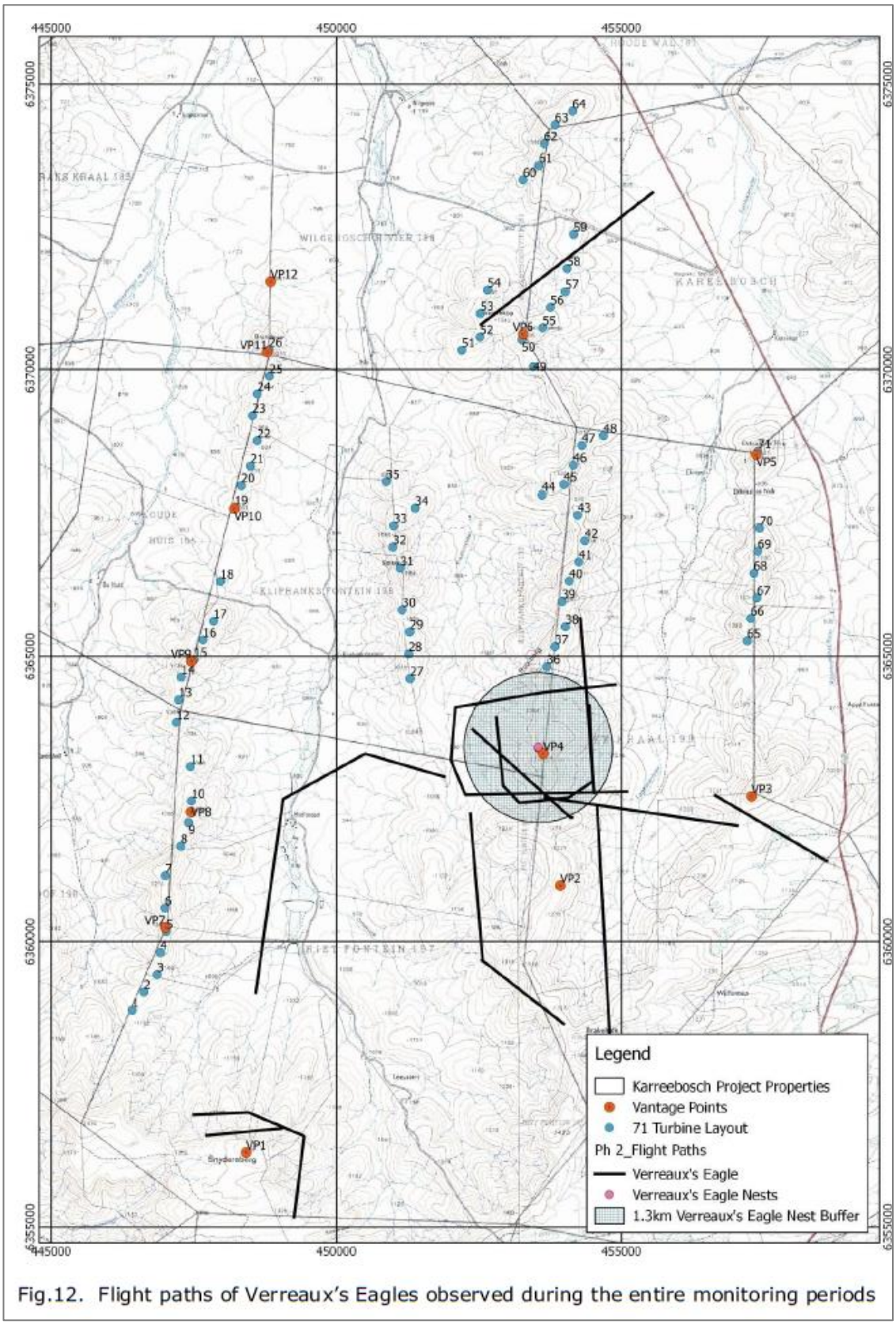



Fig.12. Flight paths of Verreaux's Eagles observed during the entire monitoring periods

**Figure 2:** A screenshot from African Insights' report (2016) for Karreebosch of all Verreaux's Eagle flights recorded in 2013/14 over 430-hours over four seasons. The Passage Rate for this species, estimated from 13 flights in 430-hours, is ~0.01 eagle flights/hour. Note that most were associated with the area where the Verreaux's nest was located by African Insights (2016) (Stippled circle).

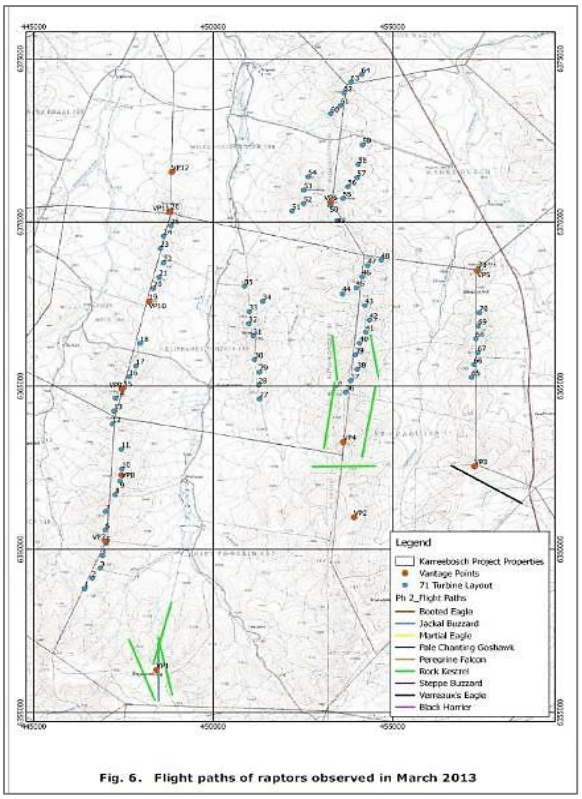
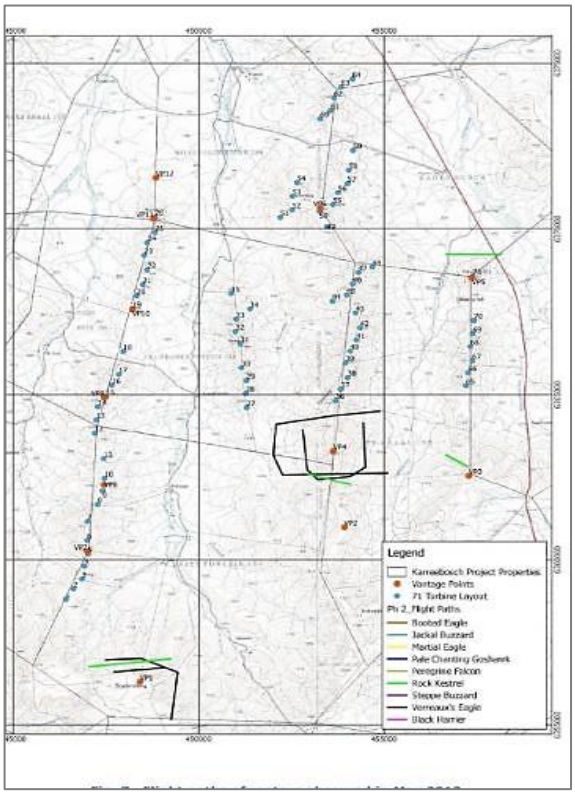



Fig. 6. Flight paths of raptors observed in March 2013



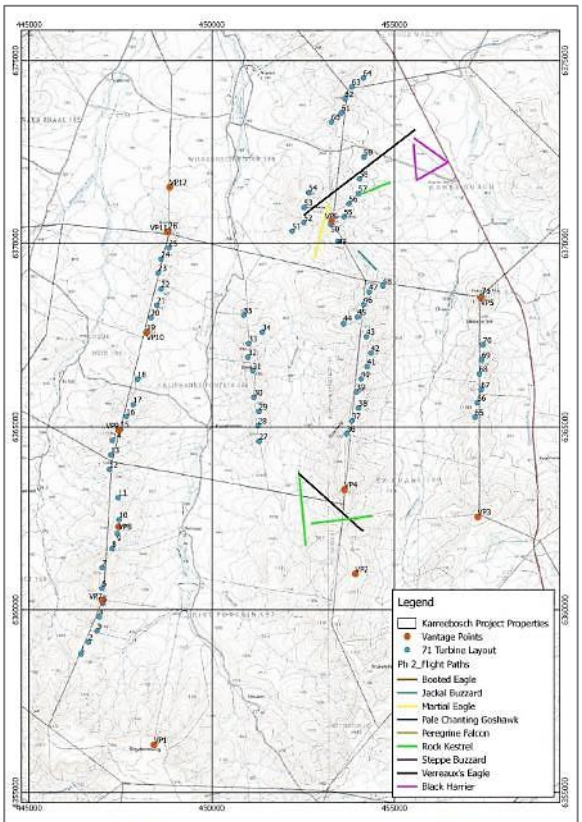




Fig. 8. Flight paths of raptors observed in July 2013

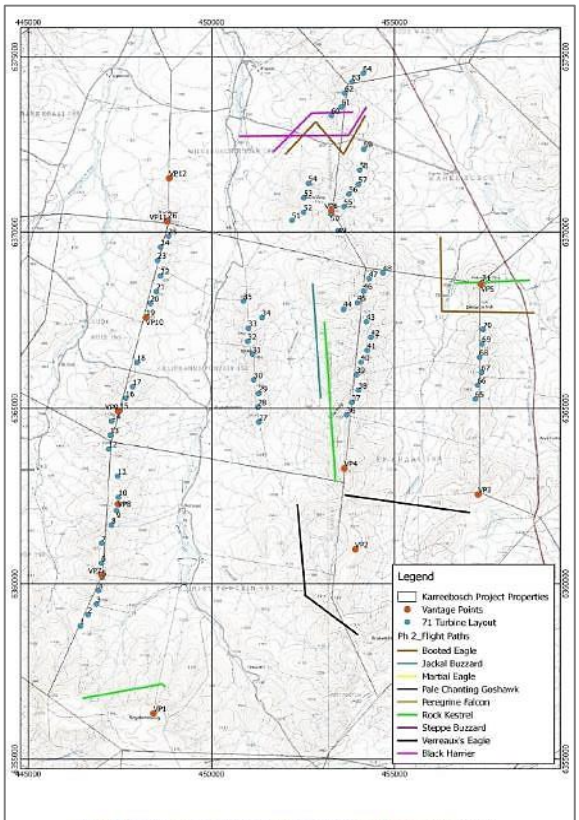



Fig. 9. Flight paths of raptors observed in September 2013

**Figure 3a:** Screenshots from African Insights' Karreebosch report (2016) of all Priority birds (other than Verreaux's Eagles) recorded in 2013/14 over 430-hours over four seasons and six visits. The Passage Rate for priority species, estimated from 19 flights in 430-hours, was ~0.04 bird flights/hour.

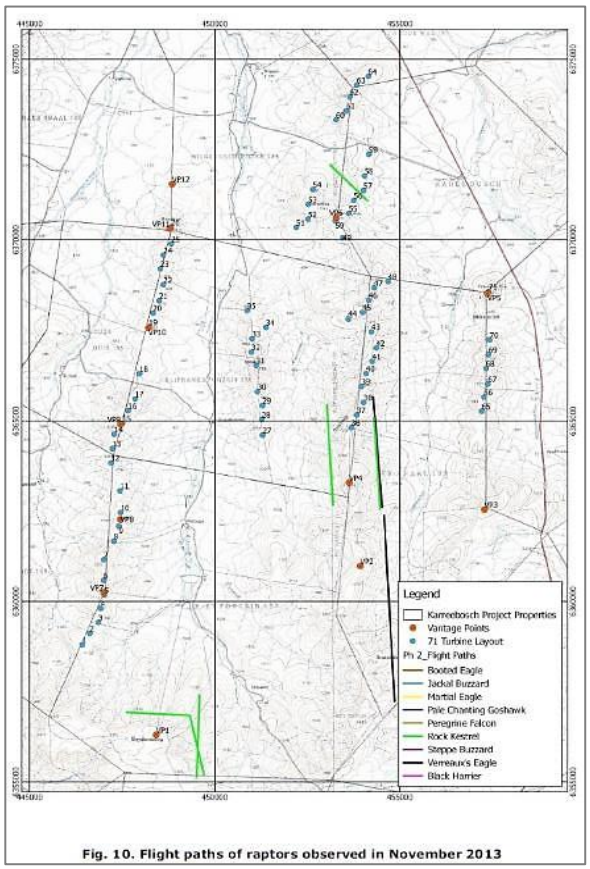


Fig. 10. Flight paths of raptors observed in November 2013

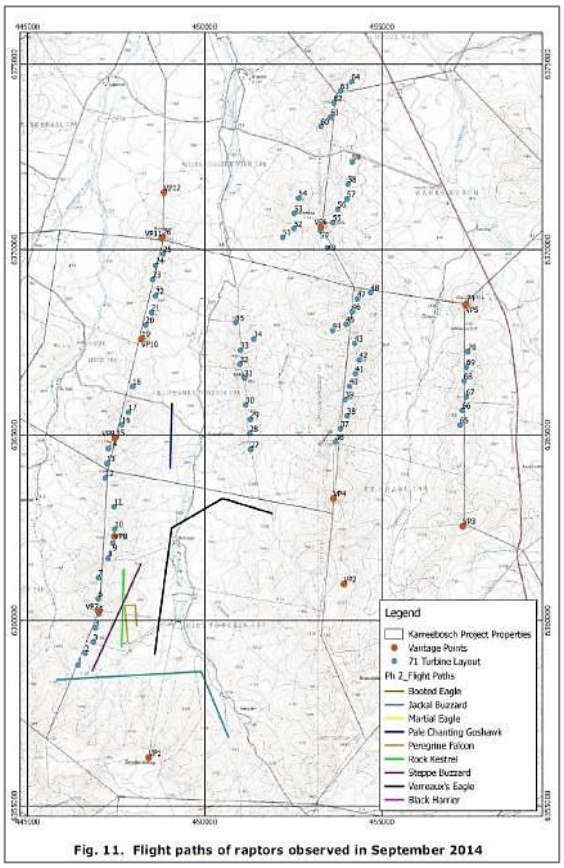


Fig. 11. Flight paths of raptors observed in September 2014

**Figure 3b:** Screenshots from African Insights' Karreebosch report (2016) of the last two site visits reporting Priority birds (other than Verreaux's Eagles) flying through wind farm in 2013/14 over 430-hours. The overall Passage Rate was low at 0.04 birds / hour (with eagles included).

# 6 RESULTS from BBU SITE VISITS in 2014, 2020 and 2021

The six days Birds & Bats Unlimited (BBU) spent in the Karreebosch and surrounding WEF projects (Brandvalley and Rietkloof) cluster (two days on Karreebosch itself) were devoted to surveying the wind farm to record eagles (and other Priority birds) in flight, and to check for possible nest sites. We include here the results of a short visit commissioned in September 2014 by Karreebosch Wind farm (Pty) Ltd a subsidiary of G7 Renewable Energies (Pty) Ltd.

In 2021, BBU confirmed the location of the Verreaux's Eagle nest in the southern sections of the WEF (Figure 4 and Photo 2) found by African Insights (2016). It was inactive, but a pair of adults was in the vicinity.

The nest was first located in 2013 by African Insights (2016) and a 1.3 km nest buffer proposed to minimise fatalities from any turbines (African Insights 2016).

The Passage Rates from 2021 and 2020 and 2014 around this nest are compared below.

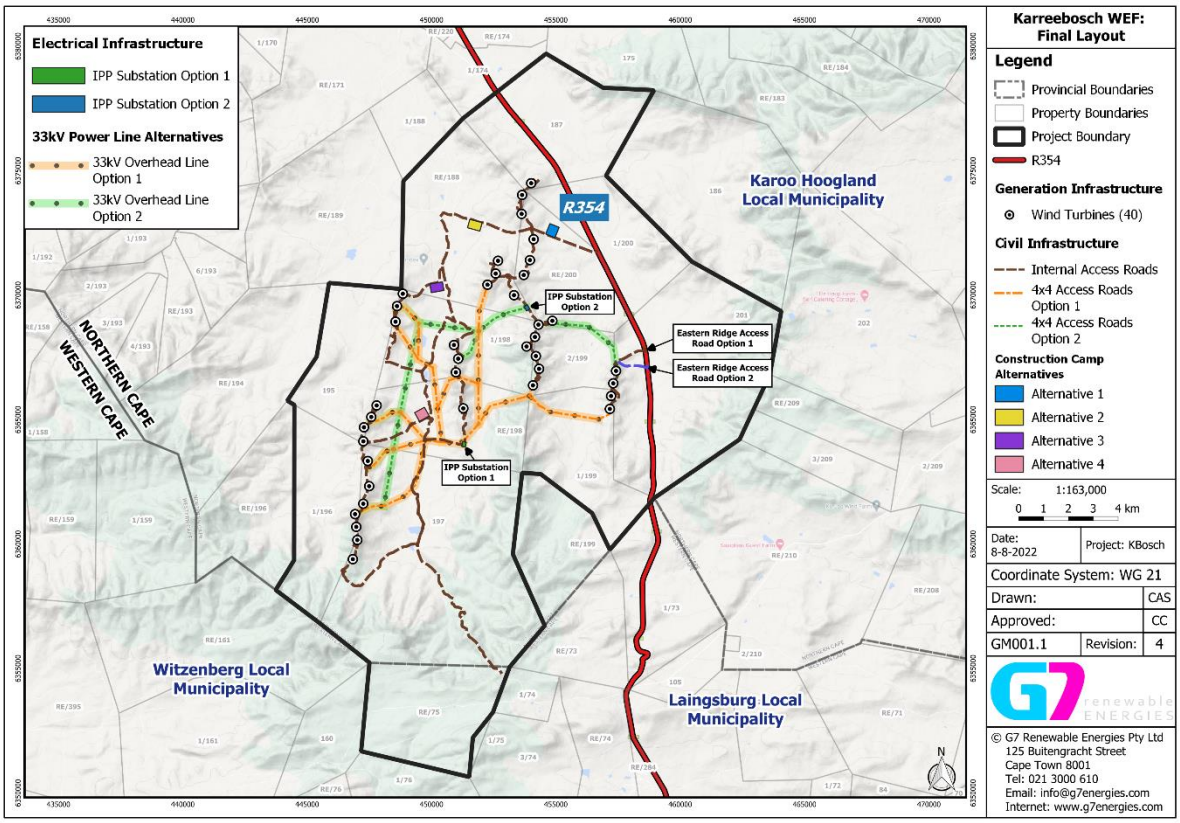



**Figure 4**: The proposed Karreebosch wind farm showing final (40) turbine positions, and all roads and overhead power lines.

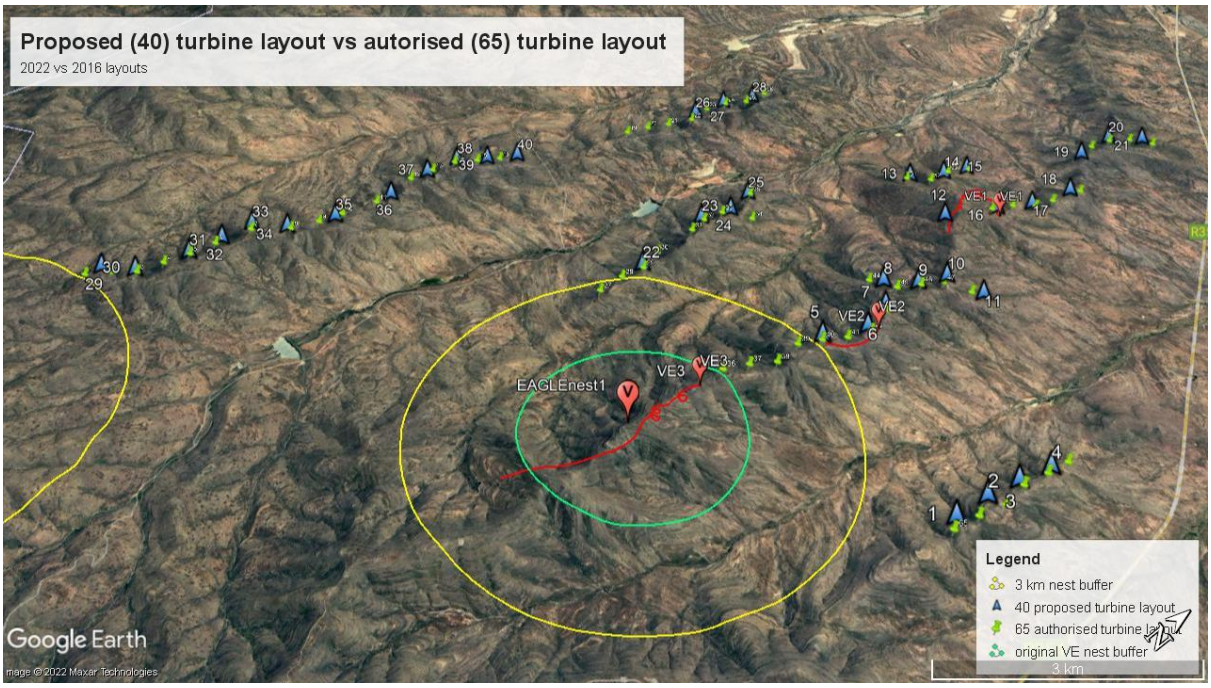



**Figure 5**: All raptor flights (= red lines) over the proposed (40 blue triangles) and authorised (65 green pins) in the Karreebosch wind farm recorded in May 2021 in 15.0-hours. Verreaux's Eagles were the only priority species recorded and their Passage Rates, based on three flights in 15.0hours, was 0.20 birds/hour. Observation here in September 2020 recorded 18 flights in 10h observation giving a high Passage Rate of 1.8 eagles/h. This compared with Passage Rates in 2016 of 0.03 eagles/hour. The Verreaux's Eagle nest No. 1 (= red balloon) was present in 2013/14. The yellow circle represents a 3-km nest buffer.


**Photo 2:** The Verreaux's Eagle nests (No. 1) discovered by African Insights (in 2013) in the southern section of the Karreebosch WEF site. No breeding activity was apparent in 2021, but the pair was in attendance in both 2020 and 2021.

## 6.1 PASSAGE RATES COMPARED over the PROPOSED STUDY SITE

In May 2021, BBU observed for a total of 56 hours throughout the three development sites, namely the Karreebosch WEF and the surrounding Brandvalley and Rietkloof WEFs. In the two days spent on Karreebosch WEF itself, BBU used the same VPs used by African Insights but undertook fewer hours on site (15.0-h) as this is a re-assessment of the findings, not a full EIA.

- We recorded three Verreaux's Eagle flight on Karreebosch in that time giving a Passage Rate of 0.20 eagles/hour for the site.
- This compares with 0.03 eagles/hour recorded by African Insights in 2013/14 on Karreebosch – a six-fold higher rate in 2021.
- The eagle Passage Rates in September 2020 around this nest area (from the Roggeveld construction-phase: Birds & Bats 2020) report were much higher from the Vantage point south of the nest. BBU then recorded 18 eagle flights in the 10 hours over three days, giving a high Passage Rate of 1.8 eagles/hour here.
- For all Priority species on Karreebosch in 2021, the Passage Rate (0.20 birds/hour) was five-fold higher than that recorded in 2013/14 (0.04 birds/hour) by African Insights.
- All 2021 flights are shown in Figure 5.
- These results indicate high variability but high use by eagles in recent years around this nest, and mitigations are required.

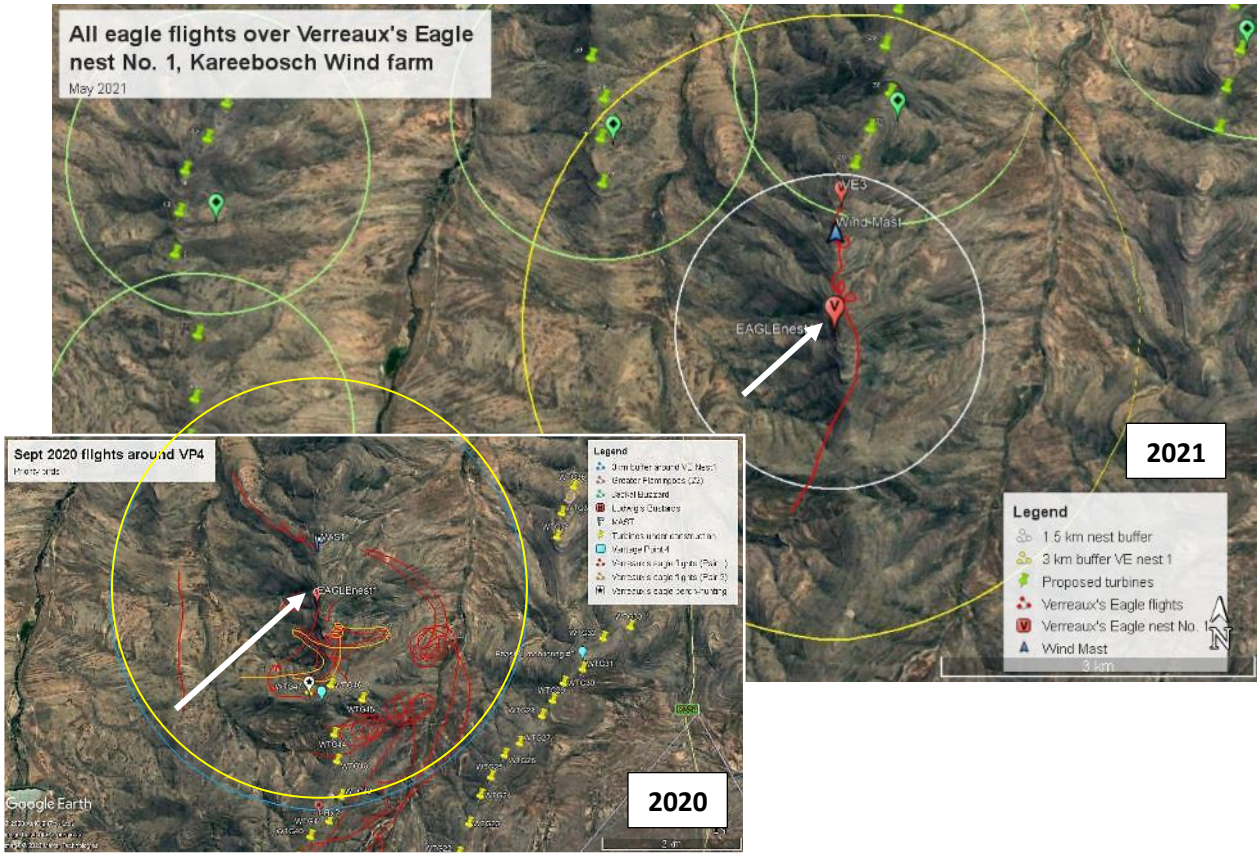



**Figure 6**: The known Verreaux's Eagle nest (no. 1, red balloon, white arrow) on the Karreebosch wind farm in relation to the previously authorised 65 turbine layout (= green pins) and the 1.5-km and 3.0-km nest buffers (= white and yellow circle, respectively). The 3.0-km nest buffer encompasses six proposed turbines, and no turbines occur within the 1.5-km buffer. Eagle Passage Rates here in 2021 were 0.20 eagles/hour. **Note that these six turbines have now been re-positioned outside the buffer.**

**Inset**: Verreaux's Eagle flight lines (=red and yellow lines) recorded in September 2020 in this same area. A total of 18 flights in 10 hours were recorded by Birds & Bats Unlimited (2020) giving a very high Passage Rate of 1.8 eagles/hour or about 18 eagle flights/day).

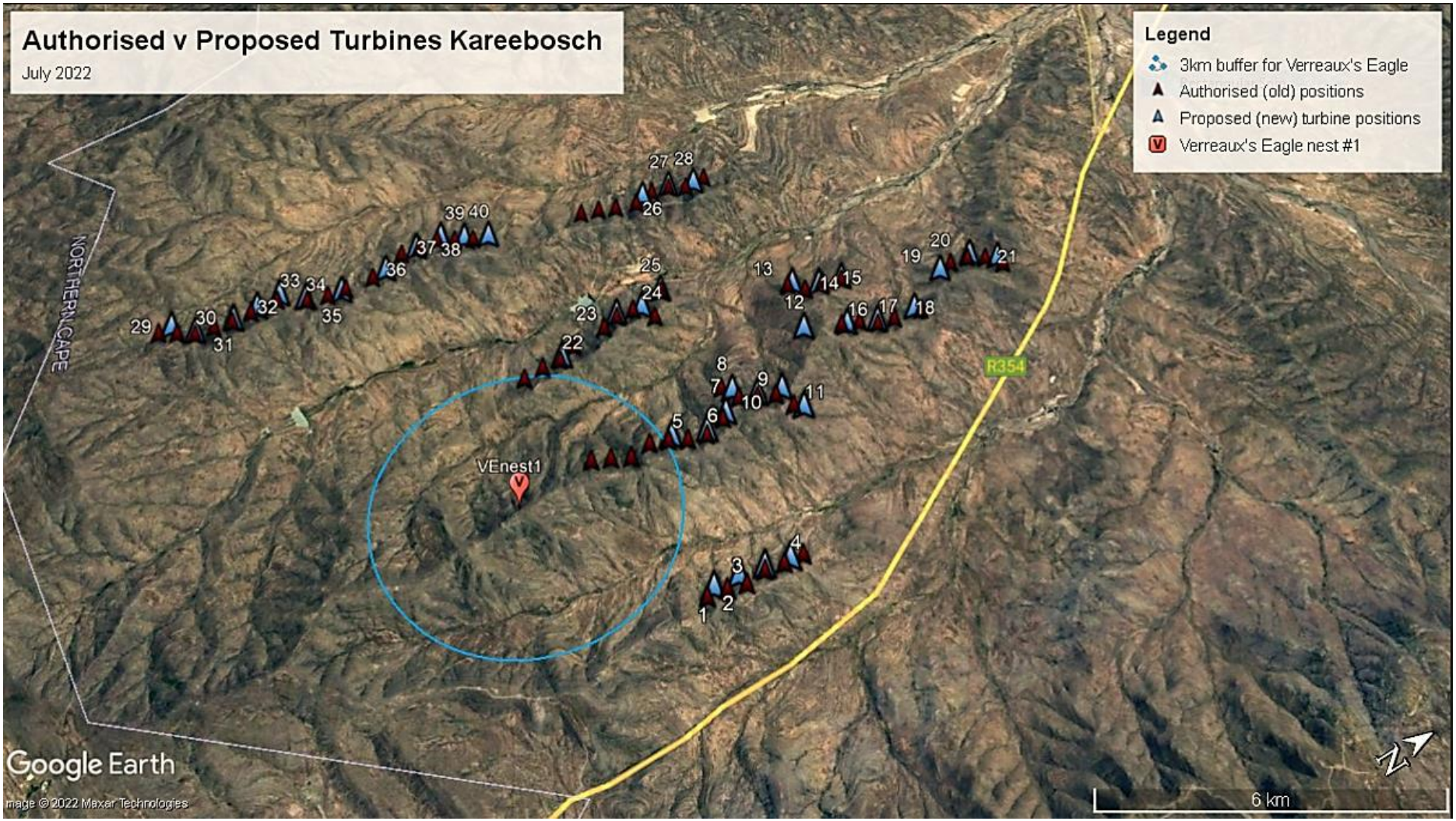



**Figure 7**: Old (Authorised) vs new (Proposed) turbine positions for the Karreebosch WEF in July 2022. The 65 authorised turbines (= red triangles) have been reduced to up to 40 (= blue triangles) and their proposed positions are shown in relation to the Verreaux's Eagle nest (= red balloon "VE nest1"). The 3.0-km nest buffer (= blue circle) indicates that six turbines have been moved out of the buffer by the developers. For the revised (but unpublished) Verreaux's Eagle guidelines there are only two turbines (WTG5, WTG22) within the 3.7-km buffer (not shown).

# 7 SIGNIFICANCE of IMPACTS – Increased hub heights and fatalities

The anticipated impacts in relation to fatalities arising from increased turbine dimensions are assessed in this section. Note that a significance table was not provided in the African Insights 2016 report, so it is difficult to compare the significance of the expected impacts in 2013 and 2021 data.

The general effects of increased turbine heights and blades (rotors) on avian collision-risk was assessed by **Loss et al (2013),** who re-analysed all data from turbines without the lattice towers (that have been discontinued) and found:

- A significant effect of hub height on the number of avian mortalities for 53 wind farm sites in the USA (Blade length could not be independently assessed because of statistical collinearity with hub height);
- In a model that included region and hub height, avian fatalities increased from about 2.0 birds/turbine/year at 40-m hub heights to 6.2 birds/turbine/year at 80-m hub height;
- This represents a ~3-fold increase in mortalities between 40-m and 80-m hub height.

**Thaxter et al. (2017)** undertaking a world-wide assessment of traits that influence wind farm fatalities found:

- more fatalities of birds (and bats) were associated with taller turbines world-wide.
- The highest fatality rates were found with more small turbines (rather than a few large turbines) to produce the same overall power output.
- This would depend on the capacity of each turbine (they modelled up to a power capacity of 2.5 MW per turbine). BBU carried out this exercise below based on turbine size and number.
- In total, 57 bird species (including 31 *Accipitriformes* – birds of prey) of 362 sampled were identified as threatened by 'renewable energy'.

BBU combined the data from Loss et al. (2013) with that from 7 wind farms in South Africa with fatalities in relation to hub height provided in Ralston-Paton et al. (2017). The results of the modelling of fatalities in relation to hub heights (Figure 8) indicate that avian fatalities are expected to *increase exponentially* 1.5-fold from an average 18 fatalities/turbine (95% Confidence Intervals 11 to 35) at 125m hub height to 28 (CL 12 to 65) fatalities/turbine/year as at 140-m.

These figures indicate a 55% increase in fatalities is expected on average ([28-18]/18) per turbine. However, at the same time, the number of turbines will decrease from the authorised 65 to a maximum of 40 – a 38% reduction.

Does this offset the expected increase in avian fatalities? The answer is yes (Table 3). The forecast of total avian fatalities is 1170 birds for the 65 shorter (125-m HH) turbines, but 1120 birds for the 40 taller (140-m HH), turbines. This is 4% decrease in avian fatalities over the larger number of shorter turbines. Confidence intervals are shown in Figure 8a and indicate that the South African data (red circles) fall within the confidence limits of the USA data. Thus, the reduction in the number of turbines reduces the overall impact and likelihood of bird fatalities in this area and from an avifaunal perspective this change is not seen as a negative but overall positive.

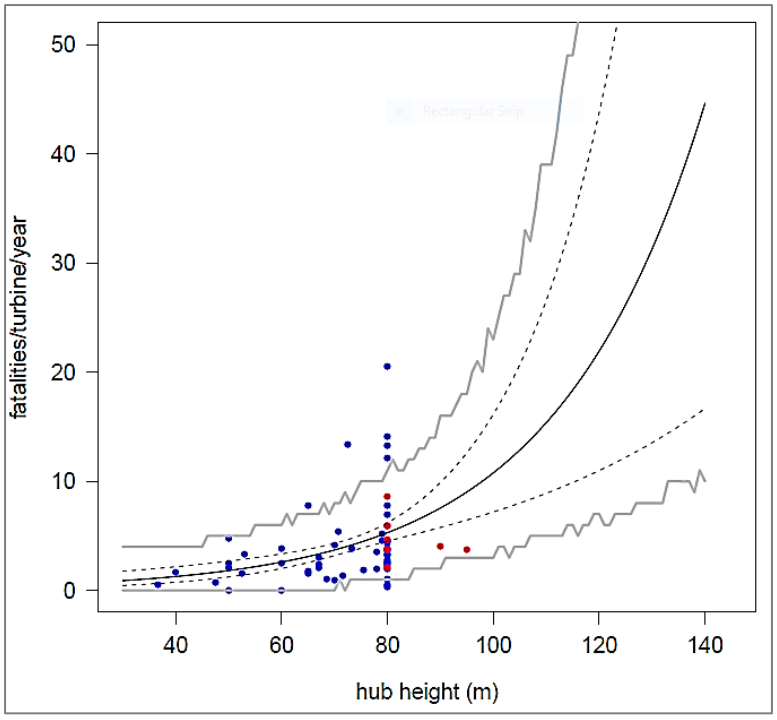



**Figure 8a:** Modelled data of avian fatalities from the USA (Loss et al. 2013) in relation to that from South Africa (Ralston-Paton et al. 2017 = red dots) and their relationship with hub height. 95% confidence limits are shown as dotted lines. The combined data and 95% confidence limits predict that on average birds will be killed per year by 130-m-high turbines. This is about twice the number of birds predicted to be killed by 100-m-high turbines. This predicted 2.3-fold increase is critical in forecasting the number of birds killed by the proposed number of turbines. Jagged lines indicate simulations testing whether the SA data fall within confidence limits of the USA data.

***Note**: this is a statistical forecast based on empirical data up to 95 m hub heights. From Simmons, Cervantes-Peralta, Erni, Martins & Loss (2017).*

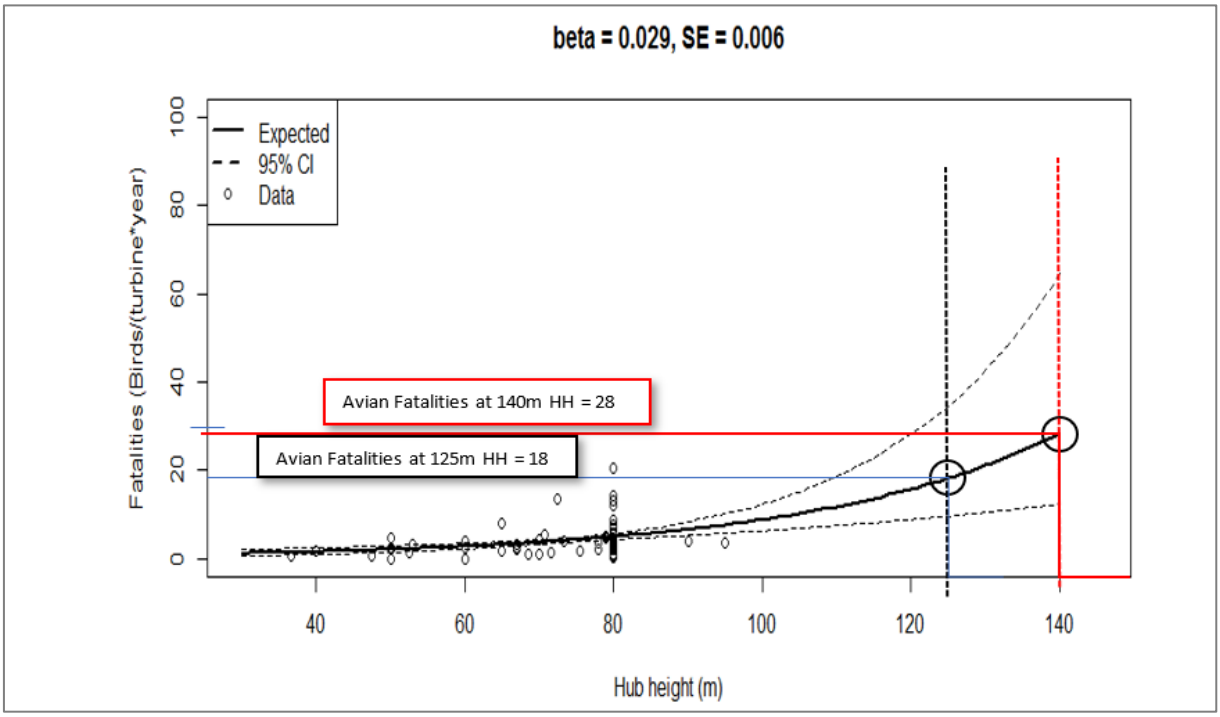



**Figure 8b:** Modelled avian fatality data from the USA (Loss et al. 2013) combined with that from South Africa (Ralston-Paton et al. 2017) and their relation to hub height. The South African data (n = 7 farms) include two with hub heights of 90-m and 95-m. The combined data and 95% confidence limits predict for 125-m high turbines that 18 fatalities (95% CI = 11, 35) will occur on average per turbine per year and increase to 28 (95% CI = 12, 65) fatalities on average for 140 m-high turbines.

**Table 3**: The combined effect of increased fatalities (due to taller turbines) and reduced impact (due to fewer turbines) on total avian fatalities. Based on average (and 95% confidence limits) forecasts from Figure 8b.

| **Hub height of authorised and proposed turbines** | **Avian Fatalities per turbine (from Figure 8b)** | | |
|---|---|---|---|
| | **Forecast**: Mean (95% CI) | With 65 **(small) turbines** Mean (95% CI) | With **40 (large) turbines** Mean (95% CI) |
| **125-m hub height** (authorised) | 18 (11 to 35) | **1170** (715-2275) | - |
| **140-m hub height** (proposed) | 28 (12 to 65) | - | **1120** (480-2600) |

This analysis indicates that the increase in height, but decrease in number of turbines, results in approximately equal numbers of fatalities. There is a marginal decrease of 4% in expected fatalities with the 40 taller turbines.

We have concentrated on expected changes in direct collisions of all birds, but displacement due to disturbance, and habitat loss may also occur. There is some evidence from overseas (Kolar and Bechard 2016, Wilson et al (2016)) that breeding raptors such as buzzards and harriers slowly move away from operational wind farms.

In South Africa, breeding Martial Eagles moved away from an Eastern Cape WEF following the death of an adult and a subadult eagle (Birds & Bats Unlimited: https://www.birds-and-bats-unlimited.com/specialist-studies).

However, given the pressure on Verreaux's Eagle territories we believe that if any birds are killed or displaced by the turbines then other floating birds seeking territories will come in to the replace the lost birds, and may cause a local "sink effect" to Verreaux's eagle population numbers as those eagles, too, may be killed by the turbines, and replaced.

# 8 MITIGATIONS

The previously known Verreaux's Eagle nest (no. 1) was given a nest buffer of 1.3-km when first located by African Insights (2016). G7 Renewable Energies (Pty) Limited moved all turbines outside a 1.5-km buffer, and they were then granted Environmental Authorisation for 65 turbines. A new 3 km buffer around the VE nest#1 was instituted in the proposed revision of the (40) larger turbine positions. All turbines now lie outside this 3-km buffer thereby complying with the avian specialists' recommendations. This will reduce the risk inherent in the high flight activity and high Passage Rates recorded here in 2020 (including two pairs of Verreaux's Eagles interacting).

Note that two turbines (T5 and T22) do still occur within the revised Verreaux's Eagle guideline of 3.7 km buffers (Ralston Paton and Murgatroyd in press). Thus, ideally these turbine should be mitigated too. We suggest blade-painting or Shut-down-on-demand (SDOD) for these and other turbines (detailed below).

In summary, BBU propose the following mitigations:

- A 3.0-km buffer (yellow circle Figure 7) –is installed around VE nest #1 based on existing Verreaux's Eagle guidelines (Ralston Paton 2017) – all six turbines are thus removed from within this buffer. This has been incorporated into the revised final Karreebosch WEF layout.
- BBU also recommends that all turbines within the 5.2km Verreaux's Eagle precautionary buffer are erected with one blade painted with "signal red" paint in two broad stripes to increase blade visibility (or as accepted by the CAA at the time) (McIsaac 2001, May et al. 2020). This recommendation is subject to CAA approval of blades painting and colouring and the selected turbine supplier accepting the warranties of blades being painted. This must include the two turbines (T5 and T22) that lie within the 3.7 km buffer that

will be recommended in the update Verreaux's Eagle guidelines (Ralston Paton and Murgatroyd in press). BBU have recommended this mitigation to accommodate the precautionary buffer of 5.2 km that the revised Birdlife's guidelines suggest where multiple flights or eagles are known to occur. Not only is this more cost-effective to instal during construction than other on-turbine mitigations, but it has no operational costs as would SDOD or even curtailment at high risk flight times of day.

- Should these two tiers of mitigation prove insufficient to prevent eagle fatalities (i.e., > 1 eagle death per year post-construction), BBU suggests an adaptive response in the form of a third tier of automated shut-down on demand (e.g., DT-bird or BioSeco) technology to reduce the risk to the eagles.

This order of mitigations:

(1) place all turbines outside 3-km buffer (Avoidance);
(2) blade painting mitigation (Increased blade visibility); and
(3) SDOD (Shut down where necessary), is proposed as the optimal combination.

The number of avian fatalities at all painted-blade turbines within the 5.2km VE buffer can then be compared with all un-painted turbines to test the effectiveness of the painted vs non-painted turbines. This maximises the likelihood that eagles will not be killed.

According to experience in Norway where painted blades were first tested the painted blades had no post-construction costs (unlike SDOD) and thus is the optimal mitigation in high use bird areas (B Iuell, Environmental Advisor at Smøla wind farm, Norway)

These mitigation are designed to reduce eagle fatalities to a minimum.

All other changes to roads, tracks, location of the construction camp and substation alternatives and fences outlined in Table 1 will have no foreseeable impact on birds in the Karreebosch environment.

# 9 CONCLUSIONS and RECOMMENDATIONS

The presence of eight Priority including four Red Data bird species in the Karreebosch WEF area (particularly the breeding Verreaux's Eagles) requires careful siting of the 40 proposed turbines.

Our May 2021 monitoring revealed that:

- Passage Rates of the Priority birds in 2021 (at 0.20 birds/hour) were five-fold higher than in 2013/14 (0.04 birds/hour).
- Passage Rates for the *Vulnerable* Verreaux's Eagles in 2021 (0.20 eagles/hour) were 6-fold higher than Passage Rates recorded in 2013/14 (0.03 eagles/hour: African Insights 2016).
- Modelling of fatalities of increased hub height (125m to up to 140 m) but decreased number of turbines (65 to 40) predicts that the number of possible fatalities will decrease over the authorised number of turbines.
- Birds & Bats Unlimited recommends a 3.0-km buffer around the Verreaux's Eagle nest (no. 1) based on existing Verreaux's Eagle guidelines (Ralston 2017), and this has been adhered to in the Karreebosch WEF 2022 turbine final layout.
- To ensure maximum efficiency in reducing risks to eagles, we further recommend that all the turbines within the 5.2km Verreaux's Eagle precautionary buffer are red-painted (or a colour accepted by the CAA and bird specialist at the time of painting) to increase blade visibility (subject to CAA approval of blade painting and colouring and the selected turbine supplier accepting the warranties of blades being painted).
- Should one or more threatened species fatalities still occur per year, automated SDOD is recommended as a backup to reduce risk

The advantages of this two-step mitigation is that:

(a) raptors see best in colour and, thus, red-blade mitigation is preferred.
(b) 'signal red' is already approved by South African Civil Aviation for towers and other tall structures (but has yet to be approved specifically for turbine blades);
(c) blade manufacturers such as Siemens and Vestas already produce painted blades in Europe; and
(d) this mitigation has no running costs.

www.engineeringnews.co.za/article/opinion-black-blade-mitigation-a-new-and-exciting-mitigation-for-wind-turbines-to-reduce-impacts-to-birds-of-prey-2020-10-09/

(i) In addition, automatic shut-down on demand (or any other adaptive mitigation measures deemed appropriate by an avifaunal specialist) be installed with systems such as DT-Bird and/or Bioseco.
(ii) This two-step process ensures that if the eagles don't see the painted blade, technology can detect the eagles and shut down the turbine, reducing the possibility of fatalities.

**This suite of amendments and re-location and reduction in number of turbines is thus acceptable from an avian risk perspective with the recommended mitigations detailed above implemented**. All other changes to roads, tracks, location of the construction camp and substation alternatives and fences outlined in Table 1 will have no foreseeable impact on birds in the Karreebosch environment.

A full 24-month post-construction monitoring must be undertaken and if that reveals that one or more *Endangered* or *Vulnerable* Red Data species are killed at any one turbine, then an adaptive management plan must be initiated within two months to reduce further fatalities.

Mitigations during construction-phase should include avoiding the construction of roads or powerlines within 500-m of active nests of Red Data species during the early breeding season. For Verreaux's Eagles this is May-July and again in August-September when small vulnerable nestlings are present (Simmons 2005). Should *Endangered* Black Harriers be found breeding, the recommendations in the Black Harrier guidelines (Simmons et al. 2020) will have to be consulted and enacted. Construction should be avoided in August-September-October for this *Endangered* species.

We suggest that the Karreebosch WEF proceeds with caution given the possibility of avian fatalities, and:

(i) an additional 12-months of construction monitoring, and
(ii) 24 months of post-construction monitoring be undertaken in the Karreebosch WEF;
(iii) Both avian monitoring stages to be carried out under the guidance and recommendation of the Birdlife South Africa guidelines (Jenkins et al. 2015)
(iv) all mitigation detailed above be implemented.

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Verreaux's eagles on Karreebosch return to the nest, with prey