SPRINGBOK WIND ENERGY DEVELOPMENT AREA :

Final Avian Report and additional monitoring to assess the revised turbine layout, May 2021

Prepared for: MULILO RENEWABLE ENERGY

Prepared by: BIRDS & BATS UNLIMITED Environmental Consultants www.birds-and-bats-unlimited.com

CONTENTS

1 SUMMARY

This study contains an appraisal of the final (2021) layout adjustments and turbine numbers made for the proposed Springbok Wind Energy Facility (WEF) by Mulilo Springbok Wind Power (Pty) Limited, and the likely effects thereof on the avian community. The springbok WEF obtained Environmental Authorisation (EA) in July 2011. An avifaunal impact assessment report (Simmons, 2010) was used to advise the EIA. This report recommended additional long term, post EA bird monitoring. The avian component was previously surveyed in 2012 and again in 2014/2015 during a long-term pre-construction monitoring programme (Simmons 2012, Simmons and Martins 2015) with additional field work and assessment of the priority raptors in April 2021. The EA has undergone a number of amendments and extensions following desktop assessments of changes in hub heights and rotor diameters (2017 and 2019) on fatalities.

The EA authorises a WEF with a maximum capacity of 55.5 MW, with up to 25 turbines that can have hub heights to a maximum of 140m. The applicant is in the process of finalising the layout with the intention of constructing a maximum of 13 turbines (but possibly 11 or 10 turbines), with a combined maximum of 50 MW, without an increase to the already approved turbine dimension ranges and capacities. This is a positive influence on the priority raptor species that occur on site, as the number of turbines is being minimised and moved further away from known eagle nests.

The reduction of turbines from 25 to 13 maximum represents a 48 % reduction and, thus the WEF will have a smaller footprint (of 503 ha) and displace fewer birds, and likely result in fewer collisions. It is noted still that the remaining turbines may still impact the priority species present, although the significance of the impact is likely to be reduced, and acceptable.

The previous monitoring in 2014/15 covering about 120 hours in the development site itself, found that Verreaux's Eagles breed about 3-km away. The species is known to be collision-prone at wind farms in South Africa. Thus they, and other priority species, may be at risk of impacts such as displacement and potential collision (Simmons and Martins 2015, 2017, 2019).

The impact zone of the originally proposed facility lies north-east of Springbok in the Nama/Succulent Karoo biomes – an area that holds a suite of southern African endemic birds as well as nine priority collision-prone species of which seven are Red Data species. The passage rate of all these priority species through the authorised project (of 25 turbines) was medium-high at 0.74 priority birds per hour.

In previous (2017, 2019) assessments done for amendments, we identified four turbines that are most likely to cause fatalities based on pre-construction flight data. We recommended fatalities can be reduced to acceptable levels by reducing the hub-height from the proposed 140-m to 105-m for the four highest-risk turbines. Mulilo agreed to this form of mitigation, although it is no longer required as those turbine positions are no longer being considered for use in the new up to 13 turbine layout.

To feed in to the EMPr update and layout finalisation, and to update the site baseline data in line with best practise, in 2021 we collected additional data in the revised (and reduced in size) project area to add to that already collected. An additional 58 h of monitoring was conducted in May 2021. The number of Verreaux's Eagle flights over the revised area amounted to 14 in 221 hours over all years, giving a **low** hourly average Passage Rate of 0.063 eagles per hour. This is 10-fold lower than the overall Passage Rates of 0.63 eagles/hour (in 2012, 2014/2015) and 0.62 eagles/hour (in 2021) across the entire study area. The low use of the smaller area within which up to 13 maximum turbines are now proposed was verified by high resolution GPS tracking of the resident Verreaux's Eagle in October, November and December 2014, indicating no overlap of the foraging areas and proposed turbine area. This low usage rate across the revised site may arise from the lack of steep cliffs favoured by Verreaux's Eagle, or the high grazing pressure of livestock in the development area reducing the hyrax prey base.

Given that some turbines may remain about 3 km from two active eagle nests, we recommend that all turbines receive additional mitigation in the form of:

- One painted blade (i.e. either signal red or black) for each turbine erected if allowed by SA Civil Aviation to increase visibility to eagles
- For turbines that may kill more > 1 red data species per year, this must trigger an assessment that re-assesses appropriate and additional mitigations for the species involved (faster response for the most threatened species). This may include additional shut down on demand.

Operational-phase monitoring is essential to determine the actual impacts on birds, and the required mitigation measures and thresholds. As recommended by Birdlife South Africa a minimum of 24 months of such monitoring is required. Given the 10-fold lower occurrence of Verreaux's Eagles in the proposed development area within which the "up to 13 turbines" will be placed, resulting in a 48 % reduction in the number of turbines from what was approved, we see no reason why the revised layout should not be approved, and the project proceed as proposed.

1.1 Qualifications of Specialist Consultants

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).

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** – 20-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 + Springbok **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) Springbok (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:	

PROJECT TITLE

EA AMENDMENT: SPRINGBOK WIND ENERGY FACILITY, NORTHERN CAPE PROVINCE - AVIAN SPECIALIST REPORT – 2021

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:

Department of Environmental Affairs

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)	5	Percentage Procurement recognition	80
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			
Physical address:	8 Sunhill Estate, Trigg Road, Capri, Cape Town			
Postal address:	As above			
Postal code:	7975	Cell:	0827 800 133	
Telephone:	As above	Fax:		
E-mail:	Rob.Simmons@uct.ac.za			

2.1 DECLARATION 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:

26 May 2021

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

26 May 2021

Date

Signature of the Commissioner of Oaths

Date

3 TERMS of REFERENCE

The Terms of Reference for the additional avifaunal specialist work are to:

Conduct additional baseline pre-construction bird monitoring on the Springbok WEF to increase the available bird data within the revised development area.
Compile a revision to the 2012 and 2015 specialist avian reports addressing the following:

- The implications of the revised turbine layout and reduced development area in terms of the potential impact(s);
- A re-assessment of the significance (before and after mitigation) of the identified impact(s) in light of the reduction in the turbine numbers for the construction and operational phases, including consideration of the following:
  - Cumulative impacts;
  - The nature, significance and consequence of the impact;
  - The extent and duration of the impact;
  - The probability of the impact occurring;
  - The degree to which the impact can be reversed;
  - The degree to which the impact may cause irreplaceable loss of resources;
  - The degree to which the impact can be avoided, managed or mitigated.

This addendum to the 2015 report must include an impact summary table outlining the findings of the re-assessment in terms of the above-mentioned assessment criteria.

- A statement as to whether the proposed changes to the layout will result in a change to the significance of the impact assessed in the original EIA for the proposed project (and if so, how the significance would change).
- A detailed description of measures to ensure avoidance, management and mitigation of impacts associated with the proposed changes.
- An outline of the potential advantages and disadvantages of the proposed changes to the turbine layout in terms of potential impacts (within your area of expertise)

- Provide confirmation as to whether or not the proposed changes will require any changes or additions to the mitigation measures recommended in our original specialist report. If so, provide a detailed description of the recommended measures to ensure avoidance, management and mitigation of impacts associated with the proposed amendments.

- Should any comments be raised during the Public Participation Process for the finalisation of the projects' EMPr and the layout relating to your area of expertise, provide responses to such comments raised. Such comments would be provided to BBU, on conclusion of the 30-day public comment period.

- The re-assessment must consider the findings of all pre-construction bird monitoring and data collection on the site.

3.1 STUDY AREA

The proposed wind farm lies 7-km north-north-east of Springbok and is centred around high ground east of the small mining town of Okiep. The central wind mast was at S29°36'38.40" E17°54'14.82". The original WEF area covers approximately 28-km^2. The substrate is rocky, and the topography of the WEF is highly undulating varying from ~940-m asl to the highest point at 1260-m asl. Two wind masts, a water pipeline, and some shepherds' huts are the only man-made structures on the WEF.

The study area of the WEF is dominated by huge granite and gneiss domes described as *Namaqualand Klipkoppe Shrubland* (Mucina & Rutherford 2006, p253). The vegetation comprises well-known species such as mature *Aloe dichotoma* (Quiver Trees) on the north slopes, with other dwarf shrubs and succulent plants in shallow soil pockets or fissures. This region just north of Springbok lies in the winter rainfall region with mean rainfall of only 161-mm/year. The area has components of both the Nama and Succulent Karoo biomes.

The habitat is not threatened and is well conserved in two protected areas – the Namaqua National Park and Goegap Nature Reserve. Other regions are subsistence-farmed with small livestock in among the large granite domes, and the area is pocketed with old and current mining claims.

3.2 BACKGROUND

The following report is a revision to the most recent avian impacts pre-construction report (Simmons and Martins 2015) for the already authorised Springbok wind energy facility (WEF). This is required to re-examine possible impacts arising from changes in the number and location of the proposed wind turbines at the proposed Mulilo (now Mulilo Springbok Wind Power (Pty) Limited) wind farm north-east of Springbok, Northern Cape. This report is intended to substantiate the pre-construction bird data set, as well as to comment on the proposed final layout, that is still required to be submitted to DFFE for final approval before construction starts.

The springbok WEF obtained Environmental Authorisation (EA) in July 2011 (Table 1). An avifaunal impact assessment report (Simmons, 2010) was used to advise the EIA. This report recommended additional long term, post EA bird monitoring. Therefore, the avifauna was surveyed again in 2012 and again in 2014/2015 (Simmons 2012, Simmons and Martins 2015). The EA has undergone a number of amendments and extensions and is currently valid and authorises a WEF with a maximum capacity of 55.5 MW, with up to 25 turbines. These can have hub heights to a maximum of 140m, rotor diameters to a maximum of 160m and turbines with a maximum of 4.5MW per turbine. The applicant is in the process of finalising the layout with the intention of constructing up to a maximum of 13 turbines, with a combined maximum of 50 MW, without an increase to the already approved turbine dimension ranges and capacities.

The layout, as defined earlier (and discussed with Mulilo), has not changed significantly except for a reduction in turbine numbers, clustering in the central section of the previously defined site, and a reduction in footprint size due to bat and bird considerations.

4 METHODS

- This report combines data from 2012 when a year's survey was undertaken (January, April, June and August). (Simmons 2012).
- This was followed by additional site visit surveys in 2014-2015 (November and February) to verify if the receiving environment had changed, and to undertake more surveys for the Priority birds on site and collect additional pre-con bird data.
- Brief amendment reports were produced in 2017 and 2019 as turbine technology increased the height and power of individual turbines, allowing developers to reduce the number of turbines and, thus, the risk to birds. The 2017 amendment for 25 turbines was authorised by the Department of the Environment.
- Additional pre-construction monitoring was conducted in May 2021, and were identical to those used in the 2015/16 surveys and follow the Birdlife South Africa survey methods (Jenkins et al. 2015). BBU:
    - Undertook 6-h Vantage Point monitoring to record all flights, durations and heights for the Priority species (Ralston Paton et al. 2017)

- Focussed particularly on the eagles, recording all flights over the revised turbine area for 58 h over 5 days in May 2021,

- Morning and afternoon watches were undertaken to ensure coverage throughout the heat and cool of the day.

- The objectives of the monitoring was to determine the suitability/acceptability of a final layout of a maximum of 13 turbines, placed anywhere within the revised turbine area (see Figure 1), and to provide input into the updated EMPr if/where applicable.

5 SUMMARY of FINDINGS of ORIGINAL EIA and Pre-construction REPORTS

A summary of the avian reports undertaken over the last 11 years for the Springbok site is given in Table 1. Part of the reason for the long gestation period was (i) the presence of highly collision-prone Verreaux's Eagle breeding in the area and (ii) several amendments to account for the change in turbine dimensions, numbers and locations, as well as delays in the REIPPP programme, resulting in technology advancements over time. The last iteration is to accommodate a revision in the location of the turbines, and a reduction in turbine numbers by Mulilo to reduce further the probability of impacts to the eagles present on site.

The original EIA report (Simmons 2010) and the comprehensive avian pre-construction report (Simmons and Martins 2015) assessed the possible impacts to birds and identified seven Red Data species that may be impacted by turbine placements (either by direct impact or disturbance and displacement). These included: four raptors, one stork, one bustard and one lark species (Table 2). Four of these have a very low likelihood of occurrence on the site (<1%, last column Table 2), and were, therefore, deemed unlikely to be negatively affected by turbines.

Table 1: Summary of the history of avian assessments related to the Springbok WEF from 2010 to present.

Year	Level of assessment	Authors	Coverage and timing	Findings and Recommendations
2010	EIA Scoping + EIA	Simmons 2010	Assessment for 119 turbines in May and September 2010	Three Verreaux's Eagle and a Booted Eagle nest located. EA granted 12 months monitoring recommended
2012	EIA amendment	Simmons 2012	Discussion of impact effects of reduction of 37 to 32 turbines Increase in hub height up to 91m	Increased turbine height likely to increase impacts, but fewer turbines and re-location +ve
2015	Full 12 months pre-construction	Birds & Bats Unlimited	330 hours of monitoring across all season (combining 2012/2014)	Three Verreaux's Eagle nests still present, Passage Rates Medium-high at 0.74 birds/h. Site turbines away from high risk areas and mitigate those in Medium risk areas
2017	Amendment Report (Taller turbines)	Birds & Bats Unlimited	Modelled effects of taller turbines	Move taller turbines away from high risk areas
2019	Amendment Report (Taller turbines)	Birds & Bats Unlimited	Re-modelled effects of taller turbines	Reduce turbine numbers and have 3-km buffer around VE nests
2021	Revision of development site and layout approval process	Birds & Bats Unlimited	Additional pre-construction data collection. Assessment of smaller central development site	Few eagle flight over revised site, Passage Rates 6-fold lower than whole site. Red blade mitigation recommended.

Table 2: Seven Red Data species identified in the avian EIA report (Simmons 2010) and the pre-construction reports (Simmons and Martins 2015).

Common name	Conservation status	Relative importance of local population[1]	Susceptibility to collision	Susceptibility to electrocution	Susceptibility to disturbance	Likelihood of occurrence* [our records]**
Black Stork	Near Threatened	Low?	High	High	High	1% **[0%]**
Verreaux's Eagle	Vulnerable	Moderate	High	Low	Medium	29% **[100%}**

Common name	Conservation status	Relative importance of local population[1]	Susceptibility to collision	Susceptibility to electrocution	Susceptibility to disturbance	Likelihood of occurrence* [our records]**
Black Harrier	Vulnerable*	Moderate to High	High	-	Moderate	9% **[0%]**
Martial Eagle	Vulnerable	Low?	Moderate	High	Moderate	7% **[8%]**
Lanner Falcon	Near threatened	Low?	High	Moderate	-	4% **[17%]**
Ludwig's Bustard	Vulnerable	Low?	High	Moderate	Moderate	1% **[0%]**
Red Lark	Vulnerable	High	Low	Low	Moderate	1% **[0%}**

1. An indication whether the population is a core, or marginal, one relative to the main population
*Likelihood is based on the reporting rate: the number of times recorded divided by the number of bird atlas cards =43.
**Likelihood of occurrence based on our own records on site over six visits x two area (WEF and Control), divided by 12]

The threatened Priority species that remain vulnerable to impacts include:

- **Verreaux's Eagle** *Aquila verreauxii* – a *Vulnerable* species (Taylor et al. 2015) and No. 2 in the list of collision-prone species (Ralston Paton et al. 2017). This species had a >90% chance of occurring on site during the operational phase as it breeds off the site, approximately 3km away and may occasionally occur on site (Simmons and Martins 2015).
- **Martial Eagle** *Polemaetus bellicosus* – a *Vulnerable* species (Taylor et al. 2015), and No. 5 in the list of collision-prone species. This species had a 7-8% chance of occurring on site but does not breed there, or any known location near the project (Simmons and Martins 2015).
- **Lanner Falcon** *Falco biarmicus* – a *Vulnerable* species (Taylor et al. 2015), and No. 22 in the list of collision-prone species. This species had a 17% chance of occurring on site and may breed there (Simmons and Martins 2015).

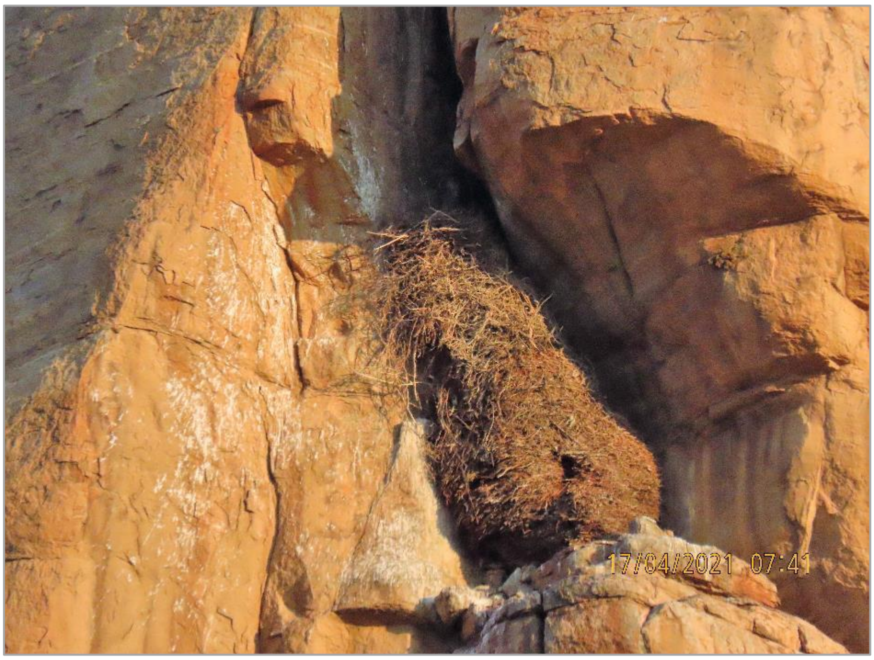
Two other Priority species that are not Red Data species in South Africa but are vulnerable to turbine collision:

- **Booted Eagle** *Aquila pennatus* - ranked 55th in the Top 100 collision-prone birds (Ralston Paton et al. 2017). This species was recorded on 25% of all visits and, thus, has a medium chance of occurring. It was known to breed within the previous wind farm site but falls outside the revised site and is designated Red Data in Namibia (Simmons et al. 2015).
- **Jackal Buzzard** *Buteo rufofuscus* – ranked 42nd in the Top 100 collision-prone birds (BAWESG 2014). This species was recorded on 75% of all visits and, thus, has a high chance of occurring.

Given that the European Booted Eagle is at higher risk than other eagles in European wind farms it may require revision in the South African rankings (A. Camina unpubl data).

Photo 1: The female Verreaux's Eagle at her nest (No. 3) in the southern section of the proposed WEF, June 2012.

Photo 2: The large Verreaux's Eagle nest (No. 2) (right) 3-km north of the proposed WEF, April 2021. This was being refurbished in our April 2021 site visit.



6 REVIEW of POTENTIAL AVIAN IMPACTS due to changes in TURBINE NUMBERS

6.1 INTERACTIONS BETWEEN WIND ENERGY FACILITIES AND BIRDS

Literature reviews (e.g., Kingsley & Whittam 2005, Drewitt & Langston 2006, 2008, Kuvlevsky et al. 2007, Loss et al. 2013) and personal communications (P Whitfield pers comm.) are excellent summaries of avoidance, displacements, and impacts, due to wind farms in other parts of the world. Data now exist for southern Africa on the impacts of operational wind farms (Ralston-Paton et al. 2017, Perold et al. 2020). Their findings can be summarised as follows:

- 20 wind farms with at least 12 months operational monitoring were sampled for carcasses.
- From 848 avian fatalities, the highest proportion at 36% were raptorial birds including vultures.
- A high diversity of 130 avian species were killed, ranging from swifts to sparrows, and flufftails to eagles.
- An average of 4.6 birds per turbine or 2.0 birds per MW are killed per year by South African wind farms.
- Two species of conservation concern killed by turbines were Black Harriers and Verreaux's Eagle.

What will be assessed here is the likely change in risk to birds passing through the wind farm where the following is altered:

- the number of turbines are reduced by 48% (25 to 13);
- the locations have changed from the original 37 turbine layout over large sections of all upland areas, to a smaller area (of 503 ha) centrally placed (Figure 1), i.e. the revised turbine area.

There are three major ways wind farms can influence birds:

a) Through **displacement and disturbance** (birds avoid the area, through the disturbance caused by the operation of the turbines).

b) Through **habitat loss and fragmentation** (the infrastructure and building phase directly destroys or divides habitat).
c) Through **direct mortality** (birds are struck by the turbines and die).

The final report (Simmons and Martins 2015) covered all three points (displacement/disturbance; habitat-loss/destruction; and direct mortality).

We can summarise **general** findings on bird-wind farm interactions as follows:

- A few turbines are often responsible for most deaths;
- Some wind farms on migration routes, and those employing lattice turbine towers, suffer high mortality rates (Loss et al. 2013) so, poorly sited wind farms can be risky;
- Identifying and mitigating individual turbines causing most mortality reduces that risk;
- Landscape features such as ridges for soaring, or valleys for commuting, are high-risk areas for raptors or migrants;
- Poor weather and high winds induce birds to fly lower and increase the chances of collision;
- Illuminating towers or buildings increases avian mortality, but gaps left in corridors of turbines may reduce overall mortality risk, and intermittent flashing lights have been found to attract fewer birds;
- High risk species include those with low manoeuvrability (cranes, vultures), or high air speed (raptors, wetland birds), or distracted fliers (raptors chasing prey, courting/displaying birds), and soaring species that seek lift off slopes (pelicans, storks);
- The most recent research shows exciting possibilities of reducing eagle mortalities by 100% - by painting half of one blade black (May et al. 2020);
- A sensitivity map for South Africa's most collision-prone species has been produced for bird-wind farm interactions and can be downloaded from: http://www.birdlife.org.za/conservation/terrestrial-bird-conservation/birds-and-renewable-energy/wind-farm-map/item/298-avian-wind-farm-sensitivity-map-documentation

Mitigating the risks is compromised by fast-moving objects being difficult to detect – even for raptors – due to retinal blur (i.e. turbine blades moving at 300-km/hour). However, exciting work has been done in Smøla, Norway, where experiments with black-painted turbine blades showed 100% reductions in fatalities of White-tailed Eagles *Haliaeetus albicilla* and other collision-prone species (May et al. 2020).

Other mitigations can include:

- Site wind farms away from:
  (i) large concentrations of birds (e.g. roosts, wetlands or breeding colonies);
  (ii) migration corridors;
  (iii) slopes used by soaring birds; and
  (iv) breeding collision-prone birds,
- Shut-down on demand with either automated technology (e.g. IdentiFlight, DT-bird or Multi-seco) or human observer shut-down.
- Monitor deaths per turbine and be prepared to shut down high-mortality turbines at times of high risk (i.e., migration or breeding seasons). Those individual turbines that kill more than one Red Data birds per year should be given particular attention. The likely position of these turbines can be identified pre-construction from the number of flights (Passage Rates) near them, and the proportion of flights at blade-swept height (BSH).

- The use of intense, flashing, short wavelength LED (light emitting diode) lights to deter raptors from close approaches to turbines in risky positions (Foss et al. 2017).

Here we review just the collisions with the turbines, and particularly the effect of changing the number of turbines and placing them in one central development area.

Photo 3 The southern-most pair of Verreaux's Eagles, in the broader area, overlooking their territory in the shade at midday, a favoured perch-site away from their nest (and approximately 2.2 km from the revised turbine area). The right-hand bird carried a GPS-transmitter in 2014 and the results are presented here.

The collision-prone birds (CPBs) found at the proposed Springbok facility were assessed over six visits and 218-hours of observation at the proposed facility, and from bird atlas cards. The seasonal presence of the nine species are updated in Table 3 (from Table 4 in our final pre-construction report: Simmons and Martins 2015).

Table 3: The seasonal presence of all Collision-prone species (CPS) recorded in the Springbok WEF, in six visits (2012-2014). Columns in orange are in the WEF site and those in green are the Control site. Red Data species are shown in red. The collision ranking from Birdlife South Africa (Ralston et al. 2017) is given next to the species name.

Months	**Jan**	**Jan**	**Apr**	**Apr**	**June**	**June**	**Aug**	**Aug**	**Nov**	**Nov**	**Feb**	**Feb**
Verreaux's Eagle [2]*	●	●	●	●	●	●	●	●	●	●	●	●
Martial Eagle [5]					●							
Lanner Falcon [30]			●						●			
Jackal Buzzard [44]	●		●	●	●	●	●	●	●		●	
Booted Eagle [56]								●	●		●	
Gymnogene [85]			●						●		●	
Black-chest Snake Eagle [56]									●			
Pale-chanting Goshawk [73]					●							
Cape Eagle Owl [41]				●								

*The collision risk ranking from Birdlife South Africa (Ralston et al. 2017) for wind turbines in South Africa.

7 IMPLICATIONS TO BIRDS FROM THE PROPOSED REVISED NUMBER OF TURBINES AND LOCATIONS

Mulilo propose a reduced number of turbines up to a maximum of 13. This has been undertaken in two phases: 37 turbines were originally authorised and were reduced to a maximum of 25 turbines, followed by the reduction to 13 turbines assessed here. Furthermore, Mulilo require final layout approval, and therefore engaged the avifauna specialist to advise on the locations of turbines for the updated layout, to reduce impacts and to move turbines further from known Verreaux's Eagle nesting areas. The specialist assessed the implications of reducing the numbers of turbines still further, from 25 to 13 (a 48% reduction) and moving them away from the two known Verreaux's Eagle nesting areas (see Photos 1 and 2).

To update the bird baseline data, and to determine how many flights are likely over the revised turbine area site Birds & Bats Unlimited re-visited the development site in April 2021 to gather more data on flights of eagles over the central development area, and amalgamated those with 2012, 2014/2015 flight data. This allowed us a complete picture of the Passage Rates and flights over this revised area based on over 200-hours of data.

We complemented these observational data with GPS-tracking data kindly provided by Alvaro Camiña of one of the breeding eagles in 2014. Data for October, November and December were made available for this exercise.

7.1 EAGLE PASSAGE RATES OVER THE REVISED DEVELOPMENT AREA - SUMMARY OF 2021 FINDINGS

We spent 56 hours observing the revised development area (of approximately 500-ha) in April 2021, with a focus on the revised turbine area, within which the up to 13 turbines will be located.

- We recorded 36 eagle flights in that time giving an eagle Passage Rate of 0.62 eagles/hour for the entire Springbok site.
- This was identical to the Passage Rates (124 flights in 196 hours) in 2012 and 2014/15 of 0.63 eagles/hour over the entire site indicating no change in eagle flight activity between years.
- However, over the revised development area (as defined in Figure 1), only 14 flights were recorded in 221 hours from all records amalgamated.
- The Passage Rate for this central section was thus 0.063 eagles per hour; this is 10-fold lower than that recorded across the entire original wind farm study site. All flights are shown in Figure 1.

7.2 GPS-TRACKS OVER THE RELOCATED TURBINES

We checked the observational data against high-accuracy GPS locations from a transmitter placed on one of the breeding eagles (by A. Camiña) in the southern Springbok nest site about 3-km from the development area (Photos 1 and 3).

- By overlaying the eagle GPS data from October, November and December 2014 onto the development site we found that the tagged eagle skirted the southern boundary of the proposed development area and did not cross into it despite being so close. Further data were unavailable for other seasons.
- The minimum convex polygon for the 3-month period available, therefore, does not intersect the proposed revised turbine area, and corroborates BBU's observational data – that few eagles venture into the chosen area. Of course, this is only 3-month's data and more data would be requires to verify this result.

It may seem unusual for eagles to avoid an area relatively close to their nests, but we suggest the following reasons why this area was largely unused.

- There are few steep slopes in the upland area that would give the eagles the lift that these large-bodied birds require and prefer (Davies 1994, Murgatroyd et al. 2020);
- Grazing pressure was high in the development area, in 2012, 2014, 2015 and in 2021, with a minimum of 50 sheep and goats regularly grazing over the veld. This would reduce food for the eagles favoured prey, the Rock Hyrax (*Procavia capensis)* and reduce the likelihood that hyrax would thrive in this area.

Both factors are likely to make it both unprofitable, and energetically expensive, for eagles to use regularly and, thus, suitable for wind farm development.

Photo 4: Goats and sheep were recorded regularly grazing the revised development areas in all years of the study. This may reduce the food available for hyrax, the main prey of the eagles and, thus, reduce the likelihood that both will occur there. This may partially explain the low occurrence of Verreaux's Eagle over this area.

If post-construction monitoring reveals that red data species are still being killed despite the recommended mitigations of re-location, reduction in numbers and blade-painting, then this will trigger a detailed investigation of the species, circumstances and turbines involved (as recommended by Birdlife South Africa).

No red data species should suffer fatalities, but different levels of mitigation are required for different species because fatalities can have different population level effects. For example, if Black Harriers are killed then a higher level of mitigation will be required than other species due to their low population levels.

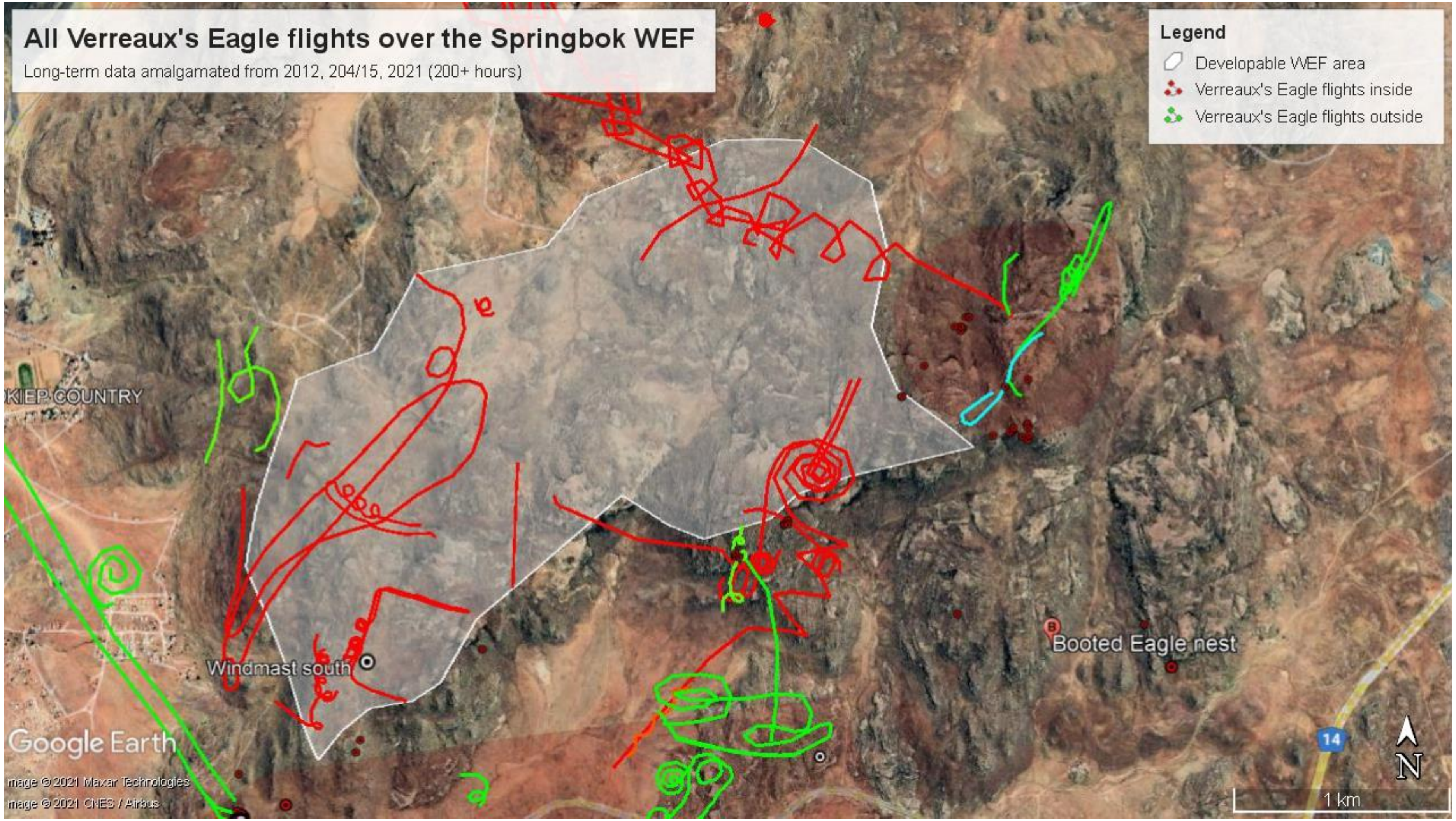


Figure 1: The revised development area (= white polygon) in relation to Verreaux's Eagle flights recorded from 2012, 2014/15 and 2021 in all seasons. The Verreaux's Eagle flights are shown as red lines inside the development area and as green lines outside the development area. The Passage Rates over the development area was 0.063 eagles per hour, 10-fold lower than the overall Passage Rate.

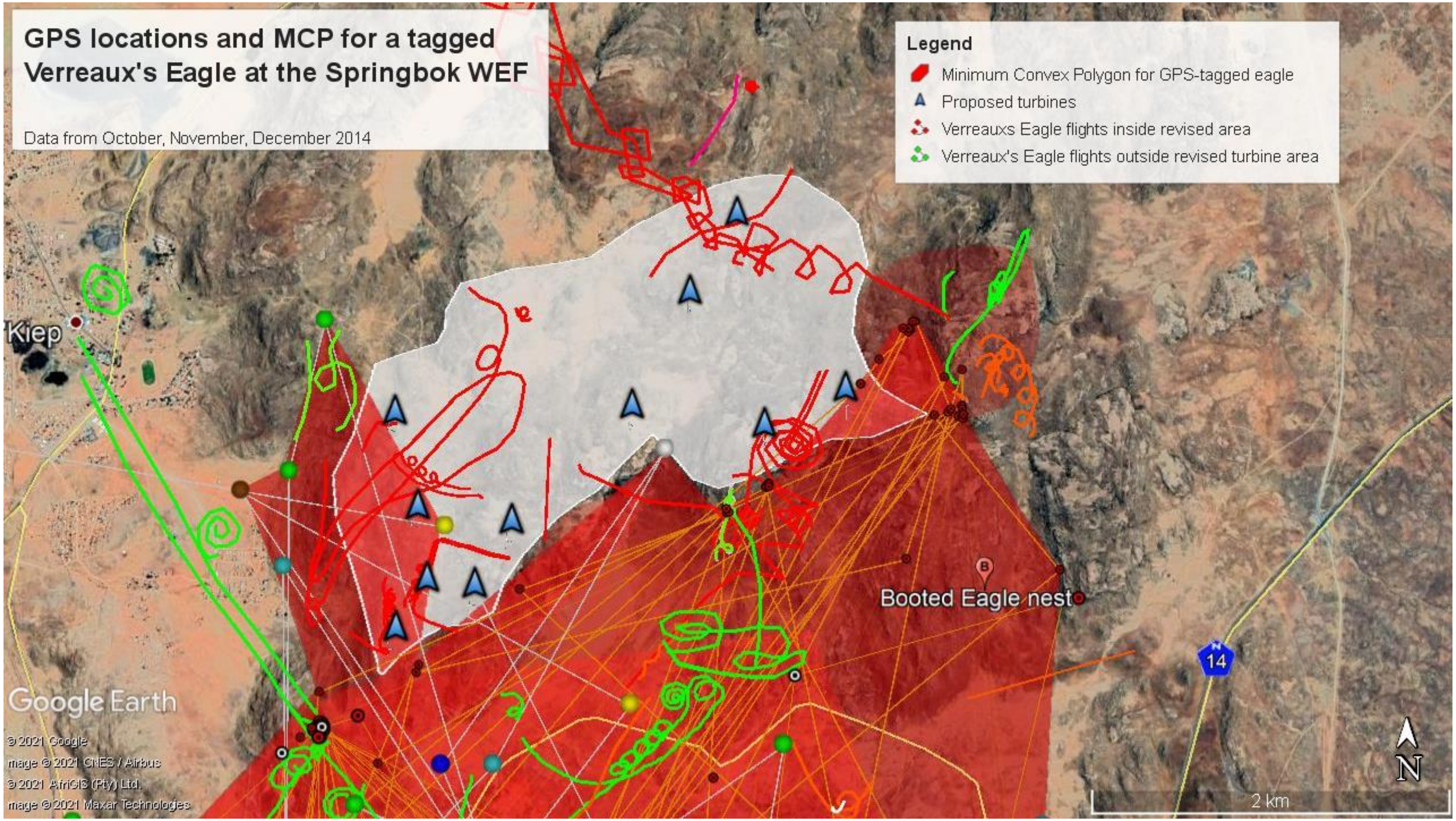


Figure 2: The GPS locations of the tagged resident Verreaux's Eagle recorded in October (= red, blue and green dots), November and December (= white dots) 2014 from data provided by A. Camiña. The minimum convex polygon (= MCP, white shaded area) encompasses all GPS points over 3 months. The MCP overlaps the revised development area by 14% of the total revised area (71.5/503 ha). This supports our own observations of low Passage Rates within this area (of 0.063 eagles per hour). This suggests that the risks to the eagles will be low, but not negligible.

7.3 QUANTIFYING THE IMPACTS

Several raptors were previously identified (Simmons and Martins 2015) as likely to be negatively affected by displacement, loss of habitat, or direct mortality. These are all in the top 100 collision-prone species: Verreaux's Eagle (*Vulnerable*, 2nd), Martial Eagle (*Endangered*, 5th), Black Harrier (*Endangered*, 6th), Lanner Falcon (*Vulnerable*, 22nd), Booted Eagle (55th), and Jackal Buzzard (42nd). The following tables quantify the impacts, and provide an updated assessment, for these raptors, particularly South African Red Data birds (Taylor et al. 2015). This considers the proposed amended layout and turbine numbers with the revised turbine area, the current knowledge on raptor impacts, as well as the data from 2010, 2014 (including GPS data), 2015 and 2021. The tables below indicate the Construction Phase impacts, and then the Operational Phase impacts.

The significance of the impact (S) is given by the equation (NEMA 2010):

S = (E+D+M)P

Where -
E = Extent (local or wide scale, ranked from 1 to 5)
D= Duration (length of time of the effect, ranked from 1 to 5)
M= Magnitude (the size of the negative effect, ranked from 1 to 10)
P=Probability (the likelihood of the event happening, ranked from 1 to 5)

The Nature of the impact will be negative in that birds will either be:

(i) displaced by habitat alteration;

(ii) displaced by disturbance during or after construction;

(iii) impacted by turbine blades directly;

(iv) impacted by the existing and proposed 132kV lines.

The Extent of the impact will be local **(1)** reducing foraging habitat in the immediate wind farm area for the raptors but may be higher if the space created by the death of territorial individuals brings in other birds to be killed (the sink effect), or they are displaced from breeding through disturbance.

The Duration will be short-term (**2)** for the duration of the construction (1-2 years?) but **(5)** for the operational lifetime of the wind farm for all species.

The Magnitude is ranked as a medium impact **(5)** for the raptors, particularly those frequently flying at 140-m hub height (Verreaux's Eagles, Booted Eagles and Jackal Buzzards).

The Probability of occurrence of the raptors being disturbed by construction or having a reduced forging area is ranked as medium **(4).** Given their aerial nature and the high proportion of time that both Verreaux's and Booted Eagles spend at these blade-swept heights (see Appendix), significance is likely to increase in the operational phase. However, this is reduced because of the low Passage Rates (0.10 eagles/hour) of the main Priority species likely – Verreaux's Eagle – in the revised turbine area, because it is 6-fold lower than the mean Passage Rate for the whole study site. This is supported by the low number of observations of the GPS-tracked bird over three months in the revised turbine area.

The significance ratings are tabulated below for

(i) the Construction phase and the

(ii) Operational Phases of the revised Springbok wind farm.

Table 4. Significance table explaining the relevance of the scores used.

Parameter	Scores	Interpretation
Extent (Area) **E**	1-5	1-2 (Local), 3-4 (regional) 5 (national)
Duration (period of impact) **D**	1-5	1 (v short term, 0-5 yr) 2 (short term, 2-5 yr) 3 (Medium term of 5-15 yr) 4 (long term > 15 yr) 5 (lifetime of the development)
Magnitude (size of impact) **M**	1-10	1 (negligible) 2 (minor) 4 (low, and cause an impact on the process) 6 (moderate, process continue but modified) 8 (high) 10 (v high, destruction of patterns and cessation of processes)
Probability (likelihood the impact will occur) **P**	1-5	1 (improbable) 2 (improbable, but still low likelihood) 3 (distinct probability) 4 (highly probably, most likely to occur) 5 (definite, will occur regardless of any prevention)
Significance **S** = (E+D+M)P	3-100	3-30 (low, impact will not have a direct influence on decision to develop) 30-60 (Medium, impact could influence the decision to develop unless effectively mitigated) 60-100 (High, impact must have an influence on the decision to develop the area).
Confidence		Sureness that the input variables are sound and well researched in determining the final significance level.

Table 4(i). A summary of the quantified impacts during **construction** to the raptors likely to be impacted by the wind farm for the amended layout and turbine dimensions. We compare the impacts with those estimated for the pre-construction report.

(i) Construction Phase

Nature: Direct mortality, disturbance, or avoidance of area around the wind farm for the raptors identified as at risk above, due to disturbance, or impacts with turbine blades and overhead lines, during construction.

	Without mitigation	**With mitigation**
Extent	1 (local)	1 (local)
Duration	2 (short-term)	2 (short-term)
Magnitude	4 (low)	3 (low)
Probability	3 (distinct possibility)	3 (distinct probability)
Significance (E+D+M)P	21 (**Low significance** = impact will not have direct influence on decision to develop)	18 (**Low significance** = impact will not have direct influence on decision to develop)
Status (+ve or –ve)	Negative	Negative to neutral
Confidence	High	High
Reversibility	High	High
Irreplaceable loss of species?	No (Both Verreaux's and Booted Eagles may suffer short term disturbance, displacement, and loss of breeding but return after construction)	Reduced
Can impacts be mitigated?		Partially, yes

	Authorised Project		**Revised Turbine Area and Number**	
	Pre-mitigation impact rating	**Post-mitigation impact rating**	**Pre-mitigation impact rating**	**Post-mitigation impact rating**
Extent	**1**	**1**	**1**	**1**
Duration	**2**	**2**	**2**	**2**
Magnitude	**4**	**3**	**4**	**3**
Probability	**3**	**3**	**3**	**3**
Reversibility	high	high	high	high
Irreplaceable loss of species?	No (Both Verreaux's and Booted Eagles may suffer short term disturbance, displacement, and loss of breeding but return after construction)		No (Both Verreaux's and Booted Eagles may suffer short term disturbance, displacement, and loss of breeding but return after construction)	
Significance rating	**21 (low)**	**18 (low)**	**21 (low)**	**18 (low)**

Mitigation: There are generally two classes of mitigation to avoid disturbing Red Data birds around wind farms during construction:

(i) limit construction activities within 500 m of known nest sites (building, blasting, etc.) to seasons when birds are not breeding – to reduce disturbance causing nest failure;

(ii) limit construction activities (building, worker-presence, power-line-stringing) from areas within 500-m of known Red Data species' nests at times when eagles or other Red Data species are incubating/feeding small nestlings.

We therefore recommend as mitigations:

(i) not constructing within 500-m of Verreaux's Eagle nests during their early breeding season (May to June) or small-chick rearing season (June-July). There are no turbines in the revised development area that fall within this buffer. For breeding Booted Eagles, the seasons to avoid are August-September;

(ii) avoid blasting or causing noise disturbance in the same seasons anywhere within 3-km of active nests for all Red Data species.

Table 4(ii). A summary of the quantified impacts during the **operational phase** to the raptors likely to be impacted by the wind farm for the amended layout and turbine dimensions. We compare the impacts with those estimated for the pre-construction report.

(ii) Operational phase

Nature: Direct mortality, disturbance or avoidance of area around the wind farm for the raptors identified as at risk above, due to disturbance, or impacts with turbine blades during operations.

	Without mitigation	**With mitigation**
Extent	1 (local)	1 (local)
Duration	5 (high)	5 (very high)
Magnitude	4 (moderate)	4 (moderate)
Probability	4 (probable)	3 (possible)
Significance (E+D+M)P	40 (Medium significance = impact should influence decision to develop unless mitigated)	30 (Medium-low significance impact and surveys will determine of mitigation required)
Status (+ve or –ve)	Negative	Negative to neutral
Confidence	High	High
Reversibility	Low	High
Irreplaceable loss of species?	No (Verreaux's Eagles are not uncommon and the rarer Booted Eagles may be less susceptible to collision and displacement)	Reduced
Can impacts be mitigated?	Yes	Partially, yes

	Authorised Project		**Revised Turbine Area and Number**	
	Pre-mitigation impact rating	**Post-mitigation impact rating**	**Pre-mitigation impact rating**	**Post-mitigation impact rating**
Extent	**1**	**1**	**1**	**1**
Duration	**5**	**5**	**5**	**5**
Magnitude	**8**	**7**	**4**	**4**
Probability	**4**	**4**	**4**	**3**
Reversibility	Low	Medium	Low	Medium
Irreplaceable loss of species?	No (Verreaux's Eagles are not uncommon and rarer Booted Eagles may be less susceptible to collision and displacement)		No (Verreaux's Eagles are not uncommon and rarer Booted Eagles may be less susceptible to collision and displacement)	
Significance rating	**56 (medium-high)**	**52 (medium-high)**	**40 (medium)**	**36 (medium)**

Note that by relocating the turbines to a central highland (i.e. the revised turbine area) area where the Passage Rates of the highly collision-prone Verreaux's Eagles are 10-fold lower than the mean for previous (original) wind farm area, the significance rating for all raptorial species (36), is lower than previously estimated for this suite of priority birds (56). This has also been directly reduced by the decision to reduce the maximum number of turbines by 48 % to 13, and partly by reducing the footprint size. Surveys over multiple years and over 200-hours of observation indicates that the development area is rarely used by the eagles. That is verified by 3-months of high-resolution GPS-tracking of one of the resident eagles which showed a 14% overlap of the revised development area by the Minimum Convex polygon of the eagle tracks.

Mitigation: There are generally five tiers of mitigation for birds around wind farms:

(i) re-position the turbines to avoid impacts or disturbance for the birds;

(ii) redesign the turbines to alter the present pattern/shape/size of the turbines so birds see them more readily and avoid contact;

(iii) shut-down-on-demand the turbines when collision-prone birds approach;

(iv) manipulate the habitat to reduce the attractiveness of the site to collision-prone raptors;

(v) reduce the overall number of turbines. Given that Mulilo have already complied with all the mitigations suggested by the avian specialist previously, the following are **micro-mitigations** that will assist in reducing further any possible impacts. (i) siting turbines as far from any steep cliff edges where eagles may gain orographic lift or be hunting for Rock Hyrax; (ii) maintaining or even increasing the grazing pressure (by sheep and goats) on the wind farm site to reduce the attractiveness of the site for mammal-eating raptors (livestock compete with hyrax and mice for food resources and reduce the prey available for large-medium raptors). (iii) Employ red- or black-blade mitigation on all turbines as they are erected, to increase the visibility of the blades to raptors that do fly in the wind farm 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/ This is subject to CAA approval which SAWEA are currently seeking. Operational phase monitoring is essential to determine the actual impacts on birds and, therefore, the required mitigation measures and thresholds. However, such an approach requires a flexible Adaptive Management Plan to be implemented during operation. Such an Adaptive Management Plan must allow for changes to be implemented within a short time frame if highly threatened species are involved. The Wind Farm must agree to follow the mitigation measures that may result from the operational monitoring and Adaptive Management Plan. (iv) In accordance with the Adaptive Management Plan, appropriate mitigation measures, such as curtailment at specific environmental conditions or during high-risk periods (i.e., post construction monitoring shows > 1 Red Data species killed at a single turbine per year, then this must trigger an investigation of appropriate automatic shut down or deterrent technology depending on the species at the applicable turbine/s for life of the wind farm. More highly threatened species (eg Endangered Black Harriers, would trigger a stronger response in time and magnitude, than a less threatened species e.g. a Booted Eagle). The operational monitoring study design must determine the exact environmental conditions as well as the turbines that require appropriate mitigation measures. We recommend two adaptive management mitigations if Red Data species are found to be killed: (ii) the automated "Multi-sensor" video system for Shut Down on Demand (SDOD), which deters incoming birds or feathers the blades, or turns off turbines as collision-prone species approach within 500-m of these turbines; This can also be observer-lead SDOD as long as it cover all daylight hours, or (iii) if patterns emerge for time of day, or specific seasons (e.g. courtship displays) then shut downs at these high risk times must be investigated. For **all** overhead power lines to be fitted with diurnal and nocturnal bird diverters to reduce collisions, and burying all internal power lines in the WEF, wherever that is technically feasible and possible. We understand that some rare small succulent plants can be displaced by attempting to bury lines in rocky terrain, so only areas where this impact is avoided should this be attempted.
Cumulative impacts: Cumulative impacts (Masden et al. 2010) are those that may affect a species in a small area (e.g., a wind farm) yet have a wide-scale influence. If resident territorial birds are killed by turbines for example, then other individuals will be pulled in to take up the vacant territory. A wide-spread population reduction may occur slowly over time as a result of the WEF (as well as other WEFs), acting as a sinks. This is less likely for the Verreaux's Eagles given that they are a relatively common (but iconic) montane species. For breeding Booted Eagles, however, this may have a greater impact on their population because there are an estimated 700 breeding pairs in South Africa (Martin 2005). All renewable energy applications within 50-km of Springbok are assessed below.
Residual impacts: After mitigation, direct mortality or area avoidance by the species identified above may still occur and further mitigation (e.g., turbine shutdown) will be needed.

comparative assessment of the impacts of the Authorised Project (25 turbines at 140-m hub height) and the Proposed Amendment (11 turbines at 140-m hub height, within the central highland area).

Option	Nature	Extent	Duration	Magnitude	Status of impact	Confidence	Mitigation	Significance post mitigation
Operational phase								
Authorised	Fatality of Red Data birds on site. Displacement of same species	Local	Long term	Moderate	-ve	High	Re-location of some turbines. Fitment of automated detect and deter systems	Medium
Revised layout	Fatality of Red Data birds on site. Displacement of same species	Local	Long term	Moderate	-ve	High	Erection of red-painted blade for all turbines at the start of the development Micro-siting turbines away from steep slopes Fitment of automated shutdown system at any turbine killing one or more red data species per year.	low

7.4 CUMULATIVE IMPACTS

Cumulative impacts are defined as "Impacts that result from incremental changes caused by either past, present or reasonably foreseeable actions together with the project" (Hyder 1999, in Masden et al. 2010).

Thus, in this context, cumulative impacts are those that will impact the avian communities in and around the Springbok development, mainly by other renewable energy facilities (wind and solar farms) and associated infrastructure in the Nama and Succulent Karoo biome. This will happen via the same factors identified here viz: collision, avoidance and displacement.

As a starting point we need to determine the number and nature of the renewable energy farms around the region within a 50-km radius and secondly, to know their impact on avifauna (Figure 2). It should be notes that the majority of these proposed projects, are very unlikely to be constructed in the short term, and unlikely in the medium to long-term, and some projects may never be constructed.

Table 6: All proposed renewable energy projects within a 50-km radius of the Springbok WEF, and their approval status with the DFFE. Source: https://www.environment.gov.za/mapsgraphics DFFE last quarter 2016.

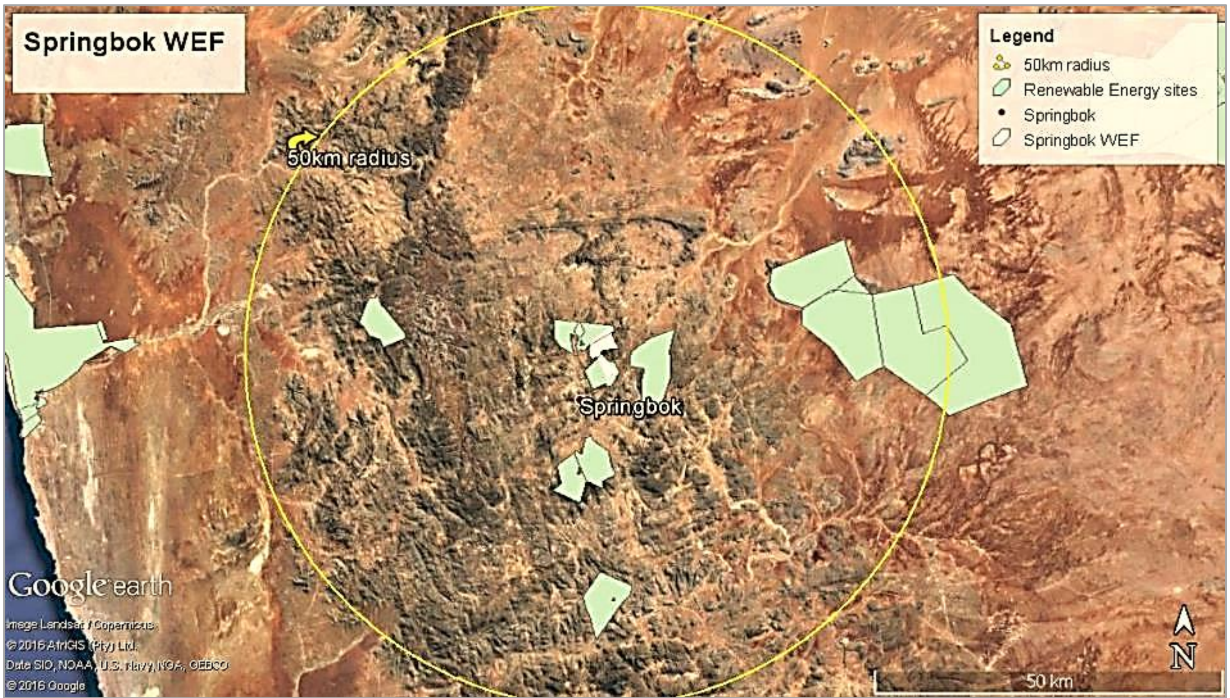
	Project Title	Distance from Springbok WEF (km)	Technology	Megawatts	Current Status
1	O'Kiep 2 PV Solar Energy	0	Solar PV	15	Approved
2	Kgabalatsane Solar	3.57	Solar PV	30	In Process
3	O'Kiep 2 PV Solar Energy	5.38	Solar PV	15	Approved
4	Melkboschkuil	8.51	Solar PV	20	Approved
5	Biesjesfontein*	15.89	Solar PV	300*	Withdrawn/Lapsed
6	Kokerboom	19.23	Solar PV	10	Approved
7	Nigramoep	31.15	Solar PV	30	In Process
8	Nama-Khoi Municipality	31.65	Wind & PV	280**	In Process
9	Baobab Mesklip	35.56	Solar PV	10	Approved
Totals:	**1 wind farm + 7 solar farms: 410 MW**				

*Excluded from further analysis
**Corrected from the DEA website (of 1000 MW) K. Low and N Holland pers comm.

Given the general assumption that footprint size and bird impacts are probably linearly related for wind farms, a starting point in determining cumulative impacts is to calculate:

- the number of birds displaced per unit area, by habitat destruction, or disturbed or displaced by human activity;
- the number of birds killed by collision with the turbines on site; and
- the number of birds killed by collision with infrastructure leading away from the site.

Nine renewable energy developments are currently on record with the DFFE (Table 6) and all but four are approved. One is lapsed/withdrawn and is omitted from further calculations. Most are south and east of the



Springbok study site (Figure 2) and they are mainly solar sites. The total output from the eight approved sites is 410MW (Table 4).

We sourced data to populate the Cumulative Impacts table from (i) a review of fatalities by Birdlife South Africa on 12 months post-construction monitoring at 20 wind farms (Perold et al. 2020); and (ii) an MSc study of the avian mortalities recorded at the Jasper solar PV farm in the Northern Cape (Visser 2016).

The national review of post-construction **avian fatalities at wind farms** (Perold et al.), includes data from 20 wind farms, and concludes that South African wind farms kill about 4.6 ± 2.9 birds/turbine/year (corrected for observer and detection biases). This is similar to the international mean of about 5.25 birds/turbine/year. This can also be expressed as 2.0 ± 1.3 bird/MW/yr. Of more concern is that a majority of the fatalities recorded (36%) in South Africa are raptors (Perold et al. 2020).

Using the value of 2.0 bird fatalities/MW/year we can calculate that:

1. the number of birds likely to be killed by the single Nama-Khoi 280MW wind farm to be **<560 birds/year** (this is all birds, and the raptor component is estimated at 202 birds).

Table 7: Summary of all birds and Red Data raptors killed at 20 wind farms in South Africa from 2014–2018. From Birdlife South Africa review (Perold et al. 2020).

Wind farms	Turbines	Months monitored	Avian fatalities	Adjusted mortality rate*
20	825 (mean = 41.25/ farm)	1101 turbine-years	848	4.6 birds/turbine/yr 2.0 birds/MW/yr
20	1811 MW (mean = 91MW/farm	Hub height: 88m (80 – 115m) Blade length: 51 m		
Main groups		Proportion of all avian fatalities		Ranking
Species killed		**130**		
Raptors (including owls)		**36%**		1
Passerines (ie small perching birds)		**30%**		2
Waterbirds		**11%**		3
Swifts (swallows/martins)		**9% (<1%)**		4
Large terrestrial species		**5%**		5
Pigeons. doves		**4%**		6
Red Data raptors as a proportion of all raptors killed : 48/175 = **27%**		Red data raptors as a proportion of all birds killed : 48/848 = **5.7%**		

For solar farms, we could only use the available data from Visser (2016) who undertook a short post-construction study of a large solar PV site at the Jasper facility. She estimated that 4.5 birds/MW are killed annually by the solar panels and associated infrastructure.

A second MSc study by Jeal (2017) of trough technology is not comparable with the PV solar here. It should be noted, however, that he recorded very few avian fatalities. We can use this to roughly estimate mortality as follows:

2. if the cumulative total power output of the six solar PV farms operating within 50-km of Springbok is 130MW (Table 4), then an estimated (130 x 4.5 birds/MW =) **585 birds/year** could be killed by the six PV facilities. If most of these are non-threatened korhaans (Visser 2016) or smaller species, then the impact on the avian community of this part of the Northern Cape is expected to be relatively minor.

Combining the two estimates (1 and 2 above) of potential avian fatalities from the wind farm (<560 fatalities) and the six solar facilities (~<585 fatalities), the potential cumulative impact in terms of birds killed by all renewable energy facilities within 50-km of the Springbok site will be approximately 1 145 avian fatalities. This is likely to be a maximum figure (with few threatened species) given that other unpublished studies of PV facilities in from the Karoo show very low fatality figures (K Low pers comm). It is also unlikely that many of these facilities will be constructed.

This number must be put in context to account for the threat status of the species of birds killed. Present limited evidence suggests that PV solar facilities are unlikely to kill many Red Data species (Visser 2016). A review of the wind farm data collated by Perold et al. (2020) summarised in Table 7 shows that of all birds killed, about 48 of 848 fatalities (6%), were Red Data species of raptor.

Hence, of the 560 fatalities at the only other wind farm, approximately (6% x 560) 37 Red Data raptors are predicted to be killed per year. Short-term displacement of raptors from PV sites was observed based on unpublished reports from Copperton and Prieska (Jenkins and du Plessis 2017), but no fatalities have been reported, and other breeding raptors have returned. Thus, a total of only 37 Red Data raptors is calculated for the cumulative impacts.

Table 8: Cumulative impacts of the Springbok wind farm in the Northern Cape, relative to eight other renewable energy facilities within 50-km of the site.

Nature*:* The impact of the wind energy facilities proposed in the Northern Cape is expected to be negative and arise from disturbance, displacement, and collision for birds around the wind turbines. The associated infrastructure will also impact species in the form of impacts with un-marked power lines.

The direct impact of the wind farms (Table 4) was gauged using unpublished data released by Birdlife South Africa for fatalities at 20 wind farms in South Africa (Perold et al. 2020). About 4.6 birds/turbine/year, or ~2.0 birds/MW/year are killed annually. If a total of 280MW is generated per year from the sole (Nama-Khoi Municipality) wind farm, then we estimate <560 birds killed there per year.

For the remaining seven solar farms (omitting the lapsed/withdrawn Biesjesfontein site), totalling 130MW, the total number of fatalities is estimated at 585 birds. In total about 1145 avian fatalities are predicted as the cumulative total for all renewable energy sites within 50-km of Springbok. This is likely to be a maximum figure given that unpublished reports from elsewhere report no fatalities, but some displacement.

About 6% of the total of the wind farm fatalities are expected to be threatened Red Data raptors (Table 7). Thus, we can predict a maximum of 37 threatened raptors may be included in this total per year without mitigation.
Thus, the likely impact varies from <u>medium to high without mitigation</u>. Careful mitigation can reduce this to acceptable levels.

	Cumulative Impact with Authorised project*	Cumulative Impact with Proposed Revised layout **
Extent	Regional (3)	Regional (3)
Duration	Long-term (5)	Long-term (5)
Magnitude	Moderate (7)	Moderate (6)
Probability	Most likely (4)	Probable (3)
Significance	**Medium-high (60)**	**Medium (42)**
Status (positive/negative)	Negative	Negative
Reversibility	Medium	Medium
Loss of resources/species?	Possible	Possible
Can impacts be mitigated?	Probably, Yes	Yes

Confidence in findings:

Medium: the mortality data released by Birdlife South Africa for wind farms (Perold et al. 2020) allows us to estimate the probable mortality, but the mitigation measures suggested to avoid major raptor fatalities are unknown for each wind farm. Without mitigation measures (i.e., the avoidance of high use and high risk avian areas by turbines) will increase the chances of mortality greatly.

Low for the solar farms: only one study of post-construction mortality has been released and we have relied on that single study. Therefore, the confidence is low for fatality estimates of solar farms.

Because individual wind or solar farms in South Africa rarely release data, it is difficult to gain accurate data without specific studies (e.g., the MSc thesis of Visser, or the compilation by Birdlife SA). Thus, these cumulative impact assessments will remain of low confidence until all specialist studies are made public.

Mitigation:

Recommended measures specifically for the proposed Springbok facility include:

- Avoiding all nest areas and high-use foraging/roosting areas of Red Data species in the siting of said facilities.
- Appropriate buffers around nests (e.g., 3-km for Verreaux's Eagles (Ralston-Paton 2017) should be applied, particularly to the most collision-prone species. This has been complied with by Mulilo when they relocated all turbines to a low use central development area and reduced the number of turbines by 48 %.
- A red-painted blade to be used for all turbines as they are erected.
- If operational-phase monitoring indicates that one or more Red Data bird is killed at any one turbine, then we recommend that this triggers and assessment of appropriate mitigations such as multi-sensor deterrent/shutdown systems are placed on those turbines.
- If audible or visual deterrence is ineffective then selective stopping of turbines should be tried.
- Marking all new overhead power lines with bird diverters to avoid large birds colliding with them.
- Reduce leakages (in the water pipes crossing the wind farm) and cover all water points so they are not visible from above to prevent/reduce arid-zone species being attracted to them.
- Introduce livestock into the area around the turbines to reduce the attractiveness of the habitat to raptors through increased grazing pressure, thereby reducing prey populations.

** With 25 turbines of 140-m hub height*

*** with 13 turbines of 140-m hub height*

8 CONCLUSIONS

The presence of breeding collision-prone and Red Data bird species in the broader area surrounding the Springbok Wind Farm (in the form of Verreaux's and Booted Eagles) and the presence of other collision-prone species requires careful siting of the proposed turbines. This has been undertaken by Mulilo for the authorised project, based on the original avian impact assessment (Simmons 2010, Simmons and Martins 2015), and in discussions with the specialists. The suggested changes to the turbine locations (through clustering in a "revised turbine area") as well as reducing the total turbines to be constructed to a maximum of 13, have been considered by the specialist with regards to the effect it may have on the large collision-prone eagles.

In general, **the reduction in turbines and relocation of all turbines to a central area with a smaller footprint (503 ha) has reduced the possible impacts greatly.**

In addition, our surveys over multiple years (2012, 2014/15, 2021) indicate that the area chosen for final turbine placement (i.e. the revised turbine area) has a Passage Rate for Verreaux's Eagles about 10-fold lower (0.063 eagles/hour) than the site as a whole (0.63 eagles/hour). This probably arises because of the lack of steep slopes in the development area, and the high grazing pressure of the livestock reducing food resources for eagle prey, especially Rock Hyrax.

To reduce further any impacts we recommend:

(i) Constructing all turbines with red- (or black-) blade mitigation already in place to increase turbine visibility for the eagles. This is subject to CAA approval. The benefit of this is that there are no running costs and black-blade mitigation has been shown to be highly effective mitigation at reducing eagle collisions (May et al. 2020)

(ii) keeping high livestock levels in the wind farm to reduce available forage for hyrax, the main prey of the Verreaux's Eagle (Simmons 2005).

If the post-construction monitoring indicates that > 1 Red Data raptor is killed at one turbine then an adaptive management plan must be triggered to reduce the fatalities. We recommend then an automated shutdown-on-demand system for each problem turbine or observer-lead SDOD.

Mitigations during construction should include avoiding construction within 500-m of active nests of Red Data species during the early breeding season.

All overhead power lines should be marked with nocturnal and diurnal bird diverters. Where possible, (where this does not cause disturbance to rare plants as recommended by the botanical specialist) those power lines on site should be buried. With this mitigation, and the marking of the overhead lines, the risks to collision-prone birds on the WEF site can be reduced to minimal acceptable levels.

The cumulative impacts for the eight renewable energy facilities (i.e., seven solar and one wind farm) surrounding the Springbok site are expected to be medium as gauged by an estimated 1,140 birds and 37 Red Data raptor mortalities per year. If all wind and solar farms enact suitable mitigation measures, these impacts, too, can be reduced to acceptable levels.

In conclusion, the revised number of a maximum of 13 turbines all placed in the revised (central) development area (at any location within this areas), is likely to incur fewer fatalities than the authorised 25 turbines of 140-m height with a larger footprint.

As such we see no problems with the approval of the final turbine layout and the construction of the Springbok WEF and recommend the project proceeds with a minimum of 24 months post-construction monitoring to determine the effects of the wind farm on the Red Data species identified as at risk, followed by operational monitoring at least in years, 5, 10, 15 and 20 in line with best practise guidelines.

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Appendix 1: Data collected and Passage Rates of all flights of Priority species over the revised turbine layout of the Springbok wind farm: May 2021.

Date	Obs period	VP	Hrs	Time	No	Species	Age	Sex	Height	Seconds	Ref on Map
2021/04/15	7:50-13:50	1	6.00	13:13	1	(Rock Kestrel)	U	U	10	7	
2021/04/16	7:50-13:50	1	6.00			NO BIRDS					
2021/04/17	07:30-13:30	1	6.00	10:38	2	**Verreaux's Eagle**	Ad	M&F	200;200;200;200;200;200;200;200;100;50;20;15;15;15;50;70;30	247	**VE1-2**
				10:41	1	**Verreaux's Eagle**	Ad	U	2;30;20	40	**VE3**
2021/04/18	7:35-13:35	1	6.00			NO BIRDS					
2021/04/19	07:10-13:10	1	6.00			NO BIRDS					
	14:15-18:20	1	4.00			NO BIRDS					
2021/04/15	8:30-14:30	2	6.00	10:23	1	**Verreaux's Eagle**	A	U	30;30	15	**VE4**
				10:28	1	**Verreaux's Eagle**	A	U	30;2	15	**VE5**
				10:35	2	**Verreaux's Eagle**	A	M&F	50;60;60;80;80;90;90;100;100;110;80;80;80; 90;90;90;90;80;70;60;50;40;30;5	360	**VE6-7**
				10:44	2	**Verreaux's Eagle**	A	M&F	50;50;50;60;80;90;100;80;20	180	**VE8-9**
				10:50	1	**Verreaux's Eagle**	A	U	150;140;70;10	45	**VE10**
				10:55	2	**Verreaux's Eagle**	A	M&F	50;60;100;100;100;10;0;20;30;60;70;90;100; 90;80;70;10;20;60;100;150;130;60;30;0	360	**VE11-12**
2021/04/16	07:15-13:15	2	6.00	7:50	2	(Rock Kestrel)	A	U	30;30;30;30;30;50;50;50;50;50;20;20;20;20	180	
				8:17	2	**Verreaux's Eagle**	A	M&F	10:20;70;20;10;10	100	**VE13-14**
2021/04/17	8:00-14:00	2	6.00	10:37	2	**Verreaux's Eagle**	A	M&F	40;100;130;150;160;160;140;100;50;30;10	150	**VE15-16**
				10:42	2	**Verreaux's Eagle**	A	M&F	20;20	15	**VE17-18**
2021/04/18	7:00-13:00	2	6.00	9:40	1	**Verreaux's Eagle**	A	U	10;20;20;100;100;100;100;150;150;150;150; 200;200	200	**VE19**
				9:42	1	**Verreaux's Eagle**	A	U	150;150;150;150;150;150;150;200;200	120	**VE20**
				9:45	1	**Verreaux's Eagle**	A	U	20;70;100;200	50	**VE21**
				9:46	1	**Verreaux's Eagle**	A	U	20;50;100;100;100;100;100;100;100;50;70	150	**VE22**
				9:55	2	**Verreaux's Eagle**	A	M&F	100;100;20;100;100;300;200;10	110	**VE23-24**

				10:23	1	Verreaux's Eagle	A	U	10;20	15	**VE25**
				10:25	1	Verreaux's Eagle	A	U	10;20;50	35	**VE26**
				10:33	1	Verreaux's Eagle	A	U	10	15	**VE27**
				10:35	1	Verreaux's Eagle	A	U	10	5	**VE28**
				10:40	1	Verreaux's Eagle	A	U	10;10;20	30	**VE29**
				10:50	1	Verreaux's Eagle	A	U	100;100;100;50;100;100;100;50;100;100;100;120;50;10;5	210	**VE30**
				10:50	1	Verreaux's Eagle	A	U	20;20;5	30	**VE31**
				10:53	1	Verreaux's Eagle	A	U	5;100	40	**VE32**
				10:59	1	Verreaux's Eagle	A	U	20;150;100;10	50	**VE33**
				11:02	1	Verreaux's Eagle	A	U	20	10	**VE34**
				11:09	2	Verreaux's Eagle	A	M&F	10;100;120;200;150	60	**VE35-36**
			58.00		**36**	**Birds 1 Species**	**VE, (RK)**				
Springbok WEF Passage Rates			**58.00**	**hours**	**=**	**0.62**	**Birds / hr**				