THE BASIC ASSESSMENT FOR THE PROPOSED KOMAS WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE NEAR KLEINSEE IN THE NORTHERN CAPE PROVINCE.

APPENDIX C.3

Avifauna Assessment

Avifauna Impact Assessment for the proposed Komas Wind Energy Facility and associated infrastructure, Kleinsee, Northern Cape Province

Report prepared for:

CSIR – Environmental Management Services

P O Box 320, Stellenbosch, 7599

On behalf of

ENERTRAG

genesis eco-energy DEVELOPMENTS

Report prepared by:

Dr RE Simmons and M Martins

Birds & Bats Unlimited

8 Sunhill Estate, Capri,

Cape Town 7975

BIRDS & BATS UNLIMITED

Environmental Consultants

www.birds-and-bats-unlimited.com

SPECIALIST EXPERTISE

Dr Rob Simmons, Director of Birds & Bats Unlimited is an ecologist, ornithologist and environmental consultant, with 3 decades research experience in North America, Africa, Europe and Asia. 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, specializing in wetland, avian and montane biodiversity. Schooled in London (Honours: Astrophysics), Canada (MSc: Biology) and South Africa (PhD: Zoology).

---

1. 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.

2. 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 2019-2020)

Consultancy work at: http://www.birds-and-bats-unlimited.com
Papers and academic background at: www.fitzpatrick.uct.ac.za/fitz/staff/research/simmons

SPECIALIST DECLARATION

I, Robert E. Simmons, as the appointed independent specialist, in terms of the 2014 EIA Regulations, declare that:

- I act as the independent specialist in this application;
- I 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 regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have, and will not have, any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- 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 have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and competent authority all information in my possession that 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 prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- 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:

Name of Specialist: Dr R E Simmons

Date: 24 January 2020, revised 23 December 2020

Note: this report was co-authored with Marlei Martins (Director of Birds and Bats unlimited). She too adheres to the principles listed above and her profile can be found at www.birds-and-bats-unlimited.com/birds

The DEA specialist declaration is given in Appendix 1

TABLE OF CONTENTS

List of Figures

List of Tables

1. EXECUTIVE SUMMARY

Genesis ENERTRAG Komas Wind (Pty) Ltd (the applicant) Ltd is proposing the development of the Komas Wind Energy Facility (WEF) in the Springbok Renewable Energy Zone (REDZ 8) south-east of Kleinsee, South Africa, in the arid Namaqualand Strandveld. The proposed Gromis WEF comprises up to 50 wind turbine generators (WTGs) with a maximum capacity of 300 MW. Birds and Bats Unlimited (Pty) Ltd was appointed by the applicant to undertake the Avifaunal Impact Assessment to inform the Basic Assessment which is currently being undertaken by the Council of Scientific and Industrial Research (CSIR) on behalf of the applicant.

A Protocol for Avifaunal Assessment was published in Government Notice No. 320 on 20 March 2020. Should an Avifaunal assessment be conducted after this date, the said Protocol must be followed and will replace the requirements for specialist studies in terms of Appendix 6 of the NEMA EIA Regulations, 2014, as amended. However, this Avifauna Impact Assessment commenced in March 2019, i.e. long before the Protocol came into effect. Therefore, the Avifauna Impact Assessment was done in terms of Appendix 6 of the NEMA EIA Regulations, 2014, as amended. This approach was discussed and confirmed with the Department of Environment, Forestry and Fisheries (DEFF) at the second pre-application meeting held on 7 October 2020.

Priority avifauna were monitored and recorded at the proposed Komas WEF site over 12 months as required by the Best Practice Guidelines for assessing and monitoring the impacts of wind energy facilities, produced by BirdLife South Africa and the Endangered Wildlife Trust (Jenkins et al. 2015).

Kleinsee lies in the Succulent Karoo Biome of the Northern Cape and this report details the number of priority species (i.e. all threatened and collision-prone birds) and their Passage Rates through the 27-km^2 area proposed for the proposed Komas WEF development from March 2019 (autumn) to December 2019 (summer). We quantify and predict possible threats, and map high-risk and medium-risk areas to reduce future potential impacts to avifauna at the proposed Komas WEF site.

The potential impacts to avifauna identified in this assessment include:

- Displacement and avoidance of nationally important species by the turbines;
- Loss of habitat for such species due to direct habitat destruction under the turbines;
- Disturbance during construction of the turbines and associated infrastructure; and
- Mortality arising from birds being struck by the moving turbine blades or associated infrastructure.

The impact zone of the proposed WEF site lies within the coastal area of the Succulent Karoo biome. Dry and uniform grazed habitats within this undulating area allows a small suite of arid-adapted and nomadic species to exist. Up to date bird atlas data from the Southern African Bird Atlas Project 2 (SABAP2) of the broader region indicates that the area proposed for the development supports a low diversity of 48 bird species.

- Our own records, focussed on the wind farm site in a particularly dry period, found 58 species in 12 months of monitoring.
- More species (43 and 49 species) were present in spring and summer, following rains, and this brought in more priority (6 and 8 species) and more Red Data species (3 and 3 species) respectively.

- Eight priority collision-prone species occurred over the year of which three were red-listed: Verreaux's Eagle *Aquila verreauxii* (ranked 2nd in top 100 collision-prone species); Ludwig's Bustard *Neotis ludwigii* (ranked 10th); and Southern Black Korhaan *Afrotis afra* (ranked 35th).

South African turbines kill 4.1-4.6 birds per turbine annually of which raptors comprise 36% (Perold et al. 2020). As such they may impact the five species of raptor that frequent the site.

- Both the annual passage rate of all collision-prone species on the WEF (0.39 birds per hour), and the three Red Data species alone (0.15 birds per hour) were medium-high, increasing the probability of impacts especially for any turbines proposed in frequently used areas by raptors.
- Risk is also increased by the proportion of time priority species spent in the blade swept area (from 100-m to 300-m, for 200m-hub height (HH) turbines with 100-m blades).
- Priority species flew at these heights 78% of the time (Verreaux's Eagle); 40% of the time (Black-chested Snake Eagle); 56% of the time (Booted Eagle) and 0% of the time (Ludwig's Bustards), thereby increasing risk to the raptors.
- Based on frequent flights of Red Data species or where two or more priority species overlapped, no areas of high-risk were identified.
- But five areas of medium-risk were found on the proposed wind farm. These were located throughout the Komas site where the Snake Eagles and Booted Eagles were particularly active.

If turbines are located within the medium-risk area, we recommend (the current layout excludes these areas):

- a black- or signal-red painted blade for select turbines found to kill birds in medium risk areas to reduce possible raptor mortalities; and
- that construction and post-construction monitoring takes place to ensure that any wind-farm-related fatalities are documented and addressed immediately.

The cumulative impacts of nine other proposed wind energy facilities within 50-km of the Komas Wind Farm were assessed, and a minimum of 2 334 bird fatalities are estimated annually from these proposed facilities. Approximately 168 of these are estimated to be priority Red Data raptors per year.

Because this is a high impact site for Red Data birds, we recommend that:

- The mitigation measures above be considered in the medium-risk areas.
- This should be accompanied by full construction-phase monitoring; and a 12-24 month post-construction monitoring programme in place. This should be undertaken by competent ornithologists following Birdlife South Africa's Guidelines (or the applicable Guidelines at the time) to monitor fatalities or problems in the construction and post-construction phases. Solutions and alternatives can then be suggested and implemented if challenges arise.
- The anticipated impacts to birds associated with the proposed Komas WEF and associated infrastructure were assessed to be negative and of moderate significance before and after mitigation. The proposed Komas WEF development layout avoids all medium risk areas identified by the avifauna specialist.
- It is therefore, recommended that the proposed Komas WEF and associated infrastructure be authorised, provided the proposed mitigation measures in this report are strictly adhered to.

The applicant provided two Battery and on-site Substation complex site alternatives to be assessed (i.e. Option 1 and Option 2). Option 2 is the preferred avian option since it is (i) closer to the incoming power line and (ii) there are slightly fewer priority bird flights in this area than at Option 1. Option 1 is not fatally flawed and can be implemented; however, Option 2 is the preferred option based on the motivation provided.

1.1 List of Abbreviations

BA	Basic Assessment
BAR	Basic Assessment Report
BARESG	Birds and Renewable Energy Specialist Group
BLSA	Birdlife South Africa
BSA	Blade Swept Area (of the turbine blades)
CAA	Civil Aviation Authority
CPS	Collision Prone Species
CSIR	Council of Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Forestry and Fisheries
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EO	Environmental Officer
EWT	Endangered Wildlife Trust
HH	Hub Height
IBA	Important Bird Area
I&APs	Interested and Affected Parties
MW	megawatt
NEMA	National Environmental Management Act 1998 (Act No. 107 of 1998)
O&M	Operation and Maintenance
PPA	Power Purchase Agreement
PV	Photovoltaic
REDZ	Renewable Energy Development Zone
SABAP	Southern African Bird Atlas Project
SANBI	South African National Biodiversity Institute
VP	Vantage Point
WEF	Wind Energy Facility
WTG	Wind Turbine Generator

1.2 Glossary

Definitions	
Blade-swept area	The area swept by the full rotation of the spinning blades. This increases with the square of the radius of the blade length and fatality rates increase as the blades get longer and taller.
Collision-prone	A group of bird species known to be highly susceptible to collisions with turbine blades (or power lines) based on empirical evidence or theoretical aspects of their vision and flight
Cumulative Impacts	The sum total of all impacts based on other renewable energy facilities (solar and wind) within 50km of the site under investigation
Passage Rate	Number of flights of collision-prone birds per hour of observation through the wind farm
Priority Species	The top 100 collision-prone species in Birdlife South Africa's compilation based on size, conservation status, social behaviour and other factors
Significance of Impact	A measure of the severity of the impact under investigation based on Extent, Magnitude, Duration and Probability of each occurring,
Vantage Point	A topographically raised point from which 6h-long observations over a 1.5 km view-shed is used to record all priority species flying through the site

1.3 Compliance with Appendix 6, 2014 EIA Regulations, as amended

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Addressed in the Specialist Report
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	 Page 1 Page 2
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix 1
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 2
(cA) an indication of the quality and age of base data used for the specialist report;	Section 3
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7 Table 7; Section 7.2
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 3
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 6 Figures 15 &16
g) an identification of any areas to be avoided, including buffers;	Section 6 Figures 15 &16
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 6 Figure 16
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4.7
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	Section 6
k) any mitigation measures for inclusion in the EMPr;	Section 7 Table 8 Section 8
l) any conditions for inclusion in the environmental authorisation;	Section 9 (stipulating conditions in Table 8 must be included in the Environmental Authorisation)
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 7 Table 8 Section 8
n) a reasoned opinion- i. as to whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and	Section 9

ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	To be incorporated following the release of the DBAR for comment (if applicable)
q) any other information requested by the competent authority.	N/A
2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	A Protocol for Avifaunal Assessment was published in Government Notice No. 320 on 20 March 2020. However, this Avifauna Impact Assessment commenced in April 2019, i.e. before the Protocol came into effect. Therefore, the Avifauna Impact Assessment was undertaken in terms of Appendix 6 of the NEMA EIA Regulations, 2014, as amended.

2. INTRODUCTION AND PROJECT SCOPE

Genesis ENERTRAG Komas Wind (Pty) Ltd (the applicant) is proposing the development of the Komas Wind Energy Facility (WEF) and its associated infrastructure in the Renewable Energy Development Zone 8 (Springbok REDZ) 40-km south-east of Kleinsee in the Nama Khoi Local Municipality, South Africa. The site lies in the Succulent Karoo Biome of the Northern Cape Province. The proposed Komas WEF comprises a maximum of 300 MW and consists of a maximum of 50 Wind Turbine Generators (WTGs).

2.1 Project location

The proposed Komas WEF project will be developed on the following farm portions as indicated below:

Table 1: Affected Farm Portion Details

Farm Name	21 Digit Code	Parcel Number
Portion 1 of the Farm Zonnekwa No.326	C0530000000032600001	326
Portion 2 of the Farm Zonnekwa No.328	C0530000000032800002	328
Portion 3 of the Farm Zonnekwa No.328	C0530000000032800003	328
Portion 4 of the Farm Zonnekwa No.328	C0530000000032800004	328
Portion 4 of the Farm Kap Vley No.315	C0530000000031500004	315

2.2 Project Description

The Komas WEF site area comprises an approximate area of 2 725 hectares (ha). The total project footprint comprises approximately 90 ha. This excludes access roads leading to the site.

The proposed Komas WEF will comprise of a maximum of 50 WTGs. Each WTG will have a hardstand area of approximately 1 500 m^2, a turbine hub height of up to 200 m and a turbine rotor diameter of up to 200 m. Associated infrastructure includes a construction laydown area (which includes the Operation and Maintenance (O&M) buildings), a lithium-ion Battery Energy Storage System (BESS) comprising of batteries within shipping containers or a suitable housing structure on a concrete foundation and, an on-site Substation (SS). The Battery and on-site SS will be located within a complex of 4 ha to allow for micro-siting of the BESS components and to accommodate internal roads (as required), a temporary construction laydown area and a firebreak around the BESS footprint.

Once a Power Purchase Agreement (PPA) is awarded, the proposed Komas WEF will generate electricity for a minimum period of 20 years. The construction phase for the proposed project is expected to extend approximately 24 months.

The proposed Komas WEF and associated infrastructure include the main components and associated specifications as tabulated below in Table 2.

Table 2: The key project and component details and associated specifications

Component	Description / Dimensions
Site coordinates (centre point)	Lat -29.843279°; Long 17.296014°
Affected farm portion/s	• Portion 1 of the Farm Zonnekwa No. 326 • Portion 2 of the Farm Zonnekwa No. 328 • Portion 3 of the Farm Zonnekwa No. 328 • Portion 4 of the Farm Zonnekwa No. 328 • Portion 4 of the Farm Kap Vley No. 315
SG code/s	• C05300000000032600001 • C05300000000032800002 • C05300000000032800003 • C05300000000032800004 • C05300000000031500004
Total project footprint	Approximately 90 ha
Proposed technology	WTGs and associated infrastructure, including a lithium-ion BESS
Komas WEF site area	Approximately 2 725 ha
Generation capacity	Up to 300 MW
Number of turbines	Up to 50 turbines
Turbine hub height from ground	Up to 200 m
Turbine rotor diameter	Up to 200 m
Turbine blade length	Up to 100 m
On-site SS and BESS complex area	Approximately 4 ha (200 m x 200 m)
Height of BESS array	Approximately 5 -10 m
Height of on-site SS	Approximately 7 – 10 m
Construction laydown area	A temporary construction laydown/staging area of approximately 4.5 ha (which will also accommodate the O&M buildings)
Permanent laydown area	To be determined based on final layout
O&M building area	Part of the construction laydown area
Turbine hardstand area	Approximately 1 500 m² per turbine
Width of internal access roads	Up to 10 m, including turning circle/bypass areas of up to 20 m
Length of internal access roads	To be determined based on final layout
Site access	Unnamed gravel public road off the R355
Grid connection and proximity	Gromis MTS Approximately 30 km
Height of SS, BESS and O&M area fencing	Approximately 2 m to 3 m high
Type of fencing	Galvanised steel
Fencing around the WEF Perimeter	Type: Galvanized steel Height: 1 m to 3 m

The Project Applicant is also proposing to develop a 132 kV power line, a 33/132 kV Eskom Switching SS and a Collector SS (if required) to feed the electricity generated by the proposed Komas WEF into the national grid at the Gromis Main Transmission Substation (MTS). These electrical infrastructure components will be assessed as part of a separate application and BA process to be undertaken by the Project Applicant.

2.3 Project Scope: Avifauna Assessment

Birds and Bats Unlimited (Pty) Ltd was appointed by the applicant to undertake the Avifaunal Impact Assessment to inform the Basic Assessment which is currently being undertaken by the Council of Scientific and Industrial Research (CSIR) on behalf of the applicant.

A Protocol for Avifaunal Assessment was published in Government Notice No. 320 on 20 March 2020. Should the Avifaunal assessment be conducted after this date, the said Protocol must be followed and will replace the requirements for specialist studies in terms of Appendix 6 of the NEMA EIA Regulations for specialist studies. However, this Avifauna Impact Assessment commenced in March 2019, i.e. before the Protocol came into effect. Therefore, the Avifauna Impact Assessment was done in terms of Appendix 6 of the NEMA EIA Regulations, 2014, as amended. This approach was discussed and confirmed with the Department of Environment, Forestry and Fisheries (DEFF) at the second pre-application meeting on 7 October 2020.

Potential impacts to birds at the proposed Komas WEF site requires a 12-month pre-construction bird monitoring. Priority species, defined as the top 100 collision-prone species (CPS) including red-listed species that pass through the 27 km^2 area, were documented from March 2019 to December 2019 covering all four seasons to help quantify, predict and reduce future potential negative impacts on avifauna.

Pre-construction avifauna monitoring was undertaken following the Best Practice Guidelines for assessing and monitoring the impacts of wind energy facilities in southern Africa, produced by BirdLife South Africa and the Endangered Wildlife Trust (Jenkins et al. 2015).

These call for four seasons' monitoring over 12 months across the proposed site, and that an additional Control site is simultaneously monitored over the same period. This allows us to determine the effect that turbines may have on birds after construction, independent of natural fluctuations due to other causes. The all-important passage rates [the number of priority collision-prone birds per hour] through both areas must also be highlighted to determine the risk to priority birds.

This Avifauna Impact Assessment Report details our findings from all four surveys covering all four seasons. We report on:

(i) all larger collision-prone species passing through the proposed WEF site (and Control area) from Vantage Points (VPs) covering 18 hours per observations; and
(ii) breeding species throughout the area.

Available waterbodies (i.e. farm dams) were also searched for wetland species. Note that VP surveys were increased from the typical 12 hours to 18 hours due to the presence of Verreaux's Eagles recorded on site in the second survey. This is a recommendation of the Verreaux's Eagle Guidelines (Ralston-Paton, 2017).

We define **high-risk** areas to be those where:

- any top-100 collision-prone **Red Data** species were seen to overlap in space; or
- single Red Data species occurred frequently (> 0.2 birds/h); and

- any of them were found to be breeding, roosting or foraging on a regular basis.

Medium-risk areas are deemed to occur where:

- any two top-100 collision-prone species (non-threatened) were seen to overlap in space; or
- any of them were found to be breeding, roosting or feeding on a regular basis.

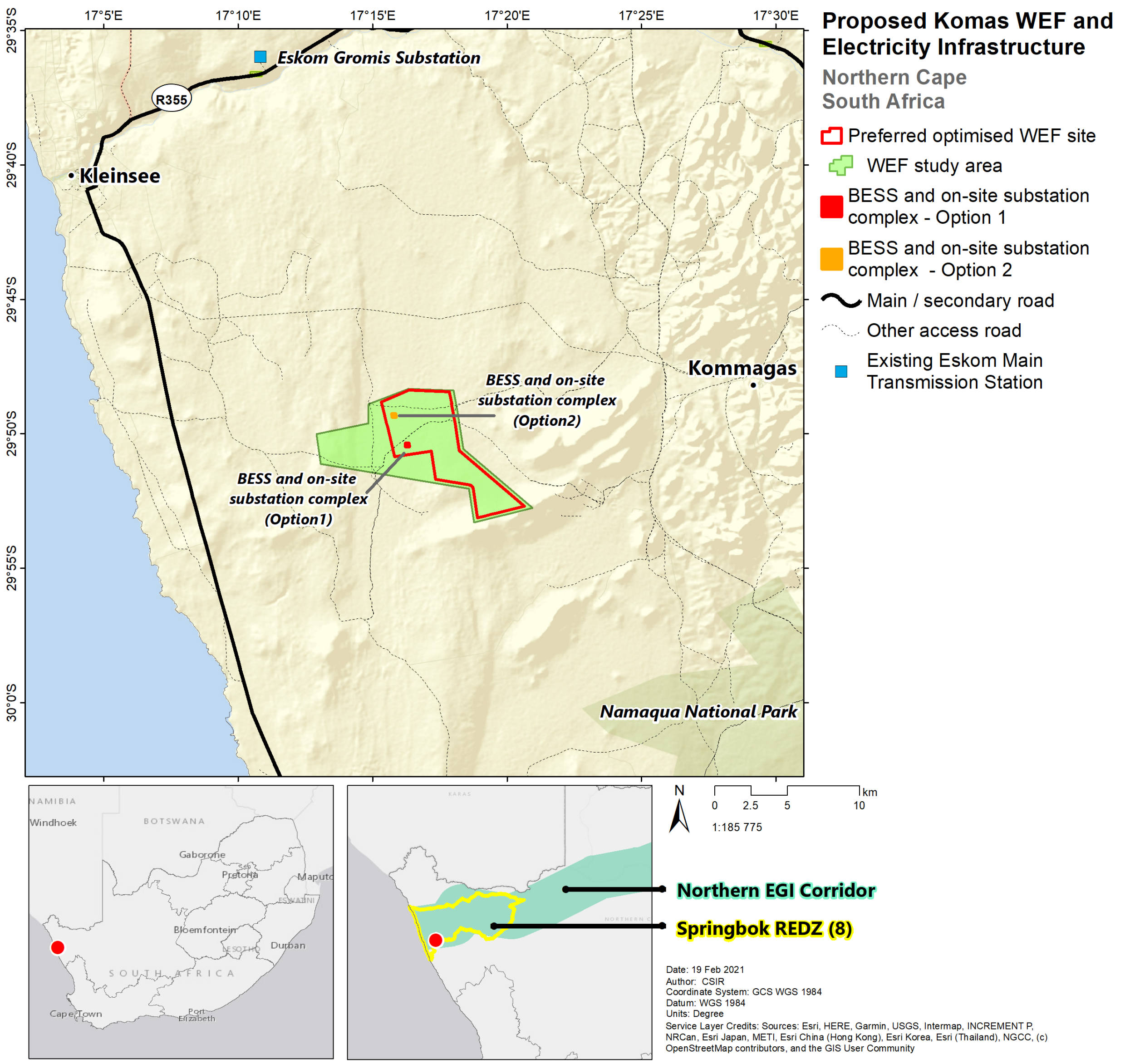


Figure 1: Locality of the proposed Komas Wind Energy Facility and associated infrastructure near Kleinsee in the Northern Cape Province

3. APPROACH AND METHODOLOGY

The avian pre-construction monitoring reported here covered 12-months in accordance with the Best Practice Guidelines for assessing and monitoring the impacts of wind energy facilities in southern Africa, produced by BirdLife South Africa and the Endangered Wildlife Trust (Jenkins et al. 2015).

Priority species, defined as the top 100 collision-prone species (CPS) and include red-listed species that passed through the 27-km^2 area were recorded. These were documented in autumn (March 2019), winter (July 2019), spring (October 2019) and summer (December 2019), to help quantify, predict, and reduce future impacts. This covers all the bird-active months for migrants and residents.

We report on:

(i) the species-richness of smaller resident avifauna species in the wind farm site by season;
(ii) the presence and passage rates of all larger priority avifauna species passing through the proposed wind farm site (and the Control area) from VP surveys; and
(iii) breeding species throughout the area.

We conclude by identifying the potential impacts and the medium-risk sensitivity areas within the proposed Komas WEF site, based on the presence and number of priority species using the area. The possible Cumulative Impacts were also identified and assessed as per Appendix 6 of the NEMA EIA Regulations, 2014, as amended.

Transects: All bird surveys took place in the morning (bird-active) hours. Each 1-km transect was walked slowly over a 25- to 40-minute duration, depending on terrain and number of birds present. All species were identified where possible, and the number of individual birds and the perpendicular distance to them recorded with a Leica laser rangemaster 1600. This allows an estimate of the density (birds per unit area and kilometre) and the species richness in each area. We simultaneously recorded all large birds (mainly raptors and bustards) and noted and recorded the position of any large active nests found in the study area.

Vantage Point (VP) monitoring is the most important aspect of such site surveys (Jenkins et al. 2015, 2015). Each VP requires 12 hours' observations over two separate days to record passage rates of Priority Collision-Prone Species. That is, recording the number of priority species (e.g. large raptors and korhaans/bustards) passing, per hour, through the proposed Komas wind farm site from equally spaced vantage points in the WEF and Control. These were undertaken from hills and other raised points allowing uninterrupted views of about 1.5-km. Because *Vulnerable* Red Data Verreaux's Eagles were recorded in VP observations in July 2019, our observation hours were increased to 18 hours per site visit, (i.e. 6 hours per day for three days) based on recommendations in the Verreaux's Eagle Guidelines (Ralston-Paton 2017).

At 1.5-km, it becomes more difficult to identify each species and their positions, but the presence and identity of larger birds is still possible over these distances with 8.5x or 10x Swarovski binoculars. The VPs were sited to cover the entire study area equally. The flight height and behaviour of identified birds was estimated every 15 seconds and recorded onto a voice recorder and then onto a laminated Google Earth maps in the field. These were subsequently transferred to a digital Google Earth image of the area. These are presented below (Figures 6-10).

Flight height is a difficult parameter to measure but we used a Laser Rangemaster, the presence of a 120-m wind mast on site and farmers' windmills to aid our accuracy. In a test of our accuracy in estimating

flight heights using a drone with a built-in GPS, our average error was found to be 9-m and the median error 11-m (Francisco Cervantes Peralta, Centre for Statistics and Ecology, UCT, pers. comm) (Figure 2).

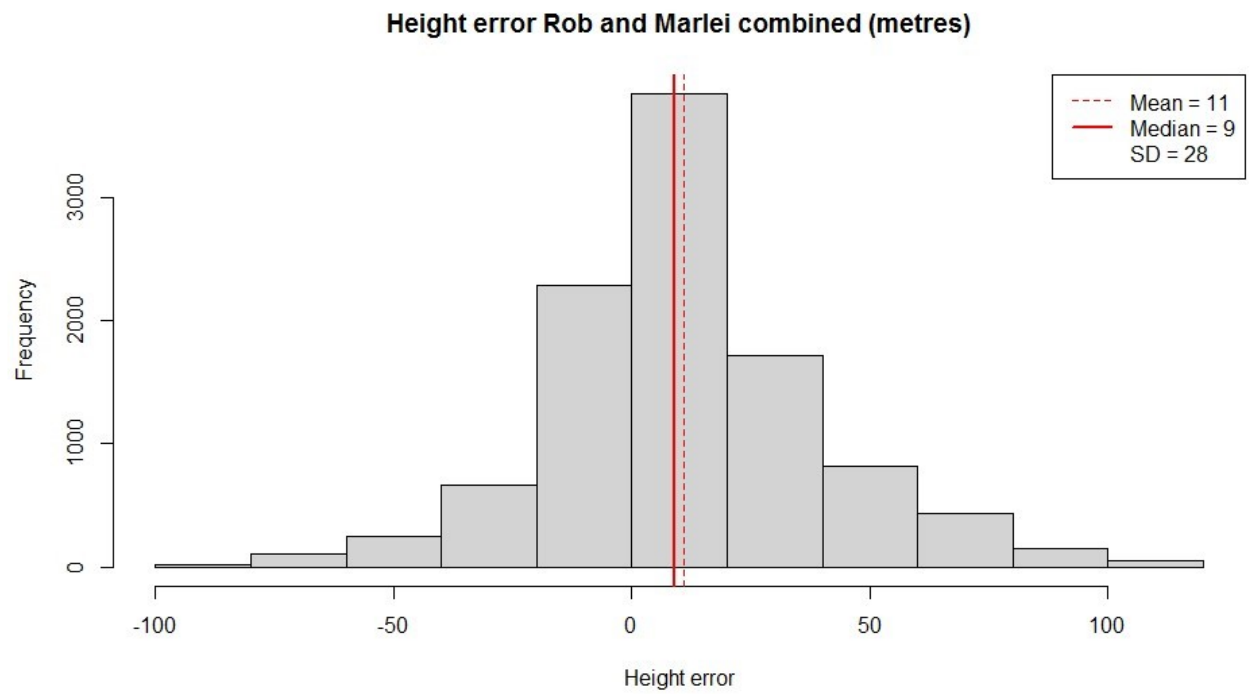


Figure 2: The error in estimating height of a GPS-fitted drone under field conditions by M Martins and R Simmons, based on over 3000 observations at a west-coast site. The median error was under 10m. Unpubl. data of F Cervantes-Peralta (UCT Dept of Statistical Sciences).

4. TERMS OF REFERENCE

The Terms of Reference (ToR) for this Avifauna Impact Assessment are as follow:

- Adhere to the requirements of specialist studies in terms of Appendix 6 of the NEMA EIA Regulations 2014, as amended;
- Conduct a pre-construction bird monitoring programme which must follow the requirements of the Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development areas in southern Africa (Produced by BirdLife South Africa and the Endangered Wildlife Trust) (Jenkins et al. 2015);
- Provide data on the number, flights paths, and breeding of priority Red Data and collision-prone species at the proposed Komas WEF site over four seasons. Propose a suitable bird monitoring programme for the evaluation of the impacts anticipated during the construction and operational phases of the development. These monitoring programmes must adhere to the Guidelines applicable at the time;
- Provide a description of any assumptions, uncertainties, limitations and gaps in knowledge;
- Provide a description of the relevant legal context and requirements;
- Describe the affected environment from an avifaunal perspective, including identification and conservation status of sensitive bird species (Regional Red Data and priority species) present and potentially present on the project site. Consideration of the surrounding habitats and avifaunal

features which include e.g. Ramsar sites, Critical Bird Areas, wetlands, migration routes, feeding, roosting & nesting areas;

- Describe and map bird habitats on the site, based on on-site monitoring, desk-top review, collation of available information, studies in the local area, previous experience, and the national web-based Environmental Screening Tool of DEFF. Provide details of any medium- and high-risk avian areas within the WEF, based on the occurrence of priority species found throughout the year;
- Compilation of a bird sensitivity map within and surrounding the project sites by identifying areas of high sensitivity and/or no-go areas and buffer zones to inform the project layout. Please note that the DEFF considers a 'no-go' area, as an area where no development of any infrastructure is allowed; therefore, no development of associated infrastructure including access roads and internal cables is allowed in the 'no-go' areas. Should your definition of the 'no-go' area differs from the DEFF definition; this must be clearly indicated in your assessment. You are also requested to indicate the 'no-go' area's buffer;
- Identify and assess the potential direct and indirect impacts of the proposed Komas WEF project and its associated infrastructure on birds during the construction, operational and decommissioning phases. Provide an assessment of the irreversibility of impacts, and the irreplaceability of lost resources;
- Identify and assess cumulative impacts from other Wind and Solar PV projects within a 50 km radius from the proposed Komas WEF that have already received Environmental Authorisation (EA), are preferred bidders and/or have submitted an application to DEFF at the start of this BA process.
- In addition, the cumulative impact assessment for all identified and assessed impacts must be refined to indicate the following:
    - Identified cumulative impacts must be clearly defined, and where possible the size of the identified impact must be quantified and indicated, i.e. hectares of cumulatively transformed land.
    - The cumulative impacts significance rating must also inform the need and desirability of the proposed development.
    - A cumulative impact environmental statement on whether the proposed development must proceed.
- Assess the project alternatives and identify the preferred alternative with motivation for this selection;
- Assess the no-go alternative very explicitly in the impact assessment section;
- Incorporate and address issues and concerns raised during the BA process where they are relevant to the specialist's area of expertise;
- Propose mitigation measures to address possible negative effects and to enhance positive impacts to increase the benefits derived from the project;
- Provide recommended mitigation measures, management actions, monitoring requirements, and rehabilitation guidelines for all identified impacts to be included in the EMPr. The results and recommendations from the pre- and post-construction monitoring programmes must be incorporated into the EMPr;
- Provide a statement regarding the potential significance of the identified issues based on the evaluation of the issues/impacts and a reasoned opinion as to whether the proposed project should be authorised. Identify any aspects which are conditional to the findings of the assessment which are to be included as conditions of the Environmental Authorisation, should the project be approved; and
- Conduct a field investigation to determine the bird community present in the study area (as undertaken during the 12-month bird monitoring campaign). Although the general bird community is considered, this study will have special focus on the species considered to be more sensitive to wind energy development related impacts.

4.1 Need for the Avifauna Impact Assessment

Birds are known to be impacted directly and indirectly by wind farms, both onshore and offshore worldwide. The Best Practice Guidelines (Jenkins et al.2015) require 12 months of pre-construction monitoring at all proposed wind farms to determine the avian species at risk. Mitigations and alternatives must be provided at the conclusion of such reports, and they are guided in these recommendations by the Birds and Renewable Energy Specialist Group (BARESG). This is an advisory group formed between the Endangered Wildlife Trust (EWT) and Birdlife South Africa (BLSA) who were tasked with producing monitoring Guidelines, based on International Best Practice, for birds and wind farms (Jenkins et al. 2015). This study arises from this need for 12-months' monitoring and the Best Practice Guidelines (Jenkins et al. 2015) were followed. This Avifauna Impact Assessment Report summarises and provides recommendations for mitigations for the priority species occurring on the proposed Komas Wind Farm site.

4.2 Description of Baseline Environmental

This arid region of South Africa falls within a generally low diversity for birds. Its aridity, unpredictable rainfall and low winter temperatures mean that species richness is very low relative to other parts of the South Africa (van Rensberg 2002).

4.2.1 Important Bird Areas

Important Bird Areas (IBAs) are classified based on the number of threatened red data species they support or on total numbers of species.

The high aridity and low temperatures, promoting low species richness mean that few IBAs occur in this region. In the Northern Cape, despite being the largest province, there are only 11 IBAs (Marnewick et al. 2015). The closest IBAs to the proposed Komas WEF study site at are found at (i) the Orange River mouth wetland, 165 km north (ii) the Bitterputs Conservation Area 145 km east and (iii) Haramoep and Black Mountain mine, 145 km east the (Marnewick et al. 2015). The latter two areas are ostensibly set up to protect the range-restricted Red Lark. This species is not found at the proposed Komas WEF site.

4.2.2 Protected areas

The northern section of the Namaqua National Park lies only 15 km south-east to the proposed Komas WEF site. This national park originally evolved to protect the Namaqua daises at the Skilpad farm but has now expanded to the coast and northwards. There are no other protected areas close by.

4.2.3 National Protected areas expansion strategy (NPAES)

Protected areas in South Africa are protected by law and managed mainly for biodiversity conservation. Protected areas are recognised in the National Environmental Management: Protected Areas Act (Act 57 of 2003) and are considered protected areas in the NPAES. The Protected Areas Act includes protected areas, special nature reserves, national parks, nature reserves, marine protected areas and protected environments. They are vital for ecological sustainability and resilience to climate change and may protect rural livelihoods too. The Komas area is designated as "poorly protected" in the government document https://www.gov.za/sites/default/files/gcis_document/201901/nationalprotectedareasexpansionstrategy2016ofsouthafrica.pdf

Importantly, the NPAES has identified the Komas study site as a nationally important area for future protection (Figure 2 in the above document). It is unknown what this means for this development.

4.3 The Strategic Environmental Assessment for wind and solar

The study area falls within the Springbok REDZ 8 and is classified as Medium sensitivity for avifauna in terms of wind farm development, based on the national avian sensitivity map of Birdlife South Africa.

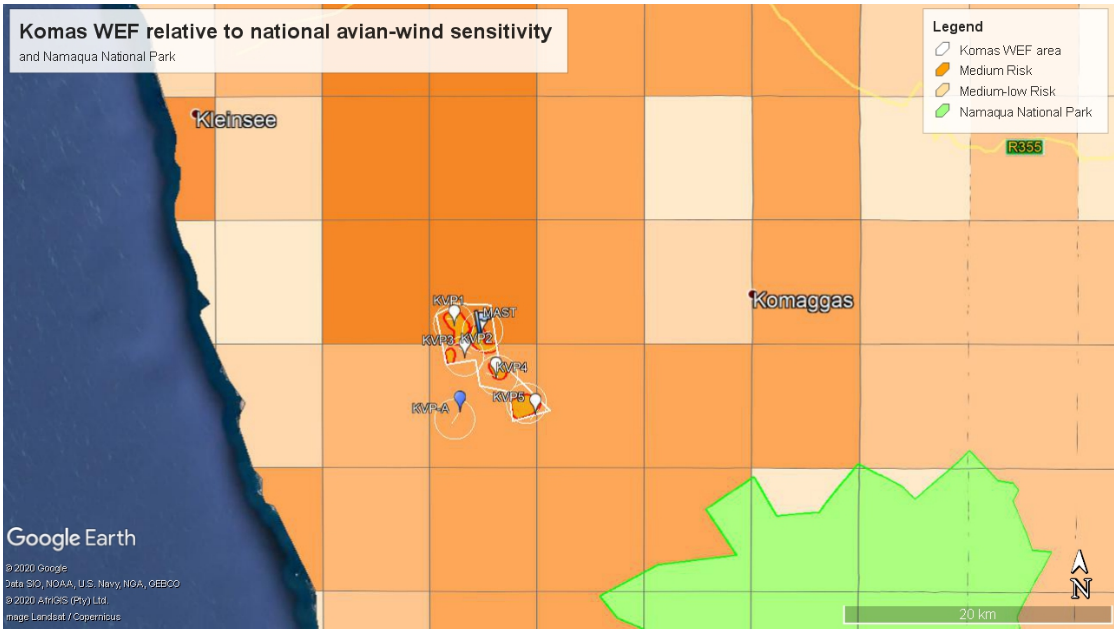


Figure 3: The Komas WEF site relative to the national avian-wind sensitivity identified in the wind and solar SEA. Dark squares represent medium high sensitivity, pale squares lower sensitivity.

4.4 Vegetation of the Study Area

The study area occurs at the north-west end of the Nama Karoo biome (Mucina and Rutherford 2006, p264), and is designated as Namaqualand Strandveld. It is dominated by low species-rich shrubland and erect and creeping succulents on nutrient-poor sand and is heavily grazed in places (Photo 1).

The study area experiences low winter rainfall averaging just 112-mm per annum, with high variability. Most rainfall falls in June-July-August. During the pre-construction monitoring phase, some rain fell in spring but the area is still in the grip of a prolonged drought. Maximum day time temperatures average between 20-27°C with some days exceeding 40°C during our summer visit. Lowest temperatures in winter average ~8-10°C. Minimum night-time temperatures rarely dip below zero for the autumn months (Mucina and Rutherford 2006).

Bird habitat in the region consists of fairly uniform vegetation type of coastal shrubs and succulent plants. Succulent shrubs such as *Tertragonia, Cephalophyllum* and *Didelta* occur and non-succulents such as *Eriocephalus, Pteronia* and *Salvia* are also found. There are a few alien trees on site (Eucalyptus, and Rooikrans), found around the farmsteads and some farm dams and water points for sheep.

Photo 1: The dry and overgrazed Succulent Karoo/Nama Karoo vegetation in the proposed Komas wind farm site (VP2 at the wind mast) in autumn 2019. Karoo Larks were ubiquitous residents throughout the area (inset).

4.5 Avian Microhabitats

Few grasses are found, making the lark species diversity rather slim. One telephone line with wooden monopoles is found within the site, providing some perch sites for raptors but no nesting sites. The most notable feature of the site is wind mast at VP2 (Photo 2).

Photo 2: The dry and grazed Succulent Karoo/Nama Karoo vegetation in the proposed Komas wind farm site, winter 2019. Pale Chanting Goshawk (inset) were apparent and bred after the rains here.

4.6 Data sources used

The following data sources and reports were consulted in the compilation of this report:

- Data on the ecology (Hockey et al 2005), distribution (Harrison et al. 1997) and conservation status (Taylor et al. 2015) of South African birds was consulted. Up-to-date data were extracted from the Southern African Bird Atlas Projects (SABAP) which were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php) for the relevant "pentads" of 5' x 5' (from SABAP 2: Appendix 2). From these data, we compiled a list of the avifauna likely to occur within the impact zone of the proposed Komas WEF site. These data were augmented and constantly updated from our four visits over the period April 2019 to December 2019;
- The ranking of CPS is drawn from the updated BARESG tabulation of 2014. We consider only the top 100 collision-prone species as priority species. This reduces the spurious introduction of species that may be influenced by the wind farm but have a low conservation status. This was sourced from the Birdlife South Africa website at www.birdlife.org.za/conservation/terrestrial-bird-conservation/birds-and-renewable-energy Among these CPS are Red Data species that require special attention;

- Red Data species conservation status, and the Red Data classification in South Africa, was sourced from Taylor et al. (2015); and
- Important Bird and Biodiversity Area (IBBA) data were collated from Barnes (1998), Marnewick et al. (2015) and the updated layers provided by D Marnewick (Birdlife SA) and available at http://www.birdlife.org.za/conservation/important-bird-areas/documents-and-downloads

4.7 Limitations and Assumptions

Inaccuracies in the above sources of information may limit this study. The SABAP1 national data set is now over 20-years old (Harrison et al. 1997) and it is likely that bird distributions have altered under the effects of climate change in South Africa (Simmons et al. 2004). Therefore, we have used only the more recent SABAP2 data set. This has a higher spatial resolution and is up to date (2007 to 2020). There were 37 full-protocol cards in the pentads that cover the proposed Komas wind farm site and, together, they help to give a picture of the overall species richness that a single site visit would not achieve.

Any site visits to record birds, even over a 12-month period, may not provide a complete picture of all species likely to occur in an arid region. Rainfall is the chief limiting factor as it dictates if birds occur at all, the species diversity, and when, and if, they breed (Lloyd 1999, Dean 2004, Seymour et al. 2015). In keeping with the prolonged drought, rainfall was scarce throughout most visits to the site, and this may reduce the overall numbers and diversity of birds occurring. We used our experience from years of surveying bird communities in arid areas (Seymour et al. 2015) to extrapolate more normal diversity measures and, thus, impacts, at times of typical rainfall.

5. BRIEF REVIEW OF AVIAN-WIND FARM IMPACTS

5.1 Interactions between birds and wind farms

Globally, birds are known to be impacted directly and indirectly by wind farms, both onshore and offshore. But which birds are susceptible and why? And what mitigation measures have been tested to reduce the impacts?

The main avian impacts, according to a position paper on the subject by Birdlife SA (http://www.birdlife.org.za/conservation/terrestrial-bird-conservation/birds-and-renewable-energy) are:

(i) displacement of nationally important species from their habitats;
(ii) loss of habitats for such species; and
(iii) disturbance during construction, and operation, of the facility.

Several literature reviews have summarised all sources of information on ecological effects of WEFs (Kingsley & Whittam 2005, Drewitt & Langston 2006, Kuvlevsky et al. 2007, Stewart et al. 2007, Drewitt & Langston 2008, Loss et al. 2013).

Concern about the impacts of WEFs on birds arose in the 1980s when numerous raptor mortalities were detected in California (Altamont Pass, USA) and at Tarifa (Spain). Mortalities at these sites focused attention on the impact of wind energy facilities on birds, and subsequently much monitoring has been done at a wide variety of WEF sites. More recently, there has been additional concern about the degree to which birds avoid, or are excluded from, the areas occupied by WEFs– either because of the action of the turbine blades or because of the noise they generate – and hence, suffer a loss of habitat (Stewart et al. 2007, Devereaux et al. 2008. Pearce-Higgins et al. 2009).

- Most studies suggest low numbers of bird fatalities at WEFs numbering tens to hundreds of birds per year (Kingsley & Whittam 2005).
- Observed mortality caused by WEFs is also very low compared to other existing sources of anthropogenic avian mortality (Crockford 1992, Colson & associates 1995, Gill et al. 1996, and Erickson et al. 2001, Sovacool 2009, 2013).
- Population declines due to climate change and fossil fuels is estimated at 14.5 million birds annually, whereas wind energy facilities killed about 20 000 -234 000 birds annually in the USA (Sovacool 2013, Loss et al. 2013). See *Benefits of Wind Farms* (5.2) below.
- In South Africa about 27 wind farms are operational in 2019 (energy.org.za). If each wind farm kills ~2.4 birds per MW annually (Perold et al. 2020), the estimated number of avian fatalities will be ~5600 birds

5.1.1 Collisions with wind turbines

5.1.1.1 Collision rates

Avian mortality rates at WEFs are compared in terms of a common unit: mortalities/turbine/year, or mortalities MW-1year-1 (Smallwood & Thelander 2008). Where possible, measured collision rates should allow for:

- the proportion of actual casualties which are detected by observers (searcher efficiency);
- the rate at which carcasses are removed by scavengers (scavenger removal rate, important in an African landscape); and
- While collision rates may appear relatively low in many instances, cumulative effects over time, especially when applied to large, long-lived, slow-reproducing and/or threatened species (many of which are collision-prone) can be of conservation significance.

The National Wind Co-ordinating Committee (2004) estimated:

- that 2.3 birds are killed per turbine per year in the USA outside California – correcting for searcher efficiency and scavenger rates; and
- This index ranges from 0.63 birds per turbine per year in Oregon to as high as 10 birds per turbine per year in Tennessee (NWCC 2004), illustrating the wide variance in mortality rates between sites.

At Altamont Pass, California, Curry & Kerlinger (2000) found:

- only 13% of more than 5 000 turbines were responsible for all Golden Eagle *Aquila chrysaetos* and Red-tailed Hawk *Buteo jamaicensis* collisions;
- total casualty estimates for Altamont run to >1000 raptors, and nearly 3000 birds killed in turbine collisions annually (Smallwood & Thelander 2008). This large figure includes >60 Golden Eagles at a mean rate of 2-4 mortalities per MW per year;
- at the Tarifa and Navarre WEF sites on the Straits of Gibraltar, southern Spain, about 0.04-0.08 birds are killed per turbine per year (Janss 2000a, de Lucas et al. 2008);
- relatively high collision rates are recorded for threatened raptors such as the Griffon Vulture *Gyps fulvus*;
- at the same sites, collisions have also been found to be non-randomly distributed, with >50% of the vulture casualties at Tarifa being killed by only 15% of the turbine array (Acha 1997);

- collision rates from other European sites are equally variable, with certain locations sporadically problematic (Everaert 2003). Migration highways, and other areas where birds funnel through a bottleneck, are areas which should be avoided;
- in a recent review from the USA, Loss et al. (2013) estimated that an average of 234 000 birds are killed by wind turbines annually; and
- variation was apparent across the USA from 7.85 bird fatalities/turbine/year in California to 1.61 birds/turbine/year in the (central) Great Plains. The average from over 44 000 turbines was 5.25 birds per turbine per year.

In South Africa

- We, too, found that a fraction (27%) of the 60 turbines killed 75% of the raptors at a wind farm in the Eastern Cape (Simmons and Martins 2019).
- Fatality estimates after 1-2 years of monitoring at eight wind farms (Ralston et al. 2017) suggest 4.11 mortalities/turbine/year (corrected for searcher efficiency and scavenger removals). The identity of these wind farms is not known – data were provided anonymously – so exact comparisons with respect to the habitats impacted, is unknown.
- Broad-scale comparisons are possible because the eight wind farms cover the Fynbos and Karoo biomes and are, therefore, applicable to the comparisons given below. It should be noted that most are in higher rainfall sites and may, thus, give slightly inflated figures for mortality rates.
- Of concern, the majority of deaths were raptors (36% of 155 mortalities). This total includes Red Data raptor species including Martial Eagles *Polemaetus bellicosus*, Verreaux's Eagles *Aquila verreauxii*, Black Harriers *Circus maurus* (Smallie 2015, Simmons & Martins 2016, unpubl data), and a Secretarybird *Sagittarius serpentarius*.

5.2 Causes of collisions

Multiple factors influence the number of birds killed at WEFs. These can be classified into three broad groupings:

- avian variables (some birds, especially raptors are more prone to collision than others);
- location variables (wind farms placed on migration routes, in pristine vegetation or near roosts or nests will attract more fatalities than others); and
- facility-related variables (farms with more turbines, more lighting, or lattice towers may attract more fatalities).

Two studies have shown a direct relationship between the abundance of birds in an area and the number of collisions (Everaert 2003, Smallwood et al. 2009), and it is logical to assume that the more birds flying through an array of turbines, the higher the chances of a collision occurring. However, this is not found in all studies: De Lucas et al. (2008), found instead a closer relationship with individual species abundance (vultures) and fatalities, but no relationship for all birds. In South Africa, the authors found that raptor abundance and fatalities were significantly related at an Eastern Cape wind farm (Figure 4).

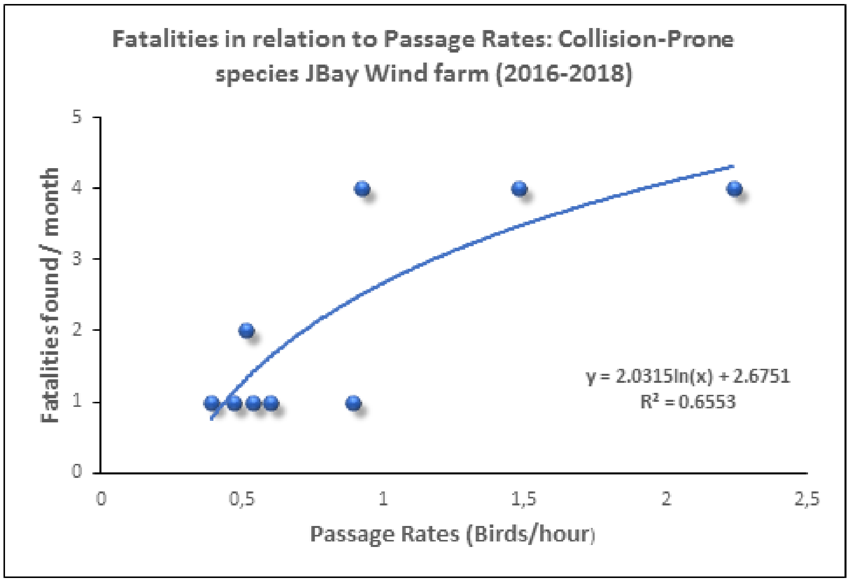


Figure 4: Raptor fatalities in relation to the Passage Rates (bird flights/h) of all raptors in 2-month sampling periods in an Eastern Cape wind farm over two years (Simmons, Martins, Smallie and MacEwan unpubl data).

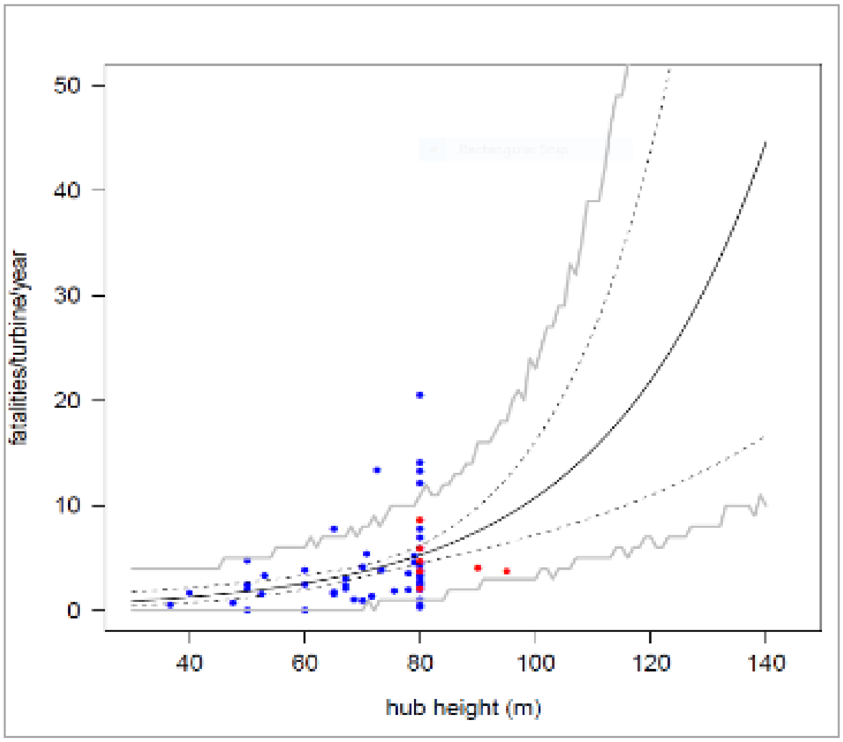
The identity of the species present in the area is also important, as some birds are more vulnerable to collision than others, featuring disproportionately frequently in collision surveys (Drewitt & Langston 2006, 2008, de Lucas et al. 2008).

Larger WEFs, with more than 100 turbines, are almost, by definition, more likely to incur increased bird casualties (Kingsley & Whittam 2005), and turbine size may be proportional to collision risk – with taller turbines associated with higher mortality rates in most instances (e.g. de Lucas et al. 2009, Loss et al. 2013, Thaxter et al. 2007).

With newer technology, fewer, larger turbines are needed to generate the same amount of power, which may result in fewer collisions per megawatt produced (Erickson et al. 1999, Thaxgter et al. 2007). Certain tower structures, and particularly the old-fashioned lattice designs, present many potential perches for birds, increasing the likelihood of collisions as birds land or leave these sites. This problem has, largely, been solved with more modern, tubular tower designs (Drewitt & Langston 2006, 2008).

However, Loss et al. (2013) undertook a meta-analysis of all wind farms and associated fatalities in the USA and found a strong correlation of increasing hub height or blade length with increased impacts to birds. Thus, taller turbines appear to be riskier for birds. We have added to that dataset with eight studies from South Africa and found that the relationship still holds (Figure 5).

Figure 5: Modelled data combining avian fatalities from the USA (Loss et al. 2013) and from South Africa (Ralston-Paton et al. 2017, = red dots) and their relationship with hub height. The South African data (n=8 farms) include two farms with hub heights of 90-m and 95-m. The combined data and 95% confidence limits predict that 16 birds (95% CI = 9, 28) will be killed on average per year for 120-m-high turbines and 28 (95% CI = 12, 65) birds on average for 140-m-high turbines. Given that the average number of birds killed for the typical 80-m turbines was 5.40 and it increased to 16 fatalities at 120-m, the increase in fatalities is forecast to be 2.9-fold if turbines are increased from 80 to 120-m. Note that this is a statistical forecast and is not based on empirical data. From Simmons, Cervantes-Peralta, Erni, Martins & Loss (2017).



Illumination of turbines, and other infrastructure, often increases collision risk (Winkelman 1995, Erickson et al. 2001), either because birds move long distances at night and navigate using the stars, therefore mistaking lights for stars (Kemper 1964), or because lights attract insects, which in turn attract foraging birds. Changing constant lighting to flashing lighting has been shown to reduce nocturnal collision rates (Richardson 2000, APLIC 1994, Jaroslow 1979, Weir 1976) and replacing white flood-lighting with red (or green) lighting can affect an 80% reduction in mortality rates (Weir 1976).

Spacing between turbines at a WEF can also affect the number of collisions. Some authors have suggested that paths need to be left between turbines so that birds can move through unscathed. Alternatively, those turbines known to kill more birds can be temporarily taken out of service (e.g. during migration or breeding). For optimal wind generation, relatively large spaces are required between turbines to avoid wake and turbulence effects.

5.3 Collision-Prone Birds (CPBs)

Collision prone birds (CPBs) generally include:

- large species, or those with high wing-loading (i.e. the ratio of body weight to wing surface area), and with low manoeuvrability (cranes, bustards, vultures, gamebirds, waterfowl, falcons);
- species that fly at high speed (gamebirds, pigeons and sandgrouse, swifts, falcons);
- species that are distracted in flight – predators, or species with aerial displays (many raptors, aerial insectivores, some open country passerines);
- species that habitually fly in low light conditions (flamingos, owls); and
- species with narrow field, or no, binocular vision (cranes and bustards) (Drewitt & Langston 2006, 2008, Jenkins et al. 2010, Martin & Shaw 2010).

To these we can add those species that more frequently fly at rotor swept height (e.g. buzzards and eagles) and are more likely to be impacted by turbines (Simmons & Martins unpubl data).

Recent studies by Martin & Shaw (2010) indicate that, particularly, collision-prone species such as bustards and cranes do not see ahead of them due to skull morphology and have a blind region that prevents them from seeing directly ahead. This is one reason why they hit overhead lines so regularly (Shaw et al. 2015).

These traits confer high levels of susceptibility, which may be compounded by high levels of exposure to man-made obstacles such as wind turbines or towers (Jenkins et al. 2010). Exposure is greatest in:

(i) highly aerial species;
(ii) species that make regular and/or long-distance movements (migrants or any species with widely-separated resources – food, water, roost and nest sites); and
(iii) species that fly in flocks (increasing the chances of incurring multiple fatalities in single collision incidents).

Soaring species may be particularly prone to colliding with turbines where this infrastructure is placed along ridges, as turbines exploit the same updrafts favoured by such birds – vultures, storks, cranes, and most raptors (Erickson et al. 2001, Kerlinger & Dowdell 2003, Drewitt & Langston 2006, 2008, Jenkins et al. 2010, Katzner et al. 2012).

5.4 Mitigating collision risk

One direct way to reduce the risk of birds colliding with turbine blades is to render the blades more conspicuous. Blade conspicuousness is compromised by a phenomenon known as 'motion smear' or retinal blur, in which rapidly moving objects become less visible the closer they are to the eye (McIsaac 2001, Hodos 2002). The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. This effect is magnified in low light conditions, so slow blade rotation may be difficult for birds to see.

Laboratory-based studies of visual acuity in raptors have determined that:

- visual acuity in kestrels is superior when objects are viewed at a distance, suggesting that the birds may view nearby objects with one visual field, and objects further away with another;
- moderate motion of the visual stimulus significantly influences acuity, and kestrels may be unable to resolve all portions of an object such as a rotating turbine blade because of motion smear, especially under low light conditions;
- research on Harris Hawks indicate that raptors see colour well, but in black and white contrast more poorly than humans (Potier et al. 2018) and this, too, may explain why raptors do not see a white blade against a bright background;
- this deficiency can be addressed by patterning the blade surface in a way that maximises the time between successive stimulations of the same retinal region; and
- the cheapest, and most visible, blade pattern for this purpose, effective across a variety of backgrounds, is a **single black blade** in amongst white blades (McIsaac 2001, Hodos 2002, Stokke et al. 2017, May et al. 2020).

Hence, marking blades may be an important means to reduce collision rates by making them as conspicuous as possible under poor visual conditions, particularly at facilities where raptors are known to be collision casualties. While Civil Aviation Authority (CAA) regulations stipulate white towers and turbine blades this could be avoided by using UV paint that is visible to birds but not to pilots. Norwegian CAA have already accepted black-painted blades.

Marking turbine blades in this way, has been tested recently in a clever experiment in Norway where turbines were killing large numbers of White-tailed Eagles *Haliaetus albicilla* and other ground-dwelling species. By painting one turbine blade black (Figure 6):

- Researchers at the Norwegian Institute of Nature Research reduced the incidence of overall bird fatalities by 71% relative to unpainted controls (Stokke et al. 2017).
- White-tailed Eagle fatalities fell by 100% to no eagles killed, relative to unpainted controls over two years.
- So successful has this experiment been that in a further six years no more eagle mortalities have been recorded, despite white blades still killing, on average, six eagles per year (B Iuell pers comm).
- The black blades kill significantly fewer eagles (P = 0.007) than the white blades (May et al. 2020).
- A review of the benefits can be found here (Simmons 2020) 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/

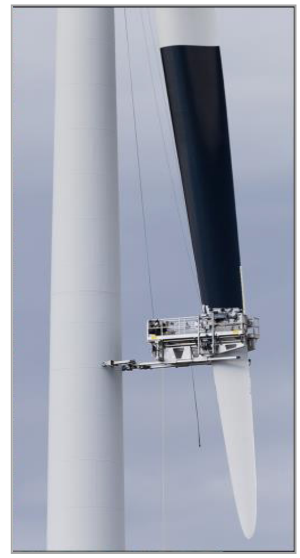


Figure 6: A single black-painted blade on turbines on the island of Smøla, Norway. This simple mitigation reduced eagle fatalities by 100%, relative to unpainted controls, and killed significantly fewer eagles (P = 0.007) than the white blades (averaging 6 eagles per year), 6 years into the experiment (R. May in litt.). Civil Aviation Authorities in Norway permitted this new mitigation technique, setting a precedent for other aviation authorities in the world (from Stokke et al. 2017).

All other collision mitigation options operate indirectly, by reducing the frequency with which collision prone species are exposed to collision risk. This is achieved mainly by:

(i) siting farms and individual turbines away from areas of high density or groupings, regular commuting, or slope-soaring, regions;
(ii) using low-risk turbine designs and configurations, discouraging birds from perching on turbine towers or blades, and allowing sufficient space for commuting birds to fly through the turbine strings; and
(iii) carefully monitoring collision incidence; and being prepared to shut-down problem turbines at particular times or under particular conditions (e.g. breeding, or increased migration activity).

5.5 HABITAT LOSS – DESTRUCTION, DISTURBANCE and DISPLACEMENT

While the final footprint of most wind farms is likely to be relatively small, the construction phase of development incurs quite extensive temporary or permanent destruction of habitat. This may be of lasting significance where WEF sites coincide with critical areas for restricted range, endemic and/or threatened species. Similarly, construction, and maintenance activities are likely to cause some disturbance to birds in the general surrounds, and especially of shy and/or ground-nesting species resident in the area.

Mitigation of such effects requires that Best-Practice principles be rigorously applied – that sites are selected to avoid the destruction of key habitats, and construction and final footprints, as well as sources of disturbance of key species, must be minimised.

Some studies have shown significant decreases in the numbers of birds in areas where WEFs occur, as a result of avoidance due to noise or movement of the turbines (e.g. Larsen & Guillemette 2007). Others have shown decreases attributed to a combination of collision casualties and avoidance, or exclusion from the impact zone of the facility (Stewart et al. 2007).

Such displacement effects are probably more relevant in situations where WEFs are built in natural habitat (Pearce-Higgins et al. 2009, Madders & Whitfield 2006) than in modified environments such as farmland (Devereaux et al. 2008).

5.5 Impacts of associated infrastructure

Infrastructure commonly associated with wind farms can often be more detrimental to birds than the turbines themselves. For example, while the wind industry in South Africa kills approximately 5 600 birds annually (below), overhead power lines kill an estimated 46 000 bustards per year (Shaw et al 2015). The construction and maintenance of substations, power line servitudes and roadways cause both temporary and permanent habitat destruction and disturbance. A separate BA is currently being undertaken in parallel for the development of the power line and electrical infrastructure associated with the proposed Komas WEF.

5.6 Benefits of wind farms

While this review focuses on the negative impacts of WEFs – and reducing those impacts to birds – it is important to give the positive side of such wind energy production. As a green, sustainable form of energy production, with no green-house gas emissions, wind farms have huge benefits over traditional fossil-fuel or nuclear energy production. At present, ~85% (or 42,000MW) of the nation's electricity is generated via coal, while renewable energy accounted for 4 000MW (~5%) by the end of December 2018. Nuclear (~5% of installed capacity), and hydro and pumped storage (~5% of capacity) account for the remainder. Wind farms provide sustainable energy, do not emit green-house gases, and can be built on otherwise productive land without altering the land-use practises. They are one of the most cost-effective sources of energy and provide energy at night when solar energy sources are dormant www.export.gov/article?id=South-Africa-Electricity-Power-Systems-Renewable-Energy

The impacts to the environment, whilst highlighted by environmentalists, are relatively negligible when compared with other forms of energy that we take for granted in our homes.

An attempt was made to determine the impact on birds of these various forms of energy production to contextualise the environmental impacts reported from wind farms (Sovacool 2009). His paper summarised the impacts as follows:

"For wind turbines, the risk appears to be greatest to birds striking towers or turbine blades and for bats suffering barotrauma. For fossil-fuelled power stations, the most significant fatalities come from climate change, which is altering weather patterns and destroying habitats that birds depend on. For nuclear power plants, the risk is almost equally spread across hazardous pollution at uranium mine sites and collisions with draft cooling structures. Yet, taken together, fossil-fuelled facilities are about 17 times more dangerous to birds on a per GWh basis than wind and nuclear power stations. In absolute terms, wind turbines may have killed about 20 000 birds [in the USA: Sovacool 2013] in 2006 but fossil-fuelled stations killed 14.5 million and nuclear power plants 327,000 birds." (Sovacool 2009, p2246).

Sovacools' (2013) revised conclusion of 20 000 birds killed at wind farms annually in the USA was revised again by Loss et al. (2013), to 234 000 birds killed annually by American wind farms by non-lattice tower turbines. This revised estimate is still 62-fold lower than the estimated 14.5 million fatalities caused by fossil-fuel powered energy.

In South Africa about 27 wind farms are operational in 2019 (energy.org.za) with an output of 2294MW per year. If each wind farm kills ~2.4 birds per MW annually (Ralston et al. 2017), the estimated number of avian fatalities will be ~5600 birds per year in South Africa. As the 19th highest greenhouse emitter on the world stage (Olivier et al. 2014) it is likely that South Africa's birds are heavily impacted by climate change and the habitat loss and range-contractions that are predicted (Simmons et al. 2004) could result in further substantial biodiversity losses. So, turning to renewable energies under the REIPPP programme will be beneficial.

Thus, whilst this report details the negative impacts to birds at wind farm sites, the goal of turning away from fossil-fuel dependence through wind (and solar) energy is a hugely positive move for South Africa and should be encouraged. In addition, the proposed Komas WEF is located within the Springbok REDZ 8, and is therefore aligned with national planning initiatives for the placement of renewable energy facilities in South Africa.

6. RESULTS OF THE PRE-CONSTRUCTION AVIFAUNA MONITORING

6.1 Species Diversity

Over the course of 12-months we recorded 58 avian species in the proposed Komas WEF site in our four equally spaced site visits. More species (49) were recorded in spring (September) than any other season. This is a typical total compared with other arid Karoo-like areas in the Northern and Western Cape that we have sampled. Most were typical residents of the arid Karoo landscape including Chats, Prinias, Warblers, Flycatchers, Karoo Larks, long-billed Larks and sunbirds.

Small aerial species which may be affected by a new wind farm included the occasional *hirundines* such as Rock Martin *Ptyonoprogne fuligula* and Namaqua Sandgrouse *Pteroclese namaqua* passing through the study site. Several collision-prone priority species were recorded and are discussed below.

6.2 Priority collision-prone species

Eight collision-prone species were recorded from VP surveys within the proposed Komas WEF site, three of which were Red Data species classified as *Vulnerable*: Verreaux's Eagle *Aquila verreauxii*; Ludwig's Bustard *Neotis ludwigii* and Southern Black Korhaan *Afrotis afra*. The remaining five species recorded are of *Least Concern* and are shown in Table 3.

Of these species, the *Vulnerable* Ludwig's Bustard (Taylor et al. 2015), ranked as the tenth-most collision-prone species in South Africa (Ralston-Paton et al. 2017), was recorded on every site visit except March 2019. This species was surprisingly the most frequently recorded of any species with a 70% likelihood of occurrence (Table 3). At least four individual birds were regularly seen in the area particularly following rains in October and December 2019 (Photo 3).

The next most commonly recorded species were chanting goshawks (60% likelihood of occurrence), Black-chested Snake Eagle (55%) and Booted Eagle (45%).

Photo 3: Pale (and dark) morph Booted were frequently seen in October and December soaring and wheeling over the veld. These are probably European migrants given their appearance in spring and summer.

Table 3: The eight priority collision-prone species, including Red Data species, recorded on the proposed Komas wind farm site from March to December 2019. Their likelihood of occurrence (Reporting Rate) and their susceptibility to collision (rank) are given along with their susceptibility to disturbance.

				Susceptibility to:	
Common name	**Scientific name**	**Red-list status**	**Reporting Rate***	**Collision (Rank**)**	**Disturbance**
Verreaux's Eagle	*Aquila verreauxii*	**Vulnerable**	**2/20 = 10%**	**2**	**High**
Ludwig's Bustard	*Neotis ludwigii*	**Vulnerable**	**14/20 = 70%**	**10**	**Medium**
Southern Black Korhaan	*Afrotis afra*	**Vulnerable**	**6/20 = 30%**	**89**	**Low**
Jackal Buzzard	*Buteo rufofuscus*	**-**	**3/20 = 15%**	**44**	**Low**
Booted Eagle	*Aquila pennatus*	**-**	**9/20 = 45%**	**55**	**Medium**
Black-chested Snake Eagle	*Circaetus cinerescens*	**-**	**11/20 = 55%**	**56**	**low**
Pale Chanting Goshawk	*Melierax canorus*	**-**	**12/20 = 60%**	**73**	**Low**
Greater Kestrel	*Falco rupicoloides*	**-**	**2/20 = 10%**	**97**	**low**

*Reporting rate is a measure of the likelihood of occurrence, based on the number of days recorded/number of days in the field through the year (combining March + July + October + December = 20 days)

** Collision rank derived from Ralston et al. (2017). Lower numbers denote higher collision-risk.

6.3 Passage rates of collision-prone species

One measure of the risk to priority birds occurring in the wind farm is the frequency with which they fly through it. These Passage Rates were sampled from five VPs throughout the year to cover the entire proposed Komas WEF site (Figure 7), and 118 flights of eight collision-prone species were recorded in 300 hours' observation. This gives a medium Passage Rate of 0.39 priority birds/hour (Table 4). Most of these flights were undertaken by Ludwig's Bustards (33) or Black-chested Snake Eagles (26), giving relatively high passage rates of 0.11 bustards/hour and 0.09 snake eagles/hour across the WEF. The Passage Rates of collision-prone birds in the Control area from March 2019 to December 2019 are shown in Table 5.

Verreaux's Eagles were much less frequent here (0.01 eagles/hour) than at the proposed Gromis WEF site in similar habitat in the south (subject of a separate BA process).

The most frequently used area was VP1, the north-western most area of the proposed Komas site, with a medium-high 0.53 flights per hour (of five species). The flights here were dominated by Red Data Ludwig's Bustards, Snake eagles and Chanting Goshawks.

VP3 in the centre of the proposed wind farm was the next most-used area with a medium passage rate of 0.38 flights (of four species). This was dominated by *Least Concern* Black-chested Snake Eagles.

VP4, just south of VP3, had the lowest passage rates of 0.3 birds/hour of six species.

In the single Control VP we recorded only 15 flights (of 5 priority species) in 54 hours, giving a lower Passage Rate of 0.28 priority birds/hour. The flights of the priority birds at the different VPs at the proposed Komas WEF site are shown in Figures 7-11. All flight tracks in the proposed Komas WEF site and in the Control areas are shown in Figure 12.

Table 4. A Summary of all Passage Rates of all collision-prone species recorded in the proposed Komas WEF area from March 2019 to December 2019. The three Red Data species recorded, are shown in red and the passage rate of all priority species was medium-high at 0.39 birds/hour. The Passage Rate of Red Data species alone was 0.15 birds/h.

Passage Rates: Summary by Species		VP1 + VP2 + VP3 + VP4 + VP5	
Species	TOTAL HOURS	Total birds	Passage Rate (birds/h)
Pale Chanting Goshawk	300	27	0.09
Southern Black Korhaan	300	8	0.03
Ludwig's Bustard	300	33	0.11
Booted Eagle	300	18	0.06
Black-chested Snake Eagle	300	26	0.09
Verreaux's Eagle	300	4	0.01
Greater Kestrel	300	2	0.01
TOTALS	300	118	0.39 birds/h
RED DATA SPECIES	300	45	0.15 birds/h

Table 5. Passage Rates of collision-prone birds in the Control area from March 2019 to December 2019. Fewer priority species (5) and fewer Red Data species (2) were recorded here as in the WEF, and the Passage Rates were lower here than in the WEF, at 0.28 birds/hour.

Passage Rates: Summary	Species: Control		
Species	TOTAL HOURS	Total birds	Passage Rate (Birds/h)
Pale Chanting Goshawk	54	5	0.09
Southern Black Korhaan	54	1	0.02
Ludwig's Bustard	54	3	0.06
Booted Eagle	54	3	0.06
Black-chest Snake Eagle	54	3	0.06
Verreaux's Eagle	54	0	0.00
Greater Kestrel	54	0	0.00
TOTALS	54	15	0.28
RED DATA SPECIES	54	4	0.07

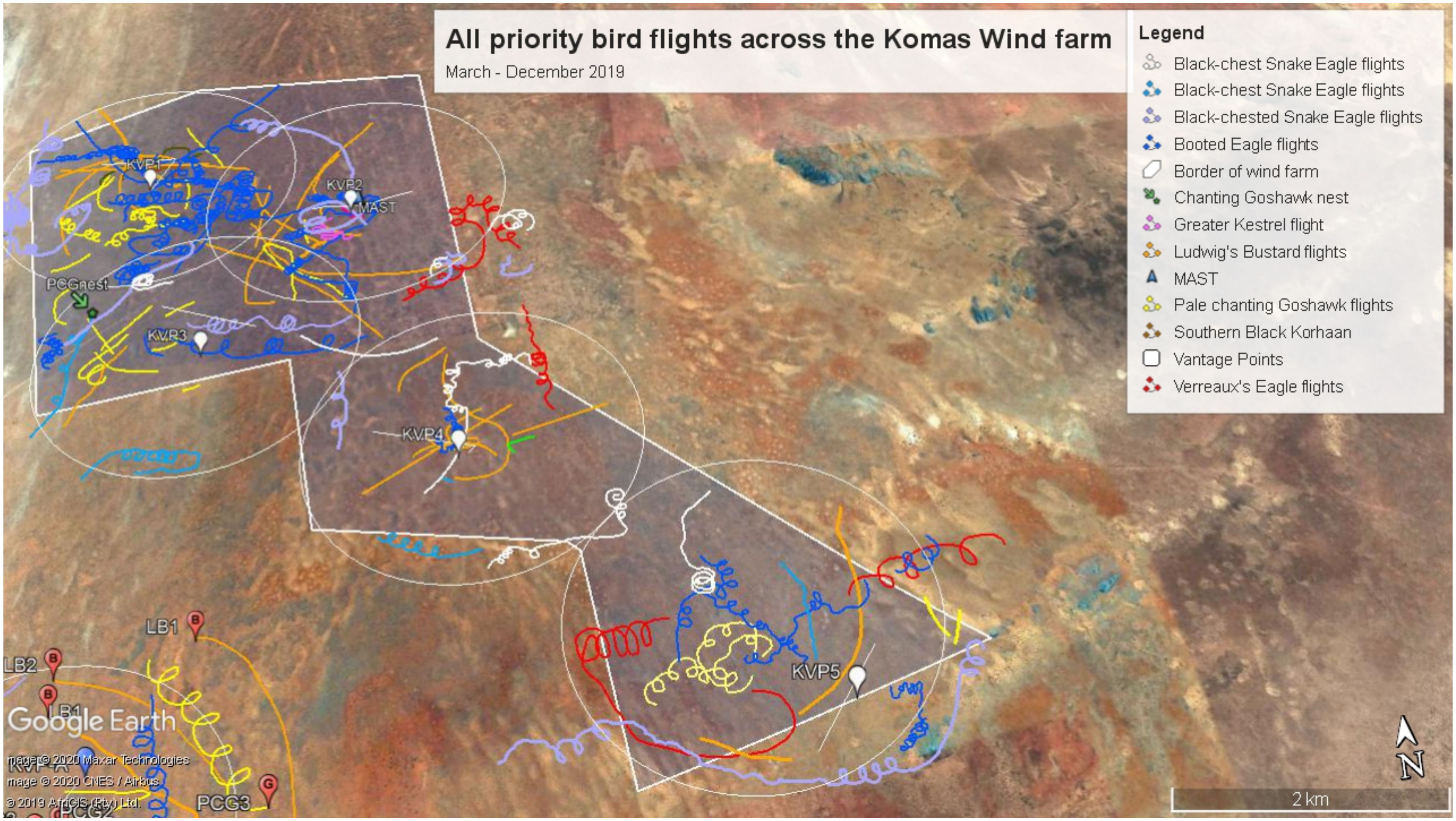


Figure 7: The proposed Komas WEF site (white polygon) showing our Vantage Points (KVP1-5 = white balloons). All Priority species flights are shown, and include Red Data Ludwig's Bustards (= orange lines), and *Least Concern* Pale chanting Goshawks (= yellow lines) as the most frequently recorded priority species, and snake eagles (= pale blue lines), Booted Eagle (= dark blue lines) and Red Data Verreaux's Eagles (= red lines) as the most frequently occurring additional priority species. The Control area (bottom left) is presented below.

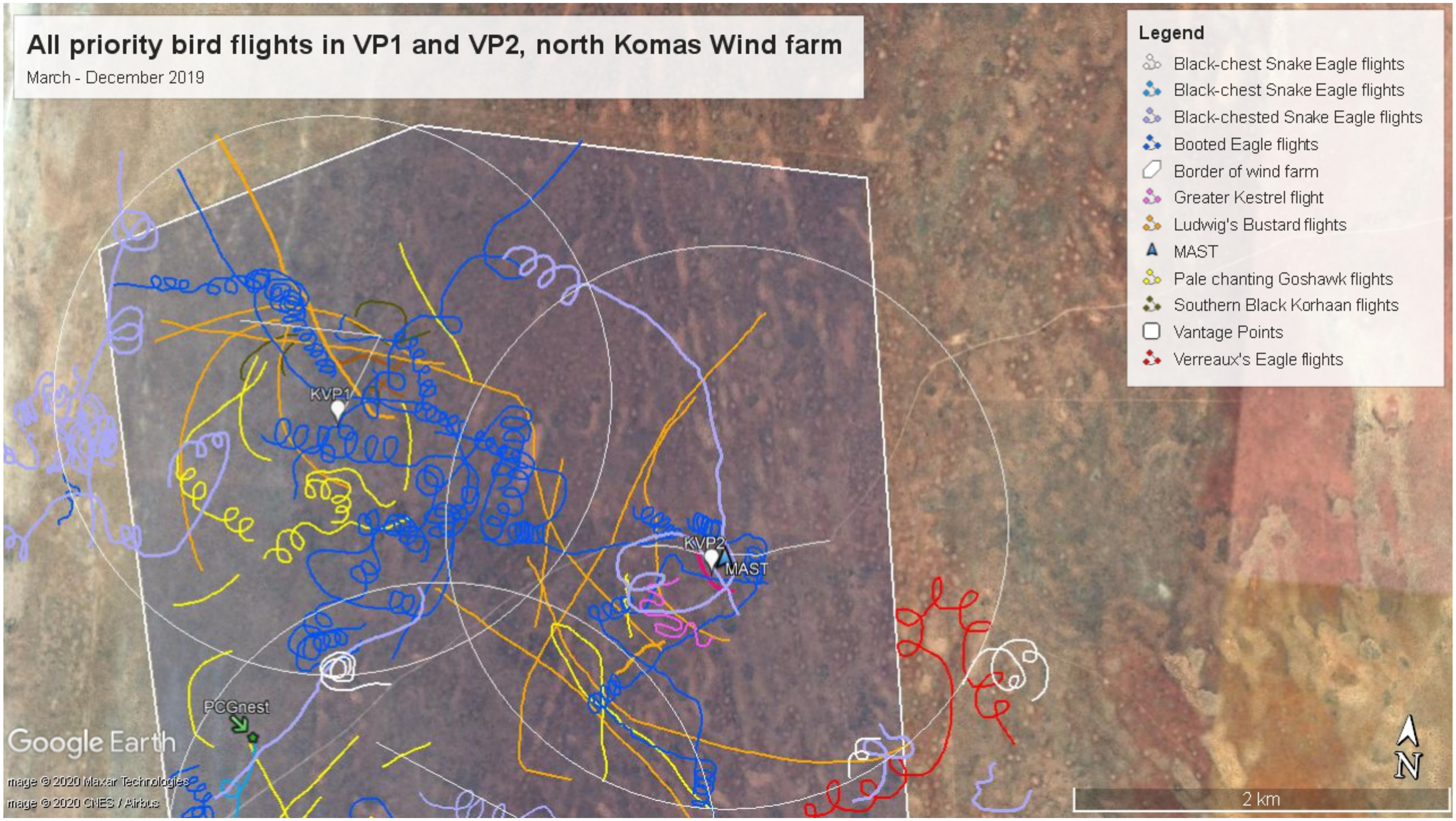


Figure 8: All priority bird flights in VP1 and VP2 (white balloons) in the northern section of the proposed Komas WEF site. Priority species flights were dominated here by *Vulnerable* Ludwig's Bustards (= orange lines) and *Least Concern* snake eagles (= pale blue lines), Booted Eagles (= dark blue lines) and Pale Chanting Goshawks (= yellow lines). Red Data Southern Black Korhaans (= dark green lines) were additional priority species. *Vulnerable* Verreaux's Eagles (= red lines) ventured once into this area from the east. The overall Passage Rate of these species in VP1 was high at 0.72 birds per hour and in VP2 was medium-high at 0.35 birds/hour.